A Study of the Effectiveness of Risk Assessment and Extension Supports for Irish Farmers to Improve Farm Safety and Health Management

2 Volumes – Vol. 1

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Declaration

I hereby declare that this thesis has not previously been submitted as an exercise for a degree at the National University of Ireland, or any other University. I further declare that the work within is my own.

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Glossary of Terms

AIW – Average Industrial Wage

AKIS – Agricultural Knowledge Information System

AWU - Annual Work Unit

BBS – Behaviour Based Safety

BSC - Balanced Score Card

CAP - Common Agricultural Policy

CDT - Cognitive Dissonance Theory

CI – Confidence Interval

COP -Code of Practice for preventing injury and occupational ill health in Agriculture.

CSO. - Central Statistics Office, Ireland

CVD – Cardiovascular Disease.

DAFM – Department of Agriculture, Food and the Marine, Ireland

EBHC – Evidence Based Health Communication

EI – Emotional Intelligence

ELM - Elaboration Likelihood Model

EPPM - Extended Parallel Process Model

ESU – Economic Size Unit

EU – European Union

EU (15) – European Union's 15 Member States (1995 - April 2004).

EU (27) – European Union's 27 Member States (since 1 January 2007)

EU-OSHA – European Union Occupational Safety and Health Agency

FADN - Farm Accounts Data Network (of the EU)

FETAC – Further Education and Training Awards Council (Ireland)

FO – Farm Operator

FOHS - Farmers Occupational Health Service (Finland).

FSP- Farm Safety Partnership (Ireland).

FTA – Fault Tree Analysis

FFI – Family Farm Income

FHI – Farm Household Income

FWMS – Farm Waste Management Scheme

FIS – Farm Investment Scheme

G P – General Practitioner

Ha – Hectare

HBM - Health Belief Model

H.I.C. – High Income Country

H.S.A. - Health and Safety Authority

H.S.E.- Health and Safety Executive (UK)

I – Intelligence

ICT – Information and Communications Technology

IQ - Intelligence Quotient

K.A.P. – Knowledge, Attitude and Practice.

LAF – Levels of Analysis Framework

L.I.C. – Low Income Country

LOC – Locus of Control

LRA – Logistic Regression Analysis

M.A.R. – Man Animal Relationship

M.H. – Manual Handling

M.S.D. – Musculoskeletal Disorder.

NFS – National Farm Survey

NFQ – National Framework of Qualifications (Ireland)

N.I – Northern Ireland

OFE – Off Farm Employment

OPR – Organisation- Public Relationship

OR – Odds Ratio.

OSH –Occupational Safety and Health

PI – Prevention Initiative jointly conducted by Teagasc and H.S.A.

P.P.E – Personal Protective Equipment

PTO – Power Take Off

PHM – Public Health Model

PMT - Protection Motivation Theory

PHMF - Persuasive Health Message Framework

QNHS - Quarterly National Household Survey (conducted by CSO)

RAD - Risk Assessment Document.

RHT – Risk Homeostasis Theory

REPS – Rural Environment Protection Scheme

ROPS – Roll Over Protection Structure

RPA- Risk Perception Attitude

RQ - Research Question

SCT - Social Cognitive Theory

SES – Socio Economic Status

SEG – Socio Economic Group

SET – Self Efficacy Theory

SLC – Safety Locus of Control

SLT – Social Learning Theory

SM - Study Model

SMD – Standard Man Day

SME - Small and Medium Enterprise

SMR – Standard Mortality Ratiio.

SHWW – Safety Health and Welfare at Work

SRS – Site Ranking System

SSWP – Safe System of Work Plan

Teagasc - Irish Agriculture and Food Development Authority

TA – Temporal Awareness

TDI – Theory of Diffusion of Innovations

TF – Theoretical Framework

TMC – Transtheoretical Model of Change

TOT – Transfer of Technology

TRC - Theory of Risk Compensation

TPB – Theory of Planned Behaviour

TRA – Theory of Reasoned Action

UAA – Utilised agricultural area

UN – United Nations

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Thesis abstract

The agricultural sector workforce in Ireland and Internationally has a poor occupational safety and health (OSH) record. Given this situation, identifying approaches to improve OSH adoption on farms are urgently required, yet limited research has been conducted on this topic. In Ireland, legislation introduced in 2005 permitted the development of a Code of Practice (COP) in association with a Risk Assessment Document (RAD) for specific sectors to assist owners of small-scale enterprises and the self-employed to manage OSH. Two state agencies, the Health and Safety Authority and Teagasc – Agriculture and Food Development Authority, formed an alliance to undertake a Prevention Initiative to develop the COP and RAD for the agriculture sector and to assist farmers to use these documents to manage farm OSH and to assess the utility of the approach adopted. The Prevention Initiative firstly developed the RAD on a pilot basis and assessed its value in assisting farmers with OSH management in association with provision of short half-day training and follow-up extension. This was followed by circulation of COP documents, including the RAD, to farmers nationally and making available half-day training based on the RAD and associated OSH extension.

A mixed-method research approach was implemented to assess the RAD utility and effectiveness while triangulation of data from different sources was undertaken to maximise the knowledge gained. Questionnaires were used among farmer participants (n=1,206) and Teagasc staff (n=54), who facilitated the training, to gain opinions of the RAD and of the training provided. RAD's were assembled (n=475) and assessed for their completion levels and nature of controls specified for action by farmers. Farm audits were undertaken (n=94) to assess implementation of farm OSH controls in association with RAD use. A nationally representative survey of farmers (n=891) was used to establish levels of COP and RAD usage and farm accident levels.

Farmers reported having a positive attitude to farm OSH. They rated the RAD developed on a pilot basis as the most helpful to them in assisting with OSH management when compared with other legal documents developed in Ireland for this purpose. Farmers perceptions of the causes of serious accidents were found to be at variance with objective data and it was concluded that use of the RAD was an

effective means of accurate communications. The COP and RAD documents were used to a limited extent among the farming population and it was concluded that greater utility of these documents requires further support through training. Participation in training on RAD completion in the project pilot phase was motivated by farmers' desire to improve farm OSH and to gain assistance in completing the legally required documents. Among training approaches used, participants rated using accident victim testimonials and visual approaches to show OSH controls most useful while the provision of information on farmers' health and level of discussion during training as least useful. Most participants were willing to engage in further OSH farm-based extension including participation in further training and attending farm demonstrations. Following RAD completion, most farmers (78%) planned to make OSH changes for which farm resources were mainly available, but just over half (55%) implemented the changes they planned and these were identified as having a prior record of OSH adoption. Farmers identified a limited number of controls in the RAD for action and those who attended training specified a higher level , while controls specified were mainly physical in nature such as machinery and farm facilities improvement.

RAD facilitators were satisfied with the content and structure of farmer RAD training and the majority (80%) were also satisfied with the training they received to provide RAD farmer training while those dissatisfied mainly felt that the training provided was too short. Advisors who facilitated RAD training when compared to those not allocated this role, subsequently reported providing higher levels of OSH advice. Farmers' completion of the RAD with or without training (half-day) was not associated with reduced farm accident levels. Farm accident level was associated with farms where the farmer and spouse had off farm work, which were comparatively larger in scale. Being a Teagasc client or having received agricultural education was not associated with reduced farm accident levels.

Overall the study indicates that farmers' knowledge is not the limiting factor to OSH implementation as use of the RAD and training did not lead to OSH change among prior non-adopters. The study recommends further assessment of extension approaches which can motivate OSH adoption such as use of farmer discussion groups which have been shown to improve farm management and technology adoption.

Research Supervisors

Supervisors of this research programme included:

Professor James Phelan – Head of the Department of Agribusiness, Extension and Rural Development and then Dean of the School of Agriculture and Food Science, University College Dublin. [January 2006 - December, 2010]

Dr Jim Kinsella, Senior Lecturer at the School of Agriculture and Food Science, University College Dublin. [January 2011 – May 2014]

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Chapter One

Background and objectives of the study

Background and objectives

1.1. Background

In Ireland, farm accident deaths account for on average one third of all workplace deaths each year and in 2006 accounted for 38% of such occurrences (Health and Safety Authority (H.S.A), 2007a) even though the farm workforce makes-up just 6% of the total workforce (Central Statistics Office (CSO), 2006). Regarding non-fatal farm accidents, Finnegan and Phelan (2003) estimated that about 3,100 accidents then occured on Irish farms each year. O'Shea (1997) reported a trend in higher mortality from all causes among farmers and farm workers than for other occupational groups while Hope et al., (1999) reported limited uptake of health promotion practices among farmers in Ireland. Improving the occupational safety and health (OSH) record of farming in Ireland is an important priority for organisations which have a role related to this issue, such as the Irish Health and Safety Authority (HSA), Teagasc (Irish Agriculture and Food Development Authority), the state Department of Agriculture, Food and the Marine (DAFM) and farmer representative organisations. This challenge also applies at an international level as farming has long been ranked as an extremely hazardous occupation and has been ranked in the top three occupations with the highest incidence rates of injuries in the United States (DeRoo and Rautiainen, 2000). These authors reported that few studies have been conducted worldwide related to improving the OSH record of persons working in the agriculture sector. Thus at the time when the study commenced, a major knowledge-gap existed in relation to strategies to assist farmers to improve OSH while the enactment of the Safety, Health and Welfare at Work (SHWW) Act 2005 in Ireland has provided a significant opportunity to generate valuable new knowledge in this area.

In Ireland, the enactment of the SHWW Act 2005 provided a fresh impetus to improving the occupationally related safety, health and welfare record among farmers. This legislation permits the vast majority of farmers, where three or less persons are employed, to complete and implement a risk assessment document (RAD) prepared under a statutory code of practice (COP) as an alternative to preparing a written safety statement (SS) required by previous legislation, which first regulated OSH in agriculture, enacted in 1989.

Following the enactment of the 2005 SHWW Act, HSA and Teagasc, commenced a Prevention Initiative (PI) to prepare the statutory COP and RAD and then to appraise extension approaches on a pilot basis (including document circulation and provision of training and advice) to assist farmers to comply with the statutory requirements. The initial pilot phase of the PI was then followed by provision of the statutory documents to farmers nationally and the making available of a Teagasc extension service to assist farmers to complete the legally required documents and to implement their requirements. This research study examines the extension activities related to the PI conducted by Teagasc among Irish farmers over the six-year period 2006 -2011.

This chapter, firstly, describes briefly the structure of Irish agriculture to set the context for the study. Secondly, it outlines the background to occupational safety, health and welfare legislation as it relates to the farming sector and describes the PI on which the study focused (note the term OSH: refers to occupational safety and health and is internationally used; ‘welfare’ in legislation refers to such measures as provision of canteen, washing and sanitary facilities and stress related issues). The chapter then concludes by presenting the aim and objectives for the study.

In recognition of the time-frame associated with the field work and data collection for this study (2006-2011), the literature reviewed to set the context to the research is framed in the time period up to the mid-2000s, while the study findings and associated discussions are undertaken with reference to the contemporary literature of the post 2006 period. Further, interim findings of the research phase of the study were issued on a regular basis by way of conference papers presented at national and international meetings on agricultural OSH which are referenced in the study bibliography.

1.2. The Structure of the Irish agriculture sector

A brief review of the structure and policy background of the Irish agricultural sector is undertaken to set the scene for this study. A farm business combines the factors of production: land; labour; capital and enterprise to achieve a return from the business (Sheehy and O'Connor, 1985) and the review is conducted broadly using this structure. A more comprehensive description of the sector and policy background is provided in Appendix 1.1.

The farmland of Ireland of 4.37 million hectares (Ha) is predominantly used for grassland-based livestock farming (92%) with the remaining 8% devoted to tillage crops (CSO, 2003). There were 132,700 farms in Ireland in 2006 (CSO, 2007) and average farm size was 31.8 ha in 2005. Data from the National farm survey (NFS) operated by Teagasc for year 2006 indicated that the percentage of farms in the principal farm enterprise categories used by the survey were as follows: specialist dairying (15%), dairying and other (8%); cattle rearing (24%); cattle non rearing (28%), mainly sheep (18%) and tillage (7%) (Connolly, 2007).

Connolly (2007) provided data on the labour input on Irish farms which showed that in 2005, 247,700 persons (either full-time or part-time) supplied 148,600 Annual Work Units (AWU's) to farms. The farm holder (referred to as farm operator (F.O.) in the NFS) was the principal provider of labour input to Irish farms, supplying 66% of AWU's. Additionally a considerable number of farm operators and their spouses engaged in off-farm employment (OFE) and for year 2006 for 59% of farms, either the farm holder and/or their spouse had such employment, Connolly (2007). Farmers were predominantly male and CSO (2007) reported that 90.6% of persons at work in the 'farming, fishing and forestry' category (92% in this categorization were farmers) were male (CSO, 2007). Regarding age, for year 2005, CSO (2007) reported that 35.6% of farmers were aged under 54 years. Various studies related to grassland-based livestock enterprises (Connolly, 2000; Leahy, et al., 2007; O'Brien et al., 2006) indicate that physical work activity accounted for about 90% of farm work time used. For tillage farms a different work pattern was reported, whereby both labour and machinery were used for short periods during the year (Forristal, 2005).

Regarding family farm incomes (FFI) which is net income from farming including CAP transfers, Connolly (2007) reported that this averaged €16,680 for year 2006 but that it varied widely from year-to-year. Connolly (2007) noted that on-average FFI had remained static for the previous 12 years at that time when compared to other sectors. Phelan (2004), however, found that real farm household income (FHI) had increased by 72% over the previous 7-year period which includes income from OFE and other transfers. A striking finding of NFS data generally, and a study by O'Neill et al., (2000) related to farm profitability, has been the wide range of performance among farmers with broadly similar resources, suggesting a wide range in managerial ability among Irish farmers.

Regarding farm investment on Irish farms, Connolly (2007) reported that this was approximately €450 million per year for the early years of the 2000s but this rose substantially for years 2006 and 2007 to over one billion euro per year due to investments supported by state grant schemes associated with pollution control.

Regarding education levels of farmers, data from the Irish census conducted in year 2006 (CSO, 2007) indicated that 37.1% had completed 'upper second level or third level' education for the 'farming, forestry and fishing' sectors compared to 62.9% in the total population. Regarding participation in formal agricultural education among farmers, by year 2003, 30% of farm operators had completed some form of agricultural training (CSO,2007) and notable differences occurred in agricultural education levels related to farm size (UAA), economic size (ESU) and farm enterprise. These differences indicated higher participation in agricultural education among farmers from holdings which were larger in both farm and economic size and among the enterprises of specialist dairying and tillage. The CSO data generally indicated that farmers from the more commercially viable farms availed of agricultural education.

The Irish agriculture industry is highly influenced by the EU common agricultural policy (CAP) and in 2007, recent adjustments to CAP under EU agreements 'agenda 2000' and the 'mid-term review' (also called the Luxembourg agreement) in 2003 (Connolly, 2004; Shalloo, 2004) were in place which led to full decoupling of supports from production and partially compensating farmers for the reduced support. Support was provided on an individual farm basis, called the Single Farm Payment, based on the average of payments for all schemes for the farm for the reference period 2000 to 2002 and has been paid regardless of current production levels. As part of this reform, farmers have been required to comply with a code of good agricultural practice, and an inspectorial process along with a penalty system for non-compliance was put in place. While this development is not directly associated with this study, it is indirectly so because it included measures associated with OSH including farmyard tidiness and safe storage of pesticides and it made farmers subject to an inspectorial process related to good farm practice.

This brief review of the structure and policy background of the farming sector in Ireland, in particular, indicates that considerable diversity exists among both farmers and farms in Ireland, which needs to be taken into account in this study. As the study planned to assess the utility of various OSH documents and their use in association with training and follow-up extension, research methods at that time were devised which allowed assessment of the study variables selected such as opinion of elements of the various OSH documents and associated training and follow-up extension. Due to the wide range of farmers with varying socio-economic characteristics and farms of varying characteristics such as farm size and system which could influence the study variables it was necessary to gain access to a wide range of farms to reflect the variation present in Irish agriculture.

To gain suitable study data it was decided, prospectively, to conduct a survey of 300 farms where wide variation in farm physical and farmer socio-economic characteristics was known to occur. To achieve this objective, it was decided to conduct the survey in counties Meath and Tipperary (north riding,.only) which had a wide range of diversity in terms of farm size and system as indicated in census of agriculture data (CSO, 2002). It was also planned prospectively to conduct audit visits to 60 farms related to document scoring and implementation of OSH controls among farms to be selected from the 300 initially surveyed. This sample of 60 farms was selected based on document scoring and among farmers with varying socio-economic characteristics and from farms of varying characteristics as indicated by the documents supplied by farmers. Thus a non-probabilistic approach to gaining a suitable sample of farms to survey and then audit was planned, based on the requirement to initially gain data on a wide range of farms and farmers and within the resources available to the study. Further, the possibility of conducting probabilistic national surveys by the NFS related to: farmer opinions of the COP document; completion of the RAD document; and occurrence of farm accidents was also available to the study.

This introductory chapter provides a review of Irish SHWW legislation as it applies to farmers as this provides the basis for national approaches to improve on-farm OSH and because assessment of the potential of recent changes in this legislation to influence farmer OSH adoption is the purpose for this study.

1.3. Safety, health and welfare at work legislation in Ireland

1.3.1. Introduction

The SHWW Act 2005 in Ireland provided the basis for the introduction of the COP on which this study is based (Its exact title is: Code of Practice for Preventing Injury and Occupational Ill Health in Agriculture). As this study is particularly focused on the utility of the RAD prepared as part of the COP to assist in managing OSH in farm work, developments in SHWW legislation since farmers became subject to such legislation are now reviewed.

1.3.2. Safety, health and welfare at work legislation

The SHWW Act 1989, brought farmers under statutory OSH at work legislation for the first time. This legislation set out a new approach to arranging the implementation of safety, health and welfare measures in all workplaces in Ireland.

The 1989 Act was strongly influenced by the work of the Commission of Inquiry on Safety, Health and Welfare at Work which reported in 1983 (commonly referred to as the 'Barrington Commission' (Barrington,1983)). One of the major recommendations of this commission was that: 'safety is a management responsibility and it should be managed in the same way as productive efficiency. The responsibility for safety should rest squarely on the shoulders of those who have the power to make decisions and see that they are implemented' (Barrington,1983, p.60). The commission recommended that the management approach it advocated should also apply to the self-employed, including farmers. This was accepted by the legislature and measures to bring this into effect were incorporated into the SHWW Act 1989.

The principal elements of this new approach set out in the 1989 Act were as follows:

- A new statutory authority, the HSA, was established under the aegis of the government Department of Jobs, Enterprise and Innovation (its current title), and is charged with overseeing implementation of OSH at work legislation in all work sectors. The HSA board is tripartite in composition, having board members representative of employers and employees and persons appointed by the Minister of the government department which oversees OSH legislation. The functions of the HSA include: making arrangements for the enforcement of the statutory provisions by its inspectorate; promoting prevention activities; provision of information and advice, and promoting and publishing the findings of research related to hazards and risks in workplaces.
- The legislation placed legal duties on all persons involved in work as follows: employers, employees, self-employed, designers, manufacturers and suppliers of goods and services to implement measures to protect safety, health and welfare of persons 'so far as reasonably practicable' which are under the control of the party involved.
- A person in charge of any workplace, including farmers, have the statutory duty to prepare and implement a SS which identifies hazards and assesses the associated risk, specifies both physical and organisational control measures, allocates OSH responsibilities to named staff and also seeks to gain the required co-operation from hired staff to implement the requirements of the SS and requires the person in control to bring its requirements to the attention of both employed and affected persons.
- The Act was a framework piece of legislation, and facilitated the passing into law of regulations which specify mandatory requirements and Codes' of Practice which provide authoritative guidance whose terms are admissible in evidence at law in relation to compliance with SHWW legislation.

The 1989 act, and subsequently the 2005 act, has provided a legal framework in Ireland for implementation of European Union legislation related to OSH for employed persons. The EU framework directive (CEC, 1989) lays down the following general approach to be followed in respect of safety and health at work: ‘the development of prevention measures, evaluating risks and combating them at source, adapting the workplace to avoid risks and engagement in information and training activities’. Preparation of a written OSH plan is specified by this directive. A number of other subsidiary individual directives, associated with the EU framework directive, related to specific safety, health and welfare issues have been transposed into Irish law since 1989.

One of the roles of the HSA inspectorate is to check if a satisfactory approach is being implemented regarding OSH management and practice at individual workplaces and if warranted to take guidance or enforcement action. However, the operational capacity of the HSA in 2006 to conduct inspections (up to 1,500 per annum in Agriculture) limited its capacity to implement this approach (HSA, 2006).

The 1989 Act, and subsequently the 2005 SHWW Act, empowers the HSA. to appoint sector specific committees to advise it on implementing the legislation in a balanced manner in a particular sector and to prioritise the problems of that sector. Since 1989, various committees have been appointed for the agriculture sector. The current committee is described as the Farm Safety Partnership advisory committee (FSP), which was established in 2003, and this research study was conducted in consultation with this committee. A report on the current programme activities of the national Farm Safety Plan to be implemented during years 2013-2015 by the HSA and the FSP is available at HSA (2013). A further description of the activities of previous advisory committees to the HSA is provided in Appendix 1.2. Since the enactment of the 1989 SHWW Act many initiatives have been implemented by state and farming organisations related to farm OSH. These have aimed at improving both farmers’ attitudes and behaviours and the physical farm infrastructure related to OSH. A description of the principal initiatives implemented is provided in Appendix 1.3.

The partnership approach sought by the HSA is in accord with the World Health Organisation (1978) approach for health promotion advocated strongly in the Ottawa Charter. It is clear from the review of previous advisory committees to the HSA and the current programme that as the various organisations associated with OSH conduct programmes within their remit and liaison takes place between organisations, trust and collaboration can develop and be maintained among organisations so that partnership approaches can take place. Child and Faulkner (1998) identified trust as one of the most important attributes to allow partnerships to work effectively.

1.3.3. Legal duty to prepare a safety statement

Preparation and implementation of a SS has been a legal duty of employers and self-employed persons, including farmers under both the 1989 (section 12) and the 2005 (sections19 and 20) SHWW Acts. This duty is regarded as a key element in practical OSH compliance since the 1989 SHWW Act was enacted as it focuses attention on practical implementation of OSH management regarding both the physical environment and work organisation on the farm (O'Sullivan, 1995). The chairman of the Barrington commission considered the ability of the manager of any business including a farmer to put in place a self-assessment control mechanism in relation to OSH performance to be a 'cornerstone' of the legislation proposed by the commission.

The principal elements of a SS required by both the 1989 and 2005 SHWW Acts as regards a farm are as follows:

- Details of the name and address of the farm to which the SS relates.
- A policy statement to be signed stating the commitment of the farm holder to manage OSH.
- Hazard identification, associated risk assessment and control specification in writing for the range of hazards encountered on a farm. Specification of both physical and organisational control measures to be implemented is required.

1.3.3.1. Implementation of the safety statement duty at farm level

Given the importance attached to the SS requirement of section 12 of the 1989 Act, the HSA advisory committee for the agriculture and forestry sectors in place at that time devised and recommended a format for a SS suitable for use by farmers, in line with the legislation (HSA, 1991). Subsequently this format was published by

Teagasc and made available to farmers at training/advisory events or on request. A template for the approach required by farmers to complete this document using hand-written inclusions were initially made available to Teagasc training staff and then published in the print media (Appendix 1.4.). However, the SS promotion approach adopted led to very limited adoption of the document by farmers with McNamara and Reidy (1997) reporting that just 2.5% of farmers nationally had completed the requirement. These authors stated that the limited uptake of the SS requirement 'reflects among other things the difficulties farmers perceive in assigning all the hazards in a systemic fashion and preparing the SS document without on-farm assistance from a 'safety expert''.

O'Sullivan (1995) also reported a limited uptake of the SS requirement of just over 16% among a highly select and commercial group of master farmers following participation in training related to preparation of the Safety Statement. This group supervised the training and work experience of farm apprentices in training to be farm managers on their farms. The most commonly cited reasons by master farmers for non-completion of the SS, 12 months after attending training, were: too busy (30.1%); too complicated (23%); worried about perceived legal implications (23%); other reasons (21.4%) which were mainly articulated as giving a low priority to the task such as 'I did not get around to it' and 'did not agree with it in principle' and other reasons (1.9%).

A further attempt was made to assist farmers to comply with the SS requirement in 2001 with the production by the HSA of 'guidelines on the preparation of a safety statement for a farm' (HSA, 2001). This document outlined step-by-step instructions and examples of how to compile a SS together with a matching template for completing a SS (available on HSA website). This document was publicised widely and made available to farmers at training/ advisory events and on request. Within Teagasc, a SS format similar to the HSA one was produced for use at training courses and advisory events which is available at Appendix 1.5. However SS completion rates remained very low; Finnegan (2003) reported completion of the SS requirement at just 9.6% of farmers nationally for year 2002.

Notably, the SS approaches that were promoted required a significant amount of writing on the part of the farmer to complete the document satisfactorily. Given the considerable non-adoption rate of the Safety Statement by farmers, McNamara and Reidy (1997) commenced a debate on the merit of moving away from the 'blank page' approach towards a more accessible form of document for farmers. These authors drew attention to the relative success in the United States reported for a more prescriptive approach to assist farmers to manage OSH assessed in the USA by Chapman et al., (1996). This approach was based principally on the use of check-sheets by farmers to conduct self-audits. While a change in the legislation would be required to change the requirements of a SS, a non-statutory 'farm safety Self-Assessment Document (SAD) for family farms and self-employed farmers' was devised by HSA Inspectors and circulated to farmers nationally in 2002. Notably, this document used a format which contrasted with SS formats in the following ways (Appendix 1.6.):

- OSH control measures were specifically and clearly stated and a farmer could check if the control was in place by stating 'yes', 'no' or 'n/a' if the control did not apply.
- A farm safety action list page was included where a farmer could list the action required where a control was identified as missing.
- A matrix format was used to allow a farmer to consider all the situations arising on the farm.
- No risk assessment quantification method was specified for the user; however the control measures selected reflected the known risk issues arising on farms based on injury reports available.
- Summary data on fatal accidents and safe work practices were provided.

A follow-up national survey of farmers participating in the NFS (McNamara et al., 2006), indicated that 28.5% of farmers reported completing the SAD. The findings of this survey indicated progress with adoption of a 'risk assessment' approach by farmers based on two new approaches namely, (1) circulating the document nationally and (2) using an alternative style of document. No attempt, however, was made to investigate how adequately the document was completed or how effective it was in motivating farmers to manage safety adequately. Furthermore, Finnegan and Phelan (2003) reported that ‘75% of farmers considered farming dangerous but the same percentage considered their own farm safe’, which also raised the question of adoption of OSH measures at farm level as 75% considered their farms to be ‘safe’ and possibly without need to implement further measures.

1.3.3.2. Code of practice risk assessment approach

Enactment of the SHWW Act (2005) provided a legal basis for implementing a new risk assessment approach based on a statutory COP in enterprises with a low level of employment or self-employment. Section 20(8) of this 2005 SHWW Act permits small scale enterprises including farms with three or less employees to complete a Risk Assessment document developed under a statutory COP. The aim of the legislative change was to produce more functional and accessible documents to assist small scale businesses with ‘three or less employees’ of those self-employed to satisfactorily fulfill the requirement to prepare a Safety Statement by completing a Risk Assessment under the terms of an accompanying sector specific COP. The term ‘three or less employees’ is not defined in law but an ‘employee’ related to farming is considered to include: the farmer as their own employee, workers and family members working on the farm with a formal contract of employment while casual workers or contractors or their employees are not included. While the number of farms in Ireland with ‘three or less’ employees is unknown, it is likely that the vast majority meet this criteria as only 9% of AWUs used on farms are employed non-family workers (DAFM., 2005).

1.4. Development of the H.S.A. – Teagasc OSH prevention initiative

Enactment of the SHWW Act 2005 provided the impetus for the H.S.A and Teagasc to develop and implement a prevention initiative (PI) to assist farmers to complete and implement the statutorily required Risk Assessment Document (RAD) and COP. The PI was to be conducted in association with the FSP. The research which is the basis of this study was largely developed as the assessment component of the PI.

The overall aim of the initial phase of the PI was to develop a pilot RAD (Appendix 1.7) and test its use in conjunction with a half-day training strategy on a pilot basis and assess its utility to assist farmers manage farm OSH. Following the initial phase of the PI, a national programme to assist farmers to comply with the new legislative approach commenced. A Teagasc health and safety officer was appointed as project manager (researcher/author of this study) to develop and manage implementation of the prevention initiative within Teagasc. A Health and Safety Authority senior inspector had overall charge of the legislative aspects of the PI. These two officials and a second HSA inspector formed a 3-person steering committee to develop and implement the PI in consultation with the FSP. In the initial pilot phase of the PI, this committee met at approximately 2-monthly intervals to consider the development of the pilot RAD and COP and develop the training course to accompany the RAD. The steering committee operated in consultation with the FSP in relation to the RAD and COP documents under development, proposed training for farmers and the training of Teagasc staff in counties chosen to pilot RAD training, and final production of the RAD and COP documents.

The PI steering committee decided to base development of the pilot RAD on the previously prepared and circulated farm safety SAD. This followed the relative success of the SAD described in the previous section. The central components of the pilot RAD were hazard identification sheets for all the major work hazards encountered in farming. Each hazard sheet was accompanied by an information sheet giving short textual information associated with the hazard. In addition to textual information, information was presented in pie-chart form and was accompanied by pictures related to the hazard sheet. The approach adopted was considered as an alternative approach to 'assessing risk' to that adopted in previous safety statement formats by using the causes associated with serious injury and ill health as the basis of questions raised in the pilot RAD and as such act as a 'de facto' risk assessment.

The PI steering committee also decided to supply the pilot RAD's to farmers in association with provision of a half-day training course on duties and requirements of farmers on completion and implementation of the documents. This inclusion of training in the prevention initiative followed the then recent publication of findings of a novel study in Denmark which indicated that farmers were responsive to OSH advisory and training interventions. The West Jutland study on farm accidents (Rasmussen et al., 2005) reported a 48% non-statistically significant reduction in injuries requiring hospitalisation among an intervention group who attended a short training course (circa 5 hours) and who jointly conducted a farm audit with an agricultural adviser trained in OSH when compared to a control group who recorded injury levels without participating in the intervention. An associated study demonstrated improvements in safety behaviour among the intervention group (Glasscock et al., 2005). The inclusion of a 'half-day' course of approximately 4 hours duration in the pilot RAD of the PI was decided upon because it was seen pragmatically as the minimum amount of time required to explain the requirements to complete the document and as the longest period for which farmers were likely to attend in one session. Also, following the earlier circulation of the SAD to farmers, provision of half-day courses on its completion had been successfully conducted by Teagasc in one county (Wexford).

The COP (available on H.S.A website) which has the legal purpose of supplying farmers with relevant OSH knowledge was drafted by the Teagasc PI project officer along with the project team in 2006 by collating, updating and extending previously prepared OSH documents, particularly a farm safety handbook (2001) and H.S.A. leaflets and Teagasc technical notes/ leaflets. The COP was prepared during 2006.

It was decided to develop and include a further document, a 'Safe System of Work Plan' (SSWP) (available on HSA website) among the COP documents. This development was motivated by HSA policy to develop and promote the use of 'user-friendly' methods of hazard identification and control and the HSA had devised SSWP documents for the construction sector which had won an international award (H.S.A, 2006 b). A SSWP is a sheet which graphically depicts health and safety controls. It can be marked when a control is required and when in place, with the minimum of writing. The SSWP can be used to overcome both literacy and language barriers in communicating health and safety measures. The specific purpose of its inclusion in the suite of COP documents was to provide a means of efficiently updating the RAD when a hazardous task was to be undertaken or of updating a RAD at future dates.

A DVD entitled 'Farm safe – A guide to managing safety and health on your farm' (available on H.S.A. U tube channel) was produced by a sub-committee of the FSP in year 2005. This DVD contained 20 sections including 3 farm injury testimonials and a section on all the major hazardous areas on Farms. As the PI project officer was a member of the FSP sub-committee which produced this DVD a high degree of consistency was achieved between the content of the DVD and COP documents. It was decided to use a shortened version of this DVD as a component of the half-day training course to assist farmers to visualise health and safety issues.

Following the initial pilot assessment phase of the PI, the COP documents were updated taking account of the views expressed by farmers and the documents were subsequently approved by the board of the H.S.A. and became an approved COP when signed by the relevant Minister of State. It was then decided to send the COP to all farmers nationally by post. All COP documents developed can be sourced at the H.S.A. web site at the following location:
http://www.hsa.ie/eng/Your_Industry/Agriculture_Forestry/Overview/Legislation_Enforcement/

While the principal objective of the PI was to develop and then assess the RAD (available on H.S.A website) and the associated training described, a further opportunity was availed of to assess all of the COP documents. This arose because a more extensive accredited OSH course for farmers (FETAC), conducted over 2 days which used all the COP documents was conducted in two counties (counties. Laois and Kildare). This significantly widened the scope of COP document assessments.

The initial 3-year PI which commenced in 2005, has been renewed on a number of occasions and the current agreement is in place until 2015. A description of the various phases of the PI as they relate to this study is available in Appendix 1.8. A map of Ireland showing the locations of all counties where assessments associated with the PI were completed is provided in Appendix 1.9.

1.5. Specific aim and objectives of the study

The aim of this study is to assess means of facilitating farmers to manage OSH effectively, in compliance with the SHWW Act, 2005 (sections 19 & 20).

The specific objectives of the study are as follows:

(1) assess the utility of the range of documents (SS, RAD and SSWP) developed under Irish SHWW legislation to assist farmers to manage farm OSH.
(2) assess the utility of components of training made available to farmers to assist with meeting compliance with Irish SHWW legislation.
(3) establish the level of implementation of control measures by farmers following completion of the RAD with or without participation in OSH training.
(4) determine the opinions of extension officers (advisers and education officers) on the utility of the RAD and half-day training provided to farmers and estimate the level and nature of OSH follow-up advice provided to farmers.
(5) estimate the national level of farm accidents in relation to use of the RAD with and without participation in training by farmers.
(6) develop knowledge on the value in promoting OSH among farmers in Ireland and to add to the knowledge available on this issue.

1.6. Study utility

It is envisaged that the findings of the study will provide new knowledge to guide effective national implementation of extension (farmer training and advice provision) strategies to improve OSH among farmers in Ireland.

The study will be of most benefit to farmers and their farm families by assessing and thereby contributing to further development of approaches to reduce the level of accidents and occupational ill health among those at work or who are exposed to risk in farming.

The study findings will be of value to legislators and policy makers in the area of OSH in agriculture in developing effective policy into the future, based on resources available. The study will be of assistance in implementing the SHWW Act 2005 in a practical manner. In particular, the study findings will be of particular relevance to HSA, Teagasc, and Farmer Organisations in programme development related to improving OSH in agriculture in Ireland.

The study will add to the knowledge available on OSH and act as a reference for future research into this topic in agriculture in Ireland.

Chapter Two

Theory of accident and ill health causation and prevention

2.1. Introduction

The purpose of this study, as outlined in Chapter 1, is to assess means of facilitating farmers to manage OSH effectively, in compliance with the SHWW Act 2005. This chapter firstly defines the principal terms of 'accident' and 'injury' as they are used in this study. A review is then undertaken of models available for both accident causation and accident prevention. This will be followed by defining 'risk' and an investigation of the factors influencing risks in agriculture.

The study broadly adopts the Public Health Model (PHM) as it is considered to offer a logical sequence to investigate accident and ill health prevention and it is the internationally accepted framework for studies in agricultural OSH (Murphy, 2003). The PHM consists of the following steps: (1) identify and prioritise problems through surveillance; (2) quantify and prioritise risk factors through analytic research; (3) identify existing or develop new strategies or technologies to prevent occupational injuries and ill health (4) transfer and implement the most effective injury and ill health measures to the target population and (5) assess and monitor the results of intervention programmes. The PHM has many similarities to Evidence-Based Health Communication (EBHC) described by Brown et al., (2006) which is defined as 'interventions based on good scientific principles including: objectives, theoretical basis, proven state-of-the-art-methods, analysis and evaluation'. The importance of using EBHC principles, especially the availability of assessment data to assess the effectiveness of interventions, is emphasised as essential for dissemination of applied research (Boland et al., 2005; Kerps 2000; Rogers, 1994; Sharf, 1999). In the public health arena, Sim and Mackie (2006) also highlighted the need for policies based on a 'robust evidence base from which to plan and implement effective action' and 'which emphasise the value of targeting those most in need'.

This chapter now commences the process of reviewing theory to devise the research questions and a conceptual approach for this study. This approach is regarded as the most effective approach to making scientific progress (Runyan, 2003). This chapter follows the first two steps of the PHM by reviewing literature which defines, identifies and prioritises the farm accident problem; and then quantifies and prioritises risk.

2.2. Defining accident, injury and ill health

In this study the SHWW Act 2005 (section 2) definition of an accident is used as follows: 'accident means an accident arising out of or in the course of employment which, in the case of a person carrying out work, results in personal injury'. Thus an accident is an event which leads to some form of bodily impairment.

There is, however, variation in the literature of the definition of the term 'accident'. For instance the Journal of Agromedicine regards the word 'accident' as unacceptable as it implies that accidents 'are chance occurrences which cannot be prevented' which they consider gives the wrong perception i.e. they consider that 'accidents' can be prevented. This journal instead uses the term 'injury'. Also, Wigglesworth (1972) defined an accident as: 'an unplanned event which interrupts normal activity and which may or may not cause an injury'. He stated that an accident involving injury arose due to delivery of energy in excess of a local or whole body threshold (e.g. impact or electric shock) or interference with energy exchange (e.g. suffocation). Bamber (1990) in addition to physical harm to persons also included damage to property or a 'near miss' in his definition of an accident. Strasser et al., (1981) included a time dimension in their perspective of an accident which they defined as: 'a complex sequence of events representing a break-down in the proper interrelationship of man and his environment'. Anderson (1999) saw an accident as a sudden and unexpected occurrence leading to harmful consequences. The literature thus suggests that the following two components are central to accident occurrence involving injury: (1) an unplanned occurrence which has an associated time dimension and (2) the exchange of energy above an acceptable level.

Ill health can similarly be viewed as a biological occurrence (which could have a physical cause) which impairs bodily function. HSA, (1998) referred to occupational ill health as an ‘accident in slow motion’ implying a similar outcome as an accident but involving an occurrence over a longer time period.

2.2.1. Models of accident and injury

According to Taylor et al., (2004), Heinrich’s book ‘Industrial Accident Prevention’ (Heinrich, 1931) revolutionised thinking in the field of industrial safety as he considered that it provided the first organised ‘framework of thinking’ and principles in the field of industrial safety, which replaced a mixture of uncertain practices. Taylor et al., (2004) stated that Henrich’s work, while still influential, has been superseded because much work has been conducted worldwide on accident causation and prevention.

Hollnagel (2001) considered that the accident causation models currently available can be divided into the following three main types: 1) linear stage or sequential models, 2) surveillance or Epidemiological models and 3) systems-oriented models. The principal accident causation models are now examined for their relevance to this study.

2.2.2 Linear stage models

Bamber (1990 p. 153) described the ‘Domino Theory’ attributed to Heinrich (1959 p.16-19) as a sequence of events in chronological order which lead-up to an accident. Heinrich (1959) postulated that five stages lead to an accident as follows: (1) ancestry or social environment, leading to (2) fault of person, constituting the proximate reason for (3) an unsafe act and/or hazard, which results in (4) the accident, which leads to (5) the injury. Each stage may have its own multi-causal prior sequence but Heinrich (1959) stated that an accident causing injury results from the completed sequence. These five stages were likened by Heinrich to ‘dominos standing on edge in a line’, so if one domino fell it automatically knocked down the next one and so on. Heinrich proposed that accident prevention should focus on removal of the third stage: ‘the unsafe act or hazard’.

Bird and Loftus (1976) cited by Bamber (1990) extended the Domino Theory to reflect the influence of management in a company setting as follows: (1) lack of management control permitting (2) basic causes (personal and job factors), that lead to (3) proximate causes (substandard practices, conditions, errors), that causes (4) the accident, which results in (5) the loss (injury). Bamber (1990) described a Multiple Causation Theory where a number of proximate ‘causes’ combine in time and place to lead to the accident. Each of the causes is equivalent to the third stage in the Heinrich theory (unsafe act or hazard) and in outlining the Multiple Causation Model, Bamber (1990) indicated that ‘causes’ can combine in complex and random ways to cause an accident.

Wagenaar and ver der Schrier (1997) proposed the Tripod Accident Causation Model which has similarities to the Domino Theory as it has the following linear sequence to accident causation: (1) fallible decisions; (2) ‘distal’ latent failures; (3) ‘proximal’ substandard act; (4) operational disturbance; (5) breached prevention barrier and (6) accident. These authors noted that distal latent failures could lead to a number of sub-standard acts and consequently a range of operational disturbances, barrier breaches and accidents.

Petersen (1978) compared and contrasted the various theories and concluded that the Domino Theory’s narrowness in relation to the Multiple Causation Theory severely limited its use in the identification and control of the underlying causes of accidents. Laflamme (1990) also considered accident causation to be multi-causal and proposed a model of occupational accident genesis in a company setting where human, technical as well as work environmental components are involved in accident genesis.

2.2.3. Epidemiological models

The Epidemiological Model of accident occurrence emerged from the public health field in the late 1940s (Gordon, 1949) where it was proposed that an accident is caused by the interaction of a host (accident victim), agent (injury deliverer) and environment when the three elements occur at the same time and place. Gordon believed that an accident occurs as a result of all three elements interacting rather than any one on its own. The environment can be split into both physical or environment incorporating such physical items as the workplace machinery and tools and the social environment including management, OSH management and working relationships generally (Suchmann, 1961; Haddon, 1980a, Andersson, 1999, Murphy, 1992). Further conceptualisation by Gibson (1964) resulted in the addition of a fourth element to the epidemiological model, namely various forms of energy including thermal, radiant, chemical, electrical or mechanical, which act as a carrier of the agent of injury.

2.2.4. Systems-oriented models

Systems models of accident causation seek to describe the characteristic performance at the level of the 'system' (a system is an organised body of things) as a whole, rather than on the level of specific cause-effect 'mechanisms' or epidemiological factors (Hollnagel, 2001). Häkkinen (1978) cited by Suutarinen (2004), considered that hazards must be examined as factors of the production system and not as isolated factors. Systems models suggest that an interaction or disturbance within the system leads to accident causation and they base accident analysis on an understanding of the functional characteristics of the system including searches for unusual dependencies and common conditions associated with accidents (Hollnagel, 2001). Reason (1997), stated that poor management is often concealed in 'so called' latent general failures.

2.2.5. Model of farm accidents

In Denmark arising from the 'West Jutland Study' (Figure 2.1.), Glasscock et al., (1997) constructed a model of farm accidents. This proposed that the risk situations arise as a function of both person and environmental factors. Person factors include knowledge, attitudes and perceptions while environmental factors include farm size and system, the safety standard of farm machines and whether or not children live on the farm. The model assumes that farmers have a major influence on their own working environment and therefore two types of behaviour are proposed. Behaviour A supposes that farmers can improve safety standards on their farm via safety checks, maintenance and planning. Behaviour B supposes that when a risk situation arises a farmer can behave in a safe manner. They can, for instance, use personal protective equipment or not engage in risk-taking behaviour. The model indicates that farmer stress can affect both types of behaviour by reducing the amount and quality of maintenance activity or by increasing risk taking behaviour. Glassock et al., (1997) also proposed that a person's previous accident record can influence attitudes or behaviour, for example, not previously having had an accident can lead to long term risk-taking behaviour

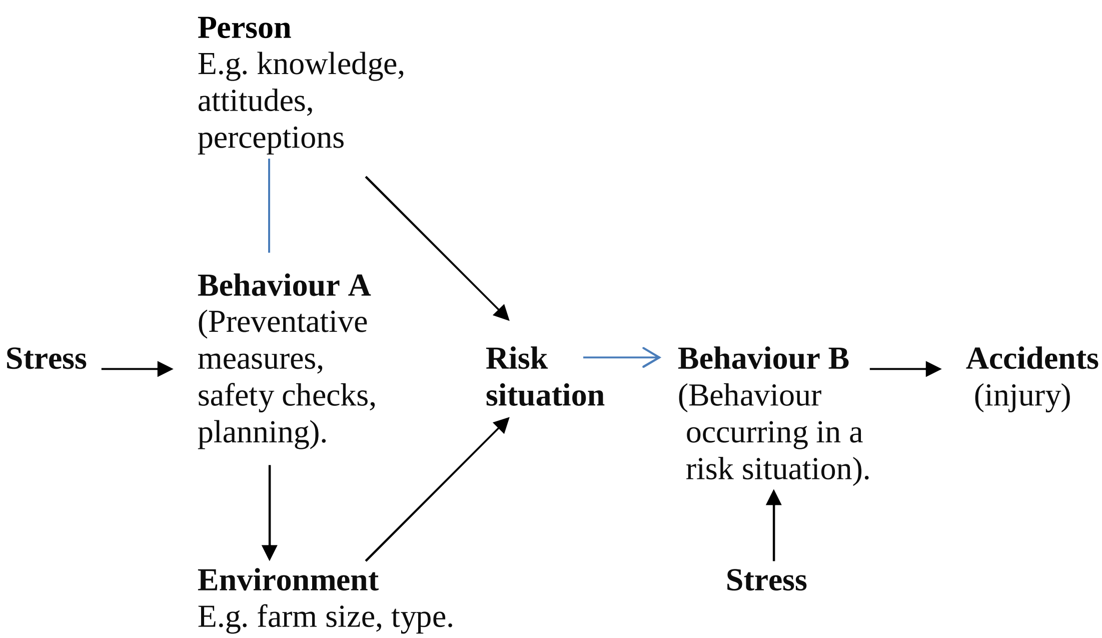

Figure 2.1: The West Jutland study model of farm accident occurrence Source: Glasscock et al., (1997)

In summary the examination of accident causation models indicates a move in the conceptualisation of accidents from more simple linear to multiple interacting causation models. Accidents are likely to vary in terms of seriousness while the risk of an accident occurrence is also variable and accordingly these two elements are now reviewed.

2.3. Accident severity and risk

Heinrich (1931) reported that just 10% of all 'accidents' result in personal injury and for every disabling injury, there were 29 'less serious' injuries and 300 accidents involving no injury. Since then, Bird and Germain (1966) after a study of 'accidents' in a large range of diverse companies in America, produced the 'Bird accident ratio triangle' which indicated that for every one serious or disabling accident there were 10 minor, 30 property damage and 600 accidents with no visible injury. Parks (1993) cited a British

Safety Council accident ratio triangle of 1 fatal or serious injury, 3 lost-time injuries, 50 first-aid injuries, 80 property damage and 400 near misses and a UK HSE (1991) ratio triangle of 1 ‘over 3-day injury’, 11 minor injuries and 441 non-injury accidents.

Parks (1993) pointed out that the causes of severe accidents are likely to be different to those of minor ones and by way of example, presented data to show that the chance of a fatal accident from a fall at over 2 meters height was 278 times greater than one at ground level. Taylor et al., (2004) made the same point and cited data from one Australian State which indicated that over a 10-year period that the frequency rate of all accidents declined by 33% but that severity rates increased. Thus accident prevention programs need to set priorities for the severity of the accidents to be targeted.

With regard to risk assessment, SHWW legislation requires all parties to secure safety, ‘so far as is reasonably practicable’ and does not require absolute safety. The Irish 2005 SHWW Act (s19) requires employers / self-employed to prepare a ‘risk assessment’ for hazards identified, however the legislation does not prescribe an approach to completing this duty. OSH text books define risk as the ‘likelihood that a hazard will result in an accident and the consequences of that accident’ (Taylor et al., 2004). Thus risk is the product of the estimation of likelihood and consequences of an accident occurrence and techniques used to assess risk in Ireland to-date have included a number of approaches which are now described. Risk was estimated as High, Medium or Low based on the consequences, with high risk likely to lead to a fatality or permanent disablement, medium a significant injury and low a slight one. (e.g. SS format produced by Teagasc, 1991: Appendix 1.4.) A description of the risk was used in the H.S.A. Guidelines for preparation of a Safety Statement for a Farm (on HSA web.) e.g. entanglement in Power Take Off (PTO) causing death. The following two key issues arise with risk assessment: firstly, it is circumstantial to the circumstances of the hazardous situation and secondly, it requires estimation of the likelihood and consequences related to the accident event.

2.4. Accident prevention models

In this sub-section a brief review is undertaken of the various accident prevention models as they have emerged before examining the preventative framework which underpins SHWW legislation in Ireland.

Hollnagel (2002) considered that the preventative goals of the accident causation models described previously were as follows: linear models - to eliminate or contain accident causes; epidemiological models - to make defences and barriers stronger; and systems models to monitor and control performance variability. Runyan (2003), from within the PHM school of thought, proposed that the social-ecologic framework as proposed by Bronfenbrenner (1979) enhances this model of accident prevention (Figure 2.2). This social-ecologic framework defines various levels of the social environment depicting the nested roles of intrapersonal factors, institutional elements and cultural elements which Runyan (2003) believed could be involved in accident reduction. Dunne (2000) considered that accidents are prevented by safety management of mans' interaction with technology; attitudes, beliefs and motivations of all employees and managers and the policies and practices of the organisation. Laflamme (1990) considered that multi-causal system approaches are required to be understood for accident prevention. Taylor et al., (2004) considered that accident prevention is based on a capacity to manage 'error factors' in a work system related to known levels of risk. When error factors in the system exceed the controls available, safety control is lost and an accident can occur.

Cooper and Germain (1974), proposed that a lack of ability, lack of knowledge and lack of proper attitudes were the reasons for mistakes and accidents, implying that accidents are caused by 'individuals' rather than 'organisations'. However, more recent thinking gets away from the concept of individual blame and instead focuses on correcting hazardous work situations, including human factors. For instance, Laflamme (1990) proposed putting aside a presumption of 'blame' associated with the perception of 'human error' and replacing it by workplace programmes drawing attention to the many different ways of correcting hazardous work situations. Hollnagel (2002) considered that while humans are no longer seen as the primary cause of accidents, they do play a role in how systems fail because they are an indispensable part of complex systems. Reason (1980 and 1987) defined human error as 'occasions in which a planned sequence of mental and physical activities fails to achieve its intended outcome' and considered error as a part of the human cognitive function. Reason (1987) supported the proposition of Broadbent et al., (1982) that externally imposed stress induces a high rate of cognitive errors.

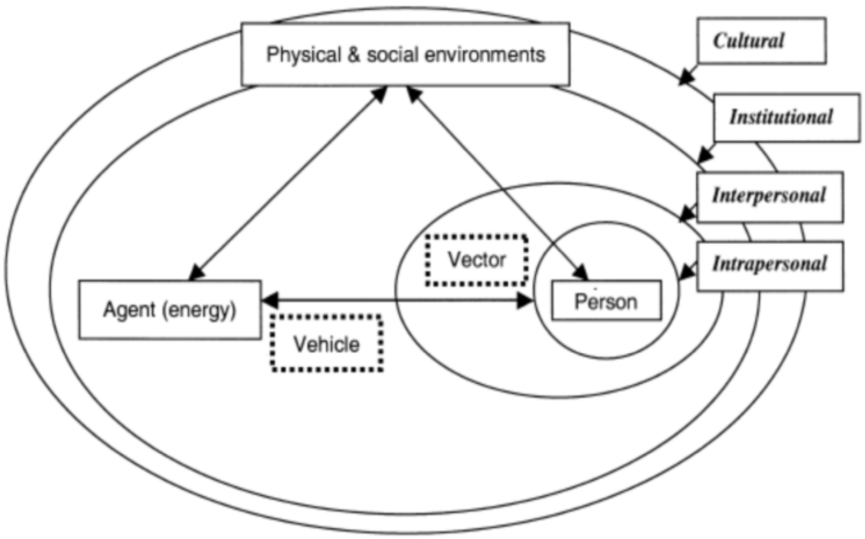

Figure 2.2: Integration of the PHM with the social-ecologic framework
Source: Runyan (2003)

In Australia, Wigglesworth (1972) developed an accident prevention model based on a combination of traditional engineering approaches with 'human factors engineering' to remove or reduce hazardous 'energy transfer'. Wigglesworth considered that the presence of a hazard is a necessary factor for an accident to occur, a further factor identified as the behavioural factor of 'non-culpable error' is necessary for an accident to occur. Wigglesworth (1972) believed that focusing on non-culpable error changes the emphasis from 'emotive discussion' to injury preventative behaviour and a meaningful search for the stimuli that produced the error. According to this model the keys to accident prevention are twofold, firstly where possible physical controls and secondly the reception of information and decision making of the operator who is interfacing with the technology to minimise error.

A major accident prevention model applied to process industries is what is commonly known as Reason's Swiss Cheese Model which describes the series of barriers between a hazard and an accident as akin to slices of Swiss Cheese (Reason, 1980 and 1987). According to Reason, having a higher number and more effective preventative barriers reduces the chance of an accident, however, most barriers are imperfect and, as he described in his model (Reason,1987)., barriers have 'holes' like 'swiss cheese'. An accident occurs when the hazard can access the target through 'holes' in barriers. In considering prevention all components of the Swiss Cheese Model must be considered including: how the magnitude of the hazard occurred; how barriers were missing, not adequate or failed and what allowed the incident to become worse after the hazard contacted the target. Reason (1987), however, contrasted complex process industries e.g. nuclear industry which are potentially highly dangerous but have many layers of protective barriers leading to very high safety records. In contrast, sectors such as hospital management (and farming) Reason (1987) considered, depend on the individual actions of people and accordingly tend to have high accident rates. Woods et al., (1994) proposed a 'sharp end-blunt end model' interaction model which strikes a similar cord to the Swiss Cheese model. The so-called sharp end is the actual work being done and is where the accidents 'actually happen' but the precursor for an accident could occur at the blunt end or background factors such as: management, company policies, government and regulatory policies and attitudinal and social norms.

The accident analytical technique, Fault Tree Analysis (FTA), utilises the principle of multi-causality, by tracing the chronological progression, either backwards or forwards, of factors leading to the accident situation (Bamber, 1990). Teagasc devised a training approach based on observing an accident on video and using FTA to map the accident causes with Belgian psychologists (Malaise and Grosjean, 1990), supported by EU funding. This method is ideally conducted in a group situation, where the group firstly lists all the 'causes' of the accident shown. Then, the various causes of accidents are traced back starting with the proximate ones and then the more distal causes using a line diagram for each cause. Thus a complete and rational diagram of the multiple causes of the accident and their relationships and interactions is built up. The method allows training participants to think rationally about the multiple causes of accidents as a precursor to considering prevention, which involves breaking as many links as possible between causes leading to the accident. An example of use of FTA to analyse an accident is provided in Appendix 2.1. Regarding farm accident investigation Kingman and Field (2005) considered that FTA has considerable potential to facilitate gaining a more complete understanding of problems and solutions with this issue.

William Haddon, Jnr, is credited with modernising thinking on accident prevention by developing two complementary conceptual frameworks, the Haddon Matrix (Haddon, 1972) and Energy Damage and the Ten Counter Measures (Haddon, 1973). The Haddon Matrix cross-tabulates the host, agent and environment with the time dimensions in accident prevention and accident consequence limitation broken down into pre-event, event and post event. Haddon (1980) identified energy as the 'vector' for injury and resulted in the addition of this component as a fourth category to the matrix. In addition, environment dimension can be split into both physical environment and social environment. The Haddon matrix provides a holistic view of the accident scenario and options for prevention are easily identified. Haddon's counter-measures list the following 10 counter-measures 'in their logical sequence' to reduce risks of injury as follows: 1) prevent the creation of the hazard; 2) reduce the amount of hazard brought into being; 3) prevent release of the hazard; 4) modify the rate of release of the hazard; 5) separate the hazard from that which is to be protected by time and space; 6) separate the hazard from that which is to be protected by a physical barrier; 7) modify relevant basic qualities of the hazard; 8) make what is to be protected more resistant to the hazard; 9) begin to counter damage done by the hazard;10) stabilise, repair and rehabilitate the object of damage.

Stave et al., (2006) developed a model which they considered provides the answer to the 'farm safety paradox' where knowledge alone does not necessarily lead to implementation of OSH measures by farmers. Their model suggests that for interventions to succeed they must simultaneously increase risk perception and reduce job stress, rather than just focusing solely on increasing risk perception. In practical terms this means that safety measures must be practically implementable, rather than adding to the overall burden on the farmer. To gain implementation these authors advocate giving attention to mediating components of interventions including creating socially supportive networks, employing participatory approaches to define safety solutions, encouraging discussions and reflection, and focusing on risk manageability..

2.4.1. Legal accident prevention models

The Irish SHWW Act 2005 (schedule 3) outlines the ‘General Principles of Prevention’ which require consideration to achieve legal OSH compliance. The principles are ordered as follows: 1) avoidance of risks; 2) evaluation of unavoidable risks; 3) combating risks at source; 4) adaptation of work to the individual; 5) adaptation of the place of work to technical progress; 6) replacement of dangerous articles, substances or systems of work with less dangerous ones; 7) giving priority to collective protective measures over individual ones; 8) development of adequate prevention policy which takes account of technology, organization of work, working conditions, social factors and the influence of factors related to the working environment and; 9) giving appropriate training and instructions to employees. The Irish legislation mirrors the approach required in the EU Framework Directive (91/383/EEC) in terms of precedence to be given in implementing controls.

Various OSH textbooks (e.g. Taylor et al., 2004; Ridley and Channing, 2008) have outlined the ‘hierarchy of controls’ approach which is similar to ‘principles of prevention’ and is depicted in Figure 2.3. Wigglesworth (1972) stated that the origin of the hierarchy can be traced to syllabi for industrial safety training courses of the UK Royal Society for the Prevention of Accidents. The primary approach advocated is to eliminate or reduce the hazard by substitution, segregation or engineering (physical) controls as these remove the hazard from the person(s) and accordingly are a collective measure. Use of work practices/ procedures and personal protective equipment are at the lower end of the hierarchy as these require individual implementation and accordingly they are less reliable and overall are less effective.

Hierarchy	Effectiveness	Approach
■ Eliminate ■ Substitution ■ Segregation ■ Engineering controls ■ Work Practices/ procedures ■ Training, supervision, instruction. ■ Personal Protective Equipment (PPE)	Most ↓ Least	■ Moving from Collective to Individual ■ Preference for controls further up Hierarchy. ■ Training leading to Understanding at all levels of Management. ■ Culture Change

Figure 2.3: Hierarchy of OSH control measures
Sources: Ridley and Channing (2008); Taylor et al., (2004); Wigglesworth (1972)

In summary, the examination of accident causation models indicates that they conceptualise accidents as occurring due to multiple interacting causal factors with transfer of energy being the vector which causes injury and where a time dimension leads to all factors occurring in the same time and place. Regarding accident prevention models, these indicate that accidents can be prevented by applying multi-faceted approaches including both physical and organisational measures. Legal preventative approaches emphasise a hierarchical approach which gives preference to physical hazard elimination.

A requirement to manage an accident and ill health risk is in place under Irish SHWW legislation based on risk assessment, however, no means of conducting a risk assessment is prescribed in the legislation. Undertaking surveillance is the first step in the PHM to gain understanding of the causes and severity of injuries and ill health to devise effective OSH prevention programmes (Knapp, 1966). A review of sources of OSH information for the agriculture sector is now undertaken followed by a literature review of injury and ill health data for the sector and factors influencing risk.

2.5. Injury and ill health surveillance and factors influencing risk

Horan and Mallonee (2003) described surveillance as ‘ongoing, systematic collection, analysis, interpretation, and dissemination of data on health (and injury) events for use ... to reduce morbidity and mortality and to improve health and safety. Alternatively, they put it more succinctly ‘surveillance is about gathering information and translating it into action’. Before considering farm accident data from various sources, the possible sources available to collect it are firstly reviewed.

The next section of this chapter reviews international literature on the level of occurrence of farm accidents, both fatal and non-fatal, and farm ill health and associated risk factors. Irish literature is given particular consideration due to specific relevance to this study. This review has been conducted to provide knowledge on which to base the development of the Irish farm health and safety COP and RAD which are to form the basis of efforts to assist Irish Farmers to effectively manage farm OSH and which forms the basis of this study. Firstly, a brief review of sources of farm accident data is undertaken to inform the study of issues related to this aspect of the research.

2.5.1. Sources of farm accident information

Farming communities are dispersed and often not included in statutory reporting systems internationally or else such systems may not work as effectively as in other sectors. Accordingly, these issues have to be borne in mind, for example, when comparing data sources and drawing conclusions from the data available. This brief review firstly considers fatal farm accident data sources followed by those for non-fatal farm accident data. A further more comprehensive review of issues related to gaining surveillance data for accidents is available in Appendix 2.2.

Fatal workplace accidents are legally notifiable to a government authority in many countries and accordingly may provide reliable data sources (McCurdy and Carroll, 2000). However, the definition of what constitutes a farm workplace accident, can vary among jurisdictions leading to possible difficulties with international comparisons. Obtaining surveillance data on non-fatal farm accidents and ill health generally presents a greater challenge than fatal accidents due to the dispersion of farmers and the related cost of data collection (Purschwitz and Field 1990; Field and Tormoehlen, 2006). Possible options for gaining this data include: statutory reporting; hospital and medical doctor reporting, and direct surveying of farmers. The various options each has its own strengths and weaknesses which need to be considered.

In Ireland, fatal farm accident reports are available through statutory means, however reporting of non-fatal farm accidents has not happened to any great extent. A national survey system for collection of such data has been developed by McNamara and Reidy (1992) in association with the National Farm Survey (NFS) operated by Teagasc. This survey system provides robust estimates of the level, causes and consequences of farm accidents and has been conducted at 5-yearly intervals since 1991 and is available for use in this study. When conducting accident surveys it is prudent to base an estimate of accident levels on the most recent period due to recall issues.

A review of international data on incidence and rates of farm accidents is now undertaken. Data may be presented in the literature where the incidence of accidents in the sample or population for a particular character (e.g. gender etc) is presented as a percentage of the total sample or population. In contrast, data for accident levels may be presented individually for a particular character (e.g. gender) and compared with other characters. Where data is presented in this way it is described as a ‘rate’ to prevent confusion with percentage incidence. For clarity of presentation, incidence levels are firstly presented, followed by rates.

2.5.2. International data on rates of fatal farm accidents

A comparison is firstly made of the agriculture sector with other main employment sectors to establish the position of the agriculture sector relative to other workplaces based on the data available. This review indicates that the agriculture sector internationally has both an accident and fatal accident rate record about four times worse than the ‘all workplace’ rate (Eurostat, 1999; Eurostat, 2006; Mather and Lower, 2001; Pickett et al., 1999). This data reinforces the need to seek strategies to improve OSH in the agriculture sector.

A review of fatal farm accident rates for various countries has also been undertaken to consider if rates vary and to indicate if particular countries have a lower rate . This would indicate the relative position of Ireland for fatal farm accident rate. In Ireland it was reported that the fatal farm accident rate for the three-year period to 2006 was 15 per 100,000 workers per year (Meredith et al., 2008), which was similar to the EU (15) average rate of the time (Trichopoulos and Spyridopoulos, 2004) but about 20-30% lower than rates for the U.S.A (Myers and Hard, 1995; Pickett et al., 1999; Rautiainen and Reynolds, 2002), Australia (Pickett et al., 1999) and New Zealand (Morgaine et. al., 2006). Within Europe, countries such as Sweden (Thelin, 2002) and the U.K. (Solomen, 2002) have been reported as having about a 25% lower fatal accident rate than EU (15). Thus the comparative data indicates that Ireland is about at the average rate for EU (15), but higher than a number of individual European countries. Further information related to this section is available in Appendix 2.3.

2.5.3. International data on rates of non-fatal farm accidents

A review of farm accident surveys by McCurdy and Carroll (2000) in the United States indicated incidence rates ranging from 0.5% to 16.6% per year with the average rate between 5% and 10%. Dupre (2001) considered that the average incidence for Europe for accidents causing over 3 work days loss for the ‘agriculture, hunting and forestry’ sectors was 7.5% per year which corresponds with the average estimate for all farm accident level for the USA of 5-10% provided by McCurdy and Carroll (2000). Suutarinen (2003) conducted a review of farm accident rates worldwide and found that estimates varied from 5.8 to 35 per 100 persons at work per year. He noted that the figure for Denmark was highest (35 per 100 persons at work per year) and concluded that this was based on intensive weekly registration of both accidents and working hours. Suutarinen (2003) also conducted a review of accident frequency rates where an estimate of working hours was made and cited several studies indicating that the rates quoted mainly fell into the 2.5 – 5 per 100,000 hours (Myers, 2001; Ferguson, 2000; Reiling 1997; Hansson et al., 1989).

2.5.4. Risk factors for accidents and ill health in agriculture

A review of the literature is undertaken in this sub-section to identify farm accident risk factors. The Irish literature on farm accidents and ill health risk was also reviewed and is presented in the following sections. As agriculture is highly diverse regarding the socio-economic and physical characteristics of individual farms which may affect either accident or ill health risk, a broadly based template was used for this purpose (Figure 2.4). In these reviews evidence from both fatal and non-fatal farm accident data sources was examined in turn. The purpose of these reviews was to identify risk factors in the literature which could be used to devise preventative programmes in association with the study data which could emerge from the research component of the study.

SOCIO - ECONOMIC FACTORS	FARM WORKPLACE AND TECHNOLOGY FACTORS
• Employment Status •Gender •Age profile • Farm Work hours • Psychosocial Characteristics – Personality and Stress •Previous Farm Accident •Education and Managerial Ability •Ill Health • Disability	• Farm Size • Economic Size. • Farm System •Agent of Injury - Mechanisation - Livestock - Physical

Figure 2.4: Template for considering Farm, Accident Risks

Source: Adapted from Finnegan (2007)

2.5.4.1. Socio -economic risk factors

Socio-economic factors are considered first, which are factors associated with persons who work or live on farms. These include the factors outlined in Figure 2.4 including: employment status, gender, age, previous accident occurrence, psychosocial characteristics, education and managerial ability, work hours, ill health and disability related conditions.

2.5.4.1.1. Employment status

The international literature indicates that the farm operator is the principal victim of farm injuries. McCurdy and Carroll (2000) reported that the risk of farm injuries was three times greater for the primary operator than other operators. In Canada, Pickett et al., (1999) reported that 60.2% of fatal farm injuries occurred to the primary operator. Research by Simpson et al., (2004) also found that the primary operator is more likely to suffer an injury.

In the UK, a considerable difference in the rate of fatal farm injuries for self -employed farmers and farm employees was reported by Leavesley (2006). Based on an analysis of UK HSE data a fatal rate per 100,000 persons of 16 and 6 was reported for self-employed and employed persons, respectively. Solomon (2002) in the UK noted that causes of farm fatal accidents among employees and self-employed were similar with the notable exception of electrocution, which was higher for employees than for self-employed.

2.5.4.1.2. Gender

Rissanan and Taattola (2003) found in Finland that among adults classified as over 15 years old, that males had 94% of fatal farm accidents, among children who suffered 8.3% of all fatal accidents that 67% occurred to males. Dimich-Ward et al., (2004), in Canada found that males had 11 times as many agriculture related fatalities compared to females. A range of studies are available in the international literature which showed a higher rate of accident risk for men than for women. (Ferguson et al., 1999; Hagel et al., 2004; Shallones and Beseler, 2003; Virtanen et al., 2003; Hwang et al., 2001; McCurdy and Carroll, 2000; Pickett et al., 1999). A study by McCurdy and Carroll (2000) showed that the gender difference in accident rates became more pronounced towards males with increased exposure to farm work while other studies show the opposite (Ferguson et al., 1999; Mongin et al., 1999).

2.5.4.1.3. Age

A striking feature of accidents in agriculture is the high involvement of the young and the old, outside the normal age range of the work force (Merchant et al., 1995; Zhao et al., 1995; Browning et al., 1998; Ferguson 2000). In Sweden, for instance, Thelin (2002) found that farmers aged over 64 had a statistically higher probability of a fatal accident. In New Mexico, USA, Crandall et al., (1997) reported that one-third of all fatalities were aged 60 years or older.

Several population-based studies in the USA for fatal work-related injuries consistently show significantly increased accident rates with age, beginning between age 50 and 60 years (Hanford et al., 1982; Hoskin et al., 1988; Myers, 1989, 1990, Carstensen et al., 1995; Myers and Hard, 1995, Kisner and Pratt, 1997; Fiedler et al., 1998; Hard et al., 1999, 2002; Pickett et al., 1999; Voaklander et al., 1999; Mitchell et al., 2005; Meyer, 2005). Work by Pratt et al., (1996) in the USA indicated that farm workers aged over 65 years had a five times higher fatality rate associated with machinery than those in the 16-64 years of age category.

In the USA, the risk of non-fatal injury has been shown to decline with increasing age (Hanford et al., 1982; Hoskin et al., 1988; Crawford et al., 1998; Lewis et al., 1998; Xiang et al., 1998; Hwang et al., 2001; Sprince et al., 2003). Xiang et al., (1999) in Colarado, USA also found a pattern of decreasing injury risk with age up to age 75 years, after which it increased dramatically. Hanford et al., (1982) in a study in 31 states in the USA and Hoskin et al., (1988) in 35 states reported a pattern of increasing permanent injury with age. Medical record surveillance also showed increasing risk of injury from falling with age among Wisconsin farmers (Nordstom et al., 1996) and specifically, among those over 65 year (Stueland et al., 1996).

A study by Etherton et al., (1991) in the USA indicated that reduced reflex speed may make older farmers more susceptible to injury while health problems such as arthritis, hearing or visual problems lead to increased risk (McCurdy and Carroll, 2000; Browning et al., 1998; Lewis et al., 1996; Zwerling et al., 1998).

Regarding ‘young’ farm operators, Suutarinen (2003) cited considerable literature indicating an elevated injury risk among this group (Gerberich et al., 2001; MacCrawford et al., 1998; Carstensen et al., 1995; Zhao et al., 1995; Geller et al, 1990) and the old (Gerberich et al., 2001; Pickett el al., 2001; Zhao et al., 1995; Erlich et al., 1993). Due to the considerable variation among studies Suutarinen (2003) did not define an age for ‘young’, however the first two studies cited for this group refer to teenagers or younger, while the last three refer to persons younger than their mid-forties. In Sweden, Thelin (2002) reported that farmers under the age of 30 had a statistically higher probability of having a fatal accident.

Specifically for childhood farm injuries, Bancej and Arbuckle (2000) cited a considerable body of literature indicating that younger children, in the under 1 to 4 years old category, had substantially elevated accident rates. The work of Bancej and Arbuckle (2000) also indicated that childhood accidents increase with increasing livestock numbers but decreased with increasing area of field crops. Mongin et al., (1999) found that children, especially young children (under aged 9) are at greater accident risk than adults per unit time of exposure. Bancej and Arbuckle (2000) found a higher accident rate for boys and cited a considerable body of literature also reporting this finding. Furthermore they found that having two farm owner operator parents was associated with increased accident risk in children. This finding is corroborated by similar findings from the Canadian Agricultural Injury Surveillance Programme (1997) who considered that this finding may be a result of parental involvement in farm work impeding their ability to supervise children or alternatively the participation of children in farming activities being reinforced by both parents. The latter proposition is supported by the research of Lee et al., (1997).

In summary it is suggested that older farmers have the highest proportion of fatal farm accidents while younger farmers had the highest probability of non-fatal farm accidents (MacCrawford el al., 1998; Myers, et al., 1998). Childhood accidents are seen to be related to gender, level of contact with hazardous farm work activities and the supervisory role related to OSH exercised by their parents.

2.5.4.1.4. Prior experience of a farm accident

Research studies of farm accidents indicate that those who experienced a prior agriculture-related accident have a much higher risk of incurring another accident (Mongin et al, 2007; Bancej and Arbuckle, 2000; McGwin et al., 2000; Browning et al., 1998; Zhou and Roseman, 1994; Elkington, 1990). However, Brison and Pickett (1992) in their study of farm accidents among farmers in Ontario, Canada did not make this finding. Possibilities for the finding that a prior accident is associated with higher subsequent risk include the possibility that a disability from a previous accident(s) caused an impairment which increased the risk of further injury (Lewis et al., 1998) or that farmers who experienced prior accidents may work in more hazardous environments, take more risks, or generally are less conscious of safety issues (McGwin et al., 2000). McGwin et al., (2000) found that farmers who exhibited ‘hurry’ when farming, were frequently tired and had lower levels of attentiveness and a less careful attitude to safety, all had a higher relative risk. In Denmark a study by Glasscock (1999) found that farmers who did not take safety precautions, such as conducting regular checks of machinery and equipment had higher accident levels. Overall, this review indicates that accident recurrence occurs among farmers.

2.5.4.1.5. Education and managerial capacity

Literature from North America (Sprince et al., 2003; Lewis et al.1998; Pickett et al. 1996; Lee et al. 1996; Zhou and Roseman, 1994) has indicated that higher education levels of farmers were associated with increased farm accident risk. Sprince et al. (2003), however, raised the issue of an association between higher education levels and higher recall and reporting with self-report accident surveys. Bancej and Arbuckle (2000) in their study of childhood accidents in Ontario, Canada found that having a parent with education beyond high school was consistently associated with greater accident risk to children, and suggested that this issue required further study. Their data, however suggested that parental education level may be associated with other farm risk factors such as farm scale and work hours of parents, particularly mothers. However, reports of increased accident risk with higher education contrasts with the trend across almost all other occupational sectors where more highly educated workers sustain lower fatal accident rates (Oh and Shin, 2003). Regarding farm safety training among farmers (Suutarinen, 2003; Sprince et al., 2003; Reis and Elkind, 1997; Murphy, 1981) have found no protective effect associated with such training. Suutarinen (2003), however, noted that information about the substance and quality of vocational education in respect of inclusion of safety management and management in general was not available and for this reason, it is not possible to determine whether this result is due to the ineffectiveness of education or from lack of inclusion of this topic. A notable exception has been the Danish (West Jutland) one-day training course and farm advisory visit which demonstrated a 48% reduction in accidents requiring hospitalization (Rasmussen et al., 2003). Also, in Australia, two studies (Day et al., 1999; Houlahan, 2003) assessing ‘managing farm safety training courses’ have indicated that following the course the farmer participants were likely to adopt some or many of the recommended changes. Overall, the level of information available related to the protective effect of farm safety training is limited and requires further investigation.

The study by Suutarinen (2003) in Finland of farmer management capacity, as measured by levels of work delays, indicated a link between managerial quality and accident levels. Other variables in this study including the number of machines on the farm, musculoskeletal disorders, exhaustion and general health, also tended to support the proposition that poor management capacity is linked with increased injury or ill health.

2.5.4.1.6. Working hours

De Roo (2000) noted that farmers can often work long hours under severe time constraints. Pickett (1995) and Gill Coury et al., (1999) stated that farmers are often subjected to shortage of time to complete a task due to weather constraints. Murphy (1992) noted that time constraints increased the risk of errors which could result in accidents. The literature indicates that individuals working full-time on farms had the greatest probability of accidents (Sprince et al., 2002; McCurdy and Carroll, 2000; Lewis et al., 1998) suggesting that number of work hours is positively related to farm accidents. Sprince et al. (2002 and 2003a) showed that operators in Iowa, USA working more than 50 hours per week were more likely to have an accident, while Ferguson et al., (2005) in 5 mid-west states of the USA found that farmers working more than 61 hours per week increased the probability of being involved in a tractor accident.

In Finland, Suutarinen (2003) found that exhaustion was significantly associated with higher accident rates and he pointed out that earlier studies (Browning et al., 1998; Lewis et al., 1998; MacCrawford et al., 1998; Zwerling et al., 1998) which had shown that when a person’s mental or physical working capacity are not equal to the task performed, injury probability increases. Schlosser et al., (2000) in Brazil reported that working long hours increased vehicle/machinery accident risk by affecting concentration. A study by Lyman et al., (1999) in Alabama and Mississippi, USA indicated that farm operators describing themselves as ‘sometimes or frequently hurried’ had a 50-100% increased accident risk.

2.5.4.1.7. Psychosocial factors

The psychosocial factors, including personality and stress are reviewed because they may have potential linkage with accident risk (Glasscock 1999).

Regarding personality and association with OSH, research among non-farming occupational groups related to both the Safety Locus of Control (SLC) (Jones and Wuebker, 1985 1993; Wuebker, 1986) and personality type (Sutherland and Cooper, 1991) indicated associations between personality and workplace accidents. As regards SLC, Jones and Wuebker (1985) proposed that people with internal control beliefs assume more personal responsibility for their safety, while those with external control beliefs are more inclined to view accidents as associated with external control beliefs such as chance or fate. Houston et al., (1987) suggested that Type A personality individuals are characterised by impatience, a chronic sense of time urgency, competitiveness, aggressive drive, and hostility which are behaviours that may also account for an increased level of accidents (Niemcryk et. al., 1987). Erisman and Huffman (1972) cited by Harrell (1986) investigated the relationship between personality and accidents among farmers and found associations between accident levels and emotional immaturity, carelessness, impulsiveness, and aggressiveness. A further study by Harrell (1986) in Canada reported a direct relationship between the masculinity trait and farm accidents.

Regarding stress, a number of international studies (Simpson et al., 2004; Sprince et al., 2002; Geller, 1990) have shown a positive correlation between farming-related stress and farm accident rates. Chronic occupational stress can manifest itself in a variety of ways which may impede farm workers’ abilities to respond to short-term challenging demands (acute stressors) (Schaubroeck and Ganster, 1993). Emotional responses commonly lead to irritability and fatigue, while cognitive responses affect thoughts by decreasing memory and alertness (Simpson et al., 2004). Grump and Mathews (1999) have found reduced levels of reactivity with increasing amounts of stress which they attribute to physiological responses that can place the worker in an excited state with an increased heart rate and elevated hormonal levels. In Norway, Melberg (2003) identified the main stressors among male farmers and their spouses as follows: their subjective evaluation of the state of the household economy, presence of unsafe working conditions, injury, ill health or disability. For both genders, education was significantly associated with reduced levels of stress while psychological well-being increased with reduced stress and levels of social support (Melberg, 2003). In Iowa USA, a study by Hodne and Donham (2003) identified six principal factors associated with farmers' stress levels, namely: farm policies; finances; family; farm work; job loss/victimization with persons reporting stress symptoms more susceptible to health and injury problems. Glasscock (1999) in Denmark also found that having insufficient manpower, long working hours, frequent interruptions by visitors or machinery breakdowns were significantly associated with increased accident levels, which linked both stress and farm accident rates with the overall management of the farm.

2.5.4.1.8. Farmer health status

Farmers' health can be viewed from two perspectives described as 'personal' and 'occupational' health. Personal health relates to issues which are independent of occupation while occupational health issues are directly attributable to work activity. The dichotomy arises because SHWW legislation extends to health conditions associated with work activity. However, many studies such as: Rautiainen et al., 2004; Park et al., 2001; Lewis et al., 1998; Crawford et al., 1998; Browning et al, 1998; Pickett et al., 1998; Penttinen and Valonen, 1995; and Suutarinen1992 indicate that poor personal health is associated with increased farm accident rates. On this basis both personal and occupational health are considered in this study.

A review conducted by Donham and Thelin (2006 p.17) of mortality rates associated with health conditions indicates that at an international level, the rates were lower among farmers when compared to other occupations, the general population or urban populations. However, in the UK, a health survey conducted by Syson-Nibbs et al., (2006) found that full-time farmers scored worse than non-farmers and significantly worse than the UK general population on health and the study endorsed the view of farmers being ‘stoic and self-sufficient’ as regards health. A study by Knowles (2001) also noted that farmers in the UK did not enjoy universal good health with 30% of respondents in a national study rating their health as average or poor. An earlier case-control study by McCrone (1999) of how farmers use General Practitioners (GP) in the UK found that farmers visited the GP for acute rather than health promoting services.

Possibilities of effecting positive change in farmers’ health behaviours have been indicated by a number of studies in the U.K. The Cumbria Health Project, which used a nurse-led mobile clinic at marts (Burnett and Howkins, 2001), found that 69% of farmers presenting with a specific complaint had not visited a G.P., but 47% showed improvement after consultation.

It is notable that socio-economic status (SES) has been strongly linked with health status in the scientific literature. Alder et al., (2002) stated that ‘individuals higher in the social hierarchy typically enjoy better health than those below’. Alder et al., (2002) cited Antonovsky (1967) and Illsley and Baker (1991) who stated that SES differences occurred for mortality and morbidity for almost every condition. As SES is a composite measure that typically incorporates economic status measured by income, social status measured by education and work status measured by occupation (Dutton and Levine, 1989 cited by Alder et al., 2002), the exact causal mechanism for the link between SES and health is unknown. Munro (2006) suggested that inequality is at the heart of the link between SES and health, this may also suggest that changing the SES status of a person/group may alter health status also, while Sim and Mackie (2006) suggest that all policy initiatives aimed at eliminating the SES-health status link should be aimed at those in greatest need.

Regarding occupational illness among farmers, musculoskeletal disorders (MSDs) are a prominent source of occupational ill health. Meyer et al., (1997) reported that 43% of all agricultural injuries in the USA fall into the MSD category. Walker-Bone and Palmer

(2002) reported that about 50% of farmers reported lower back pain compared to 37% for manual workers. These authors noted that farmers had increased risk of hip osteo-arthritis. In Dutch agriculture, MSDs account for 30% of insurance sick leave claims among self-employed farmers (Hartman et al., 2006).

A further source of farmer occupational ill health are respiratory risks. Epidemiological studies have consistently shown a significant association between farming and an excess of respiratory symptoms (American Thoracic Society, 1998; May, 1996; Chan-Yeung et al., 1992). Chaudemanche et al., (2003) in a case-control study in France found that dairy farming was associated with an excess of chronic bronchitis. Donham and Thelin (2006) provided a summary of the substances and sources of hazardous aerosol exposures in agriculture that may lead to respiratory disease. They considered that while farmers in the USA are commonly exposed to these substances when performing daily work, periodic exposure to certain harmful dusts or gases in high concentrations are likely to be more damaging.

2.5.4.1.9. Disability and farm injuries.

Disability is defined in Irish legislation as 'any restriction in a persons' capacity to participate in economic, social or cultural life'. Applying this definition, McNamara et al. (2003) found that 19.5% of farm households had one or more members with such a condition of which 39.5% were the farm operator. The most frequent disabilities identified among household members were health-related conditions (43.8%), farm injury (14.3%), learning/intellectual disability 12.9%) and other identified categories (29.0%)**.** In the USA, disability among farmers has been associated with secondary injury associated with a prior injury when they engage in hazardous farm work due to loss of personal capacity (Allen et al., 1995; Browning et al., 1997). Allen et al. (1994) indicated that disability increases with farmer age and identified livestock handling and falls as the primary cause of secondary injuries. Thus preventing disability where possible and assisting farmers to farm by adapting disability needs to be positive aims of OSH programmes.

2.5.4.2. Farm workplace and technology

Farm workplace and technology factors are now considered, which are associated with the physical dimensions of the farm and include: both physical and economic farm size; farm system and farm technology factors such as mechanisation, livestock and the physical farm environment.

2.5.4.2.1.Farm size

Internationally, the literature generally does not provide much evidence of a relationship between farm size and the probability of farm-related accidents (McCurdy and Carroll, 2000) with the exception of one review of farm accidents in 35 states in the USA (Hoskin et al., 1988) which indicated that farms with less than 50 acres had increased accident risk.

2.5.4.2.2.Economic farm size

The international literature (McCurdy et al., 2004; Sprince et al., 2003; Lewis et al., 1998; Pickett et al., 1996) did not provide evidence for an association between accidents and economic size with the exception of one study (Layde et al., 1996) where higher rates of farm machinery accidents were related to low farm sales.

2.5.4.2.3. Farm system

Numerous international studies have shown that the presence of farm animals increased the probability of accidental injury (Sprince et al., 2003a; Virtanen, 2003; Hwang et al., 2001; McCurdy and Carroll, 2000; Browning et al., 1998; Zhou and Roseman, 1994). In Finland, Virtanen (2003) found that farm accident risk was proportional to the number of dairy cows on the farm. In America, work by Zhao, Helzel and Woeste (1995) in compiling an Expected Injury Cost index based on probability and severity of injuries gave the highest rating to dairy farming, followed by grain farming and then beef farming.

Suutarinen (2003), in Finland, found a connection between accident rates and number of machines used on a farm, which he noted was consistent with previous research and he cited the following studies: Gerberich et al., 2001; ILO, 2000; Lyman et. al., 1999; McGwin et al., 2000; Rasmussen et al., 2000.

In Denmark, Rasmussen et al., (2000) reported a higher level of medically treated accidents among crop farms than dairy or mixed farms (excluding swine farms). It should be noted, however, that the technologies applied in various faming systems in different countries may be different and that these could change over time, with a consequent impact on accident levels.

2.5.4.2.4. Mechanisation

A review of farm equipment in both high income (HIC) and low (LIC) income countries by Kumar et al., (2000) found that 50% of accidents, including fatalities, were tractor related. These authors found that for the studies reviewed that about 50% of accidents (mostly fatal) were tractor roll-over related with the others being attributed to run-overs (13%); fall from the vehicle (12%), collision (10%) being crushed (9%), PTO and other part entanglement (5%). Given the high proportion of tractor/vehicle overturns it is unsurprising that this issue has received attention at a regulatory level. Regarding the fitting of Roll Over Protection Structures (ROPS) to tractors, Springfelt (1998) reported for Sweden the virtual elimination (declining from 17.2 to 0.3 per 100,000 tractors) of overturning fatal accidents, following introduction of regulations requiring the use of ROPS. Thelin (1998) reported similar findings for Norway and Denmark.

In Finland, Suutarinen et al., (1992) following a finding that 30% of all tractor related injuries related to tractor access related issues, found that operators lost the recommended three-point contact for 49% of access time and 43% of egress time. These authors concluded that design issues of tractor access paths needed further attention for ergonomic factors in 50% of cases to take into account natural human behaviour and in 50% of cases better design was warranted.

Machinery maintenance is also an issue related to safety as McGwin et al., (2000) found that where farm machinery was in fair/poor compared to good/excellent condition an

80% elevated accident risk occurred and that poor machinery maintenance was an indicator of low skill or interest in this aspect of farm management.

Suutarinen et al., (1992) concluded that human factors, machinery and equipment standards/maintenance and system factors all needed to be considered in tractor/machinery injury prevention strategies. Thus it is apparent that both technical factors and human factors and their interaction require attention to prevent machinery related accidents. A more comprehensive review of accident occurrence associated with machinery is available in Appendix 2.4.

2.5.4.2.5. Livestock

The literature indicates that both men and elderly people have an especially high risk of accidents and deaths related to animals in farming (Martinez-Ramos et al., 2006; Casani –Martinez et al. 2000; Idikula et al., 1991).

In the USA, Browning et al., (1998) found that most accidents (62%) were season-related, occurring in spring with most of these being from animal kicks. Also in the USA two studies by McCurdy et al., (2004) and Rautiainen et al., (2004) found that livestock-related accidents caused 12.4% and 12.9% respectively of total farm-work accidents. In the U.K Solomon (2002) for a twelve year period to 1999, found that just 5.8% of fatal and 7.7% of non-fatal accidents were associated with animals.

The work of Browning et al., (1998) and Layde et al. (1996) indicated that proper handling and transportation practices and the exercise of caution around bulls, steers and pregnant cows could reduce livestock accidents. However, a livestock handling facilities survey in the UK by Stroud and Walsh (1997) reported limitations in the adequacy of cattle handling facilities with 87.9% using a cattle crush whilst handling cattle, while only 35.1% used a race.

Turner et al., (2003) in the U.K found that due to increased herd size the contact between humans and livestock had declined resulting in a degradation of the Man

Animal Relationship (MAR). The scientific literature strongly indicates that a degradation of the MAR gives rise to heightened fear of man by animals and leads to difficulties in livestock handling and increases risk of accidents to man (Le Neindre et al., 1996; Rushen et al., 1999). According to Hemsworth and Coleman (1998) the fear that cattle have for humans can be determined by the ratio of negative interactions over the sum-total of all interactions. Research on commercial farms based on the Theory of Reasoned Action (TRA) (Jaen and Fishbein, 1981) has shown that the attitude of farmers to animals foretells the farmer's behaviour, and in turn also the behaviour of animals to man (Hemsworth and Coleman 1998; Breuer, 2000; Hemsworth at al., 2000; Lensink et al., 2000 and 2001; Waiblinger, 2002).

Research has also shown that heritability of genetic factors controlling the reaction of animals to man in the 0.2-0.4 range (Le Neindre et al., 1995; Gauly et al., 2001; Boissy et al., 2005). Dickson (1970) further reported a 0.47 heritability factor for docility in dairy cows. Plomin (1999) found that genetic variation makes a considerable contribution to individual differences in the normal range of behaviour in humans. Thus livestock breeding has the potential to improve docility and hence potentially safety with livestock.

This review of farmer safety related to livestock indicates that having adequate facilities, breeding programmes and the farmer's attitudes and behaviours to animal handling are potentially influential in reducing farm accidents. A more comprehensive review of this topic is provided in Appendix 2.5.

2.5.4.2.6. Physical environment

In the U.K Solomon (2002) for a twelve year period to 1999, found that falls from heights (15.8%) and being struck by an object (13.3%) were significant causes of fatal accidents. Solomon found a different trend for non-fatal accidents with predominant physical causes being: struck by an object (22.8%); lifting/carrying (19.8%); slip at same level (15%) and fall from height (13.1%). Recent studies in the USA have highlighted the significance of non-fatal physical injuries resulting from falls and blows in farming accidents. In Iowa, Rautiainen et al., (2004) reported that slips, trips and falls (8.8%) fall from an elevation (12.3%) struck by (11.3%) and against an object (7.2%) and lifting an object (7.5%) comprised 47.1% of accident occurrences reported in the Certified Safe Farm Scheme in that State. In a survey of Californian farm operators, McCurdy et al., (2004) reported that falls made up 13% of total injuries with 5% occurring at the same level, 4.3% into a hole, 2.5% from a ladder, scaffold, stairs and 1.2% from one level to another while a further 7.5% reported being struck by an object. Brunette (2004) in the USA highlighted the high risk associated with falls from heights when reporting that falls from one level to another across all work sectors caused eleven times more fatal accidents than falls at the same level.

2.5.5. Farm accident and ill health data for Ireland

Farm injury and ill health data for Ireland has been examined separately from international sources of data as it was proximate and therefore most closely relevant to the issues of the research being undertaken. When planning the development of the RAD and COP it was decided by the PI steering committee to give prominence to fatal and serious causes of farm accidents and ill health in Ireland. As no systematic examination of fatal accident 'causes' had been undertaken in Ireland up to 2006 it was decided to complete such an examination for the previous ten year period (1996-2005). It should be noted that the term 'cause' refers to the principal association with the fatality, as such an occurrence may have multiple causes. The Irish fatal accident data was the principal knowledge resource used in both the COP and RAD documents (H.S.A., 2006a). A brief summary of the fatal accident data is now provided as the information is provided in full in the COP and RAD documents (on HSA web). The PI steering committee also decided to consider data available on non-fatal accidents and ill health in Ireland for relevance in relation to information for inclusion in the RAD and COP, accordingly the data available from such sources is summarized following presentation of data on fatal farm accidents.

2.5.5.1. Fatal farm accident data for Ireland (1996- 2005)

The principal causes of farm workplace deaths are shown in the pilot RAD document (p.4). It should be noted that the term ‘cause’ refers to the principal agent associated with the fatality. The data presented indicates, in line with the international literature, that fatal farm deaths are associated with: agents such as tractors/ vehicles and machinery (48%), livestock-related (14%), fall (13%), drowning (11%) collapse/ falling of objects (5%), timber related (5%) and electrocution (4%).

In the hazard control sheets of the RAD document the hierarchy of controls approach is applied with engineering approaches to eliminating or reducing hazards being given precedence over behavioural controls. Thus in the RAD document and COP document which provides further information to support the RAD, the range of engineering and behavioural controls considered by the PI Steering Committee to be applicable to farms in Ireland are outlined and accordingly are not repeated in this thesis document.

2.5.5.2. Non-fatal farm accidents in Ireland

Three Irish national farm accident surveys conducted in association with the Teagasc NFS provided data on accident levels and causation at 5-yearly intervals from 1991 to 2001 (McNamara and Reidy, 1992, 1997; Finnegan and Phelan, 2003) These surveys showed a reduction in farm accidents from circa 5,000 in 1991 to 2000 in 1996 followed by an increase to 3,000 in 2001 among the farm population represented by the NFS. The comparable data for the annual accident rate per thousand farms was 27, 14 and 21 for consecutive surveys respectively.

The principal causes of accidents in the three national surveys are shown in Figure 2.5 and indicate a changing pattern of accidents over the time period of the studies for farm vehicles and machinery which declined from 29.7% to 19.4% of total injuries while trips, falls, buildings and blows increased from 38.6% to 47.7% in relative terms. Less variation occurred in relation to livestock accidents (range 22.6% - 27.6%) while timber related accidents accounted for a lower proportion of overall accidents and occurred in the 4.6% to 8.5% range.

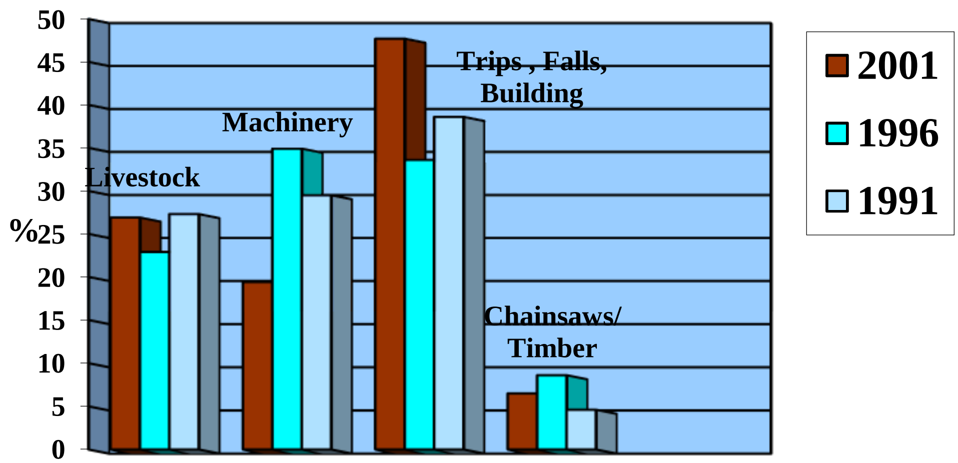

Figure 2.5: Trends in farm accident causation data in Ireland

Sources: McNamara and Reidy (1992and 1997); Finnegan and Phelan (2003)

McNamara and Reidy (1992;1997) examined trends in 'serious accidents' based on the following definition they devised to suit computer data analysis: 'an accident resulting in a fatality, hospital stay of more than 5 days or where permanent disability occurred'. In both surveys, 20% of total injuries were classified as 'serious'. These authors identified the following farming activities in the study reported in 1997 as causing 70% of 'serious accidents' as defined; chainsaw, wood and forestry work (20%), driving livestock (18%); tractor driving and repairing machinery (18%); loading and unloading bales (9%) and walking across the farmyard and climbing/closing gates (5%).

In Northern Ireland (NI) a farm accident survey (Magee, 2002), estimated the annual level of accidents requiring medical attention at 3% of farms. The NI survey of farm accidents (Magee, 2002) reported that the following causes of non-fatal accidents: hit/trampled by an animal (28%); slip/trip at ground level (14%); contact with machinery (13%); falling object/material, fall from height and using a hand tool, each 8% and other causes (21%). In previous research, Fallon and Michail (1988) found that farm accidents involved machinery (51%); animals (13%), falling objects (13%) and falls (12%) as the most frequent causes.

2.5.5.2.1. Farm accident and ill health

A similar template was used for considering non-fatal farm accident and ill health risk in Ireland as earlier for international data (see Section 2.5.4.) (Figure 2.10.). However as the availability of data was more limited than for data in the international literature a more limited number of categories are used. Particular emphasis is given to the NFS studies conducted, as these provided the most comprehensive data sets.

2.5.5.2.2. Status of accident victims

The accident victim profile for the various Teagasc NFS surveys undertaken in years 1991 and 1996 and reported by McNamara and Reidy in years 1992 and 1997 respectively, mirrored the trend for fatal accidents in Ireland with the farm operator being the predominant victim accounting for between 69.7% and 75.1% of cases. For the surveys undertaken in 1991 and 1996 the other accident victim categories were: other family adult (10% for 1991 and 6.4% for 1996), child or person under 16 years old (16.4% for 1991 and 13% for 1996), employee (3.9% for 1991 and 5.5% for 1996) and neighbours and visiting service providers (0.6% for 1991 and 2.3% for 1996) (McNamara and Reidy, 1992 and1997). McNamara and Reidy studied the association between household structure and accident rates and found that households with children present had a higher rate of accidents in both surveys. With regard to the number of regular workers on a farm, McNamara and Reidy (1997) noted an approximately three times higher level of accidents on farms with three or more such workers than those with two or less.

2.5.5.2.3. Gender

Finnegan and Phelan (2003) and McNamara and Reidy (1997) found that 92% and 95% of all farm accidents respectively occurred to males, while males were the victims of 86% of accidents in the 1991 survey (McNamara and Reidy, 1992), McNamara and Reidy (1997), however, could not determine from the data available, whether the relative reduction in accidents to females was because they adopted new OSH information or whether their role in farm work had declined in the intervening period.

No Irish studies which identified separately the accident rates for males and female farmers were identified as part of this study.

2.5.5.2.4. Age

McNamara and Reidy (1992) and McNamara and Reidy (1997) reported that 62.8% in 1991 and 61.1% in 1996 of farm accidents in Ireland occurred to persons in the 31 to 60 year age range with the 41-50 year age range having the highest proportion of accidents at 25.7% in both surveys. Accidents to persons over 60 years old accounted for 17.9% and 24.1% of all accidents in the respective surveys. Farm accidents to persons aged 30 or under, accounted for 19.1% and 14.8% of all accidents with 9.4% and 4.4% occurring to persons under 16 years of age.

2.5.5.2.5. Household structure

In Ireland, McNamara and Reidy (1992 and 1997) studied the association between household structure and accident rates and found that households with children present had a higher rate of accidents in both surveys. They noted a reduction in accident rates for all household size categories for the 1996 survey with the largest reduction in accident rate for those with children. They also noted a higher proportion of serious accidents on farms with larger households irrespective of the presence of children.

2.5.5.2.6. Farm size

The non-fatal accident data indicated that larger farms tend to have a higher level of such accidents. McNamara and Reidy (1997) found that accident levels increased with farm size. A comparison between the NFS survey data indicated that a 70% drop in accidents occurred on smaller farms (under 20ha) compared to a 40% drop in larger farms for the survey reported in 1997, thus in relative terms the proportion of accidents on larger farms increased.

2.5.5.2.7. Farm system

McNamara and Reidy (1992, 1997) in successive NFS surveys found that tillage (15.5% for 1991 and 13.1% for 1996) and specialist dairying farms (16.2% for 1991 and 12.5%

for 1996) reported a disproportionately higher level of accidents in both surveys. In contrast, accident levels declined between the surveys for the other NFS farm categories as follows: Dairying and other (14.0% for 1991 and 5.6% for 1996), cattle (10.1% for 1991 and 2.8% for 1996) and mainly sheep (9.8% for 1991 and 6.2% for 1996)

McNamara and Reidy (1997) also noted that a high proportion of 'serious' accidents occurred on specialist tillage and dairy farms with 32% and 24% of all such accidents respectively occurring on these farms. Thus the evidence available, generally, indicates that dairying and tillage farms had the highest level of farm accidents at that time.

2.5.5.2.8. Machinery

The NFS surveys reported by McNamara and Reidy in 1992 and 1997 showed accidents with tractors and trailers and machinery as follows: 16.0% and 20.8% and 13.5% and 14.1% respectively of total accidents in years 1991 and 1996 respectively. McNamara and Reidy (1997) reported that 16% of both tractor and trailer and machinery accidents were classified as 'serious'. They also found that being caught under a vehicle or machine (40.6%); being struck by or falling from a machine (27.7%); getting down from a vehicle/ machine (13.8%) being caught in the machine mechanism (9.8%, of which 2.3% involved power shafts) and being struck by machine flying parts (8.1%) were the main causes of machine related accidents. Chainsaw, wood and forestry work was associated with 8.9% of all accidents and 20% of serious accidents in the NFS survey reported in 1997.

2.5.5.2.9. Livestock

The NFS surveys reported by McNamara and Reidy in 1992 and 1997 showed accidents with livestock occurred for 27.3% and 22.9% of all accidents in 1991 and 1996 respectively. McNamara and Reidy (1997) reported that female bovine animals were involved in 48% of all livestock accidents and 45% of 'serious' ones. Bull related accidents were involved in 21% of all accidents, all of which were classified as 'serious'. Horses were 6% of all accidents but 34% of 'serious' ones. In Northern Ireland, Magee (2003) reported that livestock related non-fatal accidents (28% of total) related to being struck/trampled by an animal.

2.5.5.2.10. Farm workplace

The NFS surveys reported by McNamara and Reidy in 1992 and 1997 showed that trips and falls were reported in 23.2% and 18.1% of all accidents for years 1991 and 1996 respectively. McNamara and Reidy (1997) reported that loading and unloading bales caused 11.5% of all accidents and 9% of 'serious' ones while walking across the farmyard and climbing gates caused 9.5% of all accidents and 5% of 'serious' ones while the respective data for walking across field was 3.6% of all and 4% of serious accidents.

2.5.5.3. Data for ill health among Irish farmers

The data related to ill health among Irish farmers is presented separately for personal and occupational causes because these causes tend to be considered separately and different sources of data are available for the respective causes.

2.5.5.3.1. Personal ill health

Regarding male mortality, O'Shea (1997) conducted a study of male standard mortality ratios (SMR) by socio economic group (SEG) for the leading causes of death in Ireland for the years 1986-1991. The study demonstrated that 'farmers, relatives assisting and farm managers '(SEG 0) and' farm labourers and fishermen' (SEG 1) in the 15-64 year age group had a higher death rate per 1,000 population and was 2.81 and 2.14 times higher than for higher professional workers (SEG 2). All other SEG's had an intermediate death rate between the groups compared except 'unskilled manual workers' and 'unknown' which were higher. This author compared the SMRs for each cause of death between farmers (SEG 0) to that of higher professionals (SEG 2) and found that farmers were 4 times more likely to die from injury and poisoning, over 3 times from digestive and respiratory diseases, almost 2 times from circulatory diseases and 1.5 times from cancers.

Regarding health-related behaviours', Hope et al., (1999) conducted a national survey which compared farmers with urban workers and home-makers, who were principally females. The survey indicated that among farmers, 35%, 20% and 22% reported having an annual blood pressure check, routinely using skin cover to protect from the midday sun and participation in regular exercise. The comparable data for urban workers were 40%, 47%, and 58% and for homemakers 59%, 55% and 40% respectively, which indicates that a lower participation rate occurred among farmers for the practices surveyed. An overall conclusion indicated by the data on personal health practices among Irish farmers is that that this topic merits inclusion in extension programmes.

2.5.5.3.2. Occupational ill health

Finnegan and Phelan (2003) included questions on farm-related ill health among Irish farm operators in an NFS survey and found that 11% of farm operators reported having such ill health in the previous year. The health issues reported were as follows: chronic back pain (50%); respiratory problems (35%), contraction of diseases from animals (7.5%) and other (7.5%). Previously, in the 1996 and 1991 NFS surveys farm related ill health reports were obtained for 5% and 3.5% respectively. (McNamara and Reidy, 1992 and 1997).

Two studies (Arya et al., 2006; McGrath et al., 1999) reported on the incidence of the respiratory condition extrinsic allergic alveolitis, more commonly known as ‘farmers’ lung’ disease. McGrath et al., (1999) reported no progress with reducing the level of disease over the 15 year period prior to 1997. Arya et al., (2006) reported a marked reduction in this condition from year 2002 which they attributed to a change from hay to silage leading to reduced exposure to spores from mouldy hay. This study suggests that technology or practice change can be influential in changing the incidence of specific health conditions.

2.6. Prevention initiative risk assessment document and training development

Following the review of farm accident and ill health data, particularly from Irish sources, the task in-hand for the PI steering committee was to firstly develop the pilot RAD for assessment in the pilot phase of the project to be undertaken during January to March 2006 and was based on the evidence from Irish data on fatal and serious injury and ill health. The pilot RAD, which was developed, is provided in Appendix 1.7. A central finding of the review undertaken was that the farm operator is the manager of both the physical workplace and practices on the farm as regards OSH and accordingly for the RAD to be of value it must provide farmers with a functional tool to assist with OSH management.

As Murphy (1992) described the ‘farm safety – risk paradox’, whereby farmers know the risks but do not take action to mitigate these risks, the Prevention Initiative steering committee were aware that supplying the pilot RAD to farmers on its own was not likely to be the optimal approach to gain OSH adoption. The steering committee were also aware of the relative success of the ‘West Jutland study on Farm Accidents’ (Rasmussen et al., 2005) which used short training in association with a Risk Assessment document and an OSH advisory audit and the committee accordingly decided to include a short training and follow-up extension component in the PI to accompany usage of the pilot RAD.

To seek to gain the maximum value from the assessment components of the Teagasc/H.S.A. PI both change and learning theory which are associated with OSH are reviewed in the next chapters, so that knowledge gained can be used to assist with interpretation of the results of the study, drawing conclusions and making recommendations from this study.

Chapter Three

OSH behaviour and its change

3.1. Introduction

The aim of this chapter is to review theory and approaches related to securing change related to adoption of OSH practices on farms. The purpose of this review is to assist with devising practical OSH training and advisory strategies to support RAD and COP implementation. In this chapter firstly, behavioural theory is reviewed including those related to regulation, risk perception and risk taking and then culture and its change are reviewed. This is followed by a review of the role of use of knowledge in gaining behaviour change. Then the Transtheoretical Model of Change (TMC) which is the predominant model associated with behaviour change is outlined and a series of theories, from various disciplines including communications, behavioural change and social cognitive change are reviewed related to their roles in behavioural change and are associated with the various stages of the TMC model. Following the review of each set of theory, their application to agricultural OSH behavioural change will be examined.

3.2. Behavioural theory

Human behaviour and its change have been defined as 'the product of individual and collective human action, occurring within and influenced by their structural, social and economic context. These actions produce observable social, cultural and economic patterns which limit or enable what individuals do. Behaviour change includes coordinated attempts to promote or support change and can include: policy, communication and education, technologies and making resources available' (NICE, 2007, p.10). Thus it is apparent from this definition that human behaviour and its change can potentially be influenced by a broad range of approaches. In the first sub-section of this chapter, theory related to behaviour will be explored as follows: firstly, regulatory theory is examined; secondly, risk perception and risk taking behaviour and then the role of culture will be examined.

3.2.1. Regulatory theory

Regulation has been described as 'sustained and focused control exercised by a public agency over activities that are valued by a community' (Selzniek, 1985). Gormley (1998) pointed out that regulatory agencies are generally under legislative control and thus are part of the democratic process and obtain their authority from legislation. In regulatory theory, public interest predominates as the justification for regulation. This is because uncontrolled conditions could lead, for some reason, to failure to produce behaviour in accordance with the public interest, for instance, unsatisfactory OSH (Baldwin and Cave, 1999). Private interest theory also exists whereby individuals or groups are motivated to maximise their self-interest, by seeking to structure a regulatory framework in their interests.

Gormley (1998) stated that regulatory scholars distinguish between two models of enforcement 'deterrence' and 'bargaining' and Ayres and Brathwaite (1992) considered that programming for successful regulation should establish a synergy between persuasion and punishment. These authors elaborated on enforcement strategies by considering the various approaches as a 'pyramid' with equal sides which consecutively has the following layers: self-regulation, enforced self-regulation, command regulation with possible sanctions or punishments associated with each layer. These authors consider that programming for successful regulation should be based broadly on the allocation of resources in terms of time and effort in proportion to space allocated for each strategy in the regulatory pyramid.

Research in Ireland indicates that farmers' opinion was divided on farm inspection as a regulatory approach, which had been in place since 1989, McNamara and Reidy (1997) reported that the majority of farmers (50.7% agree; 34.7% disagree) favoured farm inspections. In the U.K. where an OSH regulatory system had been in place since 1974, Knowles (2002), found farmers preference was for more OSH advice (74% favoured) than regulatory approaches. However, also in the U.K, Gerrard (1998) found that 66% of farmers would not seek advice from the OSH regulatory authority and Knowles (2002) also noted the concern of U.K. farmers in seeking advice from the OSH regulator. This author proposed building a 'Chinese Wall' by splitting inspectoral and advisory functions of the regulatory authority to encourage greater farmer advice seeking.

Working in Australia, Grunningham (2002) conducted a comprehensive review of OSH regulation in the Agriculture sector with a view to determining the optimal policy mix to gain OSH improvement. Moreover, the OSH legislation in this jurisdiction is similar to that in Ireland. This author considered that farmers must know of the existence of regulatory instruments, without which they have very limited effect. He also saw the greatest challenge as not developing appropriate information but rather that it is 'effectively disseminated, read, digested, and implemented'. Grunningham (2002), furthermore, considered that the 'right people', which he considered as trusted sources must disseminate OSH information so that it is received by the target audience, and delivered in a face-to-face fashion, while OSH information must be sector specific, emphasise practical solutions and its delivery must be effectively coordinated. He advocated developing codes of practice as, he considered that small enterprises often require much more specific guidance on OSH requirements than their larger counterparts and such codes can provide an effective way to provide practical guidance on how to achieve compliance.

Regarding enforcement, Grunningham (2002) considered that where advice, training, education and information provision proved insufficient and the risks remained high, that 'enforcement' (including prosecution for the most serious cases) may be the only remaining tool capable of sending a strong moral and deterrent message about the importance of safety'. A more comprehensive review of regulatory theory is provided in Appendix 3.1.

3.2.2. Perception of risk and risk taking

This section reviews literature on the perception of risk and risk-taking as a means of moderating behaviour related to risk, seen as central to making progress with OSH. Slovic (1987) considered that those who promote and regulate OSH need to understand how people think and respond to risk so that effective strategies can be developed. Also, OSH management involves the assessment of risks associated with a workplace so that its acceptability can be determined (Nelson, 2004). Three broad theoretical frameworks, which are interrelated, are found in the literature, one set on how humans perceive risk, a second one on risk-taking and the third relates to human traits related to risk-taking. These topics are now reviewed.

3.2.2.1. Risk perception

Research indicates that people have poor risk-related judgements which are frequently identified as being both *ad hoc* and subject to various biases (Slovic 1987; Dunne, 2000). This is so because of the human difficulty in making judgements involving probabilities (Glendon 1999; Dunne 2000, Nelson, 2004). As a cognitive alternative to rational consideration of risk level, lay people (i.e. people with no formal training in risk assessment) develop ‘heuristics’ which Dunne (2000) described ‘as imprecise and subjective’ rules used by people to aid their decision making.

Dunne (2000) identified the following biases of lay people not skilled in objective risk assessment: **availability bias** - overestimate the probability of an easily recalled event; **imaginability bias** - overestimate the probability of events which are easily imagined,; **representative bias** - give greater emphasis to a small number of instances of an event that a person knows-of than to factual information; **confirmation bias** –people focus-on and process information that supports their current belief about a topic; **positivity bias** - people have difficulty reasoning in negative terms and accepting such data; **anchoring** - how information is presented affects subsequent perception of risk; **optimistic health bias** whereby people have unrealistic optimism about their health has been identified by Weinstein (1987).

Slovic (1987) further outlined that when judging whether a situation is hazardous, lay people (i.e. non experts) generally use two criteria **– ‘dread risk’** and ‘**unknown risk’** as follows: dread risk refers to the perception of risk based on how controllable/uncontrollable of the occurrence is and how irreversible, catastrophic or fatal the consequences appear and also whether a person has achoice in engaging in the risk; **unknown risk** refers to the extent to which the hazard is observable and its effects are immediately exposed. Slovic (1987) considered that the higher the dread and unknown risk, the more people want to see the risk reduced and the more they want strict regulation enforced to achieve reduction of risk. A consequence of Slovic’s work on risk perception is that people tend to see ordinary items such as tractors and farmyard tidiness as obvious and non-hazardous. The view of Slovic (1987) is supported by research which indicates that farmers’ perceptions of accident causes are inaccurate (Australian Safety and Compensation Council, 2006; Durey and Lower, 2004; Knowles, 2002; Murphy, 2003; Sandall and Reeve, 2000). Specifically in the U.K., Knowles (2002) found considerable discrepancies in the actual and perception of risk of a fatal injury among farmers.

Slovic (1987) stated that quantitative risk estimates expressed in some uni-dimensional index such as ‘probability of injury or death’ are not very satisfactory in their own right as lay peoples’ perceptions and attitudes are formed by ‘tangible’ quantitative and qualitative characteristics of objects and activities. Sandman (1987) further stated that people respond to ‘outrage’ rather than risk which is made up of **voluntariness –** voluntary risk is more acceptable; **control** - when prevention is in a person’s hands, the risk is perceived to be lower; **familiarity** - familiar risks provoke less outrage; **diffusion** - where incidents are dispersed it provokes less outrage. A further study of the factors involved in risk perception by Sjőberg (2000) indicated that a person’s attitude and its relationship to beliefs and values (Fishbein and Ajzen, 1975) is a crucial determinant of risk perception. Sandman (1987) considered that communicators must work to make serious hazards more outrageous and minor ones less so to communicate actual risk effectively.

Hale and Glendon (1987 cited by Saari, 1990), considered that ‘risk perception’ in people should be triggered by danger signals rather than by being constantly present as they considered that: ‘being constantly conscious of danger is a reasonable definition of paranoia’. These authors considered that in OSH learning programmes related to risk, highlighting specific danger signals is important so that people can switch over to a more conscious approach against danger than coping automatically.

The literature reviewed has indicated that peoples’ OSH risk perception is likely to be subjective and needs to be informed. OSH preventative approaches should clearly communicate factual information in a motivating manner.

3.2.2.2. Risk taking behaviour

Glendon (1999) considered that individual risk appraisal is strongly influenced by each individual’s unique experience and this author upgraded an earlier model (Hale and Glendon, 1987) of individual behaviour in the face of danger to include both emotional and rational aspects of risk taking. This model indicates that so called ‘cold’ or rational and ‘hot’ or emotional cognitions impact on problem-solving and decision-making which leads to the output of the OSH behaviour. External and internal stimuli affect both types of cognitions. Saari (1990) also commented on the emotional aspect of risk taking and how people's feelings and emotions impact on perceptions and decision making related to OSH at an individual and society level.

Wilde (1994) developed the Risk Homeostasis Theory (RHT) which is applicable to occupations where some level of autonomous control applies e.g. road transport and self-employed farming. The RHT proposes that the unique determinant of accident loss is not the level of risk within the environment, but the target level of risk desired by individual operators. Within a population, an individual's level of target risk is influenced by the relative benefits and penalties expected from risky and cautious behaviour. In choosing safety behaviours, individuals balance target risk with their estimates of the benefit of accident counter measures (i.e. engineering controls) and perceived accident risk. RHT acknowledges that risks are taken for some purpose or benefit, including the thrill or challenge of certain forms of risk-taking activity. Behavioural changes are most likely to be made by adjusting the relative benefits and penalties expected from risky and cautious behaviour, rather than adjusting the risk levels within the environment, which tend to be compensated for as for example, a perceived better motor braking system permits a motorist to drive faster.

In parallel to the RHT, the Theory of Risk Compensation (TRC) has been postulated by Adams (1995) which primarily explains accidents as a function of the human propensity to take risks. Individuals exhibit large variations in this propensity and Adams (1995) suggested that safety interventions which do not influence this propensity are likely to be frustrated by behavioural responses that reassert the level of risk with which people were originally content. Hedlund (2000) added that people can apply the TRC to consume at least some of the increased safety as performance, e.g. drive faster to save time .

Research on risk-taking has consistently shown that people accept a higher level of risk for themselves than for others when there is a voluntary aspect to the situation such as road transport and self-employed farming (Dunne, 2000; Fischoff et al., 1978; Glendon, 1999). Dunne (2000) considered that this is because choice gives people a sense of having control over the situation, thus reducing the level of perceived risk and dread risk. Regarding gender difference with risk-taking, a meta-analysis by Byrnes et al., (1999) clearly supported the proposition that males are more likely to take risks.

In summary, the literature on risk-taking adds to that of risk perception and reveals that there is both a cognitive and emotional dimension to risk-taking. People operating in a voluntary manner are more inclined to take risks than those under supervision. Persons take risk for a ‘benefit’ which suggests that pointing to the ‘losses’ associated with unnecessary risk-taking could be a strong potential motivator. Also, the review indicates that people can adjust their risk taking propensity and the risk environment in which they operate. The review of risk-taking supports the previous review which indicated that objective and clear communication is central to both reducing risk taking as well as improving risk perception.

3.2.2.3. Personal traits associated with OSH risk factors

It must be borne in mind that every person is an ‘individual’ and that variation is likely to exist in the way people within a population deal with OSH (Dunne,2000). Individual persons have certain intrinsic ways of thinking which affects the way they relate to OSH risk such as their perceptions and biases, as discussed in the previous section. This section reviews the influence of individual risk factors including accident proneness and personality on the implementation of OSH. A further more comprehensive review of such risk factors and OSH is available in Appendix 3.2.

Dunne (2000) reported that personal ‘accident proneness’ thinking has been superseded by that of ‘accident repetition’ in the literature. This shift suggests that accident involvement is a transient state miss-match between the person and the work-environment situation rather than being an innate personal trait and suggests that prevention strategies may be effective in achieving injury reduction. Dunne (2000) considered that the following five aspects of personality style influence accident repetition: Locus of Control (LOC); Behavioural Awareness; Anxiety/ Self-Confidence; Extroversion and Distractibility. Hansen et al., (1988) noted that ‘membership’ of the ‘accident repeaters’ group changes over time and Dunne (2000) considered that age related maturity leads to reduced ‘ accident repetition.

Regarding **personality**, Geller and Wiegand (2005) stated that the so-called 'big five' personality factors are relevant to OSH. These five personality categories are; extraversion (broad interests versus narrow interests), neuroticism (calm versus worry-some), conscientiousness (achievement-orientated versus aimless), agreeableness (helpful versus uncooperative) and openness to experience (imaginative versus unthinking) with the former expression of the trait being associated with higher levels of OSH performance. These factors were reported to remain relatively stable over an individual's lifetime and are generalisable across cultures (Costa et al., 1992). Geller and Wiegand (2005) considered that as up to 50% of individual differences in personality are heritable, that potential alteration in personality traits can occur over-time if persons are exposed to an environment which positively develops these traits.

Intelligence (I) is considered to be a broad and deep capability for comprehending ones surroundings (Gottfredson, 1997)**.** Intelligence is variable within a population and generally affects performance, possibly including OSH but this research sourced no study linking intelligence and OSH performance. **Emotional Intelligence (EI)** describes the ability, capacity, skill or a self-perceived ability, to identify, assess, and manage the emotions of one's self, of others, and of groups (Bradbury and Greaves, 2005). Mayer and Salovey (1997) developed a hierarchical model in pyramidal format showing the various levels of complexity associated with EI skills. From the base, the following levels occur: reception, appraisal and expression of emotion; emotional facilitation of thinking; employing emotional knowledge with emotional regulation at the top of the pyramid. The hierarchy suggests that EI has considerable implications both for receiving and giving OSH communications. **Temporal Awareness (TA)** is an operator's 'level of awareness of recent events and awareness of what could happen next' (Grosjean and Terrier,1999). . TA reflects the importance of time in all human interactions with environments and the requirement for anticipatory behaviour (Rantanen, 2008). These authors found that the presence of TA is a good indicator of performance in terms of reduced errors; however, they found that developing a learning support system for TA was largely ineffective suggesting that it may be an innate characteristic. This brief review of the limited literature available on I, EI and TA indicates that these personal traits may impact on OSH implementation by individuals. .

In conclusion to this sub-section on risk-taking, the literature reviewed indicates that peoples' OSH risk perception is subjective and needs to be informed. OSH preventative approaches should clearly communicate factual information in a motivating manner. People operating in a voluntary manner are more inclined to take risks than persons under supervision. People can adjust their risk-taking propensity and the risk environment in which they operate based on communications received. Personal traits are variable in a population, but when the right stimuli occur, positive changes supportive to OSH can be made over time.

3.2.3. Culture and its implications for OSH behaviour

Culture is the characteristics of a particular group of people, defined by everything from language and social norms. Thu (1998), from the perspective of a cultural anthropologist, considered culture as the 'shared set of values, attitudes, and behaviours that shape the collective order of any given society'. This author cautioned that there is a considerable social dimension to culture and for instance, health behaviour, is inextricably linked to social relationship: namely how people relate to and, identify with, each other.

Much research on culture relates to 'organisations' referring to those with hierarchical structures. However farming is made up of small units which are formally and informally inter-connected within larger units (e.g. co-operatives, farming organisations, extension services, regulatory systems) and thus culture theory is applicable, in some respects to the sector.

Glendon and Staunton (2000) suggested that safety culture refers to the underlying beliefs and convictions, including OSH, while climate is a more superficial term reflecting the current position within an organisation.

McCarthy (1998) cited the behavioural components of culture identified by Spindler (1955) as 'patterns of behaviour, both explicit (obvious) and implicit (inferable from behaviour) which are shared by a group of people and transmitted to new members'. McCarthy (1998) considered that culture can be viewed as represented in the cognitive maps, motivations, perceptual structuring, affective controls and ego defences of individuals in a social group. In drawing attention to the complexity of the interrelationship between societal culture and organisational culture, McCarthy and Winters (1995) pointed to evidence which suggests that cultural values significantly influence attitudes and behaviour within organisations.

Cooper (2000) produced a framework which distinguishes between three interrelated aspects of culture as follows: psychological, how people feel about the culture (beliefs, attitudes, values and perceptions); behavioural, what people do (safety related activities, actions and behaviour); situational, what the organisation has in place (policies, procedures, systems etc.).

A review by Courteney (2006) provided strong evidence that men who endorse dominant norms of masculinity adopt less health-promoting behaviour than men who do not hold such beliefs. Harrell (1986), in Canada also found that male farmers who endorsed the dominant norms of masculinity were less likely to minimise the likelihood of accidents resulting in consequent injuries. One profile characterised a group of Irish managers as having: a potential for risk taking; high ‘individualism’ which emphasises individual actions rather than involvement in supportive groups and a ‘high’ degree for masculinity (Hofstede, 1984). In an Irish context, Ní Laoire (2001) found evidence that hegemony (privilege among men by associating them with particular forms of power) persisted among rural men despite adaption and change, and in her study related to rural stress/suicides suggested that the process of change needed to be considered.

This short review of culture and behaviour indicates that safety and programmes to make positive change need to have a strong cultural dimension. Safety culture should not be considered in isolation, it is just one element of a much larger organizational culture (Health and Safety Laboratory, UK, 2002).

3.2.3.1. Farmer culture related to OSH

A number of studies in Ireland and internationally (Knowles, 2002; Seiz and Downey, 2001; McNamara and Reidy, 1997; Fallon and Michail, 1988) have indicated that farmers generally are broadly in favour of farm OSH. In Ireland, McNamara and Reidy (1997), found that 74% of farmers (85% of modern farmers) considered that safety was a major part of farm management, while Kelly (2004) found that farmers ranked ‘health’ third in importance and gave it a ranking close to ‘maximising profit’ and ‘improving quality of life’. In contrast to this broadly positive attitude to OSH, several studies (Knowles, 2002; Finnegan and Phelan, 2003) indicated considerable non-implementation of OSH controls by farmers. Thus the review indicates that the predominant deficiency in farmer behaviour generally relates to actually putting OSH measures into place or practice rather than to poor attitude to the issue.

The more or less exact situation in Ireland where a general positivity to OSH exists among farmers on the one hand and limited adoption on the other has close similarities to the work of Rich (1999) in Australia. Rich (1999) considered ‘the desire to undertake action to create a safe working environment and work practices’, which he termed ‘outrage’, as the missing stimulus necessary to improve OSH. He cited the work by Wigglesworth (1995) as stating that ‘if this stimulus can be located and modified, the risk of further error and hence, of injury or damage can be reduced’. Rich (1999) further considered that acceptance of unsafe work practices is based upon a farmer’s perception of risk and thus ‘outrage’ is also dependent on farmer’s perception of risk. He cited work by Sandall and Reeve (1997) which indicated that perception of risk by farmers correlates directly with their willingness to take preventative action. Rich (1999) considered that the following components contributed to farmers perception of risk: the likelihood of injury; ease of hazard controllability; financial consequences of controls and losses; the potential to impart hazards on other people on the farm. He further stated that there is evidence which demonstrates that farmers from different farm systems (referred to commodity groups in Australia) perceived risk differently.

Seiz and Downey (2001) suggested that OSH professionals should focus on the important and immediate OSH factors based on a realistic appraisal of the threat and consider that they acknowledge that production and OSH risks are inherent in farming and that most farmers sometimes act in a way that is ‘carefully non-compliant’ to get the job done.

3.2.4. Summary of review of theory related to risk taking behaviour

This review indicated that regulation is an important platform for building an effective OSH programme. However on its own, regulation is unlikely to provide the complete solution for a self-employed and dispersed sector such as the agriculture sector. Regarding risk perception, the literature indicates that this is subjective in lay persons compared to OSH experts. Both risk perception and risk-taking can be positively changed by factual and persuasive communications. The review of the theories of Risk Homeostasis and of Risk Compensation indicated that potential exists to facilitate persons to adjust their risk taking propensity and the risk level of their work-environments. The literature reviewed on personal factors such as intelligence and personality traits indicated that potential exists to positively modify some of these over time. The wide variation in personality traits is also likely to lead to variation of uptake of OSH initiatives.

Regarding culture, the review indicates that this is largely socially constructed, and has a powerful influence on OSH adoption. Possible characteristics of societal culture in Ireland and among farmers include a propensity for ‘risk-taking’ and ‘masculinity’ which could work against OSH adoption. The review indicated, however, that farmers in Ireland were broadly positive to farm OSH which is a hugely positive asset to support making OSH progress but change programmes must be aligned with farmer thinking and culture to succeed. A key limitation identified is the challenge of converting the positive attitude among farmers to practical OSH implementation in line with those specified in the RAD and COP.

The literature review now moves on to examine behaviour change theory to inform strategies to be tested in this study to effect adoption of OSH among farmers.

3.3. Behaviour change theory

This section commences with an examination of the role knowledge transfer plays in behaviour change related to OSH. This is an obvious starting point following the development of the RAD and COP documents as these aim to provide the information necessary to assist farmers effectively manage OSH on their farms. The section, having identified limitations of information provision as the sole means of effecting change, reviews change theories including communication, persuasion and behaviour change in an integrated manner.

3.3.1. Knowledge transfer associated with OSH

According to Schrader and Lawless (2004) the cognitive domain of learning is concerned with knowledge and understanding. Within this domain, knowledge embodies all information that a person possesses or accrues related to a particular field of study. Knowledge is more than just a simple foundation for the acquisition of new knowledge, as knowledge directs a person's attention to either discount or focus on particular elements in their environment and it allows a person to make inferences and perceive the meaningfulness of new information.

Traditional models of learning proposed that knowledge gain precedes attitudes, which in turn influence behaviour in the so-called 'knowledge-attitude-practice' (KAP) approach (Valente et al., 1998; Weiss, 1997). This KAP approach, suggests that when people gain sufficient knowledge, they form or attain the appropriate attitudes and beliefs which in turn leads to practice adoption. Valente et al., (1998) stated that the KAP process has its origins in both Social Learning Theory (SLT) (Bandura, 1986) and the Theory of Diffusion of Innovations (TDI) (Rogers, 2003) both of which are reviewed in this study at sub-sections 3.2.2.3 and 4.3.2 respectively.

Valente et al., (1998) acknowledged that several meta-analyses (Ajzen and Fishbein, 1980; Kim and Hunter, 1993a, 1993b; Petty and Cacioppo, 1981) of attitudinal and behavioural relations have overwhelmingly supported the KAP proposition that attitudes, behavioural intentions, and behaviour are highly correlated and virtually all behavioural change studies treat behaviour as the outcome variable to be predicted. However, Valente et al., (1998) felt that due to a preoccupation by researchers with the KAP approach 'other facets of the behaviour change process before attitude and knowledge change have taken place have been overlooked' and they raised the possibility that knowledge and attitudes may change after a person has had experience of a practice and not before it. However, having researched the six possible behaviour change sequences related to KAP and knowledge transfer (in a fertility control study in a developing country), Valente et al., (1998) found strong evidence to support use of the KAP learning model for technology/practice adoption. However, Valente et al., (1998) pointed to research that has shown that both a 'knowledge-gap' (Tichenor et al., 1970) and a KAP-gap (Westoff, 1988) exist. The 'knowledge-gap' hypothesis holds that as information disseminates it will be unevenly distributed between SEGs based on access to information sources. The KAP-gap occurs in the uptake area between knowledge gain and practice uptake.

The KAP-gap has been particularly identified in the area of improving OSH (Heinrich, 1941; Geller, 1996) and in agricultural OSH (Aherin et al., 1992; Dario and Rautiainen, 2000; Merchant et al., 1989; Murphy, 2002; Lewis et al., 1998). This relative ineffectiveness of the KAP as has been described by Murphy (2002) as the 'farm safety – risk paradox', whereby farmers know the risks but do not take action to mitigate these risks. A study by Elkind (1993) on safety awareness and associated behaviours concluded that taking precautions appeared to be unrelated to knowledge of hazards. Hornik (1989) stated that 'the central theoretical problem in the field of purposive communication is explaining the gap between knowledge and behaviour'. Colémont and Van den Broucke (2006) in pointing to the disappointing results of initiatives to improve agricultural OSH suggested that one reason for this may be that the initiatives are often aimed just at raising awareness and increasing knowledge rather than seeking some behavioural change. These authors pointed out that scientific literature is available (e.g. Armitage and Connor, 2000; Glanz et. 1997; Norman et al., 2000) to indicate that 'enhancing knowledge and creating awareness or knowledge is not always necessary or sufficient to change behaviour'. They argue that, by making use of knowledge available regarding the contribution of behavioural determinants to influencing specific OSH behaviours, that more effective interventions could be developed.

Schrader and Lawless (2004) also cited recent research which indicates that the interaction of knowledge, attitudes and behaviours is both complex and dynamic (Alexander and Dochy, 1985; Ajzen and Fishbein, 1977; Bouvold, 1990; Kim and Hunter, 1993; Kirby, 1985). As Schrader and Lawless (2004) explained: 'from one perspective, what an individual knows may inform their attitude about a topic, and how they feel about a topic may influence behaviour. Alternatively, attitudes can be aligned with behaviour, indicating that behaviour can inform attitudes (Fishbein, 1967). Thus attitudes can impact on what an individual perceives and therefore impacts on knowledge gains. Furthermore, knowledge or attitude, for that matter, is not necessarily a strong predictor of behaviour alone (Ajzen and Fishbein, 1977; Beavers et al., 1982). Taking all these arguments into account, one may conclude that the relationship between these dimensions - knowledge, attitude and behaviour - is dynamic and can sometimes be reciprocal. Thus Schrader and Lawless (2004) advised that it is 'beneficial and prudent to conduct research (related to knowledge, attitude and behaviour) from the perspective that these three dimensions can and do interact'.

Röling (1988), from an agricultural extension perspective, considered the processing of 'information' into 'knowledge' as the decisive step in gaining 'cognition' which is an attribute of the mind and is the outcome of lifelong information processing, storage and retrieval going on in a persons' neurophysiological system. This author considered that translation of information into knowledge occurs when a person is confronted with a decision and all the information available to the person is then processed and transformed into knowledge in making the decision, which ultimately reduces the uncertainty in the mind of the person. This line of thinking goes some way to explaining why information on its own is not sufficient to change attitudes or behaviour, as persons need to be 'confronted' with an actual challenge for cognition to occur. Röling (1988) stated that knowledge, once gained, can be shared and accumulated in social groups. Van den Ban and Hawkins (1985) concurred with Röling (1988) and considered that learning or 'cognition' occurs after such mental actions as observing, and analysing information related to a problem and reflecting then on the outcome which further develops a person's on-going 'cognitive map'.

In summary, this sub-section indicates that while knowledge is an important component of behaviour and change, it works in association with other behavioural determinants.

3.3.2. Transtheoretical model of change (TMC)

Slater (1999) considered that the TMC (Prochaska and Di Clemente, 1983) model has become increasingly influential in the health communication field, where it hasevolved to give a better understanding of behaviour change. The TMC model provides the framework for integration theories of media effects, persuasion and behaviour change described in Figure 3.1. The TMC model describes the phases a person goes through in changing behaviour commencing with a move from a **pre-contemplation** stage where a person is not aware of the problem and has no intention to change behaviour to a **contemplation** phase where the problem is acknowledged and one is willing to change in the not-too-distant future but have not committed themselves to taking action. The **preparation** stage is a transitional stage in which people have begun to experiment with or attempt the relevant action and are intending to try the action again but have not yet successfully modified their own behaviour. In the **action** phase, intention is turned into action and successful behaviour change has taken place for some specified period of time. When the new behaviour persists for a sustained period the final stage, **maintenance**, is reached and when in it people have the ability to maintain behaviour change. Prochaska, DiClemente and Norcross (1992) pointed out, however, that the paths through the stages-of-change do not run smoothly, relapse at each stage can occur, and progression moves in a spiral rather than a straight line and when relapse occurs the person returns to an earlier phase of the TMC.

Slater (1999), when considering the planning of communications campaigns to change health behaviours considered the central problem to be to identify and apply the appropriate communication, persuasion, and behaviour change theories to overcome obstacles to behaviour change. Slater (1999) considered that the TMC model (Prochaska and Di Clemente, 1983; Prochaska, Di Clemente & Norcross, 1992) provides a framework for integrating the various theories of media effects, persuasion and behaviour change (Figure 3.2). He also considered that these theories can be complimentary and are not competing and because their foci and boundary conditions are different, they can be useful in solving different kinds of potential communications problems which could be encountered at various stages of the TMC model of change.

The approach advocated by Slater (1999) is followed from now on in this review to review of the TMC model of change and theories of communication, persuasion, behaviour and socially motivated change within an integrated framework. This is done because the approach provides the study with knowledge from four major contemporary change theories in a unified manner. Given the broad nature of the study subject this approach was considered as superior to focusing on just one or on a limited set of theories. The approach to examining the study subject matter, namely OSH adoption by farmers in a broad way is also justified by the fact that few studies have been published which give guidance on the best approach to adopt (DeRoo and Rautiainen, 2000). Accordingly examining the theories available in a broad and integrated way is suggested as potentially the best way of adding to knowledge in the area of this research. By adopting this approach, a greater range and quality of evidence was likely to be available which could be used to assist with construction of the study theoretical framework and with interpreting the study findings and drawing conclusions. The approach adopted may permit possible follow-up with a particular theory or set of theories later when the study findings become available. Thus at this stage of the study it is considered important that both a width and depth of knowledge sources be available to inform the subsequent research.

3.3.3. Theories related to communications

Use of media communications is now reviewed regarding its role in promoting OSH. Slater (1999), in his framework (Figure 3.1.) suggested that communications aimed at bringing about change in a target population should match the stages-of-change model and be used to commence the process of movement from the pre-contemplation to the contemplation stage on the TMC. Slater (1999) cited the work of McGuire (1989) who described the process of gaining attention and recognition for an issue requiring communications attention. Grunig's Situational Theory (Gruing, 1978; Grunig and Hunt, 1984), from the public relations field, identified the necessity of achieving problem recognition among one's intended audience as 'the extent to which individuals recognise a problem facing them' where people start thinking about a situation where they perceive that something needs to be done to improve the situation. Slater (1999) also cited 'agenda-setting' described by Shaw and McCombs (1977) as the powerful influence of the media in telling target populations what issues are important such as OSH. Slovic (1987) noted the importance of the news media in forming people's 'perceptions of risk' by developing peoples experience with hazards by reporting on mishaps and threats occurring throughout the world.

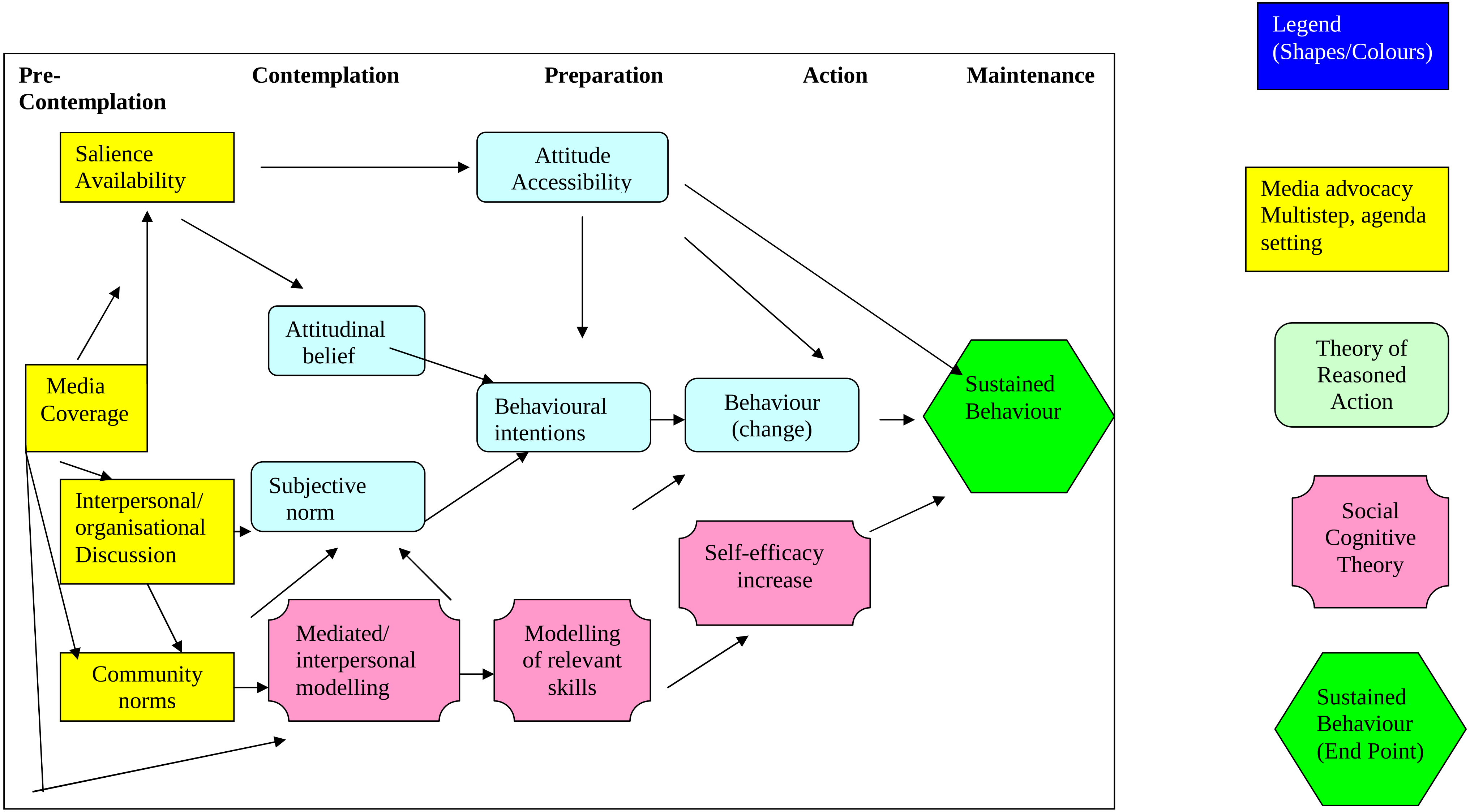

Figure 3.1. Framework for integration of Change Theories with Stages-of-Change Model

Source: Slater (1999)

Media, however, does not work on its own and its influence can be greatly amplified by opinion leaders. Slater (1999) cited the ‘multi-step flow theory’ (Katz and Lazarsfeld, 1955; Tichenor, Donoghue and Olien, 1980) which asserts that information from the media moves to opinion leaders who pay close attention to media messages. Opinion leaders then pass on their own interpretations of the media content. Opinion leaders have the characteristic of being influential in facilitating people to change their attitudes and behaviours and have similar demographics to those they influence. A media dependency hypothesis outlined by DeFleurand Bal-Rokeach (1989) suggested that an individual’s media dependency may be a major predictor variable to assess information effects on a person’s opinions and/or behaviour, with the higher an individual’s dependency on a specified medium, the more likely they will be influenced by the information carried by this medium.

In the field of agricultural extension, the TDI (Rogers, 1983 and 2003) has been a leading theory where an innovation is defined as ‘a new idea or approach’. According to Rogers (2003) the four main elements in diffusion are **Innovation, Communication Channels, Time** and **Social Systems** and he considered that to reach a rural audience, mass communicators must understand how to blend appropriate messages, communications channels and social systems.

Slater (1999) asserted that while media coverage increases issue prominence and availability in the minds of audience members, it also does more by stimulating discussion between friends, family, work colleagues and neighbours and is likely to influence perceived social norms and expectations concerning behaviour.

However, use of media for mass communications has limitations as Rogers (2003) showed, quoting the work of Bass (1969). The Bass Model of forecasting the rate of adoption of a new product suggests that adoption due to mass media alone drops off relatively early in the adoption process, whereas adoption due to interpersonal communication accelerates and drives the adoption process further. Thus, mass media on its own will achieve limited adoption without interpersonal communication follow-up.

3.3.3.1. Appraisal of public information campaigns related to farm safety

Rodrigeuz et al., (1997) conducted a review of the conceptual and theoretical framework of designing a public farm safety campaign concerned with equipping the target farm population with 'prevention competence' or the ability to prevent farm accidents. These authors cited studies by Mc Guire (1969); Cialdini et al.,(1981) and Solomon (1981) which suggested that prevention competence is likely to increase when farmers: (1) are more fully aware of effective prevention techniques; (2) hold positive attitudes about the effectiveness of self-initiated prevention activities and about their own responsibility for getting involved in prevention; (3) feel capable of carrying out actions themselves that reduce their chances of injury; (4) are concerned about protecting themselves and others from farm injuries; and (5) actually engage in actions aimed at reducing farm injuries. To achieve prevention competence, Rodrigeuz et al., (1997), considered that persuasion requires at least the following four-step process: (1) the building of awareness or knowledge; (2) the inducement of attitude change; (3) motivating individuals towards desired behaviour by generating interest and concern; and (4) effecting desired behavioural changes. They acknowledged that this sequence has a 'nice logic to it' but that in practice, campaigns probably have 'scattershot' influences on various types of farmers including personal characteristics, workload, type of operation and financial characteristics.

Rodrigeuz et al., (1997) assessed the impact of a major safe farm public safety communication campaign produced by Iowa State University (ISU) extension. The evaluation of the Iowa Safe Farm public health communication campaign identified both information and media sources used by farmers. Regarding sources of safety information, a survey revealed that: 95% of respondents received this information from newspapers/magazines; 82% from radio; 77% from television; 59% relied on ISU extension and 33% on ISU extension staff. The survey data revealed that farmers tended to organise information by 'who' provided it rather than 'how' the information was delivered with the following being the four major sources: extension; dealers, producers and suppliers; the media; and friends, neighbours and family. Information gained from media sources significantly increased concern about safety hazards and increased awareness, concern and behaviour computed from before and after surveys.

Wadad et al., (1998) in a survey (n=96) among male farmers in Missouri reported that farm magazines (62%) and information supplied by farm equipment dealers (45%) and chemical dealers (38%) were the major sources of information used for learning about personal health and work safety. However, the most frequent source of learning information was the farmers personal experience (68%), with family doctors (40%), neighbour (23%), spouse (20%) and other family members (10%) being the other personal sources. County extension agents (11.5%) were the most frequent source of information from government sources. Oskam (1995) in a study of Oklahoma farmers found that magazines (43%), television (38%) newspapers (15%) and radio (4%) were the most frequently used media channels. A survey of senior farmers over 60 years old throughout the USA by Whitman and Field (1995) also identified farm magazines (58%) as the most frequently used information source followed by farm television (24%), local newspapers (20%) and farm radio (18%). This study also identified equipment operator manuals (49%), safety decals on equipment (40%), talking one-to-one with knowledgeable people (33%) and agricultural fairs/machinery exhibits (26%) as frequent information sources. Limited use, however, was made of seminars, video tapes and brochures and books which were identified as information sources used in 15% of cases. In Iowa, Thu et al., (1990) also found that farmers commonly used magazines for OSH information and rated television/radio less highly than farmer magazines. They found that farmers also turned to the cooperative extension service for information on OSH issues and they also rated medical centres and veterinarians highly for integrity of information. Regarding believability of information among rural respondents in Texas, Oskam and Husdon (1999) found that television was the frequently used and most believable mass medium for news items.

3.3.3.2. Persuasive campaign messages

Morgan et al., (2002) conducted a review of the theories used to develop persuasive campaign messages and cited Narrative Theory (Bruner, 1986, 1990; Cole, 1997; Howard, 1991) and Dual Coding Theory (Paivio, 1978) as instrumental theories in developing campaign messages. Narrative theory states that since humans are primarily story tellers, people respond more favourably to messages when they are presented in a narrative framework (alternatively described as case studies, anecdotes or stories). The Dual Coding Theory has as its central premise that individuals possess two interdependent memory coding systems, one for language and the other for nonverbal objects and events with each system encoding and regulating the information for which it is adapted. This theory points to the utility of accompanying written or textual messages with illustrations because the information presented will be encoded in both language (semantic) and image (iconic) memory.

Morgan et al., (2002) also conducted a review of the persuasiveness of narrative versus statistics-based messages and found that most studies found that narrative based messages are more persuasive than statistics-based messages (Beasler and Burgoon, 1994; Cox and Cox, 2001) although this effect may be moderated by factors such as issue involvement or whether the audience agree or disagree with the position being advocated (Slater and Rouner, 1996). Slater and Rouner (1996) concluded that an audience favourably disposed to a message find the statistics-based message more persuasive while audiences more resistant to the message find narrative-based messages more persuasive.

Cole and his colleagues have used narrative theory to construct successful safety interventions to promote the use of ROPS among farmers in the USA (Cole et al., 1997; Cole et al., 1998). Research by Morgan and Cole (2000) indicated that narrative-based messages were more favourably evaluated than statistics based messages. Morgan et al., (2002) found that narrative-based messages (and messages that incorporate fear appeals, which will be reviewed later) are more favourably evaluated by farmers than messages that simply inform farmers of OSH messages. Morgan et al., (2002) considered the general superiority of narrative based messages comes from the fact that they take the form of a 'true story' from the lives of 'real people', while statistics-based messages rely on the 'law of large numbers' and rely on the experiences of a population than an individual case.

Schneider et al., (1974, cited by Saari, 1980) also suggest that triggering appropriate mental images is highly important for OSH, while a great problem is triggering the images that give the wrong message as regards OSH.

Wilde (1993) also conducted research on what makes a mass media communications safety message convincing and found that the communication requires perceived similarity with the advertisement characters, the need to express views that are held by message recipients, the need to be clear about the desired outcome and the need to catch the recipients' attention. In contrast, changing a persons' impressions about an issue, however, are likely to be far more challenging as Nisbett and Ross (1980) state that once an idea is implanted in a persons' mind it is difficult to dislodge, as evidence which contradicts a person's strong initial impression is dismissed as unreliable while evidence which supports a person's impression is considered reliable.

3.3.3.3. Social marketing

Social marketing which is defined by Andreasen (1995) as a planning framework that applies commercial marketing technologies to the analysis, planning, execution and evaluation of programmes to improve the personal welfare of the intended population. It aims to motivate the process of uptake of socially desirable practices such as OSH. It works to stimulate behaviour change by removing barriers and increasing motivators that exist in relation to the targeted behaviour.

Saari (1990) made the strong point that safety motivation could be more important than knowledge in gaining acceptance of standards and practices. He based this assertion on the premise that people have feelings and emotions and they respond much more positively when positive feelings are aroused rather than unpleasant ones. He contrasted conducting accident investigations, which trigger negative feelings with positive workplace developments. His work, for instance, indicates that those who have the perception that their job is interesting tend to develop their environment and work methods more. Saari (1990) cited the work of McAfee and Winn (1989) which found that positive performance feedback was successful in changing behaviour.

3.3.3.4. Communications using ICT

Information and Communications Technology (ICT) provides technologies with the potential to provide access to information and knowledge widely and at low cost. However, a United Nations (UN) report at the time of this study commencement found that while the development of ICTs had been impressive, that a 'digital divide' had developed with its uptake (UN, 2006). This digital divide has been found to be multidimensional at both access and 'ability to use' levels (Dewan and Riggins, 2005), where many factors such as age, education, social support or income influence ICT uptake and use. Regarding comparison with conventional methods, one study in Ohio U.S.A found that despite advances in ICTs and distance-based learning and on-line resources that printed information was the most preferred delivery system among extension professionals (Rodewald, 2001). Rodewald (2001) also noted that short courses, seminars and use of video all scored higher than printed or on-line material use on their own. This suggested that ICT-based learning systems have limitations as well as benefits. In Ireland, the 2006 National Farm Survey found that 15% of farmers nationally had computer access and 3.37% used the web for farm business purposes (Leveque et al., 2007). Based on the fact the COP documents to be developed were legal documents and the low usage of ICT by farmers at that time, the PI Steering Committee decided to produce documents in printed format and to use them in association with short training and then to assess the utility to farmers of these approaches. However, it was recognised that the option of adapting the legal documents for ICT usage at some future date was also available.

3.3.3.5. Conclusion for media and communications approaches

It is evident from the literature reviewed that media and communications approaches have a major role to play in promoting uptake of OSH standards and practices by farmers. Use of this approach targets a large population and can be cheap to implement. A range of media channels including TV, radio, press, magazines and ICT are available and now widely used to communicate with dispersed farmer audiences. The literature review indicates that successful media channels must be culturally close to the farming population targeted. The review also indicates that the message provider is important in gaining acceptance of the message, with professionals such as extension agents being highly rated. Communications messages become dispersed within populations by inter-person communications in families and among farmers and with relevant persons providing advice and services to farmers. Persons identified as ‘influential’ are particularly powerful in gaining acceptance of messages. Extension approaches can to used amplify and OSH communications messages. Regarding documents used in OSH communications, they need to be designed to be persuasive, using both narrative and statistical data presented in a lively format. Communications approaches supplying positive messages are superior in terms of motivation to negative messages.

However, it is clear from the literature review that communications and media strategies do not work fully on their own to gain OSH behaviour change. Thus behaviour change theories related to attitude and behaviour change will be reviewed in the next sub-section.

3.3.4. Behaviour change theories and their utility

Communications approaches, as indicated in the review in the previous sections, raise awareness of OSH as an issue in the target population which is instrumental to moving its members to the ‘contemplation’ or a further stage in the framework of change theories (Figure 3.1). The framework indicates that behaviour change theories have potential to move members of the population from ‘contemplation’, through ‘preparation’ and ‘action’ towards the ‘maintenance’ phase of the TMC. In the framework, Slater (1999) specifically used the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1974) as their central theory related to behaviour change. This theory and its successor, the Theory of Planned Behaviour (TPB) (Ajzen, 1991), have been highly influential in the field of gaining voluntary behaviour change. Numerous other theories, models and frameworks have been developed related to gaining voluntary OSH adoption which are listed as follows:

Behaviour-Based Safety (BBS) (Makin and Sutherland, 1994);
Elaboration Likelihood Model (ELM) (Patty and Cacioppo, 1979);
Health Belief Model (HBM) (Becker, 1974);
Protection Motivation Theory (PMT) (Rogers, W., 1975);
Cognitive Dissonance Theory (CDT) (Festinger, 1951);
Persuasive Health Message Framework (PHMF) (Witte, 1995).

A review of the TRA/ TPB is now undertaken and this is followed by a review of their application in agricultural OSH settings to consider what potential each one has to support this study. The remaining theories and frameworks are included in the summary provided in sub-Section 3.3.4.1.2 and a more detailed description of each of these is provided in Appendix 3.3.

3.3.4.1. Theory of reasoned action / Theory of planned behaviour

The TRA was formulated by Ajzen and Fishbein (1974) to explain human behaviour under voluntary control. It places attitude as an influencer of behaviour which is defined as ‘a learned predisposition to respond in a favourable or unfavourable manner to a particular person, object or idea’ (Eagly and Chaiken, 1993). The TRA proposed that a person's **behaviour** is determined by their **intention** to perform the behaviour and that this intention is, in turn, a function of attitude toward the behaviour and the **subjective norm** which is defined as a person’s belief about how people whose views they respect regard the behaviour. The TRA indicates that the best predictor of behaviour is intention which is the cognitive representation of a person's readiness to take an action, the immediate antecedent of behaviour. Intention is determined by three things: a person’s attitude towards the behaviour, their subjective norms and their **perceived behavioural control** or how much controls the feel that they have**.**

Eagly and Chaiken (1993) regarded ‘attitude’ as a ‘set of memories’ which link thought processes or ‘cognitions’ which activates an entire mental network of related memories to do with the object of the attitude. The ABC Tripartite Model of attitude described by Eagly and Chaiken (1993), considers that attitude has the following three cognitive components: **affective**, encompassing emotional reactions, positive or negative; **behavioural**, which is the intention to act in a way that reflects attitude, and a **cognitive** component referring to the beliefs and thoughts about the object of attitude. The three components can interact, for instance, emotions may affect behavioural intentions while beliefs can influence emotions.

The TRA was developed further by Ajzen (1991) to fill an identified gap between intention and behaviour with a new model the TPB which includes a new variable, **actual behavioural control**, referring to a personal efficacy to predict uptake of behaviour (Figure3.2.). The TPB holds that only specific attitudes towards the behaviour in question can be expected to predict that behaviour. In addition to having a measure of attitudes toward the behaviour, a measure of a person's subjective norms is required to predict behaviour. To predict someone's intentions and knowing these beliefs can be as important as knowing the person's attitudes. These predictors together lead to intention with more favourable attitude and subjective norm and greater perceived behavioural control predicting a person's intention to perform behaviour.

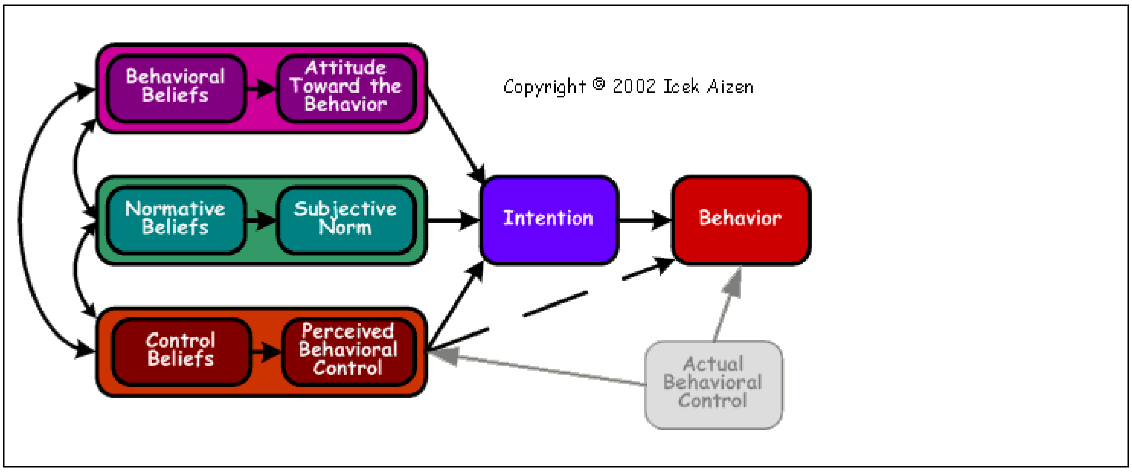

Figure 3.2: Theory of planned behaviour
Source: Ajzen, I. (1991)

3.3.4.1.1. Application of the TRA/ TPB, including agriculture

Regarding application of the TPB, a meta-analysis across 154 non-agricultural applications by Armitage and Connor (2001) found that the following three components: attitude, subjective norm and perceived behavioural control, in combination explained 39% of the variance. They also found that the combination of intentions and perceived behavioural control explained 27% of the variance across 63 applications.

In a study of the efficacy of a modified version of the TRA to predict adolescent students' behavioural intentions to safely operate farm tractors and machinery, DeBarr et al., (1998) found that behavioural intention correlated with attitude (0.60) subjective norms (0.65) and perceived behavioural control (0.61). Attitude and subjective norms explained 48% of the variance in students' intentions and adding perceived behavioural control increased this to 53%, with subjective norms being the single best predictor of intention. Petrea (1996) in a TPB study of the use of respirator masks among swine farmers explained 28% of the variance between intentions and self-reported behaviours to use a mask, with attitude (0.42) and subjective norm (0.37) correlated with intention to perform the safety behaviour while perceived behavioural control had a small negative correlation (-0.06).

Lee at al., (1997), in a TPB study related to Wisconsin dairy farm fathers' approach to allowing their children to drive a tractor, be an extra rider on a tractor or be near the hind legs of dairy cows, found that the combined influence of farm father attitude, subjective norm and perceived control accounted for 66-75% of the variance in intention. Further, these authors found that attitude (0.58-0.6) and to a lesser extent subjective norms (0.24-0.26), were the principal drivers of behavioural intention but they found little evidence to support the contribution of perceived behavioural control (0.09-0.16) to the construct.

The general conclusion that can be drawn from the studies of the TRA/TPB available is that attitude and to a lesser extent subjective norm and perceived behavioural control are the main drivers for behavioural intention. A combination of intentions and perceived behavioural control are the most influential model components of actual behaviour. The data available from TRA/TPB suggests that to make farmer OSH programmes more effective, they must seek to improve farmer's attitude and intention to take actions and they crucially must assist farmers to convert 'intentions' into action in a practical way.

3.3.4.1.2. Further behaviour change theories and their utility

The BBS process works in a management-supported, worker-driven system where workers measure at-risk behaviours critical to workplace safety and by providing feedback influence safety of behaviours or actions (Makin and Sutherland, 1994). When the TRA/TPB and BBS approaches are compared, Geller (2002) considered that it is a question of starting point to gain behaviour change and noted that attitudes and behaviour are reciprocal on their influence on one another. So the influence on attitudes by behaviour over-time can take place. Also, Makin and Sutherland (1994) considered that changing behaviour is a much faster process than changing attitudes hence the possibility of achieving OSH results in a faster timescale using BBS. However, they considered that as the BBS is an 'external' approach, attitudinal change is crucial to sustaining on-going progress, especially among self-employed persons where OSH management is under voluntary control.

The view that the 'cognitive' or internal approaches are superior, is supported by the review of the Elaboration Likelihood Model (ELM) (Patty and Cacioppo, 1979) which proposes that highly developed elaboration, which is internally developed through personal persuasion based on received messages, is the principal source of decision and behaviour. In contrast, low elaboration arises from an external source of persuasion based on messages received where a person decides to follow a principle or decision-rule.

The Health Belief Model) (HBM) (Becker, 1974) outlined readiness to take action in terms of constructs representing the personal perceived 'threat' and 'benefits', 'cues to action' and 'self-efficacy' supporting, and perceived 'barriers' hindering, taking action. Studies among farmers (Hodne et al.,1999; Wadad et al.,1998;Whitman and Field,1994) found that they exhibited both low levels of 'susceptibility' and 'likelihood' related to farm accident occurrence and these studies suggest that these perceptions are a key barrier to making OSH progress which needs to be addressed in preventative interventions.

The Protection Motivation Theory (PMT) (Rogers, W., 1979) was proposed as a conceptual model to understand peoples' response to a danger and proposed that the intention to take protective action depends on: perceived severity and probability of the occurrence and the perceived vulnerability and the efficacy of the preventative measure and self-efficacy of the person to adopt the recommended preventive behaviour. The follow-on Extended Parallel Process Model (EPPM) (Witte,1992, 1994) indicates that people ignore the danger if they consider it low or if they feel they cannot respond to it and that communicating an appropriate 'fear appeal' is necessary to elicit appropriate action. A study among farmers in Kentucky, USA by Morgan et al., (2002) indicated that farmers were more responsive to messages with an appropriate 'fear appeal' built in, rather than messages with facts and figures. The Risk Perception Attitude (RPA) (Rimal and Real, 2003) framework classified four separate potential groups based on peoples’ differences in perceived risk and efficacy of preventative measures: ‘responsive’, ‘proactive’, ‘avoidance’ and ‘indifferent’.

Cognitive Dissonance Theory (CDT) (Festinger, 1951) indicates that when the psychological conflict of holding two or more incompatible beliefs simultaneously has to be resolved by either acting to remove the dissonance or ignoring it. Geller (2002) stated that the concept of self-persuasion requires that people develop an internal justification for their behaviour, to keep their internal personal state stable and resolve dissonance. Thus raising issues can arouse dissonance and possibly lead to action. Attitude Accessibility involves having information available on an on-going basis which facilitates adoption of a relevant practice if the attitude is prominent at that time (Slater, 1999).

Finally, the Persuasive Health Message Framework (PHMF) (Witte 1995) proposed that successful communication of a health message must motivate the audience into action by convincing individuals that they are susceptible and that the threat would be averted by adapting an easy and feasible recommended response(s).

3.3.5. Social cognitive theory (SCT) and behaviour change

In his review of integrating the application of media effects, persuasion and behaviour change theories to gain change; Slater (1999) recognised the limitations of the TRA/TPB in the crucial step of converting ‘intention to behaviour’. However, he drew attention to the fact that that social theory, most notably the Social Cognitive Theory (SCT) (Bandura, 1997), is widely used to provide a range of conceptual and practical tools to fill this gap which he included in his representation of the integration of the theories of change (Figure 3.1.). Accordingly, the SCT is now reviewed to gain insights into its potential to gaining sustained behaviour change in OSH in agriculture.

According to Bandura (1997), SCT deals with the cognitive and emotional aspects for understanding behavioural change and explains how people acquire and maintain certain behavioural patterns, while also providing the basis for intervention strategies. This author stated that evaluating how behavioural change takes place depends on studying the interaction of the following factors: **Environment**,

Personal and **Behaviour**. 'Environment' refers to the factors that can affect a person's behaviour which can be social or physical. Social environment includes family members, friends and work colleagues; while the physical environment, in a farming context, includes the physical layout and facilities of the farm and the technology employed. According to Parraga (1990), environment and 'situation' provide the framework for understanding behaviour, with situation referring to the cognitive or mental representations of the environment that may affect a person's behaviour. A conceptual model provided by Pajares (2002) of the SCT is provided in Figure 3.3.

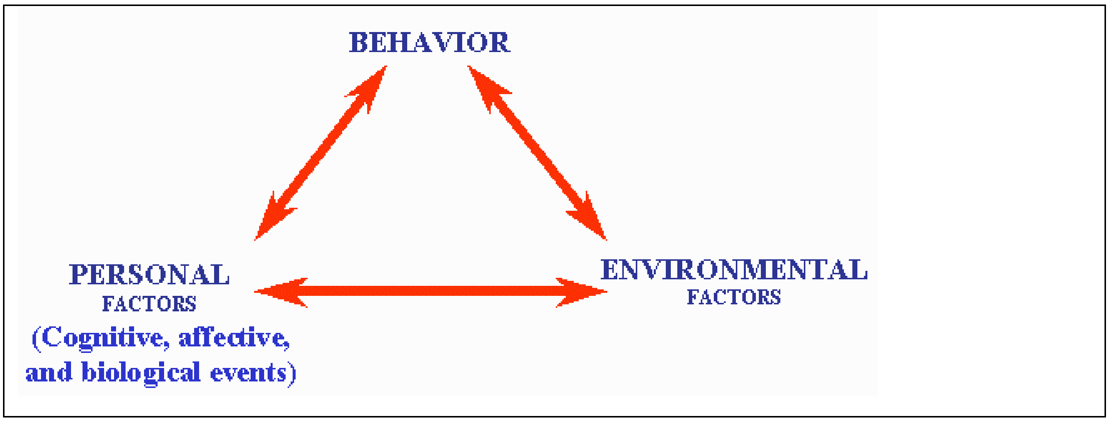

Figure 3.3: Conceptual model of the social cognitive theory
Source: Pajares (2002)

According to Parraga (1990), 'situation' refers to the cognitive or mental representations of the environment that may affect a person's behaviour and provides the framework for understanding it. Glanz et al., (2002) further added that the situation is a person's perception of the place, time, physical features and activity. Within the SCT the personal factor refers to the personal cognitions and outlook of the person and if a person is to perform behaviour they must know what the behaviour is and have the skills to perform it. Glanz et al., (2002) considered that the three factors in the SCT: environment, people and behaviour constantly influence each other.

Slater (1999) stated that the SCT incorporates the earlier SLT (Bandura, 1977) and the Self-Efficacy Theory (SET) (Becker and Rosenstock, 1986). The SLT emphasises how behaviours are acquired and modified by watching others in person or through mediated channels. When the persons' modelling the behaviour are attractive and similar to the audience member, the behaviours are positively reinforced and this raises the likelihood of the viewer imitating the behaviours. Self-efficacy can then be enhanced, and the likelihood of intentions turning to behaviour is increased in two ways: one is simply modelling and encouraging behavioural trials and the second is to provide explicit modelling of specific skills that are required to successfully carry out the behaviour. Slater (1999) reported that a number of studies have indicated substantial changes in knowledge, attitudes and behaviour due to modelling. This author also cited the work of Cole (1997) where inexpensive narrative simulations successfully encouraged improved safety behaviours among both farmers and miners. Short (1984) cited by Slovic (1987) also argued that a person's response to hazards is mediated by social influences transmitted by such persons as friends, family, fellow workers and respected public officials.

Slater (1999) considered that one of the greatest problems for change strategies occurs when a person's behavioural intentions are heavily influenced by perceptions of family, peer and other interpersonal expectations. He stated that, in community-based efforts, the communicator can attempt to change norms but that community and social influences may moderate such endeavours. A relevant example of such a communications approach were the efforts to change norms to reduce cardiovascular risk factors in target populations by public health services in both Finland (McAlister et al., 1982) and Ireland (Shelley et al., 1995), which met with much lower levels of success in Ireland than in Finland. Slater (1999) suggests that community readiness interventions, including education and training workshops for community leaders, can also be conducted to encourage mobilising community support around OSH issues. He suggested that media-based role-modelling is likely to be most effective before actual norms are set; this is in contrast to when norms are set, for example, within peer groups except when the role-modelling source is a person that the group closely identifies with (Basil, 1996).

A review by Saari (1990) indicated that gaining OSH performance is strongly influenced by social factors. This author cited the work of Komaki et al., (1978; 1980; 1982) which demonstrated the success of feedback programmes in changing behaviour, due to their socially acceptable and motivational characteristics. In a company setting, Saari found that the people are most active in improving their work methods when: (1) their job is interesting and contributes to the final product, (2) their immediate supervisor responds positively to staff initiative (3) the firm provides a vision of future prospects and (4) incentive systems, including benefits and social performance feedback, encourage initiatives.

Perloff (2003) also considered that individual behaviour including OSH behaviour is under social control and that it is important to understand the influence of organisations on attitudes and behaviours of their associated communities. Ledingham and Bruning (1998) found that 'organisational involvement and support of the community in which it operates can engender loyalty to an organisation'. These authors, in relation to banking, found that customers' perceptions of the personal and professional relationship have a significant impact on evaluations of overall satisfaction with an organisation. Among university students, Bruning (2002) also suggested that links between organisational relationship, attitudes and outcome behaviours varied between those who were 'retained' and those who 'left' an organisation. Thus the possibility exists for an organisation (s) leveraging its positive relationship with clients to engender positive attitudes and behaviours, including those in the area of OSH.

3.3.5.1. Social influence in agricultural OSH research

In the context of agricultural OSH research, Lee at al., (1997) in Wisconsin, USA found that the primary influence on father's attitudes for safety behaviours of his children: is the desire to give his children work experience, to develop a strong work ethic and build self-confidence and to utilise the child's labour to save time and money, especially in difficult farm economic conditions. The study also found that grandparents exerted the strongest pressure on fathers' subjective norms to secure safety of his children, while a child's mother is most influential in whether or not a child should be driving a tractor. Notably, also in this study, outside influences such as health care providers, youth organisations (4H), farming organisations (Future Farmers of America) and farm insurers exerted only a modest influence on fathers' feelings of social pressure regarding the safety of farm children. Further evidence that risk taking/prevention behaviour is strongly influenced by adults is also provided by a study by Pryor et al., (2005) among farm women caregivers and children in Louisiana, USA, which showed that modelling of the prevention behaviour of the caregiver by children occurs. A study of practical outdoor farm safety training at

Farm Safety Day Camps conducted in Kentucky, USA by Reed (2001) found that children learned and retained new farm safety information from their camp attendance. Significantly, the campers shared this knowledge with their parents and many parents made adjustments to improve safety on their farms.

3.3.5.2. Conclusion for social cognitive theory (SCT) and behaviour change

In conclusion, the review of SCT indicates that peoples' behaviour can be influenced by their environment, particularly their interaction with other people and organisations. The agricultural literature cited indicates that influence by family members is particularly important, with different members of the family unit having influence over different aspects of OSH. This suggests, broadly, that OSH programmes should be broadly-based to capture the benefits of participation of the whole family. The review of the SCT also suggests that OSH programmes which seek to change strongly held views in social groups may be difficult and require both the right strategy and an appropriate time scale to achieve. The review also indicated that cultural differences could lead to varying responses between populations. The review also indicates that appropriate social intervention where persons have the opportunity to engage in interpersonal modelling and gain self-efficacy in the desired skill or attribute, provides a pathway for sustained behaviour change. In the context of this study, this leads to the next chapter, where strategies related to farm management practice and adult education and extension are examined to establish their role in assisting farmers to complete and implement the legal COP documents which are being evaluated in this study. Finally, a summary is provided of the major theory reviewed in this Chapter.

3.4. Chapter summary

In summary, the review conducted in this chapter indicates that regulation provides a basis for implementing OSH prevention programmes in agriculture. However the literature indicates that regulation does not work on its own and needs to be skillfully managed to achieve positive improvement in OSH among farmers. Culture among famers to OSH is positive but gaining adoption is limited. Persons who are self-employed have difficulty making risk assessment and tend to take risks for some form of gain. Change theory indicates that change is a step-wise cognitive process with persons within a population at various stages of change. Communications and information provision strategies have the potential to inform farming populations about actual risk and motivated OSH adoption, however, this approach works to a limited extent. Behaviour change theory indicates that internal cognitive processes of attitude, social norm, behaviour control and most significantly intention are the principal drivers to gain adoption. Social cognitive theory indicates that behaviour change is mediated by an interaction between ones environmental (which could be social or physical) and personal factors. The review of the various theories related to gaining behaviour change indicates that the approach in this study of developing a COP/RAD is broadly in accord with the various theories examined.

The next chapter now examines literature related to the farm management approach adopted by farmers and small businesses and its relationship to OSH behaviour change. It then reviews adult training and advisory (extension) approaches and their influence on farmer learning related to OSH, to gain knowledge to assist with programme development related to OSH behaviour change.

Chapter Four

OSH change through learning

4.1. Introduction

The aim of the PI on which this study is based is to effect positive OSH change among farmers and to assess the effectiveness of the national programme of assisting farmers to use the COP documents and provision of follow-up advice. This chapter sets out literature related to devising practical and implementable OSH training and advisory strategies to support COP implementation. Accordingly, the approach adopted in this chapter continues to draw on the approach of the PHM which in stage 3 advocates devising OSH programme development.

In the next section of this chapter (Section 4.2), theory is examined related to the management behaviour of farmers and its development. Small and Medium Enterprises (SMEs) are also included as they are a comparable group with farmers as regards OSH management and this widens the scope of knowledge gained from the study. This review of management is conducted because studies by both Glasscock (1999) and Suutarinen (2004) showed a strong link between farm managerial quality and accident levels. In Ireland also, studies have strongly linked managerial capacity with farm business performance, e.g. the NFS (Connolly et al., 2005), Frawley et al., (1983). Walsh (1985) in reviewing technical performance for dairy farms noted considerable variation between farms which he attributed to managerial effectiveness while O'Brien et al., (2005) also noted considerable variation in technical and financial and labour efficiency among a sample of Irish dairy farmers.

4.2. Management approaches by farmers and small businesses

Management of a business involves the activities of accomplishing desired goals by using available resources efficiently and effectively and it comprises the following: planning, organising, staffing, leading and controlling the business (Drucker, 1986). As each farmer has direct and on-going management control of the activities and developments on their farms, it is important to gain knowledge on what practical management processes are used by farmers and their potential influence on OSH management. Thus a review is now undertaken of both farm business and OSH management and the analogous processes of management of SMEs.

4.2.1. Management practices in farming and their enhancement

An examination of farm management practices in New Zealand by Nuthall (2006) found three factors were associated with farm managerial success. These factors are: (1), planning, implementing and controlling; (2), a personal capacity to implement plans on an operational basis and understanding the interrelationships between the components of the farm system and (3), managing and gaining co-operation and good relationships with relevant persons both on and off the farm. They considered the factors identified to be stable across: farm type; managerial style; profit objectives; age; gender; education and computer ownership (Nuthall, 2006).

Öhlmér, Olson and Brehmer (1998) also studied farmers' decision making processes in Sweden with a view to assisting farmers to enhance their management. Their conceptual model of the decision process has four phases each with four sub-processes. The four phases being problem detection; problem definition; analysis and choice and implementation with the four sub-processes being; searching and paying attention; planning, evaluating and choosing, and checking the choice. They noted that farmers preferred qualitative to quantitative analysis including: 'quick and simple' versus detailed and elaborate analysis; small tests and incremental and on-going implementation versus major post-implementation evaluation. A review of farmer management approaches by Malcolm (1990) concurs with the findings of Öhlmér et al., (1998) and concluded that farmers largely relied on intuition, experience and simple budgeting rather than more sophisticated instruments.

Research by Nuthall (2006) in New Zealand found that to improve farmer managerial ability, farm support systems 'must help farmers extract lessons from their experiences through their careful analysis', and secondly develop extension systems that 'help farmers change the nature of their management style towards high performance approaches which they suggest means using a more analytical and less intuitive management style. Caspi et al., (2005) further considered that the human character of personality is about 50% influenced by environmental factors so management style is changeable over time. Nuthall (2006) also considered that improving farmer management skill could be achieved by training and education in various forms. Ondersteijn et al., (2003) in a study in Netherlands reported strong evidence that farmers' education level is correlated with change and achievement.

However, Galanopoulos et al., (2006), in Greece, found that education level did not affect efficiency levels in a study among pig farmers. Overall, research indicates that farmers' management processes are potentially open to change and that education and extension have the capacity to facilitate this change over time.

4.2.2. Small and medium enterprise management systems

Management approaches in SMEs are now reviewed because most farms are small businesses. A more comprehensive review is provided in Appendix 4.1. A notable similarity between farm and SME management is that they both tend to have a flat management structure with a low number of managers and few management layers. Tait and Walker (2000) for instance considered that management of SME's often centres on one manager who is likely to adopt an informal approach, where both time and resources are scarce, and who is involved in every aspect of the business. Sekaran (2003) emphasised the necessity of SME managers to effectively manage every aspect of their business and stated that a manager must document and regularly assess all business elements to learn, grow and develop. The approach of Sekaran (2003) is in keeping with the Balanced Score Card (BSC) approach (Kaplan and Norton, 1996) which is a multi-attribute rating technique to identify and integrate all the factors that are critical in contributing to business excellence.

Research by Wright and Geroy (2001) suggests that changing management style is the crucial determinant of world class performance achievement. They considered that while management performance is derived from a complex set of interacting variables, management style is a key driver of performance. Wright and Geroy (2001) saw 'socialisation' within the work environment as an important requirement for sharing skills and generating new ideas. However, they considered that a concerted effort must be made by a manager to optimise knowledge gain by its application to induce optimal performance (citing Henry and Hartzler, 1998).

Regarding management of OSH, Scase and Goffee (1980) indicated that such systems are remarkably higher in intensity in large companies than in SMEs and stated that the norms, knowledge and resources of SMEs determines the quality of their OSH management system and work environment. In Massachusetts, USA, Barbeau et al., (2004) found considerable variation in OSH management in SMEs with lack of time and in-house expertise along with production pressures being the main barriers to effective OSH management. They considered that external agents (e.g. regulators, consultants) play an important role in motivating OSH programmes in such firms. A review of the literature on preventative OSH activities in SMEs by Hasle and Limborg (2006) pointed to the important role that intermediaries (outside agents) play in assisting SMEs, including farms. Bibbings (1995) also identified the role of an intermediary as being crucial to the success of OSH prevention strategies.

This short review of SME business and OSH management indicates that the management style of the manager is likely to be crucial for effective management, that a concerted effort needs to be applied to all knowledge to achieve change and that SMEs tend to need the support of intermediaries to implement OSH strategies.

4.3. Agricultural extension theory

The term ‘extension’ owes its origin to the term ‘university extension’ where it was used to describe teaching activities beyond the campus. In USA the term ‘extension service’ came into use at the beginning of the 20th century to describe such activities as lectures and demonstrations by staff from land grant university colleges at agricultural shows and farmers clubs (Jones and Garforth, 1997). The specific term ‘extension agent’ arose from sponsorship of extension service activities of Cornell University, USA by the local railway company, and all persons associated with the company were referred to as ‘agents’. In an Irish context the term ‘agricultural adviser’ or ‘education officer’ broadly equates to the term ‘extension agent’ who provide a broad range of advisory and training services to farmers within Teagasc. Paine (1995) considered that the attainment of voluntary behaviour change by clients is the universal goal of both extension organisations and agents.

Firstly, extension is considered from three perspectives. Firstly, extension theory related to approaches commonly used is examined. Secondly, this is followed by an examination of the TDI (Rogers,2003) which has been highly influential in the extension field. Thirdly, studies related to practical use of agricultural extension are examined to assess their relevance to this study. A more comprehensive review of extension theory is provided in Appendix 4.2.

4.3.1. Extension approaches

Van de Ban and Hawkins (1988) considered extension to be the 'conscious use of communication of innovation to help people form sound opinions and make good decisions'. Rivera (1987, 1989) further considered that agricultural extension could be looked at from a narrow perspective namely to disseminate information to raise farm production and profitability or a broad perspective to include issues related to overall rural development. Black (2000) proposed that extension can be classified under the following four prominent paradigms: (1) transfer of technology, (2) problem-solving, (3) education, and 4) human development. Each successive approach requires increasing people skills and may be used in increasingly complex situations. These four extension paradigms are now briefly described.

Transfer of technology (TOT) also referred to as the 'Linear Model of Agricultural Extension' as it takes the following sequential steps: knowledge development, transmission, problem-solving and finally use (Bergevoet and Van Woerkum, 2006). TOT has been subject to the criticism that it promotes a standardised approach and may not suit all individual situations, that it promotes single-component technologies which may not serve to facilitate holistic change processes and it is a 'top-down' approach that ignores the knowledge, skills and adaptive abilities of farmers.

Problem-solving as an approach considers the role of extension work is to assist farmers to solve their technological or management problems (Bergevoet and Van Woerkum,2006). Hogeveen et al., (1992) stated that it is of strategic importance that farmers decide what knowledge is needed to solve a problem(s). Bergevoet and Van Woerkum (2006) stated that one interpretation of solving problems is to consider it a one-way flow of knowledge from an adviser to a farmer, however, an alternative model exists, the Agricultural Knowledge and Information Systems (AKIS), which suggests that multiple flows of knowledge and information occur within extension problem solving (Rivera et al., 2001; Röling and Engel., 1991).

Adult learning theories within extension promote learning among farmers (Bergevoet and Van Woerkum,2006). Learning can take place based on individual reflection or in group situations as contact with other persons can provide a stimulus to reflect on situations and experiences described by others. (Guijt and Proost, 2002 cited by Bergevoet and Van Woekum 2006).

Human development in extension, has the role to 'facilitate and stimulate' farmers to take the initiative in problem definition and seek solutions or opportunities and is considered a participatory 'bottom-up' approach (Coutts,1995). Its advantages include: that it draws upon and values the accumulated knowledge and experience of farmers and advisors, it facilitates sharing of ideas and information and it uses the group process of learning (Black, 2000; Martin and Sherington, 1997).

4.3.2. Theory of Diffusion of Innovations (TDI)

The TDI first proposed by Rogers (1962) has been highly influential in both agricultural extension and extension generally. An 'innovation' is regarded as an 'idea, practice or object perceived as new by an individual'.. Due to the newness of the idea, a perceived risk exists with its adoption leading to uncertainty. The uncertainty associated with this risk can be bridged by gaining information in various ways and Rogers (2003) further proposed the following five-step diffusion process: knowledge; persuasion; decision, implementation and confirmation. Thus diffusion is the process by which an innovation is communicated over time among members of a social system.

Innovativeness has been defined as 'the degree to which an individual is relatively earlier in adopting new ideas than other members of their social system'. Rogers (2003), identified that this characteristic can be partitioned into the following discreet and mutually exclusive categories related to the pace of adoption: innovators (2.5%); early adopters (13.5%); early majority 34%; late majority 34%; laggards, 16%. Rogers (2003) described the various adopter categories as follows: innovators are 'eager to try new ideas'; early adopters are 'opinion leaders and more integrated into the local social system'; early majority may 'deliberate for some time before adopting a new idea and interact frequently with their peers'; late majority 'are sceptical .and the pressure of peers is necessary to motivate adoption', laggards 'are traditional, adopt innovations last and tend to be suspicious of innovations and change agents'. Rogers (2003) also considered that innovators possess a type of mental ability to cope with uncertainty and deal with abstractions while later adopters can observe the results of innovations of others and do not require a mental ability to deal with mental abstractions. It should be noted that in all categories, adoption ultimately takes place.

Many studies, in a variety of disciplines, have been conducted for the purpose of predicting which people could be expected to adopt innovations more quickly or slowly than others, so that more effective communicative strategies can be devised (Leeuwis and van den Ban, 2004). Characteristics associated with adoption described by Rogers (2003) include: ‘change agent contact’, ‘more active information seeking’ and ‘intelligence’ while ‘fatalism’ is a characteristic associated with non or late adoption. Röling (1988) also reported a strong link between ‘innovativeness’ and higher levels of the following variables: education, literacy, social status, access to resources, membership of organisations, mass media and change agent contact.

4.3.2.1. Rejection or non-adoption

Rogers (2003) identified a further category of persons who reject innovations and distinguished between ‘active rejection’ and ‘passive rejection’. Active rejection consists of considering adoption of the innovation (including trial) but then deciding not to adopt it while passive rejection is not considering using the innovation in the first place. Vanclay and Lawrence (1995) noted that extension often considered that farmers who failed to adopt new techniques following exposure to ‘traditional’ top down TOT methods as recalcitrant and irrational, but their research relating to environmental practices indicated that most ‘barriers’ to change have a rational basis. They considered that barriers can be categorised as: conflicting information; risk; implementation costs and capital outlay; intellectual outlay; loss of flexibility; complexity; and incompatibility with other aspects of farm management practice and farm and personal objectives. They also considered that social and perception issues affect adoption rates while Rogers (2003) noted that a positive collective culture in a society positively influences affects adoption.

4.3.2.2. The problem of OSH preventative innovations

Rogers (2003) noted that preventative innovations, notably in the public health and OSH arenas, have a relatively slow rate of adoption. He attributed this to the perception of people of adoption relative to the probability that some future unwanted event may occur, so the relative advantage of adoption is remote or where the beneficial consequences are more distant in time. For instance, Rogers (2003) noted that by 2002 just 73% of Americans use seat belts, 46 years after its invention invention in 1946 and its roll-out in 1963. He considered that persons not using a seat belt felt the probability of being in an accident was negligible and/or that the cost or effort required to use it was greater than the benefits. In contrast to the seat belt usage example, Rogers (2003) also cited the Stanford Heart Disease Prevention programme as a positive adoption example where a mass media communications campaign recruited at-risk individuals to small group training classes to change heart-disease related lifestyle practices, with some success. Also, Rogers (2003) noted that the Stanford programme used on-going formative research while the programme was in progress to assess its effectiveness and how it could be improved if necessary going forward.

4.3.3. Engagement by extension services in OSH

Extension programming related to OSH in agriculture has been studied mainly in the USA and in Ireland. In the USA, Burton and Sharp (1991), considered collaboration with extension represents a cost-effective strategy in addressing health promotion in the USA based on its long history in delivering programmes. Chapman et al., (1995) in Wisconsin found that OSH among agricultural extension activities occupied an average of 4.8 days work time per agent per year with most reported activities being group training for farm workers. In this study, the extension agents reported that the greatest barrier to more programming in agricultural OSH was the lack of time of both farmers and extension agents. They also reported that extension agents placed greater emphasis on training in how to work with hazards than on how to recognise and permanently correct them. For future programmes, agents requested shorter format material such as fact sheets, videotapes and farm hazard inspection checklists. Chapman et al., (1995) concluded that extension agents could be more effective with more time, better material and with more emphasis on hazard correction in workplace OSH programmes. Carrabba et al., (2001) delivered training in OSH for rural youth in Indiana, USA and also advocated the availability and regular updating of the training materials available. These finding strongly suggest that provision of methodologies and training materials are a perquisite for both effective and consistent OSH training programme delivery.

Seiz and Downey (2001) in a qualitative study in Colorado, USA on the use of information sources by farmers for OSH found that cooperative extension as well as farming journals and grower associations had a track record of credibility and were viewed as both practical and reliable sources of OSH information. In contrast, distrust was expressed for safety information issued by professionals who have no farming experience. These authors cite Green and Krueter (1991) as warning that if professionals fail to adequately consult with the target population to determine their needs, problems and aspirations, they risk having their programmes receiving low or no priority. Pierson and Murphy (1996), conducted a study of agricultural, education and industry professionals throughout the USA including secondary agricultural teachers, extension agents, equipment dealers, veterinarians, insurance company representatives, grain/feed dealers, agri-chemical dealers regarding their OSH needs. These authors found a lack of knowledge among all groups (mean correct response to knowledge questions: 37%). They also found a moderately low (mean score of 1.7 on a likert-type scale with 1 being very low) level of provision of OSH service by extension agents. These authors called for the design and development of relevant OSH courses and instructional systems for present and future agricultural and industry professionals. They also noted that Rogers, (1983) would consider agricultural educators and industry professionals as local change agents and one of the main elements in an information diffusion system. An earlier study by Greaves et al., (1994) in Minnesota USA among rural OSH providers including: farm implement dealers, veterinarians, chiropractors, extension agents and physicians identified cooperative extension, professional magazines and educational conferences as the most valuable education sources. Farmers in this study reported a greater level of interest in sources of information that are specific to their particular perceived needs, sought it in a permanent form available for future reference and they valued direct contact with persons they regarded as experts. In Pennsylvania USA, Mincemoyer and Kelsey (1999) assessed the barriers to extension agent training generally and found that agents had difficulty in committing time to in-service training, but they wanted in-service training to be applicable to local issues and programming and wanted an active role in its planning.

Regarding education of future extension professionals, Scheer et al., (2006) showed that this requires the matching of competencies for success in extension at both under-graduate and graduate level training. Bruce and Carter (1967) considered that the style of extension leadership profoundly affects the quality of the service provided. Carter and Kohl (1968) found with extension delivery that social skills were used more than technical skills. Neufeld and Cinnamon (2004) found that attitudes towards experts are shaped in specific socio-cultural contexts based on local knowledge and culture, but that among experts, those providing practical advice to farmers gain higher levels of trust and utilitisation, including OSH experts. In Pennsylvania, USA, Landsittel et al., (2001) observed that where extension agents were active in OSH prevention activities, that farms had a lower hazard levels.

In Ireland, Finnegan and Phelan (2003) found that 5% of farmers sought OSH-related advice in the previous year and Teagasc was seen by farmers as the organisation from whom they would predominantly (67%) seek OSH advice. In Australia, Fragar and Coleman (1997) described a national programme developed in Australia 'Managing Farm Safety' in which research, knowledge systems and extension systems are integrated into a rural OSH system.

4.3.4. Conclusions of review of extension related to OSH

The first element of the review of extension theory indicates that a broad range of extension tools are available to facilitate OSH adoption among farmers but that selection of the correct approach is required for successful use. Farmer management styles are changeable over time, practical approaches work best and adequate resource materials and training must be provided to extension staff. The review of Diffusion of Innovations theory strongly indicates that different rates of adoption occur within a population which is associated with such variables as information seeking and membership of organisations. Ensuring that the technology or practice to be promoted is compatible with farmer management capabilities and culture is crucial for adoption. The review of use of extension to promote OSH in agriculture indicated limited engagement with this issue, however, where it has been studied it has been found to be a credible approach for promotion of OSH.

The PI associated with this study plans to use extension to provide training to farmers on completion of COP documents and follow-up advice provision to motivate farmer implementation of OSH controls. Accordingly a review of adult education theory is undertaken in the next section to allow for design of efficient and effective Adult training methodologies for assessment in this study.

4.4. Adult education theories and learning implementation

Boyle (1981) stated that the most widely accepted definition of learning is ‘acquiring new patterns of behaviour through experience’ with behaviour including ways of thinking, feeling and acting. If the learner continues to derive satisfaction from the behaviour the practice continues, in which case learning is deemed to have taken place. Adult Education theory and practice literature is now reviewed to gain insights into its role with gaining behaviour change, which can related to agricultural OSH.

Knowles (1977) asserted that adult education which he termed ‘andragogy’ is fundamentally different to pedagogy or formative education.. Rogers (2002) however considered it difficult to distinguish between what is ‘good teaching practice in any circumstances’ and ‘what is special to the teaching of adults’. Knowles (1977) proposed that andragogy is distinguished from pedagogy in that learning by adults is self-directed and needs to be based on the experience of the learner. He considered that as participation in andragogy is voluntary, the learning climate needs to reflect the learner’s maturity, be supportive, co-operative, informal and make participants feel respected and meet the needs of the adult learner.

Rogers (2002) suggested that all learning theories are valuable and when designing adult education programmes, that more than one should be considered. Elias and Merriam (2002) emphasised the importance of having a philosophical perspective on adult education and training to gain an understanding of the potential to effect change in human existence. Both Rogers (2002) and Knowles (1977) noted that many adults have a negative ‘self-concept’ to education due to their experienced failure with earlier pedagogy which leads to low confidence in their ability to learn. These authors attributed this to a focus of earlier education on one-way transmission of information, discipline, judgement and application of authority.

As andragogy is essentially voluntary, participants need to be attracted to attend. In common with OSH implementation, the subject of this study, adult education needs to be marketed to ensure that intended uptake and learning takes place which may include campaigns, advertising and social propaganda (Rogers,2002). This author further stated that the awakening of a sense of need to learn has been identified as a pre-condition of effective learning which requires an internal response on the part of a person to notice learning cues provided and engage in the learning process.

A brief review of the principal adult learning theories is now undertaken to determine their utility to this study. These include theories associated with liberal, progressive, humanist, radical learning and constructivism. This is done against the background that there is a ‘plurality in the way adults learn’ (Rogers,2002). A more comprehensive review of learning theories is provided in Appendix 4.3.

4.4.1. Adult education theories

Liberal education approaches concentrate on theoretical understanding rather than transmission and absorption of factual information and focus on the role of the ‘teacher’ as the source of knowledge. Progressive education is learner centred where educators have the task of developing peoples’ potential to the fullest extent. The humanist approach is learner-centred and sees people as individuals who respond differently to seemingly objective stimuli and perceptions as the explanation of behaviour, attitudes, feelings, beliefs and values. With radical learning theory, the teacher works with learners within the principles of respect, communications and solidarity to assist the learner arrive at their own solutions. Constructivism considers that learning is an act of self-search and discovery which is self-directed where it is stimulated and assisted but cannot be taught. In contrast, the behaviourist educational approach uses stimuli in the person’s environment to gain behaviour change.

The review of adult learning theory suggests that the initial challenge in education/training as it relates to agricultural OSH is to attract and maintain attendance which strongly suggests using humanist approaches. This particularly applies to relating the education/ training to the persons’ own farming and OSH experiences. Regarding behaviourist theory, training has the role of specifying what OSH behaviour requires implementation. With this approach, increased uptake of OSH measures is likely when reinforcement of behaviours takes place through follow-up extension measures to the provision of initial training. With humanist theory generally and empowerment education in particular, learning is more holistic and has the potential to link up learning related to OSH management with other facets of farm management to facilitate implementation of OSH measures on an on-going basis. With both behaviourist and humanist theories the literature emphasises on-going and facilitated social forms of learning to gain change.

4.4.2. Implementing adult education

Adult education needs to be implemented in both an efficient and effective manner to achieve desired behaviour change (Boyle, 1981). To gain this behaviour change harnessing human cognitive processes of those engaging in adult education by using approaches which support learning such as: motivation; harnessing learner personality and preferred learning styles is required. As harnessing these processes is associated with this study, they are now briefly reviewed and a more comprehensive review is provided in Appendix 4.3.

In the area of motivation the issue of internal versus external personal drives emerges in the literature. Internal rather than external drives are considered to impel the learner to seek-out ‘learning changes’. Motivation in learning depends as much on the motivation of the ‘teacher’ as the ‘learner’ as a positive teacher attitude drives learner motivation (Rogers, 2002). This author also considered that life-stage can impact on both work motivation and adult learning.

For the trait of personality, people with an ‘internal locus of control’ (Rotter, 1954) and ‘high achievement motivation’ (McClelland et al.,1953) are considered to have the greatest potential to learn. However, Rogers (2002) pointed out that trait expression varies at different times and in different situations for persons.

Regarding learning style, a Learning Style Inventory developed by Kolb (1976) describes four specific learning styles used by people as follows: ‘assimilators’, these learn from ideas and concepts and reflective observation; ‘convergers’, who learn through solving problems and finding solutions to questions; ‘divergers’, who learn by combining concrete experience with reflective observation and ‘accommodators’ who tend to accommodate a situation by acting on instinct rather than logical analysis. Kolb (1984) further suggested that, while persons tend to use all of these styles, persons have one or two preferred styles of learning and these become crystallised in adulthood.

4.4.2.1. Farmer learning styles and approaches

Treade and Miller (2000) studied farmer learning styles in Iowa, USA. and found that the assimilator style (49%) predominated followed in frequency by the converger style (21%). The diverger style and accommodator styles occurred equally in frequency (15%). The study findings indicates that 70% of farmers had an assimilator or converger learning style and according to Treade and Miller (2000), suggests that agricultural education providers should plan and implement learning programmes that emphasise logic, ideas, concepts and problem solving rather than just ‘learning by doing’. In New Zealand, Paine (1995) among a farmers’ group engaged in farm business performance monitoring also found the assimilator and converger styles to be dominant (60%). They noted that a person’s learning style was not static but changed and developed with participation in the group activities. They also considered that groups have the potential to harness differences in learning styles among members. Webby and Paine (1997), in New Zealand, found that farm group members expressed a preference for logical learning experiences (50%), followed by problem solving (32%), action (13%) and social interaction (5%). Trede and Whitaker (2000) reported that ‘new-entrant farmers’ (mean age 33.9 years) preferred ‘face-to-face’ education rather than ‘distant’ or home study approaches.

Kilpatrick and Rosenblatt (1998), in Australia, defined the ways in which farmers learn, as ‘the ways they acquire new knowledge and skills, including skills of locating, understanding, processing knowledge of use to their farm businesses’. Kilpatrick (2000) extensively studied ‘learning’ as it applied to farmers and found strong evidence that both life-long and continued participation in education and training brings about successful change in farm business practice. She found that education and training is able to influence change in the following three broadly defined ways: first by delivering new knowledge and skills; second by providing interaction with experts (e.g. facilitators, trainers etc.); and third, by providing interaction with fellow training participants. Her research found that multiple personal sources of information are required to ‘prompt’ change such as interaction with facilitators, peers, family and friends which provides an opportunity for awareness of new practices and it facilitates changes in values, attitudes and beliefs. Kilpatrick (2000) in fact, considered that such social and emotional connections may be necessary before change can occur. Further studies (Kilpatrick and Johns, 2003; Kilpatrick, 2002; Kilpatrick and Rosenblatt,1998; Trede and Whitaker, 2000) also emphasised the social dimension of education and training in effecting change in farm businesses. According to Kilpatrick (2000) the Australian data indicates that those who attend on-going training are more likely to make management changes. Kilpatrick (1996; and 1997), considered that training is more effective in bringing about change when farmers participate in analysing the situation and identifying changes needed related to their own farm. Kilpatrick and Rosenblatt (1998) identified the following four features of effective training and which also encourage participation: 1) conduct interactive training, with opportunities for discussion and interaction with both fellow participants and 'experts'; 2) have relevant topics, applicable to the target groups' situation; 3) Use credible facilitators/ instructors and materials; 4) design training programmes so that it can be taken in manageable chunks. Kilpatrick and Rosenblatt (1998) considered that for farmer training to be successful that choice of content and delivery style must be akin to the style that farmers use for information seeking and that ultimately farmers must be in control of their own education and learning.

4.4.2.2. Defining the content of learning

To design programmes to effect learning the content of the programme must be defined. Rogers (2002) stated that in addition to the amount of subject matter, that the sequence and conditions attached to the learning must also be defined. He stated defining what is required of the learner in particular needs to be defined and be made explicit. Agriculture has a wide diversity of hazards which need to be addressed, based on the actual circumstances of individual farms and this provided the challenge to the PI steering committee to meet this requirement with the design of the RAD. Field and Toromoehlen (2006) stated that the hierarchy of controls, discussed in chapter 2, includes both measures for safe design to eliminate and reduce hazards and for education approaches to be included. The steering committee decided to design the RAD and associated COP including the DVD to provide the information required for OSH learning based on the hierarchy of controls, which thus combines both safe design approaches and education in the same learning programme. Moreover, the RAD provided a framework by which each farmer completing the document or attending training could apply the information content of the RAD based on the hierarchy on their individual farms.

4.4.2.3. Implementing effective education methodologies

Magennis and Farrell (2005) and Dale (1969) provided a measure of the effectiveness of learning by using knowledge retention measurement. This measure indicates that the most effective methods are associated with putting learning into immediate use or when the learner uses learnt material for instance by teaching what has been learnt which has a retention score of 90%. Practice by doing (75%) and group discussion (50%) also score highly while demonstration (30%), audio-visual (20%), reading (10%) and listening to a lecture (5%) progressively rank as less effective in terms of knowledge retention. The clear inference from the data is that to be most effective, adult training should motivate the learner to immediately apply the learning and/or to use the learnt knowledge.

Regarding delivery of teaching, Carroll and Gillen (2002) regarded the critical components for success as follows: acceptance of the role as teacher; performing it effectively; and acceptance of the teacher by the targeted learners. Among the most critical factors related to these components are: ability to simplify complexity; perceived communication effectiveness; the knowledge credibility and knowledge of the teacher and the wide variety of teaching approaches. Saari (1990), made the point that information-oriented OSH programmes should be complimented by motivational-oriented programme elements to encourage adoption. Karbasioun et al., (2006), in Iran, noted that competent agricultural extension instructors needed to have the following attributes: be competent; well informed, experienced; possess the ability to apply teaching methods and be familiar with farmer culture, language and problems. They also reported that the principal reasons why farmers attended extension training were to: acquire new information; acquire skills and experience and to socialise with participants and extension agents.

Regarding management approaches for learning, Rogers (1983) and Rogers (2002) agree on the approaches required which are summarised as follows: - adult learning should seek to solve the issues at the centre of learning in a ‘practical’ rather than a ‘systematic’ sense. Adults have little interest in overall principles or generalised approached. The training needs to ‘work back’ from ‘practice to principles’.

- use the experience of the learners as a resource as it transfers meaning (Merriam and Cafarella 1999). Participants should be encouraged to use analogous thinking to broaden their experience by modifying, transferring and reintegrating meanings, strategies and skills (Brundage and Mackeracher 1980).
- teachers should be conscious of the learning styles used by adults and use learning techniques that suit these learners.
- teachers should not stop at the immediate but develop the learning to the more general, so that it can be applied later more broadly in a purposeful manner.
- break the task down into manageable units, use a logical sequence, and engage actively in doing rather than trying to learn about it first and doing it later. Use of range of methods.
- the learner should be ‘active’ and use demonstrations if possible. Limited reliance should be placed on memory or note learning.

Boyle (1981) considered that to deliver an adult education programme consistently, that structured approaches with standardised training resources are needed. However, in the USA, Bruening and Radhakrishna (1993) in a national study among agricultural extension trainers found that a ‘desperate need’ existed for agricultural training resources. This need existed for a range of farm enterprises and business areas as well as for such emerging areas as agricultural laws and regulations. They also noted that trainers expressed a strong preference for visual training materials (e.g. videos) over other training materials such as text books.

4.4.3. Conclusions to review of adult education

The review of adult education indicated that providing motivation is an essential requirement for successful adult learning. Learning can be strongly influenced by both the internal and external characteristics of the learner. Among farmers the predominant styles are assimilator and converger where learning is based on ideas and reflective observation and by solving problems and finding solutions to problems. However, styles can change over time based on the learning experiences of the learner. Given that farmers are independent managers, it is suggested that learning approaches which cognitively engage farmers are preferable to ones based on behavioural approaches only. The review also indicates that learning is strongly influenced by experienced and trusted trainers. The literature review further indicated that provision of methodologies and training resources and allocation of adequate time for training are key resources to effectively deliver training programmes. Promotion of courses to gain participation and their management were identified as essential components of implementing effective learning programmes.

In the PI on which this study is based, Teagasc was the organisation tasked with both promoting and delivering training and follow-up extension to farmers. The literature review accordingly now reviews the capacity of Teagasc to implement OSH training programmes among farmers in Ireland.

4.5. Teagasc capacity to implement extension

Teagasc has statutory responsibility for provision of research, advisory, education and training services in Ireland based on its enabling legislation, the Agriculture Act, 1988. This act confers statutory confidentiality on information supplied to Teagasc officials by its clients when seeking advice. Van den Ban and Hawkins (1988) pointed out that trust by farmers in their advisers is an essential condition for effective extension. Teagasc does not have enforcement powers which could compromise its working relationship with clients.

Teagasc adopts an AKIS approach (Rivera et al., 2001; Röling and Engel., 1991) as its operating model with two-way knowledge flows between research, extension and education and also with clients. A brief review is now undertaken of its advisory, education and training and research functions as they affect this study and a further more detailed review is provided in Appendix 4.4.

Farmer advisory service clients of Teagasc are required to pay an annual fee but Quinlan (1997) reported that this was set at a level that achieved having a high level of clients and client numbers were about 44,000 in 2005 (currently circa 40,000 clients and 230 staff with Advisory/ Training assignments). As Teagasc is also publically funded it is required to maintain a balance between servicing government and EU programmes and servicing client requirements. Teagasc engages in a wide range of advisory approaches to assist farmers with technology and practice adoption including farm and office ‘one-to-one’ consultations, farm demonstrations and discussion groups being the main approaches used. Teagasc deploys specialist advisors to promote the programme of the specialism and support advisors and education officers by regular updating and in-service training. Discussion groups, have been emphasised since the mid -nineties (In 1995 a national discussion group specialist was appointed) as these have been found, to be one of the most effective methods of farm technology transfer (Byrne, 1997; Donworth and Doody, 1999).

Regarding reasons why farmers availed of advisory services, Pettit (2001) found that the major reasons were as follows: assistance with state schemes (e.g. EU Area Aid and related schemes) (89%); technical advice (e.g. livestock or crop related) (49%); environment, pollution control and farm buildings (39%); financial and farm planning (20%) and food safety/quality assurance (3%) farm OSH was not included in this survey). This indicates that advisors mainly provide both assistance with schemes and technical advice. Pettit (2001) also surveyed advisor reasons for engagement on specific aspects of their work and found as follows: personal knowledge/ interest/ conviction (74%); attitude of clients to the issue (60%); issue is industry, national or public good priority (27%); potential of the issue to generate advisory fees (22%) and pressure from Teagasc management (16%).

Under its establishment legislation, Teagasc is required to pay particular attention to training of new entrants to a career in agriculture which includes forestry, horticulture, and equine studies. To fulfil this obligation, Teagasc provides the Certificate in Farming for new-entrants with both full-time and part-time options available. Teagasc has designated professional staff as education officers at county level to lead and coordinate the delivery of agricultural education at both new-entrant and adult level. Education officers have been provided with training in education and training delivery. Teagasc also has developed and delivered various adult education training course programmes since its inception. These have included EU European

Social Fund 25-hour courses in the nineties decade; REPS; financial management and ICT courses. However, limited assessment has been undertaken of implementation by farmers of enhanced standards and practices following adult training completion. One study (Bogue, 2001) among dairy farmers (in county Clare) found that the majority of younger farmers' had attended Teagasc new-entrant courses and while they praised them, considered that more on-going training was needed. They admitted undertaking a course mainly to qualify for incentives rather than for their educational value and reported valuing the training provided a number of years later.

Teagasc has a considerable research capacity both in agricultural production and food research (see http://www.teagasc.ie/research/). Of particular relevance to this study is access to the research capacity of the NFS operated by Teagasc. Additional questions related to farm OSH can be asked of participating farmers and the data obtained can then be cross referenced and analysed in relation to a database of up to 60 farm physical and socio-economic variables routinely collected by the NFS.

Development of a mutually beneficial relationship between an organization and its key public referred to as 'Organisation – Public Relationship (OPR)' has been identified as a key issue in the field of public relations (Hon and Grunig, 1999). Based on the performance indicators published in Teagasc Annual Reports (www.teagasc.ie) the organisation has a considerable engagement with the farming community suggesting a positive OPR.

4.6. Summary of Chapter 4

In this chapter, possibilities for effecting change through learning have been reviewed. The information available indicates that considerable potential exists both with extension and adult learning to effect OSH change among farmers over time. However a limited number of studies have taken place in this field. Chapter 5 will now commence the research component of this study by development of the Theoretical Framework which will provide a link between the literature review and research chapters so that conclusions and recommendations can be made.

Chapter Five

Theoretical Framework

5.1 Introduction

Literature presented in Chapter 2 (sections 2.5.2 and 2.5.3.) revealed a major problem with accidents and ill health in agriculture both in Ireland and internationally. DeRoo and Rautiainen (2000), however, reported that few studies have been conducted worldwide related to improving the health and safety record of the agriculture sector. Prior to undertaking this study several studies were published which indicated the potential for extension to reduce hazards, increase OSH adoption, increase OSH knowledge and risk perception among farmers. The following studies related to OSH adoption in agriculture have been published and are particularly relevant to this study: 'the use of a hazard audit manual and expert feedback significantly reduced hazards' (Legault and Murphy, 2000); 'three hour educational sessions on pesticide exposure significantly reduced pesticide use and increased PPE usage' (Perry and Layde, 2003); and 'a group farm walk-through session empowered by farmers led to increased OSH changes' (Heikkonen and Laouhevaara, 2003). Vela Acosta et al., (2005) in their report on pesticides and OSH on farms reported that an educational intervention on the toxicity of pesticides led to increased pesticide knowledge and safety risk perception among participants. Recent research in Denmark also indicated that a considerable reduction in injury levels (Rasmussen et al., 2005) and improvements in safety behaviour (Glasscock et al., 2005) were achievable through farmer participation at short OSH training courses and participation in follow-up advisory audits. In the United States, earlier research by Chapman et al., (1996) provided positive feedback from farmers on the use of check-sheets to conduct farm self-inspections.

This Chapter describes development of the Theoretical Framework which is the Study working model which suggests the various factors influencing farm OSH risk and identifies relationships between them based on the literature reviewed. The Theoretical Framework provides the basis for development of the Study Model which indicates the variables and potential relationships among these in the Model. All the components of the Theoretical framework are explained and specific literature which supports their inclusion is summarised. Then the Study Hypothesis and its subsidiary hypotheses are stated, these present specific propositions which can be examined and tested in this study. When this is done the study findings can be produced and considered and based on these and on literature reviewed, study conclusions, implications and recommendations can then be drawn.

5.2 Developing a Theoretical Framework for the Study

This study requires the development of a Theoretical Framework (also referred to as a conceptual framework). The purpose of developing a Theoretical Framework is to present the factors influencing OSH on Irish farms according to the literature reviewed (Chapters 1-4) and the relationships that exist between them. After development of the Theoretical Framework a Study Model is derived from it where the hypotheses for testing and associated dependent and independent variables are identified.

5.2.1. Defining a Theoretical Framework

According to Sekaran (1992), once the literature has been surveyed and the problem defined, it is then necessary to develop a theoretical framework. Sekaran (1992) defined a theoretical framework as a conceptual model, of how one theorises the relationships among the various factors that have been identified as important to the research problem. Thus the theoretical framework is central to examining the problem under investigation. The theoretical framework also allows one to move from individual sources of information and make sense of information as a whole, including similarities and differences (Rudestam and Newton, 2001).

Kolb et al., (1979) considered the development of theory, and stated that it is based on the same principles of how individuals learn from particular experiences. They consider that learning could start from a particular experience, which the individual attempts to make sense-of. This leads to the generation of an explanation of how or why something has happened, which in turn forms an abstract rule or guiding principle, which can then be applied to new events or experiences. Gill and Johnson (1997) and Sarantakos (1997) considered that theories are derived from what we have perceived to have happened previously and thus they influence our future actions. Rudestam and Newton (2001) stated that placing research within a theoretical context is essential to ensure that it develops the existing body of knowledge in that field, rather than just conducting a study on a particular problem.

Both Gill and Johnson (1997) and Sarantakos (1997) however highlighted the importance of testing theories in real-life situations, and amending them if necessary, to reflect the actual situation. Accordingly, in Chapter 6, a review is undertaken of theory related to the conduct of research in social science disciplines, particularly related to occupational safety and health of relevance to this study. The theoretical framework therefore examines the inter-relationships among the variables that are considered to be components of the situation being investigated. Thus devising a theoretical framework assists the researcher to propose and devise a framework for testing various relationships to improve our understanding of the issue being studied (Sekaran, 1992).

5.2.2. Development of the Preliminary Theoretical Framework

In order to develop the preliminary theoretical framework, it is firstly necessary to draw together the conclusions from the literature review (Chapters 1-4) and link these together into a preliminary theoretical framework.

The conclusions from chapter one, which was introductory, focused on the following key themes:

- Persons working in Irish Agriculture and internationally have a poor safety and health record. In Ireland, improving this record represents a major priority to State and farmer organisations who wish to devise effective strategies to achieve this aim.
- Newly adopted OSH legislation enacted in 2005, permits farmers to complete a Risk Assessment Document (RAD) under the terms of a statutory Code of Practice. This provides a new means to assist with OSH farm management. The pilot RAD design was based on self-assessment documents which Irish and International studies indicated were positively used by farmers related to OSH adoption.
- An International study indicated that farmer short training course attendance in OSH and a follow-up advisory audit positively influenced OSH adoption. Accordingly it

was decided to provide these elements in the pilot and subsequent National Initiative to assist farmers with RAD completion and implementation.

- As the review in Chapter 1 indicated that the agricultural sector in Ireland is diverse in term of the deployment of the factors of production, land, labour, capital and enterprise on individual farms, the possibility for variation in adoption of the OSH Initiative could arise.

5.2.3. Injury and Ill Health Prevention in Agriculture

As prevention of injury due to accidents and ill health among farmers is the focus of this study, theory related to their causation and prevention was examined both for Ireland and internationally (Chapter 2). This was undertaken both to provide information to assist with preparation of the pilot RAD and devise the study Theoretical Framework and the following points emerged from the review:

- An accident leading to injury is defined as the culmination of one or a number of unplanned events in a 'time' relevant sequence which results in the impartment of energy to cause injury or biological impact to cause ill health.

- Numerous accident risk factors occur for agricultural work including personal factors such as gender, age, health and farm factors such as farm enterprises, infrastructure and machinery, cropping or livestock used collectively referred to as farm technology in this study, and the physical nature of the farm including scale, labour deployed (full or part-time) and economic resources available referred to in this study as the farm environment.

- Accident prevention models at farm level require the implementation of a wide range of technical and organisational measures.

The literature reviewed suggested that knowledge gain on its own is unlikely to be sufficient to bring about behavioural change related to OSH among farmers which suggests that further interventions involving human behaviour change are required.

5.2.4. Human Behaviour Change

Behaviour Change Theory was reviewed in Chapter 3 to provide knowledge to support strategies to gain OSH adoption using the RAD and the following points emerged:

- Regulatory Theory indicated that regulation provides a strong societal mandate to develop OSH programmes to assist farmers and to provide regulatory tools to implement them. The review indicated that 'enforced self- regulation' backed up by 'command regulation', which applies to the Prevention Initiative being assessed in this Study, provides a workable option for such sectors as agriculture where regulatees are predominantly self-employed. However, the literature indicated that behaviour change can be promoted either internally or externally to a person. Internal approaches include influencing cognitive processes such as attitude and associated behaviour leading to intention to act. External approaches use an outside stimulus, such as legislative compulsion. Internal approaches when successful lead to sustained long-term change while external ones give immediate results but must be reinforced on an on-going basis to maintain change.
- Culture Theory suggested that OSH culture needs to blend with the overall culture within a population in which change is sought. Strong cultural themes to emerge related to OSH indicated that risk-taking thresholds vary within a population but are higher among populations or persons with 'male' traits and self-employed persons. Persons also find 'tangible' risk easier to conceptualize than 'probabilistic' risk.
- The Stages-of-Change Theory indicated that persons go through a process of change before sustained adoption is achieved. This commences with 'pre-contemplation' and ends with 'adoption/ maintenance'. The theory indicated that considerable variation occurs among members of a population as regards adoption stage at a particular point in time. This Theory suggests that the correct stimulus needs to be applied at the correct stage to bring about change. Communications approaches are required at the early stages (pre-contemplation/ contemplation stages) to raise the profile of the issues. Subsequently at the contemplation/preparation/action stages, Behaviour Change approaches based on Theory are used to gain intention to act. Behaviour change is strongly associated with attitude, social norm, and perceived behavioural control in

gaining action. Social Cognitive Theory over-laps and follows-on from Behaviour Change Theory. These involve interaction among persons in social settings (e.g. among people, groups, training etc) which gives persons the opportunity to conceptualise the requirements and gain self-efficacy to provide a path-way to sustained behaviour change. Overall this literature review indicates the range of behaviour change approaches which are available and which can be used in the Prevention Initiative being studied as gaining 'intention' and then 'action' based on the RAD is at the centre of the approach being studied. However, the literature indicates that success rates for voluntary actions can be low (30-40%). However this may be enhanced by learning in social settings, which is now reviewed.

5.2.5. Change through Learning

Literature reviewed in Chapter 4 indicated that learning to achieve OSH change is likely to be strongly supported by social involvement which includes adult education and/or extension activities. In such environments, cognitive development or development in mental thought related to OSH change can take place. Also, the characteristics of how farmer's learn and manage change needs to be considered to facilitate OSH adoption. These issues have been considered in the literature review undertaken and are set out in the following:

- Learning style studies among farmers indicated that they learn most from gaining and reflecting on ideas and also by considering and solving problems. So learning approaches need to predominantly reflect these styles. Learning retention studies indicated that immediate use of the learnt material is the most effective learning approach. However, learning should be viewed as an on-going approach rather than once-off.

- Recent studies indicated that farmers' managerial capacity is strongly linked to implementation of accident prevention measures. The literature also indicated that learning and management style development requires on-going reinforcement including contact with intermediaries, such as extension. A review of managerial style, including that of farmers, indicates that an individual's style is strongly reflected in the operation of a business. However, the review indicated that managerial style can be changed gradually due to social contact, such as with extension. The key starting points identified in the literature for managerial change include 'problem recognition' and 'gaining the motivation' for the issue(s) requiring adoption. Also, the literature indicated that the change required needs to be compatible with both farmer management style and be straightforward for implementation to be successful.

- A review of the extension scientific literature indicated that demand for OSH services in Ireland and internationally is low and accordingly strong extension leadership is required in this area to gain farmer participation to promote both learning and change. The review of learning indicated that it is strongly influenced by trusted training sources and that in Ireland, the public extension service provided by Teagasc has the capacity to impart OSH learning to farmers. This is a positive resource for the Prevention Initiative being undertaken on which this Study is based.

Overall the literature on behaviour change indicated that adopting a legal Code of Practice approach in association with using a RAD to assist farmers to manage farm OSH supported by short-training/extension has potential to assist with positive change. However, the literature indicated that a limited number of studies have been carried-out in improving farm OSH through farmer learning/ extension and limited success has been reported from the studies undertaken, with the notable exception of the Danish (West Jutland) study (Rasmussen et al.,2000). Thus, assessment was needed to gain knowledge on the efficacy of the approach being piloted in Ireland using a COP Risk Assessment document and associated short-training and extension, which is the subject matter of this Study.

5.3. The Research Question

The themes of the previous chapters can now be linked together to formulate the core research question for this study as follows:

'Does the Code of Practice Risk Assessment Document used on its own or in association with extension lead to reduced farm OSH risk and farm accident occurrence?'

To address this question, the following subsidiary research questions (RQ) have been formulated:

1. **To what extent do Irish farmers use the Risk Assessment Document?**
2. **What are farmers' opinions of the utility of the components in the Risk Assessment Document?**
3. **Does use of the Risk Assessment Document assist farmers to adopt OSH controls and reduce injury levels?**
4. **To what extent do Irish farmers avail of short training courses based on the Risk Assessment Document?**
5. **What are farmer's opinions of the components of training provided based on the Risk Assessment Document?**
6. **Does participation in training assist farmers to adopt OSH controls and reduce farm accident levels?**
7. **Does farmer/ advisor participation in training on the Risk Assessment Document increase use of follow-up extension?**

The research question and its sub-questions set-out the issues to be studied in this research project and are considered within the Theoretical Framework. However, the theoretical framework is conceptually larger than the study issue and considers the wider policy, farming and agri-socio economic issues which could impact on farm OSH. Accordingly, the preliminary theoretical framework depicted in Figure 5.1, attempts to link to the overall agricultural socio-economic environment in which farmers operate with the research question and sub-questions of the study. The components of the theoretical framework are considered in the following sections.

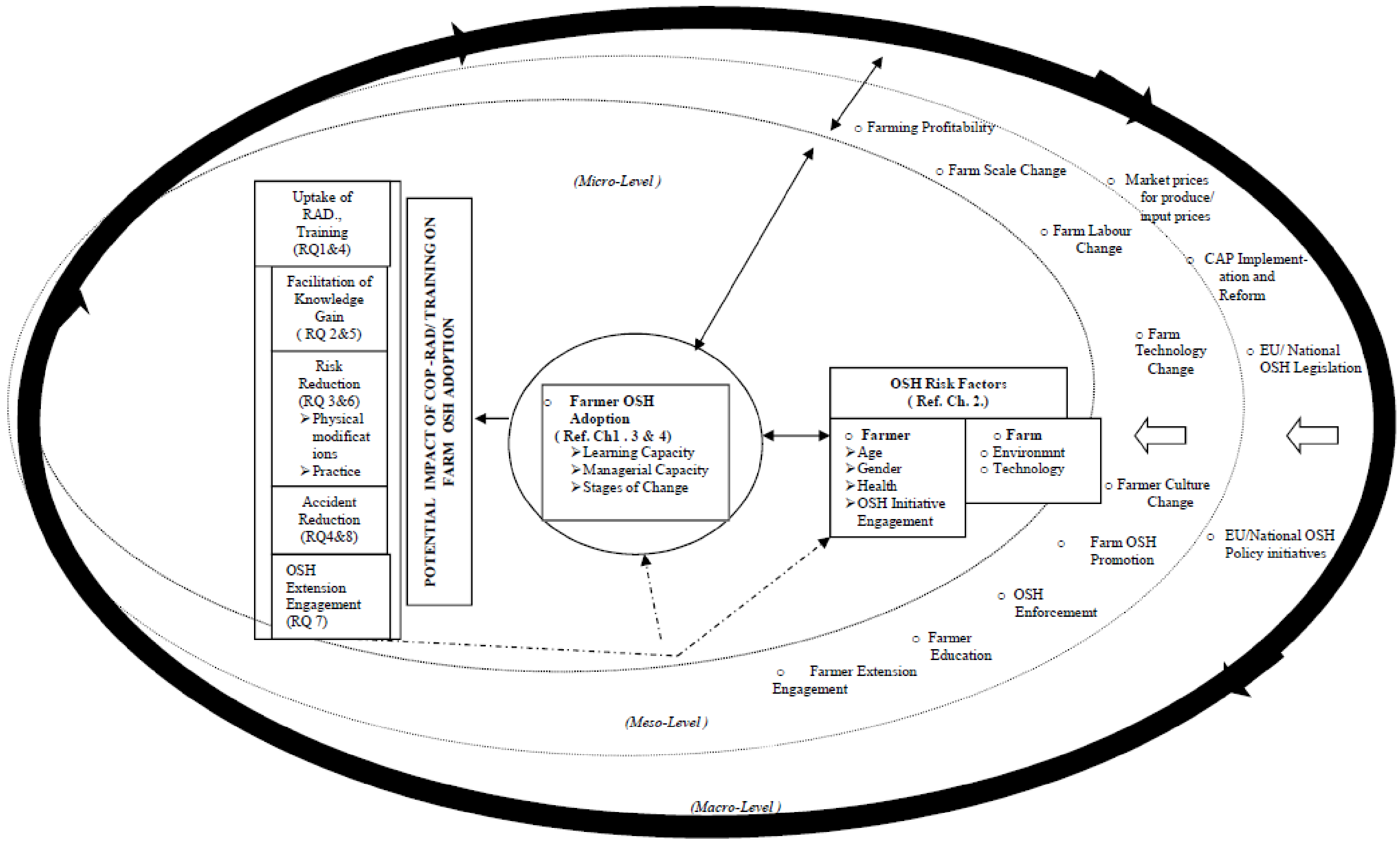

Figure 5.1: Theoretical Framework for Impact of Code of Practice Risk Assessment on OSH Adoption

5.3.1. Description of the Theoretical Framework

The theoretical framework developed illustrates the possibilities for the Code of Practice RAD in association with extension to influence farmers to engage in management of Farm OSH. The study Theoretical Framework adopted follows the ‘Levels of Analysis Framework’ (LAF) approach advocated for social scientific studies by Jaffee (1998). In this framework an issue can be analysed at different levels such as ‘individual’, ‘organizational’, ‘societal’ and ‘international’ levels, with different sets of theories being applied at each level. This author described the framework as a ‘nested hierarchy’ of progressively broader levels of analysis which is shaped by actions at inner levels and constrained or facilitated by forces operating at higher levels of analyses. The LAF is similar to the social-ecologic model described by Runyan (2003) (shown in Chapter 2, Figure2.5). This model is based on the work of Bronferbrenner (1994) in the field of human development, who argued that in order to understand human developments, one must consider the entire ecological system in which development can occur**.** This social-ecologic framework also defines various levels of the social environment, depicting the nested roles of intrapersonal factors, institutional and cultural elements which Runyan (2003) believed could be involved in accident reduction.

Jaffee (1998) considered that the LAF helps to bridge the gap between theories dealing with ‘individualistic’ and ‘structural’ explanations of human behaviour. Individualistic theories view human behaviour as the product of individual characteristics or personality traits, whereas structural ones interpret human behaviour in a broader social context as a result of the influence of external social forces, structure and institutional arrangements. While most theories tend to focus on a particular level of analysis at the site of the primary causal factors explaining behaviour, the best theoretical frameworks integrate and account for different levels of analysis in an interconnected causal chain (Jaffee, 1998). The study Theoretical Framework adopted has many similar components as the Health Promotion Framework (Green and Kreuter, 1999 p 14.) adapted for Injury Prevention by Gielen and Sleet (2003). The adapted Injury prevention model (Gielen and Sleet, 2003), however, adopted a parallel linear design which distinguishes between implementation of theory for behaviour change separately at individual and collective levels. This point is particularly relevant to this study which seeks to examine the use made by the Code of Practice RAD by farmers in Ireland and the knowledge gained may be used to devise strategies to influence farmers both at individual and collective levels as described by the Injury Prevention Framework.

The principal components of the Theoretical Framework for this study are described as follows:

- **Micro-Level**: In the centre of the model, at the micro-level farmer OSH adoption characteristics are centrally located. These adoption characteristics include farmer learning and managerial capacity which could influence engagement of individual farmers in OSH adoption. Also included is 'stages of change' which indicates that within a population individual farmers may be at many different stages of readiness related to OSH change. The model illustrates that farmer adoption is influenced by both farmer and farm OSH risk factors. The model demonstrates that potential impacts of the COP –RAD / Training Initiative of this Study are the outputs of farmer adoption including: uptake of the COP- RAD /Training; facilitation of OSH KAP gain, OSH extension engagement, risk reduction and accident reduction. The model indicates that the outputs of COP-RAD /Training feedback into both Farmer Adoption and Farm Risk Factors to influence these.

- **Meso-Level:** The model illustrates that the Meso-level exists which contains variables which may influence OSH adoption indirectly through such changes as culture change and changes in the factors of production and technology which impact on farm OSH. In addition on-going programmes of OSH promotion, enforcement and extension can impact on farmer OSH adoption. Meso-level variables are influenced both from the Micro and Macro levels of the Framework

- **Macro-Level:** The model illustrates that a Macro-level contains Irish and European OSH legislation, which are interrelated, and an associated National and EU

Plans and Implementation Programmes, all of which potentially influence factors inside the model.

- **Time Dimension**: Around the boundary of the model a Time dimension is included which indicates that both OSH adoption among farmers and developments related to both farming and farm OSH are not static and are subject to on-going change over time.

- **Interaction between Levels in the Theoretical Framework:** The framework indicates that change principally emerges from the outside inwards. Namely, that legislation (OSH and COP) and associated policy mandates and influences Meso- level changes which in turn have an influence on Micro-level changes or individual level actions. However the framework also indicates that change can occur from the centre outwards. Namely, change in farmer adoption can influence such Meso- level areas as culture change, factors of production and extension engagement, which in turn can ultimately influence policy and legislation. This view is in accord with the Injury Prevention Model proposed by Gielen and Sleet (2003) which suggests that the output of research can be used to influence both individual actions and policy.

A more detailed description of the literature underpinning each of the sections of the theoretical framework is summarised in the following section.

5.3.1.1. Micro–Level of Theoretical Framework

The Micro-level for the purpose of this study is defined as the farm as a workplace which is controlled by a farmer’s actions. Research in Ireland by Phelan et al., (2007) indicated a dynamic and reciprocal relationship related to OSH adoption occurred between farmers and their interaction with both the farm workplace environment and farm technology deployed. Put simply the farm reflects the farmer.

Accident causation theory reviewed in Chapter 2, (Section 2.2.) while indicating that multiple causes occur including physical ones involving technology and workplace environmental ones and human factors, however it strongly indicates that human factors are strongly linked to accident causation (Cooper and Germain,1974;Dunne,2000; Reason 2000; 2003; Taylor et al.,2004; Wigglesworth, 1972).

Thus at the centre of the model at the micro-level are farmer's characteristics related to adoption. These have been strongly indentified in the literature as the prime personal internal drivers of implementation of OSH change. These characteristics include: having an accurately informed risk perception (Hale and Glendon, 1987; Rich,1999; Sjőberg 2000; Slovic,1987; Stave et al., 2005; Wilde,1994**)**, propensity to take risks (Adams ,1995;Hedlund,2000), adequate knowledge (Röling, 1988; Schrader and Lawless, 2004; Valente et al.,1998; Van den Ban and Hawkins, 1996), possessing the behavioural determinants attitude and behaviour to motivate OSH adoption (Aherin et al., 1993;Ajzen and Fishbein, 1977; Ajzen, 1991; Geller, 2002; Green, 1999; Lee at al.,1997; Petrea 1996) and managerial capacity to implement adoption (Suutarinen,1992,1997,2004). These internal drivers for OSH change have thus been strongly identified in the literature as superior to external ones, especially in the context of occupations where self-management occurs, such as farming, which involves voluntariness of action (Sandman et al., 1987). However, adopting the external approach of focusing on gaining behaviour change in the first instance has also shown merit (Geller, 2002). Social Cognitive Theory (Bandura, 1977) indicates that people's behaviour can be influenced by their environment, particularly their interaction with other people and organisations.

Regarding knowledge gain, the work by Valente et al., (1998) strongly indicates that this can lead to attitude change and then to practice adoption with the so called KAP approach. Valente et al., (1998) regarded this approach as the most advantageous approach to gain technology/ practice adoption in comparison to other sequences of the KAP. Further more recent research by Ghosh et al., (2004) and Land and Water Australia (2006) provided support for this proposition. Thus adequate knowledge gain requires prioritisation in programmes to lead to OSH adoption. This, for instance, could lead to altered perception of risk and its acceptance. It also has that potential to highlight in the farmers mind the key issues causing accidents and ill health as mis-perception of actual risks has been highlighted in the literature as a key human shortcoming as regards accident causation (Knowles, 2002; Slovic, 1987).

Colémont and Van den Broucke (2006), however, pointed to the disappointing results of initiatives to improve agricultural OSH based on just increasing knowledge and suggested that greater use be made of the influencers of the determinants of behaviour. This suggests that strategies to facilitate OSH change should combine knowledge gain approaches with ones having the potential to cause attitude change which in turn leads to 'behavioural intention' and then to 'action taking' as outlined in the Theory of Planned Behaviour (TPB) (Ajzen and Fishbein, 1977).

Thus it is hypothesized that gaining beneficial change in OSH is likely to occur by following the KAP approach used in conjunction with strategies which positively motivate behaviour change. . However, various theories and frameworks including the Stages of Change framework (Prochaska and Di Clemente, 1983) and the TPB (Ajzen and Fishbein, 1977), along with research on the 'knowledge-gap' (Tichenor et al., 1970) and a KAP-gap (Westoff, 1988) indicated that uniform uptake of change may not occur with the KAP and consequently variability within a population can occur. It has been shown that action taking is likely to vary among individuals due to such factors as personality (Caspi et al., 2005) and managerial capacity (Nuthall, 2006). The latter capacity which is an alterable characteristic over time while the former can occur more slowly, suggesting that within a population uptake is likely to vary but that sustained programmes may lead to progress across the population over-time.

Developing the adoption characteristics of farmers is a pre-requisite to change at farm level as regards OSH. Theory reviewed indicates that change can be motivated by influential persons or organisations. These include the 'social norm' dimension of the Theory of Planned Behaviour (Ajzen and Fishbein, 1977) and the Social Cognitive Theory (Bandura, 1977) which strongly indicated that people's behaviour can be influenced by their environment, particularly their interaction with other people and organisations or both (chapter 3). In the context of this study the adoption sought is specified in the RAD, whose design draws inspiration from reports of use of farm audit documents in the USA and Denmark (Chapman et al., 1996; Landsittel et al., 2001; Rasmussen et al., 2003; Wilkinson et al., 1994) which have been associated with positive OSH adoption.

The training approach used in this study in conjunction with RAD completion is designed to facilitate individual farmers to reflect on their own farms and work practices. This approach is in harmony with the Experiential Learning Theory (Kolb, 1984) which proposed that the learning cycle incorporates concrete experience, observations and reflections, then forming conceptualisations and testing these in new situations. Rogers (2002) further added to this theory that decision-making is needed to progress and learn, suggesting that knowledge uptake must be followed by adoption. Literature reviewed related to farmer management styles indicated a reliance mainly on straightforward experiential approaches which feed-forward into future change and learning (Malcolm, 1990; Öhlmér et al., 1998). Improving managerial capacity has been identified as important to reduce accident rates (Suutarinen, 1992, 1997, 2004). Thus the approach of farmer RAD completion in association with short training followed by implementation of the RAD requirements at individual farm level is supported generally by learning theory, as it draws on an individual farmer’s knowledge and experience. The short training approach used in the Danish West Jutland Study in association with an advisory audit reported a significant reduction in accident levels (Rasmussen et al., 2003) which also suggested potential for the training approach adopted in this Study. Further support for provision of training to improve OSH is provided by Stallones (1989) who found that ‘education’ could prevent 58% of machinery accidents and the work of McCallum et al., (2005) which indicated that attending training increases knowledge and alters behaviours related to machinery use. Hemsworth and Coleman (1998) found that farmer’s attitudes and behaviours towards animal handling could be altered through training, with potential positive benefits for MAR and farmer safety. Work by Grunningham (2002) supported ‘self-audit and assessment approaches’ delivered by trusted sources in a face-to-face fashion. Finnegan and Phelan (2003) however reported limited implementation of control measures at farm level in Ireland. Rich (1999) considered that 'the desire to undertake action to create a safe working environment and work practices' which he termed 'outrage' is the missing stimulus in making progress with farm OSH. In essence, these studies describe the meso- level for the current study whereby a self-audit and training attendance was encouraged by policy as an alternative to being inspected in the pilot phase of the project.

Irish farming is extremely heterogeneous in both farmer and farm workplace and technology use variables (chapter 1). The efficacy of use of the RAD and training in relation to OSH adoption and accident levels could possibly vary with both farmer and farm variables. The literature review (Chapter 2, Section 2.5.4) indicated that farm accidents can be related to farmer variables most notably gender, age and health status. For farm variables, accident levels are most notably related to systems with livestock and number of machines on the farm.

In summary, the theoretical framework indicates that OSH change among farmers is related to farmer adoption characteristics located in the micro-environment. Such change is subject to variation within the farming population based on diversity of farms in Ireland and its study is desirable to gauge the effect of OSH interventions. Overall the micro-level of the theoretical framework represents the domain in which farmer practice adoption related to use of the Code of Practice RAD and training takes place and can be assessed.

5.3.1.2. Meso–Level of the Theoretical Framework

The Meso-level contains variables which may influence OSH adoption indirectly through changes in the overall environment influencing farms. These may include: changes in the factors of production; technology changes related to OSH; farmer culture related to OSH adoption and programmes of OSH promotion and enforcement and promotion along with education and extension leading to human capital development. Meso-level variables can in turn be influenced by the macro-level where legislation and associated policies for both OSH and agricultural production are located. On-going changes in the structure of Irish Agriculture and the overall approach to promotion of OSH in Irish Agriculture were outlined in Chapter 1 and a summary of meso-level variables of particular relevance to OSH are now provided.

Regarding the influence of factors of production on OSH standards, notably the international literature does not provide evidence for an association between accident levels and farm size (McCurdy and Carroll, 2000) or economic size (McCurdy et al., 2004; Sprince et al., 2003a; Lewis et al., 1998; Pickett et al., 1996). However, working full-time on farms (Sprince et al., 2002; McCurdy and Carroll, 2000; Lewis et al., 1998) and working long hours (Ferguson-Carlson et al., 2005; Sprince et al., 2002, 2003a) has been associated with increased accidents. In Ireland, McNamara and Reidy (1997) showed an association between accident rates with larger farm size and with specialist dairying and tillage farms. This research justifies including factor of production variables as meso–level variables of the Theoretical Framework.

Evidence of the impact of farm technology on OSH standards is provided as follows: use of tractor ROPS (Springfelt,1996; Thelin1998) and use of tractor seatbelts (Myers et al.,2006), improving visibility by design (Barron et al., 2005); improved design of machine power driveshaft covers (French Powershaft Guards Survey 2000-2001); specification of improved livestock handling facilities (Stroud and Walsh,1997); improved livestock breeding for docility (Boissy et al., 2005 ; Gauly et al., 2001; Golden et al., 2000; Boissy et al., 2005 Le Neindre et al., 1995) and technology for preventing falls from heights (Brunette, 2004).

Direct legislative enforcement is located in the meso-level of the Theoretical Framework. O'Sullivan and Kennedy, (1998) pointed out that having law is ineffective without its implementation including enforcement as necessary The literature indicates that legislation has most utility by facilitating 'enforced self-regulation' which requires synergy between 'persuasion' and 'punishment' to allow it to be successful (Ayres and Brathwaite, 1992; Gormley, 1978; Hutter, 1989; Reiss, 1984; Shover et al., 1986). Setting the balance between 'persuasion' and 'punishment' is a matter principally for the regulator who liaises or negotiates with the regulated sector, which in this case is the farming community. Wilde (1994), however, considered that for OSH law is ineffective as a tool to motivate change of risk-taking behaviours. Rich (1999) considered that adoption of risk management is mainly dependent on farmer acceptance of the importance of safe work practices and to undertake self-regulated actions.

Regarding promotion of OSH among farmers in Ireland, programmes in this area have been described in Appendix 1. These have been conducted principally by state agencies most notably the H.S.A. and Teagasc with considerable support from farmer organisations. Regarding farm organisation and farmer engagement with OSH, the work of Bogue (2001) generally indicated that such a balanced approach as with 'enforced self-regulation', is likely to gain support from farmer leaders and farmers generally who negotiate to avoid policies and measures they consider as undesirable (e.g. Restrictive regulation and controls) and to gain measures they consider as desirable e.g. incentives. In contrast, alternative strategies such as 'command and control' type enforcement may lead to a counterproductive reaction to OSH regulation, as reported by Kelsey (1994) which led to suspension of OSH legislation for the majority of farmers in the USA.
OSH promotion at a meso-level is indicated by the following studies. Conroy (1994) considered it is imperative to communicate clear and consistent messages to succeed with health promotion. Work by Sandall and Reeve (1997) indicated that perception of risk by farmers correlated directly with their willingness to take preventative action. Thus seeking intention to act through correctly informing farmers of OSH risk is a crucial dimension to OSH promotion.

The Meso-level also includes cultural change related to OSH Glendon and Staunton (2000) stated that safety culture refers to the underlying beliefs and convictions, including OSH, while climate is a more superficial term reflecting the current position. Thu (1999) warned that change cannot be imposed on any group and advised that understanding the cultural matrix of a group is paramount to achieve adoption. This author suggested that change can be facilitated culturally, but must be communicated and be behaviourally acceptable to the group. Work by Neal et al., (2000) within organisations indicated that safety climate influences safety performance through their effects on knowledge and motivation. Among farmers in Ireland, a positive 'climate' towards safety was indicated by the findings of market research on the advertising described in Appendix 1 (H.S.A., 2004b check), which indicated that 76% of the sample were encouraged to take action following viewing of a T.V. advertisement. McNamara and Reidy (1997) and Knowles (2002) reported farmers as an occupation group are in the main positively disposed to OSH.

Regarding developing human capital at a meso-level, a study by Oh and Shin (2003) indicated that general education has a major role to play in reducing accident levels. Numerous studies (outlined in Chapter 2.5.4.1.) indicated that for fatal farm work-related accidents that age beginning between ages 50 and 60 years increases risk. Meso-level approaches to dealing with this issue include farmer retirement through state or voluntary schemes or by communication activities aimed at changing the culture related to work activities at advanced age.

Overall, it is evident that many variables as outlined in the Theoretical Framework at the meso-level have potential to influence farm OSH. Also the current study is being undertaken against a background of considerable meso –level activity in Ireland related to farm OSH which provides a positive context for the Study.

5.3.1.3. Macro–level of the Theoretical Framework

The Macro-level of the Theoretical Framework demonstrates that National and EU OSH legislation along with the associated implementation of national plans and programmes are the predominant drivers seeking to influence OSH change among farmers in Ireland. OSH legislation in Ireland includes the self-employed, which includes farmers and this has led to the development of National Plans related to OSH in agriculture as outlined, more fully, in Appendix 1. Prioritising of the agriculture sector by the H.S.A, in association with FSP member organisations has been due to its poor OSH record when compared to other workplace sectors.

Gormley (1978), pointed out (chapter 3), that legislative control, including OSH, is part of democracy and is society's way of setting standards and ensuring that there is a means where implementation can be fostered and enforced where necessary. Having legislation in place provides a strong mandate for annual and multiannual OSH programming which brings about accountability. It also mandates the deployment of resources to support such programmes.

The EU Framework Safety and Health Directive (CEC, 1989) provides the origination of the OSH preventative approach to be followed for workplaces with employees: the development of prevention, evaluating risks and combating them at source, adapting the workplace to avoid risks and engagement in information and training activities. The directive also requires that a risk assessment approach be adopted at workplace level. This legislation was the driver of modernisation of Irish OSH legislation and its extension to all work sectors including agriculture.

Irish OSH legislation, the Safety Health and Welfare at Work Act, 2005 and the earlier 1989 Act follows the template of the EU Framework directive regarding the preventative approach to be followed; however, the Irish legislation includes all workplaces including those operated by self-employment persons, including farms, in contrast to the EU Framework Directive which covers only employed persons. The Irish legislation emphasises the management of OSH to prevent injury and ill health and it requires the preparation and implementation of a written Risk Assessment or Safety Statement for each workplace. The Irish legislation due to its wide ranging nature generally requires and encourages organisations providing services and supports to farmers (state and voluntary) to consider their role related to OSH inclusion and promotion and to develop and implement a programme appropriate for each particular organisation.

Ayres and Brathwaite (1992) considered that successful regulation programming should establish a synergy between persuasion and enforcement. In an Irish context the persuasion component has been catered for by legislative inclusion of provision for statutory consultation by the Health and Safety Authority with an advisory committee representative of the particular sector, such as agriculture where a statutory Farm Safety Partnership advisory committee is in place. The consultative approach has led to development of programmes by a range of organisations servicing farmers. It also has the potential to create synergy between the regulator and industry representatives which in turn has potential, through dialogue, to ensure that OSH programmes devised target practical OSH issues.

It should be noted that legislation is not 'carved in stone' and its approach can be modified by activating various sections. Legislation can be changed by the legislature to meet changing circumstances or where it is demonstrated that it is not working effectively. This, in fact, occurred with the passing of the 2005 Act, where the requirement to complete a Risk Assessment under the terms of a statutory Code of Practice was included as an alternative to a Safety Statement for small scale enterprises with less than four employees (Section19). This was done because it was evident that the previous approach of requiring completion of a Safety Statement was not successful in self-employment/SME sectors such as agriculture (Finnegan and Phelan, 2003). However, for legislation and associated policy to be developed and strengthened, evidence is required to support the proposed changes and to indicate more effective approaches. Developing such an evidence-base is an objective of this study.

A review of policy issues affecting the agriculture sector has taken place in Chapter 1 and the associated Appendix. The macro-level reflects these factors for both 'agricultural market profitability' and the CAP and its reform. At a macro-level these two variables broadly set the level in farm profitability which in turn influences changes in the factor of production use. CAP reform also has the potential to prescribe measures to improve the structure of the agricultural sector. Thus these variables have the potential to influence factors related to OSH adoption and are included in the Theoretical Framework.

Thus overall at a macro-level it can be seen how OSH legislative approaches and implementation programmes aimed at securing its implementation is the major driver for change in the OSH record of Irish Agriculture. Also agricultural profitability and the CAP and its reform can influence developments in the sector affecting OSH.

5.3.1.4. Time Dimension

At the periphery of the Theoretical Framework a time dimension is indicated. This signifies that all the variables of the framework are subject to change over time. Change can either be beneficial or deleterious to OSH change.

At a human resource level data presented in Chapter 1 indicates that the farming population in Ireland on average is getting older which increases farm OSH risk while both general and agricultural education levels are increasing which has potential to reduce risk. At a farm scale and technology level, on average, farms are increasing in size which could increase workload and OSH risk while on-going investment in farm technology such as mechanisation, buildings and livestock breeding has potential to provide improved OSH conditions which could moderate risk Regarding profitability, which influences investment and development and hence OSH, supports have been agreed under the EU Basic Payments Scheme for the period 2015-2019 at modestly reduced payment levels, while demand for food globally is expected to rise and lead to increased output prices and profits, due to population and prosperity growth, however fluctuations in world markets are expected depending on food demand and supply. As regards availability of extension services to support farm OSH developments, globally and in Ireland, public funding is likely to be constrained due to the current recession and on the other hand demand for extension is likely to be high due to a new phase of farm development. It can be seen from the trends outlined that the model adopted for supporting OSH farm implementation over time is not static and its components are likely to require adjustment over time.

5.3.1.5. Development and Potential Outcomes of the Study Model

The potential outcomes from the application of the Theoretical Framework (Figure 5.2) are listed as: uptake of the COP RAD and associated training; facilitation of knowledge gain among participating farmers; reduced accident risk and injury reduction. These are clearly linked to the Research Questions of the Study. As outlined in the Public Health Model (Murphy, 2003), in Chapter 2 (Section 2.1), surveillance is a crucial step to accident and ill health prevention approaches which will occur in the research component of this study (Chapter 7). However, the outcome of any evaluation cannot be presumed and Sherrard and Day (2001) and McKillup (2005) stated that there are two ways that an OSH assessment programme can be judged as being successful namely: either the assessment demonstrates an improvement in OSH; or alternatively where no improvement is demonstrated the assessment may be judged as a success by adding to knowledge and potentially saving other groups from implementing non-effective programmes and it may suggest alternative approaches for assessment.

In conclusion, as the key components of the Theoretical Framework have been discussed, it is now necessary to outline scientific hypothesis testing and distinguish the components of the Theoretical Framework which can be tested in this study.

5.4. Scientific Hypothesis Testing

To conduct research using scientific methods the ‘hypothetico-deductive’ approach is applied (McKillup, 2005). With this approach the researcher observes or samples components of the ‘world’ to be studied, in this case associated with the theoretical framework. The researcher then makes intuitive, logical guesses, called ‘hypotheses’, about how the system functions. Each hypothesis predicts how a particular component operates and this is then tested by conducting a ‘hypothesis test’. All hypothesis tests are binary in nature and it may be accepted or rejected based on the evidence presented, including statistical testing, to support or refute the claim made of the hypothesis. McKillup (2005) further explained that if a hypothesis is rejected it is likely to be incorrect and another one needs to be proposed. If a hypothesis is retained, withstands further testing, and has some very widespread generality, it may progress to become a ‘Theory’. However a theory is only a very general hypothesis that has withstood repeated testing but with the possibility of being disproven by new evidence in the future.

To test hypotheses, classical experimental testing relies on comparing the results obtained from a ‘control’ and ‘experimental’ group which vary only in an experimental treatment applied or ‘variable’. However, with survey research the opportunity to implement a controlled design is rare, however, the same principles as experimental testing apply to this approach, most notably the concept of having a ‘control’ group against which to measure the effect of another variable (SPSS Training Manual, 2005, p 4). Treatment variables are referred to as ‘independent’ variables while the quantity being measured is the ‘dependent’ variable. Sekaran (2003) stated that the dependent variable is the variable of primary interest to the researcher as it is the one which is influenced by independent variables as follows: ‘an **independent** variable is one that influences the **dependent** variable in either a positive or a negative way. That is, when the independent variable is present, the dependent is also present, and with each unit of increase in the independent variable, there is an increase or decrease in the dependent variable also’. Thus Sekaran, (2003) considered that the researcher’s goal is to explain or predict the variability in the dependent variable’.

Two further types of variable which alter the relationship between a dependent and independent variable have been described by Sekaran and Saks (2003). The presence of a **mediating** variable could enable a relationship between an independent and dependent variable while the a **moderating** variable alters the relationship between an independent and dependent variable either in magnitude or direction.

5.4.1. Study Hypothesis Testing

The core research question or hypothesis for this study is as follows:

Does the Code of Practice Risk Assessment document used on its own or, in association with extension lead to reduced farm OSH risk and farm accident occurrence?

To provide a framework to address the research question and its sub-questions outlined earlier, a Study Model has been devised from the Theoretical Framework and presented in the form of a schematic diagram in Figure 5.2. The Theoretical Framework is derived from a social-ecologic model (Runyan, 2003) which defined various levels of the social environment, integrating intrapersonal, interpersonal institutional and cultural elements possibly involved in accident reduction Runyan (2003). Runyan (2003) also pointed out that numerous studies across a range of disciplines would be required to test all components of such a framework. Thus the Study Model focuses specifically on identifying the study hypotheses for testing. It is aligned particularly with the micro components of the Theoretical Framework and it is located in the discipline of Agricultural Extension.

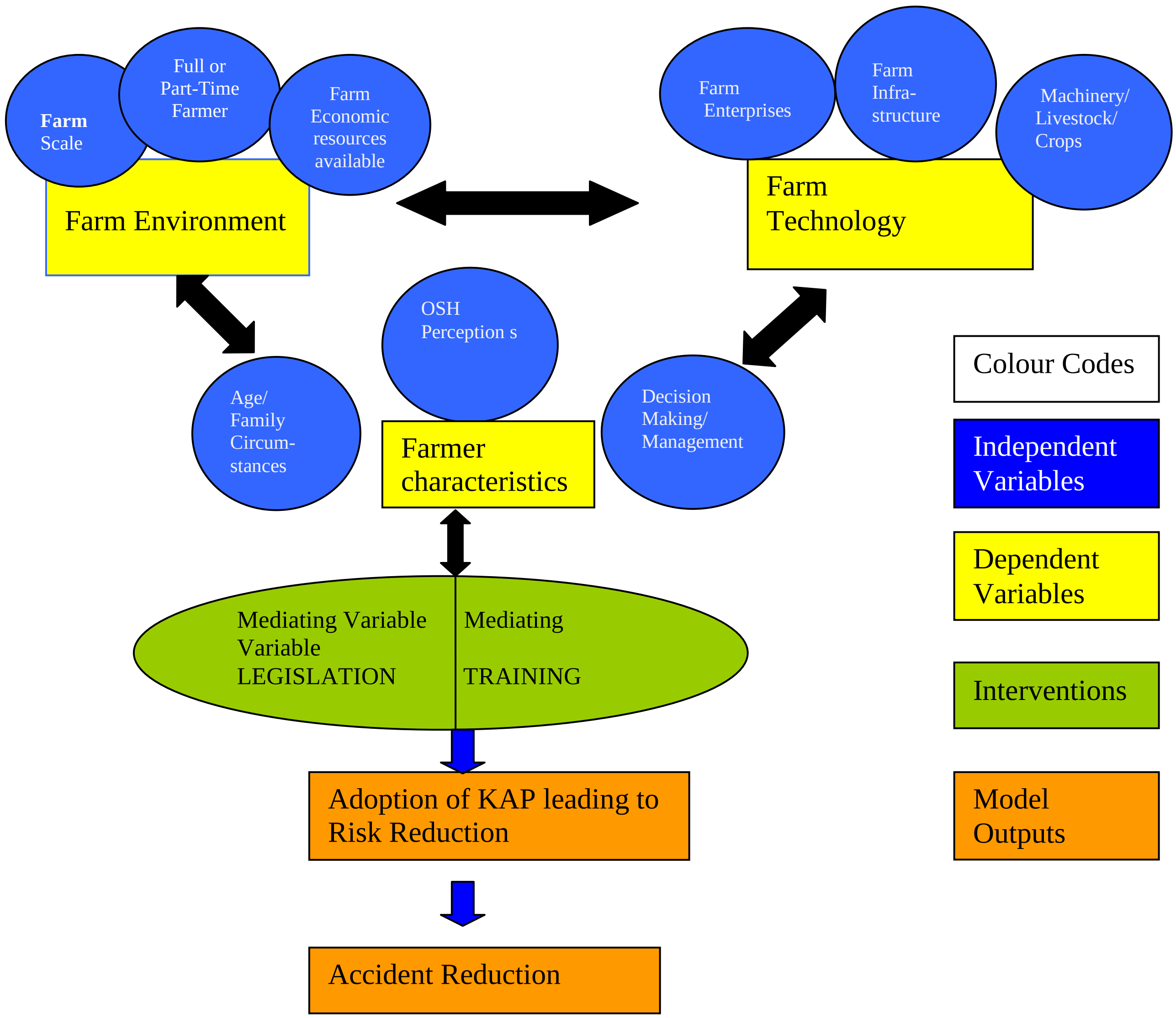

Figure 5.2: Potential Linkage between Dependent and Independent Variables in Study Model

The Study Model indicates that its central components are Legislation (COP RAD use) and Training interventions (Colour Code: Brown). These are the potential influencers to assist farmers to manage OSH under examination in the study.

In the Study Model farmer and farm characteristics including Farm Workplace Environment and Farm Technology have been indicated as dependent variables (Colour Code: Yellow). The input of Farmers is shown in the model as inputting and responding (note double-headed arrow) with the Legislation and Training interventions. The 'input' represents the cognitive engagement of farmers into the Legislation/Training interventions while 'response' represents the adoption output from this engagement process. The Model indicates that both Farm Workplace Environment and Farm Technology variables are linked to the Legislation/Training interventions through the Farmer characteristics variable signifying the mediating effect of managerial control exercised by farmers over farm tangible resources.

Surrounding the study dependent variables Farmer Characteristics, Farm Workplace Environment and Farm Technology are clusters of potential Independent variables (Colour Code: Blue). These clusters have been developed from the literature review as potential influences on the dependent variables as follows:

- **Farmer Characteristics**
  - Age/ Family Circumstances
  - OSH Perceptions.
  - Decision Making/ Management.
- **Farm Workplace Environment**
  - Farm Scale
  - Farming Full or Part-time
  - Farm Economic resources available
- **Farm Technology**
  - Farm Enterprises
  - Farm Infrastructure
  - Specific technology used (e.g. mechanization, livestock etc).

A range of up to 60 farmer and farmer environment/ technology variables are available to the study from the Teagasc NFS (See http://www.teagasc.ie/nfs/). However some of these variables may be co-linear or aligned and for this reason initially clustering has been undertaken. It is planned to seek to identify a specific independent variable(s) indicating an effect on dependent variables in the study. Also, it will not be possible within the constraints of the resources available to the study to measure all farm and farmer variables related to farmer participants, so proxies or indicators of variables may be used to indicate the presence of independent variables.

The Study model indicates that the outputs from the interventions are as follows:

- Adoption of OSH measures leading to Risk Reduction
- Accident reduction.

Adoption of OSH risk reduction measures is the measureable component, **practice adoption**, of the KAP earlier described by Valente et al., (1998). These authors strongly indicated that **knowledge** leads to **attitude change** and then to **practice adoption**. As practice adoption is the measurable output which signifies that the KAP approach has been completed, so particular emphasis will be given to identifying if this measure has been completed.

Accident reduction is the natural measureable follow-on from taking risk reduction measures and the study will endeavour to measure the effect of the interventions on this measure.

The following Hypotheses have been derived from the Study Model:

- **Hypothesis 1:** That farmer personal characteristics influences use of the RAD.
- **Hypothesis 2:** That farm characteristics influences farmer use of the RAD.
- **Hypothesis 3:** That farmer personal and associated farm characteristic influences their opinion of the RAD and associated training.
- **Hypothesis 4:** That, among legal planning documents associated with the COP, that the RAD is the one which farmers consider has the greatest utility for them.

- **Hypothesis 5:** That participation in Half-day Training on the RAD increased the level of controls specified relative to completion of the RAD without training.
- **Hypothesis 6:** That Farmer completion of the RAD in association with training facilitates a reduction in farm accident risk.
- **Hypothesis 7:** That Farmer use of OSH planning documents (SAD/SS and RAD) leads to a reduction in farm accident levels.
- **Hypothesis 8:** That Farmer use of the RAD following Training leads to a reduction in accident levels.
- **Hypothesis 9:** That certain farm characteristics combine to moderate the level of farm accidents.
- **Hypothesis 10:** That Farmer characteristics influences farm accident levels.
- **Hypothesis 11:** That participation in RAD Half-day Training influences the subsequent use of extension on OSH.
- **Hypothesis 12:** That Farm efficiency performance is associated with farm accident rate.

Chapter 6

Research methods

6.1 Introduction

Easterby-Smith et al., (1991) emphasised that it is vitally important to select the appropriate research method for testing of study hypotheses. Accordingly, this chapter firstly reviews the dominant philosophical perspectives of social science research and then describes and justifies the research methodologies that have been chosen for this study. It then concludes by describing the inter-connections between the various research methodologies to be used and discusses measures for the avoidance of bias.

As completion of the research is contingent on implementation of the PI on which it is based, described in Chapter 1, The component of this initiative will be described in association with related research methods. Finally, throughout this chapter the reliability and validity of the research methods to be used to produce the study data are considered and critiqued.

6.2 Philosophical perspectives and approaches

Research can be described as 'a systematic and organised effort to investigate a specific problem that needs a solution' and it is important to understand philosophical perspectives, have clear objectives and appropriate research methods (Sekaran, 2005). Easterby-Smith et al., (1991) considered that it is important for a researcher to understand the various research philosophical perspectives which exist within the social sciences, as these influence the approaches undertaken to conducting research. Thomas (2004) further considered that within the literature there are two dominant philosophical perspectives to undertaking research as follows: 'positivist' and 'interpretive' ones and these have implications for the selection of the research methodologies.

Positivism as a theory is based on the premise that every rational assertion can be scientifically verified or logically explained (Walliman, 2001). The positivist perspective is that science is deductive and that it proceeds from the general to the specific and that science is value free, based on strict rules and procedures enabling causal laws to be established to predict the occurrence of events (Sarantakos, 2005). By way of contrast, the interpretive perspective advocates a need to understand the meanings behind the behaviour being studied and it recognises that the researcher is an intrinsic part of this process who places their own interpretation on what is observed as part of the research (Easterby-Smith et al., 1991).

Gill and Johnson, (1997), stated that two alternative research methods may be used, either ‘deductive’ or ‘inductive’ approaches. These authors defined the deductive research method approach as the development of a theory and hypothesis (es) relevant to the research issue prior to its testing through empirical observation and confirmation or otherwise of the theory and hypothesis. The inductive approach, in contrast, focuses on the development of explanations and theories based on observations of the subject of research, as it is (Gill and Johnson, 1997). These observations may include general explorations without a hypothesis; communication between the researcher and respondents with no intention of establishing independence; an examination of patterns and their meanings related to the research subject, which make up reality and an appreciation of the social context of the study. Deductive and inductive approaches are commonly referred to as ‘quantitative’ and ‘qualitative’ approaches, based on the fact that the former approach provides findings as data whereas the latter provides findings based more as descriptions.

It has been argued that the deductive approach has limitations relating to its application of theories for predicting human behaviour. For instance, Laing, (1990) argued that human behaviour is complex and is based on a large number of factors including attitude, beliefs and motives and as a result, it is essential to study and understand the subjective capabilities of human action and it may not be appropriate to develop a theory to predict future events as a basis for commencing research.

Using a ‘mixed method’ approach for conducting research by using a combination of deduction and inductive research methods has emerged according to Easterby-Smith et al., (1991) who reported that there has been considerable academic debate related to use of this approach. Rossman and Wilson (1985) identified the following three viewpoints on combining quantitative and qualitative methods as follows: the ‘purist’, the ‘situationalist’ and the ‘pragmatist’ viewpoints. Purists argue that the methods cannot be combined due to their irreconcilable philosophical bases. Situationalists see merit in using both approaches but specific methods or their combinations may be more suitable than others for specific research, given its circumstances. Pragmatists seek to integrate quantitative and qualitative methods into one study and oppose the dichotomy of argument presented by situationalists and purists. Pragmatists aim to maximise the merits of both approaches through their efficient use of both methods in pursuing social research.

Morse (1991) described various options for using mixed methods within the limitations of each method. This author considered that a principally qualitative approach can be used simultaneously with a quantitative one to enrich the description of the study sample or sequentially to test a hypothesis emerging from the qualitative data using quantitative methods. A principally quantitative approach can be used simultaneously with a qualitative one to describe part of the phenomena under study which cannot be quantified or sequentially to further study findings from the quantitative phase. Easterby-Smith et al., (1991) further identified a number of categories of triangulation of research methods including: **triangulation of theories**: exchanging models among disciplines to explain situations and reveal fresh insights from study data; **triangulation by investigators**: is where different people collect data on the same situation and the results are then compared and contrasted; **methodological triangulation**: entails utilising both qualitative and quantitative methods of data collection and collaborating the findings.

In the social sciences, research needs to be conducted on a mutually trustful and cooperative basis among participants and by applying well-accepted ethical conventions including: ensuring that participants understand the nature of the study and give informed consent to participation, selecting the appropriate methodology, collecting and processing the data accurately and interpreting the data correctly and in an unbiased manner (Sarandakos, 2005). Conformation with ethical requirements took place throughout this study and descriptions and backgrounds of the assessments to be conducted were provided prior to requesting participation from respondents, which can be found throughout appendix 6 of this study. A more comprehensive description on philosophical perspectives and approaches to conducting research can be found in Appendix 6.1.

As this study directly involves OSH research, approaches and techniques related to conducting such research are now reviewed to ascertain their relevance to devising specific methods relevant to conducting this study.

6.3. Conducting occupational safety and health research

Due to the general challenge of improving OSH in workplace settings, this topic has been the focus of considerable research endeavors. Accordingly a number of reviews have been carried out on approaches to conducting research on this topic including one by Robson et al., (2001) on work related OSH assessments and one specifically for the agriculture industry by Australian authors: Sherrard and Day (2001).

6.3.1. Introduction to assessment of effectiveness

The guidelines to assessment of the effectiveness of strategies for preventing work injuries by Robson et al., (2001) have been published by the National Institute of Occupational Safety and Health (referred to as NIOSH), USA, while guidelines for assessment of safety programmes specifically for the agricultural industry have been prepared by Australian authors: Sherrard and Day (2001). Boyle (1981), from an adult education, perspective also considered that assessments needed to be conducted through the lifecycle of a project including the ‘planning’, ‘structuring’, ‘implementing’ and ‘recycling’ stages. The assessment process culminates in a comparison of actual results and those originally intended and any discrepancy identified is used to feedback into the system through a redesigned programme.

Sherrard and Day (2001) stated that conducting an assessment is an integral component to any OSH prevention programme in the agricultural industry because it ‘provides an evidence base for prevention programmes, provides guidance on the selection of effective strategies, demonstrates the value of programmes, and increases the commitment from funding agencies’. Specifically, Sherrard and Day (2001) outlined the following uses of OSH assessments: it contributes to the development and refinement of the current (and future) programmes; determines effectiveness; gains and develops community and technical support; identifies any unanticipated benefits and dis-benefits; establishes accountability to a funding body or an employer or performance management system; supports submissions for continuing resources and legislation and justifies the application of the OSH programme in another setting.

Sherrard and Day (2001) also stated that it is highly desirable that assessment is incorporated into the planning, implementation and management of a programme. They cited Thompson and McClintock (1998) as stating that approximately 10- 15% of total costs of an OSH prevention programme should be devoted to assessment. Sherrard and Day (2001), however, noted that funding agencies tend to limit funding for assessment purposes. This phenomenon also extends to agricultural extension as Röling (1988) commented on the lack of attention generally given to assessment. A review of the need for research and assessment to contribute to workers' health and safety programmes by McQuinston (2000) reported the continued under-development of assessment practice and this author suggested that 'opportunities for assessment to show how education enhances worker protection continue to be lost and possibilities for programme improvement, innovation, and diffusion continue to go unrealised'.

Sherrard and Day (2001) also noted that various agencies tend to have differing views on what type of information is important to them. For instance, one agency may wish to see a reduction in 'fatal accidents' whereas demonstrating an improvement in competency (knowledge, attitude and skills) may satisfy another agency.

Saari (1990) suggested that both a long term and a broad perspective should be adopted in OSH assessment as an intervention such as a OSH campaign may not be immediately effective in reducing accident or ill health levels but may improve some other associated factor (e.g. farmer perception of OSH) which could lead to gains in the longer term.

Sherrard and Day (2001) laid out the format and elements of a programme plan (Table 6.1) applicable to OSH which gives relationships between plan stages and assessments. While assessment at all stages is essential, inferential scientific knowledge is principally associated with 'impact' and 'outcome', also referred to as effectiveness assessment and this is regarded as the most valuable output on an assessment (Robson et al., 2001).

Sherrard and Day (2001) advised that 'goal setting' in OSH must reflect the capacity to measure the goal set and they gave the example of measurement of accident reduction which requires a large sample to measure scientifically. Thus impact assessment measures (e.g. knowledge gain or behaviour change) are used as the outcomes of many OSH programmes because of their measurability rather than accident reduction which is more challenging to measure due to a requirement for access to large sample sizes.

Table 6.1: Programme plan and assessment for health and safety

Programme Plan	**Assessment**
Needs Analysis: Establish the incidence, pattern and nature of the problem to be addressed.	**Formative Assessment:** Documents the Programme Plan and record its implementation
Strategies: Detail activities to be conducted to achieve objectives	**Process Assessment:** Measurement of achievement of strategies.
Objectives: Defining the desired measurable improvements of the programme.	**Impact Assessment:** Measures the achievement of programme objectives.
Goal: Desired measurable long-term outcome of the programme (intervention).	**Outcome Assessment:** Measures level of achievement of programme goals.

Adapted from: Sherrard and Day (2001).

Sherrard and Day (2001) considered that there is no one correct way to assess a OSH programme, which suggests that assessment methods must be devised for specific programmes. They consider that consultation and collaboration between interdisciplinary professionals and stakeholders is essential at all stages of a programme to gain useful and informative assessment results.

6.3.2. Methods of conducting OSH assessments

The USA's NIOSH Guidelines provide practical advice on all aspects of conducting OSH assessment including: defining assessment, planning, design, sampling, measuring outcomes, quantitative and qualitative methods and statistical issues (Robson et al., 2001). Robson et al., (2001) considered that it is preferable to have an assessment conducted by an independent party with no vested interest in the research outcome but conceded that in many instances, practitioners must conduct assessments or they would not be conducted at all. They considered that potential for bias can be minimised with practitioner-led assessments by inviting others to comment on analyses and to be very explicit in advance about what is to be measured.

As this research project was practitioner-led, measures were taken to prevent bias of assessments including that colleagues conducted surveys undertaken, that two people conducted farm OSH audits and that all study documentation and results are available for inspection. A further review of bias and measures taken to prevent it in this study is provided in Section 6.4.6.1 .

With effectiveness assessments Robson et al., (2001) believed that complete effectiveness assessment data should be collected 'on all concepts represented in the intervention models', using **qualitative** and **quantitative** methods. They considered that to clearly demonstrate intervention effectiveness it is almost mandatory to use quantitative techniques and measure an outcome variable (e.g. accident rate) and to demonstrate a statistically significant change in this variable. However, they considered that the use of both qualitative and quantitative methods provides potential to gain rich sources of information with quantitative methods providing a 'measure' of the effect and qualitative methods helping to explain 'how the effect occurred'.

6.3.2.1. Quantitative methods

Both Robson et al., (2001) and Sherrard and Day (2001) discussed the strength of evidence provided by the following types of assessment designs: **experimental**; **quasi-experimental** and **non-experimental**. Experimental designs, they state, provide the strongest evidence of a causal link between the intervention implementation and observed effects as the design incorporates a ‘control’ and ‘intervention’ group where subjects are assigned by an unbiased process (i.e. randomization). However, Robson et al., (2001) noted that very often the logistical requirements of experimental designs can cause them to be unfeasible. A quasi-experimental design represents an alternative, but with less strong evidence to an experimental design, as it includes a control group created by a non-random process and thus can be more workable in a workplace setting. A non-experimental design, which includes the common ‘before-and-after’ design, provides weaker evidence than experimental designs as it does not have a control group.

6.3.2.2. Survey techniques

Conducting a survey(s) is a powerful assessment tool as it makes it possible to determine the distribution of a characteristic (attitude, belief, behaviour or attribute of each respondent) in the survey population (Robson et al., 2001; Dillman, 2000). Thus conducting a self-administered survey is a practical and cost-effective means of obtaining quantitative information on an assessment subject. Considerable practical advice on how to practically conduct self-administered surveys (Belnaves and Caputi, 2001; Denscombe, 2003; Dillman, 2000; Sarantakos, 2005) is available in the literature with the advice being summarised as follows:

Drawing up surveys: Questions should be short and clear, have one meaning, and be relevant to the research.

Measuring Questions: Suitable categorisation and / or assigning values to the variables by scaling should be used, followed by checking for validity or reliability.

Administration: The questionnaire should have a ‘welcoming’ appearance, be of the right length (about 20 minutes max), have adequate instructions and be properly introduced to participants and provision needs to be made for non-responses to eliminate bias. Eagly and Chaiken (1993) cited Davison and Sharma (1990) as indicating that parametric statistical tests performed on attitudes data is a valid approach.

Dillman (2000) and McKillup (2005) stated that to allow generalising of the survey results to represent a population, the variation of the population must be known to calculate sample size. Dillman (2000) added that probabilistic (or random) sampling may not be possible in all situations and 'convenience' sampling is regarded as an acceptable assessment approach, provided that no claim of representation is made (Sekaran, 2005; Weiss, 1998).

As serious or fatal accidents are relatively rare events, this means that assessments require a large sample size to demonstrate a statistical difference if present. They stated that an alternative to assessing accident levels is to assess work-site standards and practices associated with accidents (Robson et al., 2001), however, these proxy measures must be closely associated with accident levels to allow inference of the effect of an intervention on accident levels (Dillman, 2000).

6.3.2.3. Collecting qualitative data

In this study it was decided to use a number of qualitative methods, but particularly including use of open-ended questions in questionnaires designed to obtain quantitative information for assessment. Robson et al., (2001) considered that such an approach is useful for verifying the picture obtained from quantitative measures, gauging participant reactions, identifying programme barriers and bringing out unintended consequences of the intervention. However, the depth of responses is limited with this approach because there is no follow-up on participants' statements with further questions which is in contrast to 'stronger' qualitative methods such as using interviews and focus groups.

A second qualitative method which it was decided to be used in this study was RAD document analysis. Robson et al., (2001) stated that generally, document analysis offers evidence of intervention implementation but warns generally that 'documents are never more than a partial reflection of reality'. Thus the document assessment component of this study is particularly relevant along with its triangulation with other assessment techniques, particularly on-site evaluations.

A third qualitative method used in this study was to go on-site and conduct farm OSH audits to both observe the farming practices and informally interview farmers involved.

Robson et al., (2001) considered that on-site visits could be the best way to verify that the intervention activities are occurring as prescribed. These authors raised the issue of minimising evaluator bias in workplace assessments by such means as having more than one evaluator collect the data. Kuusisto (2000) who studied the use of audit tools and their reliability in auditing Safety Management Systems in workplaces found that an auditor's expertise in the field of OSH is always an essential component of auditing. This author found reasonably high reliability in the use of an audit tool he tested when the auditor was familiar with the workings of the audit tool, national legislation and the culture of organisations being audited. Reliability, however, decreased when the auditor was less familiar with the audit method and the local conditions. Regarding OSH auditing of farms in Iowa, U.S.A. Jones et al., (1999) sought to devise and assess the use of a Site Rank System (SRS) to assess OSH standards and practices on farms by combining four rankings, two for farm operator: attitude and practice and a further two for farm elements: physical environment and equipment. They noted that with '…observational assessment tools, the training, knowledge and experience of the investigator plays an integral part in what is identified and noted', however they found that use of the SRS increased consistency of OSH scoring of farms. These authors noted that approximately one hour was sufficient to interview the farm operator and conduct audits of the key equipment and facilities of the farms visited.

An important point related to allocating on-farm scores to OSH of particular relevance to this study is that it was decided that an even number of scores would be applied (e.g. 4) as this would allow reducing scores into a lower number of categories if necessary (e.g. 4 to 2). This point was made by the authors of the two studies which most closely resemble the current Irish study, the Iowa SRS study (Jones et al., 1999) and the Danish West Jutland Study (Rasmussen et al., 2003) and also generally by Dillman (2000). Having an even scoring system also facilitates decision making by the on-farm auditors as a choice has to be made between 'satisfactory' and 'unsatisfactory' as there is no 'mid-point' score for the auditor 'to rest on', i.e. the auditors must make up their minds. In the case of this study a four point scoring system was used for farm assessment, whereby unsatisfactory scores were equated to the legal position under the SHWW Act

(2005) where an **improvement notice** (score 3) and a **prohibition notice** (score 4) would be implemented by a H.S.A. Inspector, while the highest score (score 1) represents an **excellent** standard and score 2 represents an **acceptable** standard.

6.4. Implementation of the assessment plan to test the study model

Development and implementation of the Prevention Initiative (PI) and testing of the study model took place concurrently. Consequently in this sub-chapter, the training components of the Project are firstly described to provide a context for explaining the assessment component which was undertaken as part of the research.

6.4.1. Introduction

In chapter 1, the development and implementation of the PI was outlined in the chronological manner in which it was conducted. In this sub-section the data gathering plan to accompany PI activities is described. The assessment methods to be used are related to the literature review on research methods conducted in the previous sub-chapters. Four phases are to be now used to describe the research data gathering with the amalgamation of the two chronological phases involving RAD and FETAC training provision and the associated assessment of the OSH legislative documents used in training into one phase.

An overview of the data gathering plan adopted for the study is depicted in Figure 6.1. This shows the research philosophies adopted, the assessment undertaken which indicates the progression of the assessment in association with the project plan and the linkages with it. The research methods and analysis depicted in Figure 6.1 indicates that a mixed-method approach has been used.

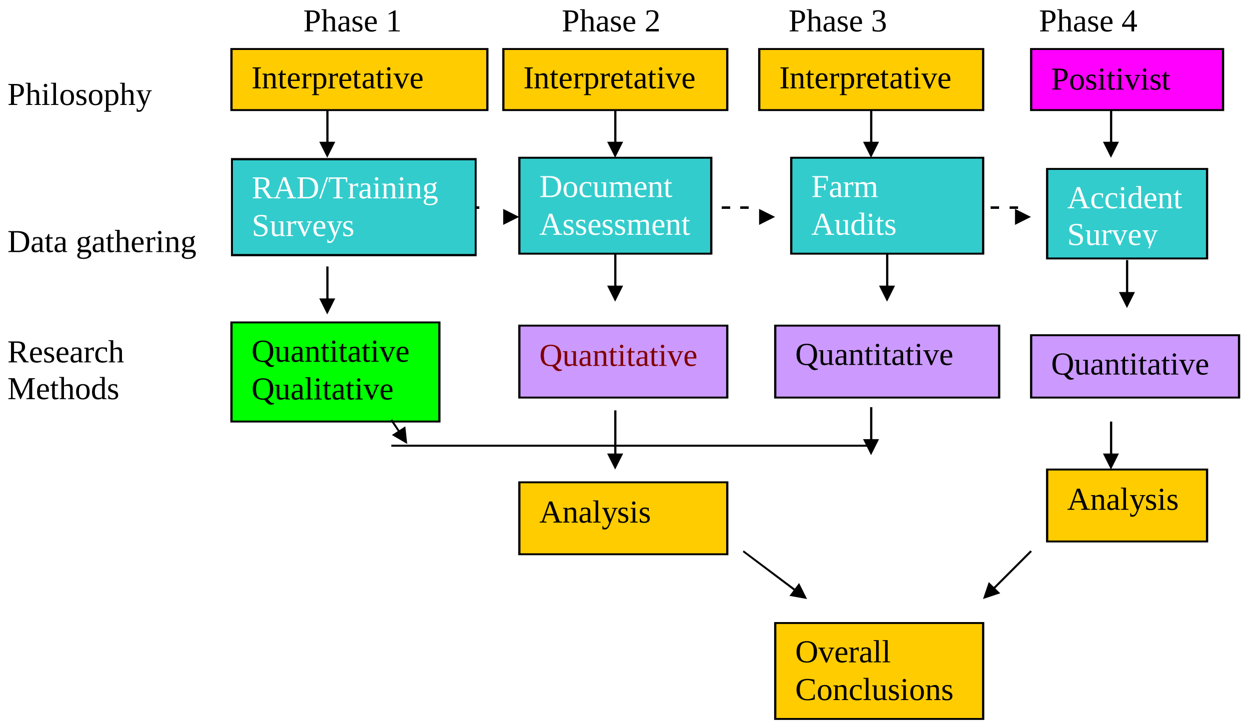

Figure 6.1: Study research data gathering plan

A summary of the assessments undertaken as part of this study is provided in Table 6.2. which is then followed by a description of each study phase. The first phase of the assessment includes surveys among farmer participants at half-day and FETAC training courses, and surveys of advisors and trainers on facilitating RAD training and follow-up OSH extension, which will provide information on opinions on the OSH documents used and the utility of the training provided. In this phase also, farmer opinions on accident causation will be sought and a national survey (NFS, 2008) on farmer opinions of COP documents and DVD viewing, following national circulation, is to be conducted. Phase two will involve examination of collected RAD's from farmers who did or did not participate in RAD training. Phase 3 will involve farm level assessment of RAD completion and implementation of OSH controls by means of farm audits. Phase 4 is to involve completion of a national survey (NFS, 2011) of farm accidents among farmers who completed the RAD with or without training and farmers who did not complete either of these interventions.

Table 6.2: Alignment of study model phase and assessment methods

Study Phase	Study Model	Evaluation method	Time Scale	Instrument (no. of responses)
1	RAD and associated training assessment	Survey of R.A.D half-day course participants. Farmers opinions: accident causation	Jan -Mar. 06 Oct. 06-Mar. 07 Jan 06 – Mar.07	Principal questionnaire (291). Short questionnaire (915) Exercise conducted at half-day course (1151)
		Surveys of advisors opinions of RAD and training. Survey of advisors inclusion of OSH in work programmes Survey of trainers opinions of RAD and training	Survey 1: June 2006. Survey 2: June 2007 June 2008	Questionnaire (27) Questionnaire (54) Questionnaire (27)
		Survey of 2-day course (FETAC) participants	November 2006 – April 2007	Questionnaire (85)
		Farmers opinions of COP documents & DVD viewing. NFS survey (year 2007)	Year 2007	NFS survey (1040)
2	RAD completion	R.A.D examination	Collected 2006	RAD scoring (475)
		R.A.D controls quantification	Collected 2006.	RAD control no./ count/classification (477)
3	RAD implementation / adoption at farm level	RAD verification and farm controls examination.	2006 (after half-day training) 2007 (after FETAC training)	Farm audits (66) Farm audits (28)
4	Injury levels	NFS survey (year 2011)	Year 2011	Survey (891)

6.4.2. Phase 1: Assessment of utility of COP/RAD and training

Implementation of the PI commenced with provision of half-day training on the RAD and then FETAC OSH training and assessments associated with this phase are now described. Surveys were conducted among farmer training participants and advisors and trainers who facilitated training and these are firstly described. The approach of using a scoring method to estimate farmer opinion on the causes of farm accidents conducted at training is then described. Methods of assessment for documents used and training approaches used at FETAC 12.5 hour training are then described. The methods used in a national survey of use of the COP and RAD following their national circulation are then described. This sub-section concludes with a critique of the assessments used.

6.4.2.1. Objectives

The objectives of this assessment phase were to obtain the opinions of farmers, drawn from a range of personal, farm and socio-economic backgrounds, on the utility to them of the pilot RAD and of their participation in a COP-related training course (either a RAD half-day or FETAC course) where the RAD document was explained. In this first phase of the study research also, farmer opinions were obtained on their engagement with all of the COP documents as well as their opinions of the causes of farm accidents.

6.4.2.2. Assessment methods for RAD half-day training

As outlined in Chapter 1, provision of half-day training on the use of the RAD was the initial and central component of the Prevention Initiative, accordingly both its delivery and assessment are now reviewed.

6.4.2.2.1. Provision of half-day training

During January and February 2006, farmers in the five counties selected to implement the pilot PI were invited to attend a half-day course by their Teagasc advisor by letter. Subsequently a similar letter was used when training associated with the RAD was provided. Both letter templates are available in Appendix 6.2 After sending the letter, advisors also canvassed farmers by follow-up phone call or text. The invitation indicated that the course would assist farmers to comply with their legal duty to complete a risk assessment under the then new SHWW legislation. The letter indicated that attendance at a course, would exempt participants from a possible routine inspection by a HSA inspector (other than where an accident or dangerous occurrence was reported) for year 2006. Courses were free of charge and were advertised jointly by Teagasc and the H.S.A. in the local farming press (Appendix 6.3) and on local radio, thus courses were available to all farmers. A leaflet describing the RAD training courses was available at Teagasc offices (Appendix 6.4).

The RAD half-day training was provided to circa 1,600 farmers at 40 courses in the five pilot counties during the first quarter of 2006 and each course had an attendance of 30 to 50 farmers. The training was conducted by Teagasc trainers and advisors who received a one-day specific in-service training and they were provided with a memorandum describing the training methods to be used (Appendix 6.5). Each course was facilitated by at least two Teagasc staff members, including an advisor and trainer.

The half-day course length (circa 3.5-4 hours) was chosen as the minimum amount of time considered to be required to adequately explain the requirement to complete the pilot RAD. It was also considered as possibly being the maximum amount of time for which farmers in general would attend RAD training. This view was formed based on limited provision of training in one county (Wexford) on completing the Farm Safety SAD issued by the H.S.A in year 2002.

A description of the pilot half-day RAD training course is provided in Table 6.3. The course was designed principally to focus on the participant's duty to complete the RAD based on the practical realities of their individual farms. The course was designed to be motivating to participants to take safety action and during the course considerable use was made of both 'visual' and 'interactive' type approaches. The course commenced with a short description of OSH legislation focusing on the duty of farmers to take all appropriate measures 'so far as is reasonably practicable' as specified by the legislation. This was followed by viewing a testimonial of a farm accident on DVD and a follow-up discussion where participants were encouraged to discuss accidents or near misses on their farms. The course continued with a discussion on the causes of farm accidents based on a short exercise where participants listed and ranked their opinion of the causes of farm accidents on a card distributed at the start of each course (Appendix 6.6). This exercise was designed as a 'discussion opener' to get interaction occurring within the group. On completion of discussion on causes of accidents a power point presentation was used to show data on the principal causes of fatal farm accidents.

6.4.2.2.2. Farmer opinion on the causes of farm accidents

Following completion of the card scoring exercise by participants, a discussion on the causes of farm accidents took place at the course. Cards were collected from 1,151 course participants and forwarded to the study researcher for analysis. As the data on these cards had the potential to reveal trends in the thought process of farmers, it was tabulated and examined for major trends.

Table 6.3: Topics, methods and time used at pilot half-day RAD training courses

Topic	Training methods	Duration (minutes)
Causes of Accidents exercise	Completion of Card supplied	5
Introduction	Power point	5
Health and Safety Legislation	Power point	10
Discussion on Accident Prevention incl. exercise summary	Flip chart/ discussion	10
Victim Testimonials	DVD/ discussion	10
National Causes of Accidents	Power point / discussion	10
How to complete the Risk Assessment Document	Divide into groups to consider all questions in the document. Stimulate discussion. Show section of DVD before explaining each section	180
Demonstration of Protective Equipment	Demonstrate protective equipment supplied.	10

The central component of the training then occurred namely how to complete the RAD, which took up about 70% of course time. This involved explaining to participants how to complete the pilot RAD. Prior to explaining each 'hazard and risk assessment' section of the document, a short DVD clip from the DVD 'Safe Farm – A Guide to managing

Safety and Health on Your Farm' was shown to illustrate key issues related to the pilot RAD to be considered. After this the trainer showed the risk assessment section visually on a display screen and explained the meaning of each question individually. Farmers' health issues were emphasised at RAD training courses by showing a DVD providing an interview with a medical doctor who outlined key issues related to farmer's health. A short session to demonstrate farm personal protective equipment (PPE) took place and its prime objective was to motivate PPE use.

Following consideration of each section of the RAD, participants were given time (circa 5 minutes) to consider the questions in each risk assessment section in relation to their own farms and to discuss the specific issues with fellow-participants. While this process was on-going the training facilitators circulated among groups and stimulated discussion and answered any questions raised. Course participants had the opportunity to partially complete the document in relation to their own farm during the training and were advised before the course concluded to fully complete the RAD.

A Farm Safety Handbook already published by the H.S.A. (H.S.A., 2002) was distributed to farmer participants as an additional information source. A photo of a typical RAD training course is shown in Appendix 6.7.

6.4.2.2.3. Farmers opinions following attendance at half-day training

A questionnaire survey was conducted among 291 farmers who participated in a pilot RAD training course and is referred to as the 'principal' questionnaire' as it contained 42 separate questions (Appendix 6.8.). This questionnaire was conducted in two counties (Meath and Tipperary N.R.) which were selected because of the range of enterprises on farms in these counties as indicated by the spatial maps available from Crowley et al., (2008). A further shorter questionnaire including 13 key questions in common with the principal questionnaire seeking farmers opinions of the training provided and RAD was completed by 915 farmers at courses in all five counties where half-day training was provided on a pilot basis (Appendix 6.9). Questions were asked in both surveys mainly using five point Likert-type question responses, which is the most common form of question used in social research type surveys (Balnaves and Caputi, 2001). Such a scale allowed agreement and disagreement on individual items as respondents could select from the following possible answers strongly agree; agree; neutral; disagree; strongly disagree. The mean score for each is obtained by averaging the score allocated to point on the scale (e.g.: strongly agree, score 5, and strongly disagree score 1). The Likert-type questions were deemed most suitable for the study questionnaires as the objective of each question was to obtain farmers opinion on a component of the RAD document or associated training which was gained from computing the relative tendency of agreement or disagreement with the statement in each question. Piloting of the principal questionnaire at one course among farmers with 40 in attendance took place to consider if the questionnaire could be efficiently used by farmer participants, before being used for the study.

The 'principal' questionnaire collected information among half-day training course participants on: reason for attendance, importance of safety in farm management and the worth of offering the training to all farmers; overall opinions of the training course including: length of training, participant numbers, adequate discussion, its assistance in understanding OSH legal duties; opinions of components of the RAD including: number of questions, ease of understanding questions; opinions of provision of information in written form, picture and pie charts:; opinions of training course individual components including use of RAD during course, video use showing controls, use of victim testimonials, discussion of accidents in local area and health messages received; opinions of motivation to implement controls after course attendance and plans to make improvements; whether or not a farm safety SAD or SS had been completed in the previous 3 years; personal, household and farm structure information related to the farm household and farm was obtained and participants were asked to optionally provide their name and contact details.

Regarding the obtaining of qualitative data a 'comment box' was provided for all questions seeking farmer's opinions (27 comment boxes provided in the principal questionnaire and one overall comment box was provided in the short questionnaire).

Comments for individual questions were received at a rate of 1.4-10.3% for questions in the 'principal' questionnaire and for 27.4% of short questionnaires.

A formal participation rate was not calculated for completion in the participant surveys as the vast majority of participants who were available (i.e. those who had not got a commitment immediately after the course) to complete questionnaires did so.

6.4.2.2.4. Surveys of advisors and trainers

Surveys were conducted among advisors (Appendix 6.10) and trainers (Appendix 6.11) who facilitated RAD half-day training courses to obtain their opinions of the course design elements, their benefit to farmers, demand for follow-up OSH advice from farmers, training they received to facilitate RAD training and operational considerations in providing such training. All advisors who facilitated pilot RAD training in the pilot phase of the PI were surveyed 3-6 months after their facilitation of RAD training and 27 responded (out of 31 advisors giving a 90% response rate). One year later a further survey was conducted among the advisors who facilitated RAD training and a random sample of advisors with a similar work profile who did not participate in the pilot RAD training related to the level and methods of provision of OSH advice to farmers so that a comparison could be made between the two cohorts (Appendix 6.10). Among advisors who facilitated RAD pilot training 20 (out of 28 advisors – a 71% response rate) responded while 34 responded (out of 42 advisors giving a 81% response rate) among advisors who had not facilitated such training.

Regarding trainers, a survey was undertaken in 2008 among all trainers who had facilitated RAD half-day training, either as part of the pilot or main phases of the PI and in total 27 trainers responded to the survey (out of 31 advisors an 87% response rate).

The questionnaires administered to both advisors and trainers who facilitated RAD training sought information on the following:; opinions of importance of farm OSH as an issue among farmers and if they considered the training worthwhile, well-structured, of the right length and motivating; opinions of components of the pilot RAD including:

number of questions, ease of understanding questions; provision of information in written form, picture and pie charts; opinions of training course individual components including use of: completion of document during course; DVD- use showing controls; opinions of the in-service training they received to facilitate the RAD half-day training; opinions of further possibilities related to training and advisory OSH provision; level of follow-up at advisory level to OSH queries received after RAD half-day training provision and demand for OSH advice generally. Advisors who facilitated RAD training were further asked about the utility of including the topic at a ‘farm walk’ or an on- farm demonstration and the utility of forwarding a copy of the DVD to farmers. Trainers who facilitated half-day training were further asked about the ease of attracting farmers to training, the optimum size of classes and if co-facilitating training with advisors was the best approach.

A considerable volume of high quality data was obtained from both advisor and trainer questionnaires in survey comment boxes, which were completed in 30 – 48 percent of cases.

6.4.2.3. Certified OSH training course provision (12.5 hours)

The assessment conducted following farmer participation at pilot RAD half-day training courses indicated that 26% of participants did not complete the RAD satisfactorily and independent of document completion, 24% were not achieving satisfactory on-farm OSH controls. This assessment relates to the validation of RAD completion in association with the farm audits of OSH standards and practices in phase 3 of the assessment, conducted in 2006 (Table 6.2). Based on the findings of the assessment of pilot RAD half-day training, it was decided to conduct an assessment of the utility of a more extensive health and safety course of 12.5 hours duration provided by Teagasc and accredited by the Further Education and Training Awards Council (FETAC). This body had at that time national statutory authority in Ireland for accrediting educational and training awards up to level 6 on the national framework of educational qualifications (NFQ, 2009). The ‘safety on the farm’ course provided was classed as a minor award or the minimum level of training that could be certified by FETAC. Since then, FETAC has been subsumed into a newly established statutory body with the national statutory authority to oversee accreditation of all Irish education and training called Quality and Qualifications Ireland (www.qqi.ie).

The purpose of this assessment was to gain insights into how this more extensive training could be of further assistance to farmers with OSH legal document completion and implementation of OSH controls. The specification of a 12.5 hour course is provided in Appendix 6.12. and a description of the assessment survey is provided in the next sub-section.

6.4.2.3.1. Survey of farmers attending 12.5 hour training courses

Data were collected at four 12.5-hour FETAC 'safety on the farm' courses from 85 of the 113 farmers in attendance who completed an assessment questionnaire on their opinions of the course (Appendix. 6.13). The four courses were representative of 24 such courses held between 2002 and 2007 with a total of about 600 farmers in attendance. The courses assessed were conducted during years 2006 and 2007 and two each were in counties Laois and Kildare. Each course had the same course presenters (Mrs Elizabeth Nolan R.I.P. principally and Teagasc Health and Safety Officer John McNamara, who conducted a circa 3 hour session on Manual Handling of Loads and Health of Farmers). Courses were promoted by various means including: writing to Teagasc clients, posters in public places frequented by farmers (e.g. Marts), and notices in Teagasc and parish newsletters. Follow-up phone calls or texts were used near to the time of the commencement of the Training course to remind potential participants of the start date of training.

The purpose of administering an assessment questionnaire to the farmer participants of the 12.5-hour FETAC farm safety course was to obtain their opinions of the course components including the utility of three OSH planning documents used during training (risk assessment document (RAD); safety statement (SS) and safe system of work plan (SSWP). The questionnaire collected information from participants on the following: reasons for attendance, importance of safety in farm management and opinion on offering the training to all farmers.; gain opinions of the training course including: length, ease/difficulty in securing time to attend training; gain opinions on the OSH planning documents used during training (RAD.SS,SSWP); gain opinions of training course individual components including participation in lectures, a farm visit, training on prevention of MSDs' and maintaining health; gain personal, household and farm structure information; ask participants to optionally provide their name and contact details.

6.4.2.4. National survey (2007) related to use of COP documents

During the second half of 2007, an additional OSH survey with questions related to use of and satisfaction with the Farm Health and Safety COP was conducted by the Teagasc NFS on behalf of the study author (Appendix 6.14). This survey was conducted approximately 6 to 12 months after the COP documents were circulated to all farmers nationally on behalf of the H.S.A by the state DAFM.

Information on the conduct and representation of farms by farm size and system of the NFS sample has been provided by Connolly et al., (2006). In summary, the NFS sample has been selected using CSO criteria to be representative of farms nationally by farm system and size over 2 hectares but excluding pig and poultry farms, when weightings supplied by the CSO are applied to the sample data. In the 2007 additional OSH survey 1,040 farmers were surveyed and these represented 112,451 farms nationally. This survey was conducted by means of face-to-face interview on a confidential basis by trained and briefed NFS recorders. While the NFS has been designed to be representative by farm system and size, other personal, farm and socio-economic variables (approximately 60) are routinely collected by the NFS and additional surveys can be weighted or analysed in association with these variables also. However, when NFS data is statistically analysed, this is done with the sample data and thus represents the sample population rather than the national population.

The additional OSH questions included in the NFS in 2007 sought farmer opinions on the COP documents and on level of use of the RAD and viewing levels of the DVD accompanying the COP. Participants were asked if they had received the COP documents and if so their opinion on their usefulness using a four point scale (excellent; good; fair; poor). They were also asked if they had completed the RAD and to provide information on viewing levels of the DVD in their farm household. The information obtained was analysed with data available from the NFS, using data analysis software (SAS, 2002) for farm size and system. The outcome gives national estimates of farmers opinions of the usefulness of the COP, completion of the RAD and farm household viewing levels of the DVD for farm system and farm size as represented by the NFS.

6.4.2.5. Critique of research methods used in phase 1

As Sherrard and Day (2001) pointed out, resources to conduct the 'perfect' research projects, particularly in agricultural OSH seldom arise and accordingly projects can have both strengths and limitations. A researcher should be conscious of both the strengths and limitations of their research methods. Thus a critique is undertaken of this and all phases of the study assessment components as follows.

The strengths of the research methods in this phase of the study include: a high potential survey response from farmer training course participants from a range of farm enterprises and socio-economic backgrounds and from trainers and advisors facilitating training and provision of follow-up advice. Potential also arises for obtaining both quantitative and qualitative data as does the possibility of triangulation of the findings among the various groups surveyed (via. farmer participants, trainers and advisors). A limitation of the survey methods used is that they measure participants' opinions on course components rather than actual knowledge gain. However, these are indicators of knowledge gain and precursors to practice adoption.

The NFS additional survey conducted has potential to yield considerable nationally representative data by farm size and system on farmer engagement with and opinions of the COP documents.

6.4.3. Phase 2: assessment of RAD completion

The objectives of phase 2 were firstly to assess completion of the RAD by farmers in terms of completeness, consistency and farm risk and secondly to assess number of controls identified by farmers as necessary for implementation.

6.4.3.1. Methods

A sample of RAD half-day training course participants in the two counties (Meath, Tipperary N.R.) where the principal survey was administered following training, were requested to provide their completed RAD to the study researcher for assessment. The request took place at the end of training courses and a stamped addressed envelope was provided for forwarding of the document to the researcher. Approximately 500 envelopes were distributed at 12 courses chosen at random and to gain representation by enterprise reliance was placed on the diversity in farming systems in these counties as indicated by Crowley et al., (2008). In a further county (Wexford) where training was not provided as part of the pilot PI, but where farmers were supplied with the RAD with instructions on its completion, 300 farmers were contacted by letter on a random basis and requested to return their completed RAD to the researcher. Following photocopying, RAD documents supplied by farmers were returned to their owners. Following RAD half-day training attendance 337 RAD documents were received and a further 137 where no RAD training was provided. Letters seeking RAD documents are available in Appendix 6.15.

Two methods were used to assess the documents as follows: 1) document scoring and 2) enumeration of controls specified for action. These methods are now described.

6.4.3.1.1. Scoring risk assessment documents

The purpose of scoring pilot RAD's was to commence the process of determining if the documents were validly completed and to determine if differences in controls specified varied with farm enterprise and following attendance at RAD half-day training. Quasi-experimental statistical comparisons for document completion for RAD's following training or not, were made.

Each document was scored for **completion**, **consistency** and **farm risk** and the nature of each score is now described.

Completion score - A score of 1 to 4 was allocated to each document with this score being based on the degree of satisfactory or otherwise completion of all sections of the document. The scores 1,2,3,4 represented: very satisfactory; satisfactory; unsatisfactory and very unsatisfactory completion of the document.

Consistency score - A score of 1 to 4 was allocated to each document with this score based on the degree of consistency noted for the document. This score sought to detect major inconsistencies in document completion such as identifying controls which were not valid or for identifying controls as missing on the 'action list' page(s) but where the control was outlined in question format in the document. Such inconsistent completion implied that the document had been completed without a considered input. The scores 1,2,3,4 represented: very satisfactory; satisfactory; unsatisfactory and very unsatisfactory consistency of the document.

Farm risk score - The farm risk score of 1 to 4 was allocated based on such measures as the scale of farming operations indicated by the number of farm vehicles and machines, number of farm buildings and types of stock on the farm. Scores of 1,2,3,4 indicate very low, medium, high and very high risk for scale, respectively.

6.4.3.1.2. Enumeration of controls specified for action

The purpose of this assessment was to objectively count the controls in the RAD identified as necessary by farmers by enterprise and to establish if a difference existed in number and type of controls specified between those who did or did not attend a RAD Half-day training course. Quasi-experimental comparisons for control numbers specified following training or not, were undertaken.

Controls specified for action on the action page of the pilot RAD document (page 26) were counted and tabulated. The data obtained was then analyzed both descriptively and inferentially (using the T-test statistic) in association with the principal farm enterprise for farms, as indicated on the RAD and for whether RAD half-day training had or had not been undertaken associated with RAD completion.

6.4.3.1.3. Critique of research methods used to assess pilot RAD completion

The strengths of the research methods used in this phase of the study include: procuring a high number of RAD's from farmer half-day training course and non-participants from a range of farm enterprises. Also, two approaches were used to assess these documents, one using a scoring methodology which can be considered subjective but received subsequent on-farm audit verification and the second method involved objective enumeration of controls. Limitations of the research methods in this phase were that obtaining RAD documents was voluntary among farmer participants and accordingly the data is non-probabilistic. Also, statistical comparisons of data associated with pilot RAD's from farmers with and without training was only possible on a quasi-experimental basis.

6.4.4. Phase 3: Farm audits

The objectives of phase 3 were to conduct farm audits to assess completion of the pilot RAD by farmers and validate the scoring of RADs' which was undertaken in phase 2 of the research. In this phase also assessment was undertaken of the implementation of OSH control measures by farmers in follow-up to completion of the RAD document.

6.4.4.1. Methods for farm audits following pilot RAD completion

Initially an on-farm follow-up was carried out on 66 farms, 49 of whom had obtained half-day training on RAD completion and 17 who had not received training. Amongst farmers who had attended RAD half-day training, those selected for a voluntary farm audit were amongst those who had returned their completed RAD for assessment and who had completed the principal survey questionnaire (phase 1) and gave agreement to participate in an audit. Farms were selected purposefully to reflect both a range of RAD completion levels and a range of farm enterprises and farm sizes, all of which was determined from examination of completed RADs'. Otherwise, selection of farms occurred on a random basis and any farms known to auditors were not visited, and no contact was made related to the visit with the farmer's Teagasc advisor.

Farm visits were undertaken by two persons, the study researcher and a HSA inspector with experience of the agriculture sector, both of whom were qualified and experienced in occupational safety and health as it relates to farms. The H.S.A. inspector participated in the study audit farms on a purely advisory basis, however, where issues arose related to OSH legal non-compliance, farmers were advised of the situation. In the case of auditing farms following farmer completion of the FETAC 12.5 hour farm safety course an experienced Teagasc education officer with a university certificate in OSH substituted for the H.S.A. inspector for operational reasons.

Farmers chosen for OSH audit were contacted by phone to request permission to conduct an audit purposefully at a short time of, about 24 to 48 hours, before the proposed visit. Farmers were given general information that the purpose of the audit was to assess the RAD training provided. Further permission to examine the farm related to OSH was requested at the commencement of the actual audit visit. This approach was taken to ensure that major changes in on-farm OSH were not undertaken in advance of the audit. A 100% agreement rate to allow an audit visit was obtained (in two cases a visit did not take place because of farm operational or family reasons).

The purpose of farm audits was, firstly to check the accuracy of completion of the RAD in comparison with the actual safety and health situation on the farm. An **accuracy score** of 1,2,3,4 was recorded for each farm for Completeness, Consistency and Farm Risk following comparison of completion of the RAD having conducted the Farm Audit.

Secondly an assessment of the management of OSH on each farm was conducted and a Safety Score allocated as follows: This **safety score** estimated the overall level of management of OSH on the farm and reflects the on-going management of the farm again using a 1,2,3,4 scale representing very satisfactory, satisfactory, unsatisfactory and very unsatisfactory respectively. An audit-sheet was developed and used for assisting with the purpose of applying the safety score which was compiled by modifying and expanding one developed within Teagasc (Teagasc, 1997) for the purpose of assisting with auditing OSH management on Host Farms where trainees were placed for on-farm experiential learning (Appendix 6.16).

Thirdly, an assessment of **implementation of controls** was undertaken by examining the implementation of controls listed in the RAD ‘action list’ page of the RAD. A positive score (Yes) was allocated when the majority of the controls and including all controls which would have led to an unsatisfactory Safety Score were implemented or where intention to implement them was explicitly demonstrated (e.g. evidence available to indicate waiting for a machine part to arrive). In contrast, a negative score (No) was applied when the controls listed on the Action List were not implemented and where intention to implement them was not apparent.

The general scoring system 1,2,3,4 used for all scoring in this study for RAD and farm assessment was motivated by and followed the same approach used in the Danish Study (West Jutland) of prevention of farm injuries (Rasmussen et al., 2003). This system, in contrast to a 5-point scale has no mid-point and ensured descision making at the mid-point when acllocating satisfactory and unsatisfactory scores. Also, the possibility of contracting the scores from a four to a two-point scale was available as follows: 1 – satisfactory; 2- unsatisfactory.

6.4.4.2. Farm audits following 12.5 hour certified (FETAC) training

As indicated previously, the initial assessment conducted following farmer attendance at RAD half-day training courses (McNamara et al., 2007) indicated that 26% of participants did not complete the RAD satisfactorily and, independent of document completion, 24% were not achieving satisfactory on-farm OSH controls. Accordingly it was decided to conduct an assessment of the utility of the more extensive FETAC accredited Farm Health and Safety Course of 12.5 hours duration provided by Teagasc. It was decided to conduct farm audits where farmers had attended this training using the same methods as described for the assessment following RAD half-day training, with course participants supplying their completed RAD during the farm audit. The purpose of the farm audit was to assess implementation of OSH measures specified in the RAD after a period of approximately 6-12 months following attendance at the FETAC 12.5-hour course.

Tutorial assistance with COP document completion (all documents RAD, SS and SSWP) was made available as part of the 12.5 hour FETAC training course and estimates for time input required for this tutorial assistance provided for 113 course participants were made. Thus an additional comparison was possible of implementation of farm controls required as specified in RADs', between those who had and had not availed of tutorial assistance on a substantial basis (circa 3 hours). Twenty eight (28) farm audits were undertaken, split evenly between farmers who had or had not availed of tutorial assistance; otherwise the sample was balanced by enterprise and randomly selected.

In total 94 farm audits were undertaken as part of the study including those who completed RAD half-day training (no. 49), those who completed the RAD without training. (no. 19) and those who completed FETAC training (no. 28).

6.4.4.3. Critique of research methods used for farm audits

The strengths of the research methods used in this phase of the study include: random but purposeful selection of farms for audit by RAD completeness and enterprise and size using information from RAD documents. The sample size used permitted inferential statistical analysis of data for a range of personal and farm variables. Two auditors with expertise and experience in farm OSH conducted the farm audits. Limitations of the research methods were that farmers who returned the RAD were a non-probabilistic group. Also, the farm audit conducted related to the observation of the farm environment and equipment and no observation of farmer work behaviour related to OSH was undertaken.

6.4.5. Phase 4: Assess accident levels among farmers following RAD usage

The objective of study phase 4 was to accurately estimate farm accident levels among farmers after completion of the RAD or attendance at a training course on use of this document. Inferential statistics were used to study associations among RAD completion, training participation and farmer and farm variables.

6.4.5.1. Farm accident survey (2011) methods

In year 2011, an additional survey among farm operators related to farm accident levels and RAD completion and RAD training participation was conducted by the National Farm Survey (NFS) on behalf of the study author (Appendix 6.17). This survey included questions on farm accident occurrence, completion of the RAD and participation in RAD training. Information was obtained on farm accidents occurring during the year of survey and the previous 5 calendar years, was conducted in the September to November period. Information was also obtained related to the status of person injured; location of accident, accident type, treatment (first aid, medical or fatality) treatment obtained and estimated farm work days lost and a short description of the accident.

Information on the conduct and representation of farms by farm size and system of the NFS sample in 2011 is available from Hennessy et al., (2011). NFS surveys are conducted by means of face-to-face interview by trained recorders. The NFS sample is selected using CSO criteria to be representative of farms nationally over 2 hectares by farm size and system and 891 farmers were surveyed in the 2011 survey. Data collected can be weighted to represent farms nationally (99,448 in the current survey). However, when the data is statistically analysed, this is done with the sample data and thus represents this population rather than the national population.

The data from NFS additional surveys can be analysed in association with personal, farm and socio-economic variables routinely collected and available from the NFS. In total, 16 variables and 9 efficiency variables (using combinations of two variables) available from the NFS, in addition to the variables of RAD completion and the RAD Training were selected for analysis in association with the dependent variable of ‘farm operator’ (F.O.) accident occurrence, which is now described further.

The statistical analysis of the NFS data firstly planned to use cross tabulations involving the dependent variable of farm operator accident occurrence or non-occurrence with independent variables which could potentially influence the dependent variable as follows:

Personal variables RAD completion RAD training attendance, F.O. age; F.O. gender F.O. marital status, household number, F.O education level; F.O. agricultural education undertaken and Teagasc client membership;

Farm variables: farm size; farm economic size, farm income, gross farm output; farm enterprise; farm labour units; farm categorisation as full or part-time; off farm employment, farm investment;

Farm Efficiency variables: investment, farm economic size, gross farm output and farm income were all divided by farm size, labour units and economic size (used as denominator only) to give 9 farm efficiency variables**.**

In total twenty seven independent variables potentially influencing farm operator accident occurrence were to be analysed using cross tabulation and statistical testing. This bivariate cross tabulation with statistical testing was to be the first step in a two-step process to allow selection of appropriate independent variables, which are statistically significant or close to significance, in influencing the dependent variable: accident occurrence for inclusion in regression analysis. This second step of the analysis has the capacity at a uni-variate level to allow calculation of predicted change effect of independent variables on the dependent variable, and at a multivariate level gives an independent measure of the effect of the independent on the dependent variable

*6.*4.5.2. Critique of research methods used in phase 4

The strengths of the research methods used in this phase of the study are that a probabilistic approach is used for this assessment based on the survey methods used by the NFS. Also, access to farm and personal variables are available within the NFS which can be analyzed in association with the study variables. Sufficient time was allowed to elapse (over 5-years) so that RAD completion, RAD training participation and accident occurrence data were at adequate levels to allow statistical testing. A limitation is that the NFS is designed to represent farms nationally by size and system.

6.4.6. Overall critique of research methods

In summary, the particular strengths of the research methods design, described in Figure 6.1, are that a broad range of research methods are to be used in order to gain a rich set of insights into the issues around adoption of OSH by farmers based on the RAD. Both probabilistic and non-probabilistic surveys with high participation of farmers who provide their opinions of COP documents and RAD training undertaken. A qualitative dimension is included in non-probabilistic surveys to gain direct farmer feedback on OSH. High numbers of RAD documents were available to be assessed and this was to be validated by farm audits. A probabilistic survey of farm accidents related to RAD completion and attendance at training was undertaken. Thus a broad range of sources of research data is available and methodological triangulation of findings between sources is possible. A limitation of the research method design identified is that accidents are highly associated with 'behaviour' while working but that it was not possible to observe farmer work behaviour as part of this study.

6.4.6.1. Avoidance of bias in this study

The aim of research generally is to provide objective findings which are of use to its sponsors in particular and to society, as useable knowledge, in general. Thus it is of the utmost importance to ensure that the research is conducted with a minimum level of bias and that possible sources of bias are recognised in the design stage of the study and measures undertaken to minimise their effect on the study findings. As the researcher in this study was also engaged as the manager of the PI on which the research was based, particular emphasis was placed on the possibility of bias and its prevention. This issue in now briefly reviewed and the steps taken to avoid bias in this study are then outlined.

Bias can arise, or be perceived to arise, due to a researcher having a conflict of interest. This may arise when the researcher has a vested interest in the outcome of the research which possibly could cause a person to make judgments or decisions which could affect the findings (Lo et al, 2000). Examples of where a conflict of interest could arise include having a financial interest or being under some form of control (e.g. organisational control) in relation to the study outcome. In response to these potential forms of bias, numerous institutions and publications require persons to declare any 'conflict of interest' related to research conducted (Lo et al, 2000). As the study was conducted under the supervision of two independent statutory agencies and with university supervision, bias related to conflicts of interest while kept under review, were considered as highly unlightly.

Podsakoff et al (2003) conducted a critical review of the literature related to 'method bias' in behavioural research. With method bias, variance is attributable to the measurement method rather than to measurement of the construct being investigated. They considered in particular that this form of bias is most likely to arise when both dependent and independent variables are determined by a single rate or measurement instrument. For conduct research by means of questionnaires, they emphasized prevention of bias by controlling for priming effects and the use of unambiguous and clearly stated questions. Podsakoff et al., (2003) also outlined a range of statistical remedies to reduce method bias. Dillman (2000) described the principles of writing survey questions to gain accurate answering while minimising the risk of bias. Dillman (2000) also emphasised the benefits of the survey sponsor being seen by participants as having a legitimate and trustful role in the research, however, he also acknowledged the possibility of bias due to social desirability in answering questions.

Participant Observation is a form of research for human studies where the researcher is or becomes directly involved in the community under examination which provides the possibility of gaining perspectives in a qualitative way 'as an insider' (Jorgensen,1989). According to Jorgensen (1989), this methodology provides direct experiential and observational access to the insiders' world of meaning. The reliability of this methodology is gained by securing multiple forms of evidence from access to the insiders' world, detailed explanation of the procedures used to collect information followed by their public examination and scrutiny. Jorgensen (1989) considered that while consistency of results is more likely to be obtained by quantitative measurements which by their nature are simple, routine and highly standardized, however this author considered that this approach has limitations with complex situations which can be reliably studied by the qualitative approach of participant observation.

The following specific measures were adopted to minimise bias in this study:

- The researcher had academic freedom within Teagasc to conduct the research and ask whatever questions were deemed appropriate.
- The H.S.A. placed no restrictions on the conduct of the research including , methods to be used and questions to be put to survey respondents. Academic supervision was in place for the research as a means of having oversight as regards objectivity and bias avoidance and in this regard the research was conducted in line with the UCD Ethics policies (UCD, 2010).
- Research instruments such as questionnaires were principally quantitative in nature and are conducted mainly by persons other than the researcher and participants' comments were made in written format. Copies of all study instruments were retained up to the study conclusion and were available for inspection.
- For farm visits where a degree of judgment was required for assessments of standards and practices, the researcher was accompanied by a H.S.A. Inspector to provide a second opinion.
- Sections of National Farm Surveys (NFS), conducted as part of this research, were conducted independently by the Teagasc NFS Unit on behalf of the researcher.

In summary, the issue of bias had been considered in the conduct of this research. A range of both qualitative and quantitative approaches were applied to maximise collection of reliable data. It is further planned to review the study methods in the final chapter and make recommendations related to bias prevention for future studies.

6.4.6.2. Description of the findings of statistical tests.

In this study where statistical testing is undertaken, the methods used are described adjacent to presentation of the study findings in Chapter 7. Levels of significance are indicated as follows: * = $p<0.05$; ** = $p<0.01$; *** = $p<0.001$. In addition the ‘p-value’ associated with a finding are provided and the notation ‘n.s.’ is used to indicate a non-significant finding.

Chapter Seven

Results

7.1. Introduction to results section

The central objective of this chapter is to present the findings from study data in such a way that each study hypothesis can be considered and either be accepted or rejected. To present the study data in a coherent and integrated way the findings are firstly presented in accordance with the phases outlined in table 6.2 of chapter 6. Throughout this chapter the study findings are interpreted for the reader and then discussed in relation to key literature reviewed. The study findings are then discussed in relation to each of the study hypotheses. For both consistency and clarity of communications, farmers who participated in the various RAD assessments conducted will be referred to as 'participants' in this chapter. Findings associated with the four assessment phases outlined in Table 6.2. are presented in the four sections of this chapter as follows:

Section 7.2: farmer participant and advisor/ trainer assessment of the utility of the RAD/ COP and associated training.

Section 7.3: examination and assessment of RAD documents completed by participants.

Section 7.4: assessment of implementation of OSH controls at farm level by participants

Section 7.5: presentation of findings of a national Survey (NFS) of farm accidents following RAD completion and training participation or not.

7.2. Utility of RAD and COP and associated training

These assessments firstly involved an examination of participants opinions on the causes of farm accidents and secondly of the usefulness of the RAD. Thirdly, the opinions of advisors and trainers, who facilitated RAD training, on its utility to participants were examined. The follow-up use of extension by participants after RAD training and opinions of Teagasc staff who facilitated RAD training on their own training for this purpose was also examined. Fourthly, the findings of a national survey providing data on the level of uptake of the COP/RAD following their national circulation are presented.

7.2.1. Introduction to assessments of COP/RAD utility

Previously, in sub-section 6.4.5.2., the objectives and methods associated with assessments among farmer participants of the utility of the RAD and half-day training were outlined. A brief summary of the objectives is now provided here to provide continuity to the study.

The PI aimed to develop farm health and safety Code of Practice documents (COP/RAD) and provide half-day training on their completion to circa 1,000 farmers, and then to assess the utility among a sample of 300 participants who undertook the RAD training.

The objectives of this assessment were:

1. To gain participants opinions of the pilot RAD and associated half-day training.
2. Gain detailed demographic, farm and accident record information related to participants for analysis using both descriptive and inferential statistics. The purpose of the use of inferential statistics was to reveal dependent and independent variables associated with participants' opinions of the pilot RAD and half-day training.
3. Seek qualitative data by way of 'comment boxes' for each question on farmers' opinions of the RAD and half-day training.
4. Seek permission and contact details from participants to allow follow-up assessments (response rate 36.1%) which would allow possible integration among data sets obtained.

In the event, about four thousand farmers participated in pilot RAD half-day training and 291 of these completed the RAD assessment which is referred to as the 'principal' questionnaire. A further 915 participated in the shorter survey with 13 common questions to the principal questionnaire and with one 'comment box' also seeking an overall opinion of participants of the RAD and or half-day training. The principal and short questionnaires have been provided in Appendices 6.8 and 6.9 respectively.

7.2.2. Assessment of the RAD half-day courses

The assessment data obtained from participants in RAD half-day training is now presented. This is done in ten sub-chapters covering the assessments conducted among RAD training participants. These sub-chapters include: recruitment of participants;

farming and socio-economic situation; reasons for RAD training attendance; report on accident cause ranking exercise; participant opinion of the RAD and training, OSH control implementation and follow-up extension, comments of participants on the RAD training and farm accident levels.

7.2.2.1. Recruitment for RAD half-day courses

Gaining participation in RAD half-day training was the challenge for the PI following-on from the pilot RAD development. These courses were promoted among the farming community in 2006 in the pilot counties chosen using the following means of contact: a letter (Appendix 6.2) from a Teagasc advisor to clients and follow-up by phone contact; an advertisement in local farming newspapers giving venues/ dates of courses and an advertisement (Appendix 6.3) on local radio with similar content. As the training was publically available to farmers, it was decided not to enquire if participants were Teagasc clients, as part of assessments conducted.

Subsequently during 2008, when RAD courses were offered nationally to farmers, the following four means of contacting farmers were deployed: a letter from a Teagasc Adviser to clients and follow-up by phone contact; advertisements in national farming newspapers giving venues/dates of courses or a national radio advertisement outlining the availability of the course and a newsletter which was sent to all Teagasc clients, stating the aims of the course and giving course dates/ venues on a county basis. The following response from a stand-alone survey of RAD training participants in three counties (n=251) indicated that a letter and follow-up contact from a Teagasc advisor (68%) was the most influential means of gaining farmer participation, followed by newspaper advertising (20%), Teagasc newsletter (11.6%) and radio advertising (0.4%).The data on RAD training recruitment indicates that the majority of course participants surveyed (n=251) were Teagasc clients, with 79.6% contacted via advisor letter or newsletter. This data is generally expected as the scientific literature indicates that extension is related highly as a source of information (Rodrigeuz et al., 1997; Thu et al., 1990) and accordingly likely to be influential in gaining farmer participation. Also, the finding that personal contact from an advisor was the most influential means of gaining attendance is in accord with research by Mahajan et al., (1995) which indicates that adoption of new practices is more influenced by interpersonal communication than by mass media channels. Androgogy literature also indicates that participation in adult education is based on past experiences of the learner (Knowles, 1977) while having an 'OPR' is associated with positive client behaviour (Bruning and Lambe, 2002). In the event, the target of conducting an assessment on the RAD half-day training involving one thousand farmers in the pilot phase of the Initiative was exceeded and made the RAD assessment conducted in this study possible.

7.2.2.2. Farming and socio-economic status data of RAD training participants

Data from the principal questionnaire about the farming and socio-economic circumstances of participants (n=291) are presented in Appendix 7.1. This indicates that 53.5% had a dairying enterprise, 40.1% had drystock and 6.4% had a specialist tillage enterprise. Regarding farm size of participants 6.1% were less than 20 hectares, 57.5% were in the 20-60 hectare range and 36.4% were greater than 60 Hectares in farm size.

The modal class for age of participants was 45 to 55 years which contained 35.5% of participants, 21.8% were in the 56-65 age range and 4.7% were aged 66 or over. Farmers aged 45 years or less made-up 38% of participants. The modal class for household size of participants which included persons living on or near the farm was 'six of more' with 30.4% in this category while the category with one household member had 3.4% of participants. Over forty nine per cent (49.2%) of households of participants had no child or young person aged less than 17 years living on the farm while 54% of households had a person(s) aged over 66 years in the household. In 94.5% of cases, the RAD training participant was the farm operator, 89.5% were male while 79.9% had a spouse. Over forty two per cent (42.1%) of the farms of participants employed hired labour of whom 25.8% were full-time; 24.2% part-time and 50% occasional.

The personal and farm data for the principal survey participants indicated that these were not representative of the farming population, nationally. For instance, when compared to national data (CSO - Farm Structures Survey, 2005), principal survey participants were younger (38% under 45 years compared to 23.1% and 4.7% were over 65 years compared to 23.6% for national data). Participants also farmed larger farms (6.1% under 20 Ha versus 36% for national data) and a higher proportion of participants were engaged in the dairying farm enterprise (53.5% versus 23.2% for national data).

The principal questionnaire indicated that the self-reported farm accident rate during the preceding 5 years was 10.4% on RAD training participants farms (farm operator 62.4%; family member 31.2%; worker 6.3%). In 73% of cases the injury required medical or hospital treatment and 42.9% caused an absence from work of more than 10 days. This accident level is similar to the findings of the then most recently conducted NFS survey of farm accidents (Finnegan and Phelan, 2002) who found that an accident occurred on 9.7% of Irish farms in the preceding 5 year period with 75% involving the farmer.

7.2.2.3. Participants reasons for attending half-day RAD training

The primary reasons given by participants (n=291) for attendance at half-day RAD training were to: improve safety and health on own farm (47%), to comply with SHWW legislation (43%) and on account of being invited by their advisor (10%). Thus it is apparent from this data that participants considered the RAD course to be of benefit in two ways of approximately equal proportions: improving OSH of their own farms and to comply with SHWW legislation. A recent Australian study by Pollock (2010) found that legislation (25.3%), farm business improvement (41.1%) and personal motivation to improve OSH (33.4%) were the principal drivers for OSH change, and this data has some similarity with the principal questionnaire study data. The finding that participants were interested in improving OSH on their own farm also concurs broadly with the findings of an Irish study by McNamara and Reidy (1997) who found that the majority (74.2%) of farmers were positively disposed to farm OSH as an issue. This data is further supported by a finding of this study, presented in Table 7.3 which found that 99% of participants considered that OSH management was an important issue. A further study by Finnegan and Phelan (2003) indicated that 50% of farmers reported needing further information on OSH and that 64% would seek such information from Teagasc.

7.2.2.4. Participants rankings of main causes of farm accidents

At the commencement of RAD half-day training courses, participants were requested to complete a ‘card’ ranking in order of importance the five main causes of farm accidents shown in Appendix 6.6. The training purpose of this exercise was to provoke thought among participants on farm accidents and provide an early forum for discussion on this issue. Teagasc staff who facilitated RAD half-day training collected completed cards and returned them to the study researcher for assessment with completed RAD assessment questionnaires. A total of 1151 completed cards were returned to the researcher accompanying 1211 ‘principal’ and ‘short’ questionnaires which gave a return rate for ‘cards’ of 95%.

The results for the farm accident ranking exercise are provided in Table 7.1 and more comprehensive results of this exercise are provided in Appendix 7.2. The exercise indicated that among causes ‘machinery/vehicles’ was 1st ranked and within this category ‘PTO / power shafts’ accounted for 56% of first ranked and 46.9% of all ranked accident causes. ‘organisational’ as an accident cause was 2nd ranked and within this category, ‘carelessness/ rushing’ accounted for 84.1% of first ranked and 65.5% of all ranked causes. Livestock was 3rd ranked with ‘bull-related’ causes accounting for 41.6% of first ranked and 46.0% of all causes in this category. Notably, ‘children’ farm accidents were lowly ranked at about 1% of causes while the issue of ‘older farmers’ involvement in a farm accident received no ranking.

Table 7.1: Ranking of causes of farm accidents in order of importance

Ranking order [1]	**1st**		**All**	
'Accident causes'	**Score**	**%**	**Score**	**%**
Machinery/vehicles	3165	**55**	5083	**31.6**
Organizational	1554	**27**	3430	**21.3**
Livestock	576	**10**	2964	**18.4**
Slurry related	230	**4**	2122	**13.2**
Trips,falls,buildings	115	**2**	1167	**7.2**
Electrical	58	**1**	766	**4.8**
Children	12	**1**	203	**1.3**
Chemicals	0	**0**	117	**0.7**
Other	0	**0**	242	**1.5**

[1]Ranking: 1st ranked accident causes allocated a score of 5 and 5th ranked allocated a score of 1

The findings of the 'accident causes' ranking exercise indicated that participants attributed farm accidents principally to a number of physical causes and to farm work organisation issues. This attribution is in broad accord with general theory on accident causation which indicates that accidents have multiple causes (Gordon, 1949; Wigglesworth, 1972; Haddon, 1980b; Laflamme, 1990). However, the data presented in Table 7.1. indicates that participants perceptions related to accident causation are inaccurate when compared to objective data which is in accord with the findings of other studies (Australian Safety and Compensation Council, 2006; Durey and Lower, 2004; Knowles, 2002; Murphy, 2003; Sandall and Reeve, 2000). For instance data from the COP indicated that 22% of 'vehicle and machinery' farm accidents were associated with entanglement in PTOs/ power drives, however RAD training participants attributed almost 47% of accidents to this cause within the 'vehicle and machinery' category.

Furthermore, the COP indicated that 20% and 38% of accidents respectively were associated with children and older farmers while in the ranking exercise, children were estimated as associated with 1.3% of causes and older farmers were not ranked, which indicates a limited perception of accident occurrence among these categories among participants.

The data from this exercise supports the assertions in the literature (Conroy, 1994, Hodne et al., 1999, Sandman, 1987, Wilde, 1994) who considered that communication of objective risk to a target population is an imperative requirement to promote risk reduction. This is the strategy deployed in the PI using the RAD which is the subject of this research. Further, as the literature indicates that accident causation is mostly multifactorial, involving both physical and organisational causes, undertaking an analysis of accidents causation permits communication of the multifactorial causes to strengthen awareness of prevention factors. For example, analysis of fatal accidents for preparation of the COP indicated that the majority of PTO deaths occurred for machine use when stationary and a further example related to use of Fault Tree Analysis for providing training on multiple accident causes was provided previously in section 2.4.

7.2.2.5. Participants opinions of pilot RAD

In the principal survey, participants were asked their opinions of the pilot RAD and the findings are presented in Table 7.2. They expressed positive opinions about all components of this document as all statements received a score of 4.0 or higher out of a possible 5. This assessment indicated that the pie-chart diagrams of the document obtained the highest score. Participants also expressed the opinion that they would complete the document within 2 weeks of completing the RAD training. Scores related to the pilot RAD and its completion, however, were lower than the score given to score for importance of farm safety management as an important issue, which suggests that participants were less concerned about the RAD and its completion than their perception of the importance of safety management.

Table 7.2: Percentage distribution of participants by their scored perceptions of the value of the pilot RAD (n=291)

Perceptions of the pilot RAD	**%**					**Mean score**
	5	**4**	**3**	**2**	**1**	
Safety management is an important issue	82	17	0.5	0	0.5	**4.8**
Questions in document easy to understand	22	65	11	2	0	4.0
Number of questions in Document right	17	69	12	2	0	4.0
Pictures aided communication	23	73	4	0	0	4.2
Pie Charts showing data useful	41	56	2	1	0	4.4
Will complete Document within 2 weeks	37	59	4	0	0	4.3

5=Strongly Agree: 4=Agree: 3= Neither: 2=Disagree: 1= Strongly Disagree.
Mean Score: Score applied (e.g. 5 = Strongly Agree) multiplied by number receiving score, totaled for all scores and divided by total number of participants.

The study findings related to the pilot RAD attributes indicated generally that participants regarded it as a positive tool to aid OSH adoption. This is in accord with the work of Chapman et al., (1996) who found that the majority (80%) of farmers they surveyed reported that they would use a self-help hazard inspection document. Moreover, the pilot RAD presented practical OSH issues to which farmers are positive (Lees and Reeve, 1991) and was printed in a 'lively format' which Cole (1997) considered of assistance in aiding document use. The document also provided positive messages and encouraged participants to adopt OSH measures which Saari (1990) and (Murphy, 2003) with the BBS approach considered as a superior to negative messaging.

The high positive response to completing the pilot RAD within 2 weeks, suggests that participants were predominantly positive to adopting OSH measures based on the RAD and were in a state of readiness to adopt change, as described in the Stages of Change Theory (Prochaska and DiClemente, 1983). Overall the data in table 7.2. indicates that the pilot RAD meets the criteria in various literature sources as being a document which could assist the user to implement OSH change based on its use.

7.2.2.6. Farmer opinions of half-day training on the RAD

Following training, participants expressed strong positive opinions in the principal questionnaire related to all aspects of training provided (Table 7.3.) and recommended that the course be offered to all farmers (average rating of 4.6 out of 5). The use of DVD both where a victim described their accident (4.6) and to show OSH controls (4.5) and the use of a visual power-point presentation of accident causes (4.5) all received particularly high scores. Participants strongly considered that attendance at the course motivated them to implement OSH controls (4.5) and they planned to make improvements following course attendance (4.4). In relative terms, the least positive responses were obtained to questions on the use of the SSWP document to regularly conduct farm OSH checks (4.0); the adequacy of discussion among participants (3.9) and the message about farmer's health delivered on a DVD by a medical doctor (3.9).

Data in Table 7.3. indicated that participants generally found participation in RAD half-day training worthwhile. The victim testimonial training component made the highest impact followed by visual presentation approaches which is in accord with education theory which indicates that demonstration and visual approaches outrank other approaches such as lecturing and reading (Magennis and Farrell, 2005). Level of discussion and the health message components of training received the lowest score and the limited time available for discussion may have contributed to this score while the issue of 'farmers health' is one on which farmers are poorly informed (Hope et al., 1999) and it is likely that more time would be needed to deal with this topic than was available at the RAD half-day training course.

Table 7.3: Percentage distribution of participants by their scored perceptions on the value of the RAD half-day training courses (n=291)

Perception of RAD training	%					Mean score
	5	4	3	2	1	
My attendance was worthwhile	47	53	0	0	0	**4.5**
Overall length of course about right	25	65	6	4	0	4.1
Helped me understand legal duties	42	56	2	0	0	**4.4**
Number of participants satisfactory	33	59	7	1	0	4.2
Learning objectives made clear at start of course	34	63	3	0	0	4.3
Presentation on H&S law informative	37	58	3	2	0	4.3
DVD of victims describing accidents worthwhile	65	33	2	0	0	**4.6**
DVD showing H&S controls worthwhile	55	43	2	0	0	**4.5**
Presentation on accident causes & prevention (power point) worthwhile	51	47	2	0	0	**4.5**
Discussion on local accidents worthwhile	30	55	13	2	0	4.1
Completion of document in groups useful	35	59	5	1	0	4.2
Adequate discussion among participants	19	61	12	8	0	3.9
Motivated me to implement measures	50	47	3	0	0	**4.5**
Will make safety improvements.	42	58	0	0	0	**4.4**
I have adequate H&S Info after course	24	69	5	1	1	4.1
Will use SSWP to regularly check farm	16	71	12	1	0	4.0
Worthwhile to offer course to all farmers	65	34	1	0	0	**4.6**
Doctors DVD message about health*	28	45	22	4	1	3.9

5=Strongly Agree: 4=Agree: 3=Neither: 2=Disagree: 1 = Strongly Disagree.
Mean Score: Score applied (e.g. 5 = Strongly Agree) multiplied by number receiving score, totaled for all scores and divided by total number of participants.
*5=Excellent: 4= Very Good: 3=OK: 2=Poor; 1=Very Poor.

Throughout the training, participants partially completed the pilot RAD as it related to their own farm in conjunction with group discussion and participants reported that the training motivated them to take OSH action on their farms. This is a very positive study finding related to RAD training as the TPB (Ajzen and Fishbein,1980) indicates that gaining intention to take action is a precursor to taking action. Furthermore, the training included elements which drew on numerous other OSH motivation theories including Extended Parallel Process Model (Witte, 1994), Persuasive Health Message Framework (Witte, 1992), Health Belief Model (Becker, 1974) and Protection Motivation Theory (Rogers. W., 1983). These theories collectively advocate including a strong fear appeal message as was provided by victim testimonials, providing ‘cues to action’ and assisting with ‘reducing the barriers’ to motivate action-taking as was provided by the pilot RAD. As participants were required to indicate what OSH issues needed to be addressed on their own farms, the training potentially drew on Dissonance Theory (Festinger, 1957) which motivates action by drawing on dissonance such as by indicating variances between ‘actual’ and ‘compliant’ OSH standards and practices. Furthermore, the BBS approach (Murphy, 2003) operated during RAD training in a modified format as participants received feedback on OSH on their own farms, which occurred when participants considered their own OSH standards and practices compared to those depicted in the RAD. Also, the RAD training was focused on ‘practical’ issues to which farmers are most disposed (Lees and Reeve, 1991).

Social Learning Theory (Bandura, 1977) was purposefully deployed at half-day RAD training courses as training and completion of the RAD took place in a group situation and dialogue was encouraged among participants throughout the course after viewing DVD clips and before completing individual pilot RAD sections. This theory indicates that such social interaction, where the learner is an active participant, is helpful in assisting with processing and understanding new information and knowledge (Rogers and Anders, 1996). Thus, the social learning approach used allowed participants to become positively engaged with the content of the pilot RAD.

Lastly the approach adopted in RAD training provision is in accord with the model developed by Stave et al., (2007) which they considered provides the answer to the ‘farm safety paradox’ (Murphy, 2003) where knowledge alone does not necessarily lead to OSH adoption. This model requires simultaneously increasing risk perception and reducing job stress by advocating practicable OSH measures. Stave et al., (2007) considered that the mediating components needed for inclusion in risk reducing interventions are: creating socially supportive and participatory networks, using process orientated strategies, encouraging discussions and reflections, and focusing on risk manageability by defining solutions.

It is clear from the data in Table 7.3. that provision of training based on the RAD contained many of the elements of the model developed by Stave et al., (2007). Further, Kogi (2002) considered that development of practical participatory ‘tools’ such as action checklists and manuals used in conjunction with training are useful to help people in small enterprises to assess their existing OSH conditions at the same time as looking for practical solutions. This author cited the successful use of these methodologies in work by Jensen et al., (2001) and Kogi et al., (2002).

Overall, the data presented in Table 7.3. indicates that participants found the pilot RAD training worthwhile and that it motivated them to intend to make OSH improvements. The training approach adopted is in accord with literature which supports using a visual, practical approach in a socially supportive environment where cues to gain intention to take OSH action are emphasised.

7.2.2.7. Control implementation and follow-up to RAD half-day training

In the principal questionnaire, 78.5% of participants stated that they felt they would have no difficulty implementing controls they specified in the RAD. Of the 21.5% of participants who felt they would have a difficulty implementing the OSH controls, two thirds outlined their concerns which related to: electrical installations (25%); upgrading of machinery or buildings (20%); costs associated with implementing controls (13%); using a bull chain (13%); chemical container disposal and chemical storage (11%); health/older people/children (9%) and other (9%). This data indicates that where a difficulty was reported, 58% related to infrastructural issues or costs associated with implementing controls, while the remaining difficulties (42%) were associated with problematic practical, personal or organisational issue.

Ninety three percent of course participants stated that Teagasc should include OSH as a topic at seminars and farm walks, while 86% of course participants stated that they were willing to attend a practical on-farm demonstration as a follow-up to the half–day RAD training course. This finding indicates that the overwhelming majority of RAD training course participants were positively disposed to further extension activities in farm OSH.

Regarding previous completion of the SAD /SS (257 responses to question), 38.9% stated that they had previously completed either of these documents. The level of SAD/SS completion reported by participants is higher than the level reported for a NFS national survey (28.5%) conducted by McNamara et al., (2006) which indicates a higher level of engagement in OSH document completion among RAD training participants.

7.2.2.8. Participants views of the RAD and half-day training

The findings for the short survey undertaken following RAD half-day training (n=915) in counties where the principal survey was not used are presented in table 7.4. and the findings of this survey strongly concurs with the findings of the principal questionnaire. With the exception of three questions, the mean score for answers were the same and where a difference occurred this was a 0.1 difference in the mean score. This data provides confidence in the accuracy of data obtained in the principal questionnaire. It also indicated that the RAD training was provided consistently in the pilot counties.

Table 7.4: Percentage distribution of participants by their scored perceptions of the value of the pilot RAD and half-day training (n=915)

Perception of RAD and training	**%**					**Mean score**
	5	**4**	**3**	**2**	**1**	
Safety management is important	80	19	1	0	0	**4.8**
My Attendance worthwhile	52	46	2	0	0	**4.5**
Overall length of course about right	31	61	5	2	1	4.2
Helped me understand legal duties	46	51	2	1	0	4.4
Number of participants satisfactory	33	60	5	1	1	4.2
Adequate discussion among participants	28	60	9	3	0	4.1
Will complete pilot RAD within 2 weeks	37	56	6	1	0	4.3
Motivated me to implement measures	55	42	2	1	0	4.5
Will make safety improvements.	45	53	1	0.5	0.5	4.4
Worthwhile to offer to all farmers	71	27	1	1	0	**4.7**
Questions in document easy to understand.	26	59	9	5	1	4.0
Will use SSWP to check farm for hazards.	29	59	10	1	1	4.1

5=Strongly Agree: 4=Agree: 3=neither: 2=Disagree: 1 = Strongly Disagree.

7.2.2.9. Participants comments on the RAD and half -day training

With the principal questionnaire, a comment box accompanied all questions except one on the 'importance of safety management'. This provided participants with the opportunity to provide their views in addition to ranking an issue on a likert-type scale. Responses rates for individual questions ranging from 10.3% (n=30) to 0% were obtained and responses to the five questions having a response rate over 6% are now described along with the one related to implementation of controls.

For the question on the 'length of the course being about right' (response rate 10.3%) , 50% suggested that more time be given to training including refresher training, 33% made functional suggestions about running the course e.g. more breaks, while the remaining 17% suggested that the course length could be shortened. As regards the message on farmers health delivered on DVD by a medical doctor (response rate 8.3%), 58% suggested that this issue needs more attention with one comment putting it as follows: 'we (farmers) are a bit like an ostrich with this issue'; 34% made comments about further inclusions of health related issues such as stress and avoidance or prevention of back injuries. Eight percent felt that 'health' was not an important issue.

Regarding the question on the course element where the victim described their accident on DVD (response rate 7.9%), 100% of comments were positive to this approach with the comments 'this was the best part of course - we all saw the results of accidents' and 'most hard hitting part of course' reflecting the sentiment expressed. For the question about offering the course to all farmers (response rate 7.2%), 100% also were positive to this strategy with comments made representing the sentiment expressed including 'farmers have no regard for the dangers' and that this strategy would be important 'to prevent accidents'.

As regards the question on the reason for attending the course (response rate 7.2%), 100% of the comments were positive with representative comments made including 'concerned about safety' and 'some sound advice received but some impractical'. For the question on discussion on local accidents (response 6.4%), approximately 50%

stated that this occurred to a limited extent only, while the remaining 50% felt that it was a useful part of the course with comments like ‘this aspect needs to be further developed’ and ‘ask participants about their own experiences’. For the question ‘I will complete the RAD within 2 weeks’ (4.1% response rate) 50% of respondents suggested that ‘it may take longer’ or ‘it could be put on the long finger’. These comments suggest that intentions were not always acted upon.

The short questionnaire (n= 915) included one comment box with a question requesting any suggestions which a participant felt would help with conducting future RAD training courses. A response rate of 27.4% (n=251 of respondents making 282 suggestions) was obtained from this comment box. Of the suggestions made, 27% (76) related to a comment about enhancing the training methods at the course. Of these suggestions 43% related to altering the length of time used for training (with 41% suggesting increasing and 2% decreasing the amount of time); 30% to enhancing training methods (including more farmer testimonials (30%); more use of visual aids (30%); having a farm visit demonstration (23%) and more time for discussion (17%) and 27% suggesting further inclusions or enhancing clarity of RAD information used in training (40% more content e.g. more content on chemicals, electricity etc.; 35% having a H.S.A. inspector present/ reducing vagueness of law; 25% suggesting distribution of materials to further assist participants (e.g. DVD or notes).

Over fourteen percent (14.2%) (40) related to improving the design or content of the pilot RAD. Of the comments made on the pilot RAD, 80% related to making the document simpler and easier to understand and 20% related to suggested specific inclusions or modifications to the document e.g. inclusion of chemical symbols, fire extinguisher specifications etc. A further 34.4% made a positive suggestion about the course: 5.7% related to a particular element of the course design and 12.3% related to a convenience issue related to the course (e.g. time of year or day for scheduling training) and 16.4% related to a wide variety of ‘other’ suggestions.

Overall, the comments made suggested that farm OSH requires on-going attention as reflected by the comment 'there is a lot of carelessness out there, we (farmers) could do a lot more with OSH'. Participants were positive to both the pilot RAD and associated half-day training and many suggestions were made for enhancing both. They are also influenced by the approach/commitment of the course presenters as reflected in the comment 'Joe is doing a great job'. The responses also indicated that farmers are 'slow' to do 'paper work' and are more concerned about 'practical farming' and that they respond to practical straight forward solutions. Overall, the comments made concur with and add narrative to the data presented in Tables 7.2; 7.3 and 7.4. on the RAD and associated half-day training.

7.2.2.10 Farm accidents among RAD half-day training participants

Regarding accident levels among RAD half-day training participants who completed the principal survey (n= 291), 10.4% reported having had a farm accident on their farm in the previous 5 years. Data related to causation, person injured, medical treatment and work days lost are provided in Table 7.5.

Table 7.5. Percentage distribution of farm accidents among respondents to principal RAD questionnaire (n=291/ accident no.=26)

Category	Sub-categories			
Accident Type %	Machinery 31.3	Livestock 31.3	Maintenance 6.2	Other 31.2
Injured Person %	Farm operator 62.5	Family member 31.2	Worker 6.3	- -
Medical Treatment %	None 13.3	1st Aid 13.3	Doctor 20	Hospital 53.4
Work Days Lost %	None 35.7	1-3 21.4	4-10 0	11=> 42.9

The level of self-reported accidents reported at circa 2% per annum per farm is in line with other Irish studies conducted by the NFS (Finnegan and Phelan, 2003; McNamara and Reidy, 1997) who asked a similar question related to an accident occurring in the previous 5 years. The causes, treatment and work-time loss consequences of farm accidents found were similar to findings of the other Irish studies. No significant association using the chi-square test was found between having had a farm accident and enterprise type (p=0.817), age category of farmer (p=0.774) or previously having completed a SS/SAD (p=0.393).

Of participants who completed the principal questionnaire and who agreed to allow an OSH audit visit (n=97) (study phase 3, section sub-section 6.4.1.), 11.3% reported having had an accident on their farm in the previous 5 years. Among this sample, no significant association occurred for accident level with enterprise type (p=0.618); RAD completion score (p= 0.446) and previous SS/SAD completion (p=0.394).

The data available from the principal questionnaire indicates that for the farms of participants sampled, accident levels and their causes and consequences were in line with the national population sampled by the NFS (Finnegan and Phelan, 2003; McNamara and Reidy, 1997). The sub-sample who agreed to allow an OSH audit visit were similar with the total sample who completed the principal questionnaire in terms of accident levels and of the absence of a significant association between accident occurrence and previous completion of a SS/SAD. This data indicates that completion of the OSH farm planning documents devised and used previously in Ireland, the SS/SAD did not influence the subsequent level of farm accidents which is a new finding.

The data available on accident levels among respondents to the principal questionnaire also indicated that farm accidents occurrence was independent of age, farm enterprise and level of completeness of the RAD by participants. This data does not support in an Irish context, the findings reported in the literature that younger farmers have the highest non-fatal farm accident rate (MacCrawford el al., 1998; Myers, et al 1998; Suutarinen,2004) or that farms with enterprises with farm animals have higher accident levels (Sprince et al., 2003a; Virtanen et al., 2003; Hwang et al., 2001; McCurdy and Carroll, 2000; Browning et al., 1998; Zhou and Roseman, 1994; Zhao et al.,1995).

A further more comprehensive NFS survey on accident levels and the possible influence of RAD completion on this variable has been undertaken as part of this study (study phase 4, see Section 6.4.1.) and the results of the findings of the NFS survey and the data presented here related to accident levels associated with SS/SAD completion will be compared to these later in the results section.

7.2.2.11. Summary of participants views of RAD and half-day training

Overall, participants in RAD training were very satisfied with the pilot RAD and the training provided. In the majority, participants also expressed positive intentions to implement the requirements of the RAD. The findings are in accord with the findings of Kogi (2006) who reported that farmers are willing to accept low cost local good OSH practices conveyed through personal informal sources. Kogi (2006) further stated that such practice adoption is facilitated by locally adjusted training approaches using action check-lists and group training methods and that positive networking of these experiences is essential to gain adoption. Chapman et al., (1996) in contrast, in Wisconsin USA, reported that farmers preferred to use OSH check-lists on their own and were not interested in extension programming in this area.

From the perspective of the overall study plan, the highly positive findings to the RAD document and training were not anticipated as generally studies in Extension produce findings with sub-groups with varying opinions to interventions. In particular, the high level of positive views rendered conducting further inferential statistical analysis on the data from the principal questionnaire of little value. However, it was considered worthwhile to include the question on ‘previous SS/SAD completion’ (38.9% yes) from the principal questionnaire in phase 3 (see Section 6.4.1.) of the study involving farm OSH audits for further investigation.

The study will next examine the opinions of advisors and education officers who participated in facilitating RAD half-day training which will provide data for triangulation with participants views.

7.2.2.12. Facilitators views of the RAD and half-day training

Advisors and trainers who facilitated RAD half-day training were surveyed on their opinions of the utility of this intervention to farmer participants. All the staff who facilitated RAD training were experienced in advisory and/or training work. From now-on in this study when data is presented which is the combined view of both advisors and trainers the term ‘facilitator’ is used to identify the total of these two staff categories. Their views on the training each group received for their respective roles in the provision of RAD training were also investigated. Additionally, follow-up demand for an OSH service from RAD half-day training participants and the provision of this service to farmers by both the facilitators of RAD training and advisors who did not facilitate training is explored in the next sub-Section 7.2.2.12.1.

7.2.2.12.1. Advisors and trainers views of RAD half-day courses

The distribution of ranking of opinions together with mean scores for perception of the RAD and half-day training of Advisors who facilitated pilot RAD training and trainers who facilitated RAD training are presented in Table 7.6. Overall high mean scores were given for all the attributes of the training delivered and ‘accident victims describing accident on DVD motivating’ obtained the highest overall score and ‘farmers regard health and safety as important issue’, received the lowest score.

Course facilitators gave very positive feedback on the RAD half-day course, with their opinion related to its overall provision that ‘farmers attendance worthwhile’ receiving the second highest score (score 4.3) with the course component ‘accident victims describing accident on DVD motivating’ receiving the highest score (score 4.35). All other course components received a consistently high score over 4.0 with the exception of the following two: ‘relevance of health message’ (score 3.9) and ‘presentation on OSH law sufficient’ (3.95).

Advisors and trainers expressed broadly similar views of the components of training with the exception of three components where trainers gave a higher score than Advisors. These components were ‘farmers found attendance worthwhile’ (scores 4.5

and 4.1); ‘course well structured (scores 4.4 and 4.1) and ‘accident victims describing accident on DVD motivating’ (scores 4.6 and 4.1). The data in Table 7.6. indicates that 8-11% of advisors expressed a neutral opinion or disagreed with these statements in contrast to trainers who were uniformly positive.

In Table 7.6., the lowest score was given by facilitators to the statement that ‘farmers regard safety and health as important issue’ (score 3.6) with 23% disagreeing with this statement. This data contrasts with farmer RAD training participants opinion to broadly the same question that ‘safety management is an important issue’ in Table 7.4. which received a score of 4.8 and 99% of participants agreed with the statement. Therefore the data identifies a difference between RAD training participants and facilitators opinion on how farmers view the importance of OSH.

Table 7.6: Percentage distribution of advisors and trainers by their views (%) on the RAD half-day training course (n=54)

Perception of RAD or training	Staff Type (no.)	%					Mean score
		5	4	3	2	1	
Farmers regard health and safety as important issue	Advisor (24)	11	**62**	8	11	8	3.6
	Trainer (26)	12	**61**	4	23	0	3.6
	All (50)	11	**61**	5	17	6	3.6
Farmers found attendance worthwhile	Advisor (27)	**52**	37	11	0	0	4.1
	Trainer (27)	**52**	48	0	0	0	**4.5**
	All (54)	**52**	43	5	0	0	**4.3**
Motivated to implement health and safety controls	Advisor (27)	19	**70**	11	0	0	4.1
	Trainer (26)	31	**65**	4	0	0	4.3
	All (53)	24	**69**	7	0	0	4.2
Course well structured	Advisor (27)	30	**59**	4	7	0	4.1
	Trainer (27)	41	**59**	0	0	0	**4.4**
	All (54)	36	**59**	2	3	0	**4.25**
Course about the right length	Advisor (27)	22	**59**	8	11	0	3.9
	Trainer (27)	30	**63**	0	7	0	4.1
	All (54)	26	**61**	4	9	0	4.0
Learning objectives clear	Advisor (27)	26	**66**	4	4	0	4.2
	Trainer (27)	22	**70**	0	8	0	4.1
	All (54)	24	**68**	2	6	0	4.15
Presentation on health and safety law sufficient	Advisor (27)	22	**52**	19	7	0	3.9
	Trainer (27)	19	**70**	4	7	0	4.0
	All (54)	20	**61**	12	7	0	3.95
Power point on accident causes and prevention worthwhile	Advisor (24)	**53**	29	9	9	0	4.3
	Trainer (26)	42	**50**	8	0	0	4.3
	All (50)	**48**	40	8	4	0	**4.3**
Accident victims describing accident on DVD motivating	Advisor (25)	**56**	36	4	4	0	4.1
	Trainer (27)	**56**	44	0	0	0	**4.6**
	All (52)	**56**	40	2	2	0	**4.35**
Completion of RAD at intervals worked well.	Advisor (27)	33	**52**	8	7	0	4.1
	Trainer (27)	37	**52**	7	4	0	4.2
	All (54)	35	**52**	8	5	0	4.15
Use of DVD to show control measures was useful	Advisor (25)	36	**48**	12	4	0	4.2
	Trainer (27)	33	**59**	8	0	0	4.3
	All (52)	35	**54**	9	2	0	4.2
Discussion on accident causes in local area provided useful focus	Advisor (26)	38	**54**	8	0	0	4.2
	Trainer (27)	33	**52**	11	4	0	4.1
	All (53)	35	**53**	10	2	0	4.15
Relevance of health messages provided on DVD by doctor*	Advisor (25)	28	32	**40**	0	0	3.9
	Trainer (26)	23	**46**	31	0	0	3.9
	All (51)	26	38	**36**	0	0	3.9

5 = Strongly Agree: 4 = Agree: 3 = Neither: 2 = Disagree: 1 = Strongly Disagree
* 5 = Excellent: 4 = Very Good: 3 = OK: 2 = Poor; 1 = Very Poor.

7.2.2.12.2. Views of facilitators of RAD half-day courses

Facilitators (n=54) were provided with the facility to add comments in 'comment boxes' provided after each likert-type question in the surveys of these staff. This data is now examined to gain further insights into facilitator's views on RAD training. The data is presented in its entirety so that the reader is fully informed on issues raised and in an unbiased manner, which in one case involves comments from just four facilitators (7% of all facilitators).

Among facilitators, some 48% (n=26) expressed the view that farm OSH management is in practice given low priority by farmers. A comment which reflects the sentiment expressed was: 'health and safety is the last thing they think of - they are too busy and too familiar with their own yards'.

In relation to facilitators comments on participants' perception of the course, 41% of advisors (n=11) made a positive comment on this including: 'some farmers did not take it completely seriously at the start, but most were surprised at how much they learnt'. Similarly 52% of trainers (n=14) commented positively that they considered that participants found the training worthwhile with the following comment indicating the sentiment expressed: 'all participants showed great interest and participated in wide ranging discussions'.

Regarding the training motivating participants towards OSH action, 37% of advisors (n=10) commented positively on this, however 70% of comments made indicated that farmer motivation to improve OSH was 'debatable' or 'fades with time'. Forty one percent (n=11) of trainers commented that they considered that the training motivated participants about farm OSH action as indicated by the following comment 'the course promoted positive thinking in relation to the implementation of improvements'. Overall the data suggests that facilitators considered that the training motivated participants about OSH, but the majority of advisors who made a comment considered that such motivation is temporary. Thirty three percent of trainers (n=9) further commented that some external motivating factor such as legislation, grant aid to farmers or publicity was driving culture change in farm OSH.

Thirty three percent of trainers (n=9) commented positively on the clarity of the learning objectives with the following comment giving an indication of satisfaction expressed with course design: ‘a nice mix of DVD, written, practical, best layout of a course I have ever delivered’.

Sixty three percent of facilitators (n=34) regarded the presentation on the law was sufficient for the farmer audience. Twenty two percent of advisors (n=6) commented that the presentation on law as sufficient reflected in the following comment: ‘short is ideal, if too long it may put farmers off’. However 11% of advisors considered that more clarity on OSH laws was needed suggesting that ‘practical’ information rather than broad legal concepts are best understood. Among trainers 41% (n=11) commented that the presentation on the law was sufficient for a farmer audience.

Regarding the use of a DVD interview where accident victims described their accident at training, 29% of advisors (n=8) made a positive comment about this approach including ‘this shock treatment undoubtedly will have sent home the message very closely’. Similarly 33% of trainers (n=9) made a positive comment on this aspect of the training with one comment being ‘these personal testimonies are great - worth a thousand charts’. Use of the power-point presentation on accident causes and prevention was positively commented on by 48% of facilitators including the comment that this approach is ‘very effective in getting the ideas across’.

Regarding discussion of accident causes in the local area where RAD training was provided, 48% of facilitators commented positively on this aspect of the training. Comments included: ‘very useful as farmers knew the people involved in these accidents and took note of the causes of these and how they could have been prevented’.

Participants partial completion of the RAD during the course was reported to have worked well with positive comments received from 41% of facilitators (n=22). However, 15% (n=4) of comments by advisors focused on the difficulties posed by the document, for example: ‘farmers don’t understand the content of many sections’. Among trainers, 33% (n=9) made a positive comment on completion of the RAD during training including that it was ‘interactive’ and it ‘kept the momentum of the course going’.

Health messages were provided by means of an interview with a medical doctor on DVD during the training. Facilitators made comments on this aspect of the course in 44% (n=24) of cases including ‘an area often overlooked’, ‘worthwhile’ and ‘farmers look on health and safety as machinery, PTO shafts and not about their own health’.

7.2.2.12.3. Summary and conclusions of facilitators views of RAD half-day courses

In summary, RAD half-day facilitators considered that the course as designed worked satisfactorily. Comments they made reflect the principles of adult learning outlined by Rogers (2007) which indicate that for it to be successful it must solve practical problems of participants, use the experience of the learner and use a learning style compatible with the learner. The learning styles of farmers reported in the literature are predominantly ‘reflecting’ and ‘problem solving’ styles (Treade and Miller, 2000). Kilpatrick and Rosenblatt (1998) further indicated that effective adult learning among farmers must be interactive, relevant, have credible facilitators and training materials and must be delivered in manageable chunks. Regarding the use of audio-visual materials (video, DVD), previous research by Smyth (1984) in Ireland indicated that these enhance learning when used in conjunction with facilitators, which is reflected in the views of course facilitators. This literature indicates that the RAD training provided was in strong accord with the principles of adult education and explains why high satisfaction ratings were received from both participants and facilitators. In particular, the training was conducted by credible facilitators, used mainly visual communication approaches, used reflective and problem solving approaches, was interactive and was designed in a manageable format.

However, the comments of facilitators indicated that while the RAD training motivated participants to implement controls, farmers generally give OSH a low priority in practice and that motivation derived from training declines with time. This view is supported by facilitators quantitative rating on this issue. Thus the scenario emerging from the data is that converting OSH positive sentiment into on-going action is challenging and requires on-going motivation, which is in line with Stages of Change Theory (Prochaska and DiClemente, 1983; Slater, 1999) which indicates that people work through various stages to achieve change and that relapse can occur. This view is also in accord with Change Theory generally as Armitage and Conner (2000) found that generally intentions and perceived behavioural control accounted for 27% of implementation and broadly similar findings were reported for TPB studies in agriculture (DeBarr et al., 1998; Lee et al., 1997). Similarly in relation to the Health Belief Model, Whitman and Field (1995) found inconsistency between farmers' opinion on the effectiveness of a control and actual implementation of it. Stulginskas et al., (1985) and Streff and Wagenaar (1989) also reported that self-reports overstate the actual use of the safe practice of motor seat belt use. In the field of health self-management (Type 2 diabetes control) through adult education, Norris et al., (2002) found that control measures were adopted in the immediate aftermath of the education and increased with educational contact, but declined after the intervention ceased. These studies support the views of facilitators that positive intentions on their own may not be sufficient to secure on-going overall implementation as relapse can occur and they suggest that on-going reinforcement is required to increase OSH adoption.

The study findings indicate generally that farmers require on-going assistance to implement OSH change. Research by Pettit (2001) indicated that both advisor motivation and attitude of clients to a topic principally drive engagement on advisory issues. Thus the motivations and competencies of extension staff about OSH are a resource in providing OSH assistance to farmers with this issue. To gain insights into these attributes associated with this study, advisors and trainers views on the training they received to provide RAD Training and subsequent demand for OSH extension service are now presented in the following section.

7.2.2.12.4. Training of advisors and follow-up OSH activities

A survey of advisors, who facilitated farmer RAD training regarding their in-service training to facilitate these courses and follow-up advisory OSH activities, was undertaken 4-6 months after completion of RAD courses. The data from these surveys is provided in Table 7.7. A comment box was provided with each question and this qualitative data is discussed for each question after the quantitative data has been presented.

The results indicate that 62% of advisors were satisfied while 26% were not satisfied with the training they received for RAD facilitation, with the remaining 12% expressing a neutral opinion. The main criticism made by advisors (from 58% of advisors who were not satisfied who made a comment in a 'comment box') was that the training was too short in duration. One advisor referred to the ever increasing workload of advisors generally and the greater suitability of health and safety specialists for this work.

Following 4-6 months after pilot training course delivery, as indicated in line 2 of Table 7.7, 31% of advisers received 'some' (19%) or a higher level (12%) of follow-up queries from farmer participants. The principal place where a follow-up query was made by participants was during a farm visit. During the following 12-month period after the initial period following the courses, as indicated on line 3 in Table 7.7, 60% of advisors who facilitated a pilot training course indicated receiving 'some' (55%) or a higher level (5%) of safety and health queries

Table 7.7: Percentage distribution of advisors by scored views on training received to deliver RAD courses and on follow-up actions (n=27)

Advisor views of training for RAD delivery and of follow-up	%					**Mean score**
	5	4	3	2	1	
Advisor satisfied with training to conduct course (n=27)*	8	**54**	12	11	15	3.2
Level of advisory queries received following course (n=26) **	8	4	19	**42**	27	2.2
Level of advisory queries received in subsequent year (n=20) **	0	5	**55**	25	15	1.9
Worthwhile to follow-up with a 'farm walk' on RAD (n=26) *	27	**46**	15	8	4	3.8
Worthwhile to provide a DVD to farmers as follow-up to course (n=27) *	22	26	18	**30**	4	3.3

*5 = Strongly Agree: 4 = Agree: 3 = Neither: 2 = Disagree: 1 = Strongly Disagree
** 5 = Very High Level: 4 = High Level: 3 = Some: 2 = A Few; 1 = None

As indicated on line 4 of Table 7.7., the majority of advisors (73%) who facilitated a pilot RAD training course(s) considered that it would be worthwhile to provide a 'farm-walk' or an on-farm demonstration as a follow-up to the half–day RAD course on managing on-farm OSH. Operational issues related to providing an on-farm demonstration were raised in the comment box provided by 19% advisors (n=5) including: gaining access to a suitable farm, work time constraints and receiving specialist support. Among advisors, 48% agreed that it would be worthwhile to provide a copy of the DVD to farmers for home use.

Regarding comments about conducting future OSH courses, 67% of advisors (n=18) responded with positive comments about the course and how it could be improved, while 15% of advisors indicated that 'evidence of the law being enforced would be helpful'.

The data from advisors generally indicates a positive outcome to their participation in RAD farmer training. It is possible to increase the in-service training of advisors on farm OSH which was the principal deficiency in in-service training reported. While a positive view was received from the majority of advisors (73%) on providing a follow-up farm walk after RAD training, it is a matter of concern that 27% were neutral or negative to providing this service. From comments received, operational issues such as work-load or specialist support were seen as the main reasons for non-engagement in this service, which are issues that can be addressed in OSH programmes and training.

The most positive message as regards OSH extension which emerged from the data in Table 7.7 was that the majority of advisors (73%) were positively disposed to including OSH in ‘farm walks’ or demonstrations while the majority (62%) were satisfied with the training received for RAD facilitation. This suggests that a majority of advisors are well disposed to assisting farmer clients with OSH. The data also indicated that OSH queries at a moderate level were received from participants following RAD training, suggesting their engagement with OSH issues.

7.2.2.12.5. Inclusion of OSH issues by advisors in work programmes

A further survey related to OSH follow-up queries involving RAD training among participating and non-participating advisors was conducted one year after the initial survey of advisers who facilitated RAD training. In this survey a comparison was also made between advisors who facilitated a pilot RAD training (n=20) and a sample of comparable advisors who were not involved in RAD training (n=34). This comparison related to inclusion of OSH in advisors work programmes for the year subsequent to the one in which pilot training courses were conducted. The comparison found that 90% of advisers who participated in a pilot RAD training course reported including some aspect of OSH in their work programme compared to 71% for non-participating advisers (figure 7.1.). Data for specific advisory activities indicated that for advisors both participating and not-participating in pilot training courses providing advice related to farm OSH occurred most frequently during advisory visits (85% and 59%), followed by at an advisory event (67% and 53%), office consultation (40% and 35%), phone consultation (30% and 15%) and ‘other’ activities (5% and 15%) such as including the issue in newsletters or media articles/radio. For all advisory activities except ‘other’, a higher level of advisory activity was reported for advisors who facilitated a pilot RAD training course. Comparisons related to provision of all forms of advice were made and tested for significance using the chi-square test which indicated that provision of any form of advice was not statistically significant (p= 0.098) but showed a trend towards significance. The farm visit comparison only from among the individual advisory approaches tested was statistically significant (p= 0.045).

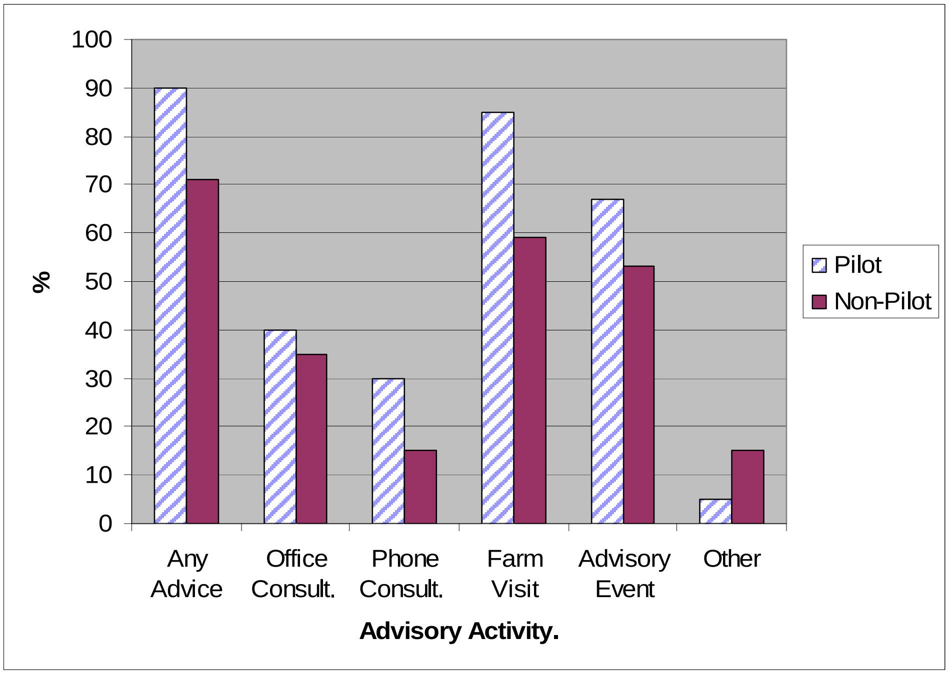

Figure 7.1. Comparison between methods of OSH advice provision between RAD pilot (n=20) and non-pilot advisors (n=34)

Reports on inclusion of OSH in advisory work programmes in comment boxes were obtained from 70% of advisors who facilitated a pilot RAD course compared to 59% of non-facilitating advisers. The reports received from all advisers surveyed (n=54) on providing OSH advice respectively related to the following advisory work areas: at an advisory event such as a 'farm walk', 'discussion group' or at a training course (39% of reports); during a farm advisory visit (24%); in relation to state grant schemes/farmyard or buildings layout and design (22%); assistance to farmers with completion of health and safety legal documents related to health and safety management (SS or RAD) (7%); advice related to machinery guarding (5%) and inclusion in newsletters/radio programmes (3%). A comment made by an advisor in relation to the provision of OSH advice summed up the situation as follows: 'mostly at dairy discussion group meetings, but also during farm visits, nearly always in relation to conversions/additions to farmyards, where farmers are availing of the farm waste management grant scheme'.

The data presented in this section confirms the finding in the previous section that OSH advice provision increased following advisor engagement in RAD training. Such provision increased across all elements of advice provision measured with the exception of ‘other’. The highest level of engagement in OSH advice occurred during ‘advisory visits’ and at ‘advisory events’ where advisors engage most at a practical level with farmers at the farm workplace. The comments made by advisors surveyed indicate that provision of assistance with OSH legal documents took place to a very limited extent. This new information available provides a positive finding related to advisors engagement in RAD training facilitation, namely that this increased their subsequent engagement in OSH advisory activities. Magennis and Farrell (2005) reported increased learning retention rates following use of training particularly by ‘immediate use of learning’, ‘practice by doing’ and ‘discussion groups’. Thus advisor engagement in RAD facilitation which led to increased levels of subsequent OSH advice provision suggests that it has the potential to enhance advisor engagement in OSH and provide an on-going advisory resource as regards farm OSH.

7.2.2.12.6. Training of trainers for RAD facilitation and follow-up OSH demand

A survey of trainers (n=27) who facilitated RAD training is presented in Table 7.8. Ninety six percent of trainers expressed satisfaction with the level of training they received to conduct the RAD training, with 26% (n=7) providing a positive comment on it. One representative comment provided was ‘I felt very competent after training’. Suggestions were made for continuing updating by 15% of trainers including: ‘updating necessary on a regular basis’.

Regarding the number of farmer participants which trainers considered optimal at a course, 18% of trainers considered this to be less than 20; 67% in the 21-30 range and 15% in the 31-40 range. Fifty six percent of trainers made a comment on this aspect of training organisation with the consensus being that for an attendance of less than 20, one person facilitating the course is required and two staff for an attendance of 21-30.

Just 19% of Trainers reported providing a ‘high’ level of assistance to farmers with RAD completion and 27% (n=7) commented relating to providing assistance which also indicated that limited assistance was provided as indicated by the comment: ‘most were capable of completing the RAD when it was explained to them’. Further comments suggested that ‘those with literacy issues required a very high level of assistance’ and another that ‘there was very little time to help due to pressure of work’. Overall the data suggests that trainers provided limited additional assistance to RAD participants with document completion.

Eighty five percent of trainers considered a half-day course for farmers was adequate. Comments made by 27% (n=7) of trainers indicated that a half-day course was adequate with a specific comment being that farmers are ‘busy people and longer events might only turn them off’. A further 18% of trainers commented that some type of follow-up to RAD training would be beneficial such as an ‘event’, ‘farm walk’ or ‘newsletter’.

Just 21% of trainers agreed and 33% disagreed that there was merit in providing a FETAC health and safety course to farmers with 56% (n=15) making a comment expressing doubt that there would be sufficient demand or interest among farmers. One comment put it as follows: ‘the half-day training caught farmers' imagination, they came in droves, extending it might prove counter-productive’.

Regarding suggestions for any further initiatives that would improve the effectiveness of assisting farmers with OSH, 63% (n=17) of trainers made a suggestion(s) with 35% of these suggesting some form of on-farm demonstration and 29% each making the suggestion that farmers be given assistance/ check if the document is satisfactorily completed or that they be given some form of on-farm assistance with OSH.

Table 7.8: Percentage distribution of trainers (n=27) by their scored views (%) on Training received to deliver RAD training and data on follow-up actions

Trainers views of training for RAD delivery and follow-up	%					**Mean score**
	5	4	3	2	1	
Satisfied with level of training to conduct half day course*	11	**85**	4	0	0	**4.1**
Consider half-day course adequate for farmers*	11	**74**	4	11	0	3.8
Is there merit in providing the FETAC Module to farmers*	4	17	**46**	33	0	2.8
Rate ease/difficulty in gaining farmer attendance at half-day course**	4	**37**	29	30	0	3.1
Rate level of individual assistance with RAD***	0	19	**66**	15	0	3.0
Consider co-facilitating course with advisor the best approach.*	**37**	33	26	4	0	**4.0**
Rank H&S queries from advisors after course***.	0	0	33	22	**45**	1.9
Rank H&S queries from farmers after course ***	0	0	**41**	37	22	2.2
Demand to trainer to provide OSH service at Teagasc Events***	0	8	**46**	27	19	2.4

* 5 = Strongly Agree: 4 = Agree: 3 = Neither: 2 = Disagree: 1 = Strongly Disagree
** 5 = Very Easy: 4 =Easy: 3 = Neither: 2 = Difficult; 1 = Very Difficult
*** 5 = Very High Level: 4 = High Level: 3 = Some: 2 = A Few; 1 = None

Forty one percent of trainers rated it as ‘easy’ to gain farmer attendance at a half-day RAD training course (table 7.8), with 37% (n=10) of trainers commenting that it would become increasingly difficult to gain attendance at future RAD courses. The overall feeling expressed was that committed farmers had attended a RAD training course to-date. Comments made reflecting this thinking included: ‘there is no indication of buying-into this initiative by ‘middle ground’ farmer’s to-date. One trainer stated that ‘public campaigns’ are important in attracting attendance to RAD training courses.

Regarding receiving follow-up queries from advisors or farmers in the 9-12 month period after course delivery, Trainers reported getting ‘some’ queries from 33% of advisers and 41% of farmer participants. A limited number of comments were made to trainers from advisors (15%) regarding OSH queries with one comment relaying an advisor’s opinion of increased perception of OSH issues among course participants as follows ‘farmers can discuss OSH in greater depth if questioned on visits after RAD training due to more awareness’. The comments made by 19% of trainers on farmer follow-up indicated that both the course and RAD were satisfactory as indicated by the following one: ‘there was ample opportunity for discussion and questions during the group sessions, also the RAD is easy to follow and presents few difficulties’.

Overall, 26% of trainers made the comment that half-day RAD course worked very well with the comment ‘….one of the most successful initiatives, the challenge now is to keep it freshened up’ reflecting the sentiments expressed.

The data obtained from trainers indicates that almost all (96%) were satisfied with the training they received to deliver RAD half-day training. The majority of trainers (85%) regarded the RAD half-day training as adequate for farmers but a majority (63%) made suggestions for follow-up to RAD training. Overall the data provides a positive picture of engagement by trainers in the RAD half-day pilot training. However, the findings indicate that gaining participation in RAD training throughout the whole farming population is likely to be problematic.

7.2.2.13. Summary of assessments on COP/RAD use

Farmer participants were very satisfied with both the RAD and half-day training and planned to implement OSH measure specified in the RAD document. Advisors and trainers also expressed positive views about the utility of both the RAD and accompanying half-day training to participating farmers. All three groups indicated that follow-up extension activities would be worthwhile following RAD training. However, both advisors and trainers staff groups felt that OSH adoption by farmers is likely to be less than the levels self-reported by farmers. A significant minority of advisors (26%) considered that they required more training to facilitate RAD training which contrasted with trainers views. Provision of OSH advice by advisers increased across a range of advisory activities following their participation in RAD training. A majority of trainers were neutral or considered it difficult to gain participation in RAD training by farmers.

Overall, the findings indicate that all parties involved in RAD training were satisfied with the training structure and accompanying resource materials. This finding is particularly relevant as various authors have considered that having a sound structure and accompanying resource materials is a prerequisite to effective delivery of educational programmes in OSH (Ajani and Onnubaya, 2012; Bruening and Radhakrishna,1993; Carrabba et al., 2001; Chapman et al, 1995) and in adult education generally (Boyle, 1981). However, having the capacity to attract farmer participation in OSH programming is ultimately required to make training successful and doubts were expressed by trainers about attracting 'less-committed' farmers without assistance from campaigns or incentives. The study findings indicate that RAD training is a valuable extension tool to engage both farmers and extension staff in OSH on-farm adoption. However, the feed-back from comments of facilitators of RAD training indicated that among farmers, implementing OSH, intentions to take action may not be followed-up on or be abandoned. This is in accord with literature reviewed earlier (Armitage and Conner, 2000; Prochaska and Di Clemente, 1983; Slater, 1999) presented in section 3.2.2., and more recently by research by Van den Broucke (2013) which indicates that intention needs to be supported to gain adoption. The study data indicates generally that further and on-going extension initiatives in OSH are needed to support adoption of this issue among the farming population. In the context of this study, the opportunity to assess a more elaborate FETAC OSH training course and associated documents became available and the findings are now presented.

7.2.3. FETAC training and COP documents

Following assessment of RAD half-day training, it was decided to assess the utility of providing a more extensive 12.5 hour farm health and safety FETAC accredited course. Assessment in this study of FETAC accredited course was conducted firstly because short-comings in RAD completion and in on-farm adoption of OSH following half-day training were identified which will be outlined in results from phase 2 of the study involving farm audits in the next sub-chapter. Secondly, as the FETAC training involved a greater range of training approaches and the use of the full range of COP documents it provided a worthwhile opportunity to extend the scope of the study. The specification of the FETAC course is available in Appendix 6.12. The specification indicates that the legal OSH documents used in this training were the RAD along with a format for a Safety Statement (SS) (www.hsa.ie) and Safe System of Work Plan (SSWP) document from among the COP documents. The specification requires participation in a practical manual training handling (MH) and considering work-related health problems.

The findings of the assessment related to FETAC training are now presented as regards participants farming and socio-economic circumstances, opinions of the utility of the COP documents used and of the training approaches deployed.

7.2.3.1. Profile of FETAC farm OSH course participants

Data were collected from a sample of (n=85) course participants (see section 6.4.5.1. for methods used and appendix 6.13 for the survey questionaire). Data is presented on the socio-economic circumstances and farms of FETAC course participants in Appendix 7.3. This data indicates that 32.1% had a dairying enterprise, 49.3% had drystock and 16.0% had a specialist tillage enterprise and 6.2% had an ‘other’ enterprise e.g. horses. Regarding farm size, 57.4% were in the 20-60 hectare range, with 13.4% less than 20 hectares and 29.2% greater than 60 hectares. The modal class for age of participants was 45 to 55 years which contained 32.5% of participants, 30.1% were in older age categories, with 3.6% aged over 65 years while those under 45 year olds represented 37.4% of participants. Over twenty three per cent (23.5%) of farms had 4 household members living on or near the farm with 34.5% of farms having less than this number and 6.1% having one household member. Over forty one per cent (41.9%) of farms had more than 4 household members with 9.8% having seven or more members. Fifty per cent of households had no young person under 17 years old living on the farm and 67.9% of households had no persons over 66 years old. In 89% of cases, course participant was the farm operator and 80.2% were male while 80% of these had a spouse. Farm operator had off-farm employment (OFE) in 36.9% of cases and of these 75.9% spent more than 40% of their work-time working off farm. Over fifty eight per cent (58.6%) of spouses had off-farm employment with 71.1% working longer than 20 hours a week off-farm. Over forty two percent (42.2%) of farms of the FETAC training participants employed hired labour (occasional 70.6%, full-time 2.9%; part-time 26.5%). The personal and farm data for FETAC participants indicates that this group is not representative of farmers nationally. For comparison, national data (CSO farm structures survey, 2005) indicated that nationally farmers were older (37.4% less than 45 years and 3.6% were over 65 years for FETAC course participation versus 23.1% under 45 years and 23.6% over 65 years for national data); FETAC participants farmed larger sized farms (13.4% under 20 Ha versus 36% for national data) and a higher proportion were engaged in dairying (32.1% versus 23.2% for national data).

7.2.3.2. FETAC farm OSH course participants opinions of training

Course participants in 55% of cases cited that their principal reason for course attendance was to improve farm OSH, followed by compliance with SHWW legislation (37%), with 8% stating that they attended because they received an invitation from Teagasc. Participants opinions on the training presented in Table 7.9 indicated that 98% agreed that they found course attendance very beneficial, while 88% disagreed that the course was too long and that a half-day would be adequate. Farmer participants agreed that all the elements of the training provided had a positive influence or assisted them to improve farm OSH. The majority of participants (82.1%) considered that implementation of the controls required on their farm would not be difficult to implement and where difficulty was anticipated, it was of an operational rather than a resource requirement in nature.

Table 7.9: Percentage distribution of participants (n=85) views (%) of the elements of the FETAC training course

Participants views on elements of FETAC training	**%**					**Mean score**
	5	**4**	**3**	**2**	**1**	
Participation in training was very beneficial*	58	40	1	1	0	**4.5**
Course length not too long /half-day would be adequate*	22	66	6	2	4	4.0
Lectures: increase opinion of importance of OSH *	52	44	1	0	3	**4.4**
Farm Visit: had positive influence to make OHS changes*	45	48	6	0	1	4.3
Farm Visit: host farmers approach influential re OSH *	45	50	5	0	0	**4.4**
Training on MH: will assist with reducing lifting*	58	36	6	0	0	**4.5**
Training on MH: will assist with correct lifting*	48	44	7	1	0	4.4
Training on health: will assist with health improvement*	26	60	13	1	0	4.1
Satisfied adequate information received at course*	20	79	1	0	0	4.2
Importance of receiving FETAC certificate**	44	36	12	8	0	4.1

* 5=Strongly Agree: 4=Agree: 3=Neither: 2=Disagree: 1 = Strongly Disagree.
**5=Very Important: 4=Important: 3=OK: 2=Minor Importance: 1= Not Important
Score: Weighted mean of 5-point scale.

To gain a greater understanding of the course elements which participants found of most benefit, a question was included which allowed participants to rank five elements of the training in order of importance to them. Seventy two percent (n=61) of participants fully completed this ranking and only these were included in the score calculation. The course elements ranked in order and mean score computed were: ‘completion of legally required OSH documents at the course’ (score 3.8); ‘OSH information provision’ (score 3.2); ‘health promotion’ (score 3.2) with the sessions on ‘manual handling of loads’ and the ‘farm visit’ receiving scores of 2.4 and 2.3 respectively. This analysis indicated that participants considered completion of legal OSH documents as the course element of most importance to them followed by OSH information provision.

Regarding finding out about the FETAC course, 98.8% of participants (n=84) reported that this occurred via a letter from Teagasc. Among participants, 28.4% reported having previously completed a SS or SAD and 89.3% stated that they planned to make one or more OSH change with 83.5%; 69.4 and 47% respectively specifying one, two or three changes after FETAC training participation. Over ninety percent (90.5%) considered that Teagasc should include farm OSH in its seminars and on-farm demonstrations.

Overall, the study data related to FETAC training indicates that participants were predominantly recruited to attend by Teagasc letter and were highly satisfied with all components of the course scored. The ranking scores further indicate that the completion of OSH legal documents was most valued by participants. Notably the farm visit component of training ranked lowest in the ranked score indicating that participants ranked being trained on completion of OSH legal document and gaining knowledge in a class based-training session more highly. The majority of participants planned to make OSH changes following participation in the FETAC training.

7.2.3.3. Preference for legal OSH documents and their utility

Participants opinions on the various legal COP documents used at training courses (Table 7.10.) indicate a positive view about all the COP documents used in training. They were particularly positive that the RAD made clear what OSH measures were required and in the use of pictures in this document. However, participants gave lower scores related to the number of questions in the RAD and to the SS and SSWP approach.

Table 7.10: Percentage distribution of participants (n=85) scored views (%) on the legal OSH documents used at the FETAC training

Participants opinions of COP documents	**%**					**Score**
	5	**4**	**3**	**2**	**1**	
RAD: number of questions about right*	6	73	12	9	0	3.7
RAD: made clear what OSH measures required*	23	73	2	2	0	**4.2**
RAD: information provided about right*	13	77	6	3	1	4.0
RAD: pictures helpful to communicate OSH practices*	26	69	4	1	0	**4.2**
SS written approach better than RAD tick box approach*	16	52	24	6	2	3.7
SSWP approach used the easiest and best approach*	12	74	10	3	1	3.9

*5=Strongly Agree: 4=Agree: 3=Neither: 2=Disagree: 1 = Strongly Disagree.
Score: Weighted mean of 5-point scale.

To gain a greater understanding of which of the three legal documents associated with the COP (RAD, SS, SSWP) which participants found of greatest utility, they were requested to rank them in order (out of three) for being of the most help with management of on-farm OSH and for ease of completion. Eighty percent (n=68) fully completed this ranking and the data is presented in Table 7.11. which indicates that the RAD was the document they found of both ‘most helpful’ and the ‘easiest to complete’.

Table 7.11: Ranking by ‘helpfulness’ and ‘ease of completion’ of COP documents (mean score) for completion ranked in order of utility by farmers (n=68)

Document type	**Most helpful**	**Easiest to complete**
Risk assessment document	2.3	2.15
Safety statement	2.0	1.85
Safe system of work plan	1.7	2.00

It should be noted that participants ranked the training components of the FETAC course (Table 7.9) generally more highly than those given to OSH documents (Table

7.10), indicating a higher favourable view of FETAC training elements than of the COP documents used at training. The study data available indicated that training is likely to be an important facilitator of legal COP document completion as prior to obtaining training just 28.8% of participants had completed such a document. Following training, as indicated in Table 7.10, all documents received a high rating with the lowest positive rating being 68% for the question ‘that the SS written approach was better than the RAD tick box approach’ (line 5).

Regarding document type, in the ranking score the finding that the RAD was considered most helpful and easiest to complete may be attributed to its style of posing questions which made clear what OSH measures were required and its presentation style including picture and pie charts with limited text. The SSWP notably presented the same OSH measures as the RAD but used graphical drawings or ‘pictograms’ as its visual medium which was less favourably rated. The SS used written narrative to describe farm hazards, risks and control measures and was regarded as the most difficult document to complete but the second most helpful document ahead of the SSWP.

The ranking of the documents is broadly in accord with the scientific literature. Keyserling et al., (2007) found that a checklist is an effective rapid-screening instrument for identifying hazards which the RAD and SSWP resemble. Cole (1997) considered that a ‘lively format’ aids communication and that visual aids such as photos assist with triggering the right mental images while Saari (1990) suggested that positive presentation of messages which the RAD provides are preferable to negative ones.

In summary the RAD received both the highest rating from participants which is considered based on the study data is related to its design, as it is in accord with the literature related to document design and style. This suggests that this style of document from among the three assessed in this study has the most utility to farmers in assisting them to manage farm OSH.

7.2.3.4. Provision of tutorial assistance with OSH documents

Tutorial assistance with completion of the legal OSH documents was offered to FETAC course participants among a sample of participants (n=113) and 45.1% availed of this additional service. Estimates of tutorial time revealed that of those requesting it (45.1%), 38% required 3.7 hours, and 2.7% each required 2.5 and 1.5 hour and a further 1.8% required 0.2 hours. Participants requesting tutorial assistance predominantly required assistance with all documents (88.2%) and the tutorial assistance was universally to help with completion of the documents rather than explanation of their contents. For those requiring estimated 3.7 hours assistance, the time used for assisting with completion of the SS, RAD and SSWP documents was estimated at 2.0; 1.5 and 0.2 hours respectively. Thus the SSWP was the document requiring the least amount of time for tutorial assistance. A comparison made between two age categories: those aged under 55 years and aged 55 and older indicated that 28% of farmers in the younger age category availed of tutorial assistance compared to 54% in the older category, which was statistically significant ($p= 0.016$) using the chi-square test. This indicates that demand for tutorial assistance approximately doubled for the older age category. The proportion of female course participants was 17.7% in the sample survey regarding the option of availing of this service and no statistical difference was found ($p= 0.627$) in the demand for tutorial assistance between male and female participants.

In summary, the study data available indicates that tutorial assistance was availed-of by close to half of training participants when it was made available and especially among older participants, but the level of its use was not associated with gender. Provision of such assistance is time-consuming in terms of tutor time particularly for the SS and RAD. Possible reasons for the demand for tutorial assistance include an assurance of quality control with the OSH document completion and literacy as the level of literacy issues in the Irish population is of the order of 25% (Department of Education, 2000).

7.2.3.5. Comparison of RAD and FETAC training provision

When comparing the RAD half-day and FETAC training courses a notable difference occurred in their length. The RAD training was designed specifically to explain the content of the RAD and support implementation of its measures. The FETAC OSH training course in contrast was longer (12.5 hours) and was designed to provide both a greater range of OSH training and SHWW legal document completion. Both course types received very positive feedback from participants. Participants in RAD half-day training reported that they would be prepared to attend more OSH events while FETAC participants expressed satisfaction with the overall length and content of training. Thus it can be concluded generally that among farmers who attended OSH training that they are positively disposed to on-going OSH training and initiatives. Participants of both courses expressed positive opinions about the importance of OSH prior to training. Efficacy of RAD training through completion of the document, implementation of controls and estimation of accident rates is to be measured during further phases of this study; however an immediate issue to be investigated is the level of COP and RAD use when circulated nationally and the characteristics and opinions of its users.

7.2.4. National use and views of the code of practice documents

In December 2006, COP documents were circulated to all farmers nationally by post and during the second half of 2007 a national survey was conducted related to farmers use and opinions of the COP documents. This was done using an additional survey to the Teagasc NFS where 1,040 farmers were surveyed. Information on the conduct of the NFS add-on survey is available in sub-Section 6.4.2.4. of this study.

7.2.4.1. Opinions on the code of practice documents nationally

The national survey found that the COP was received by 98.6% of farmers and 54.2% offered their opinions on their usefulness which are now outlined. Forty four per cent of farmers could identify that they had received the documents but had not read them while 1.8% stated that they had not received them. Of those who rated the usefulness of the COP documents, a rating of ‘excellent’, ‘good’, ‘fair’ and ‘poor’ was given in 12.3%, 60.7%, 20% and 7% of cases respectively. This is a positive finding for the COP documents as 72.9% who offered an opinion rating them as either ‘excellent’ or ‘good’.

Further analysis of the NFS data related to usefulness of the COP documents was conducted by McNamara et al., (2010) using a multinomial logit model using SAS (2004) software which included the following potential explanatory variables: farm size; farm system; region; economic size; labour units; age of farmer; use of hired labour; number in household; educational attainment of the farmer; rural environmental protection scheme (REPS) participation, Teagasc client membership and whether the farmer and/or spouse had off-farm employment. This modeling exercise found that the interaction of ‘region’ and ‘labour units’ only was statistically significant (p=0.031) and as ‘region’ was considered a statistical blocking factor further analysis focused only on ‘labour units’ required to operate farms. A statistical blocking factor is a source of variability which is not of interest to the researcher and accordingly is not included in further analysis. The NFS classifies farms as either ‘full’ or ‘part time’ based on the standard labour units required with a ‘full-time’ farm requiring at least 0.75 and ‘part-time’ farm requiring less than 0.75 standard labour units.

In the NFS survey related to opinions of the COP, among full-time farms (33.5% of survey participants) 71.1% rated the COP documents as: excellent (16.8%); good (55.5%); fair (22.2%) and poor (5.5%) respectively while among ‘part-time’ farms (66.5% of participants), 48.5% rated them as : excellent (10.1%); good (66.9%); fair (16.5%) and poor (6.5%). Thus the data available indicates that a higher proportion of full-time farms (71.1%) compared to part-time (48.5%) rated the COP documents. However opinions on the COP documents were broadly similar for full and part-time farms, who rated them as ‘excellent’ or ‘good’ in 72.3% or 77.0% of cases, respectively.

7.2.4.2. Use of RAD by farmers nationally

The NFS survey conducted in 2007 indicated that 41.5% of participants reported completing the RAD and further analysis of the NFS sample data was undertaken related to RAD completion by applying logistic regression analysis using SAS (2004) software (McNamara et al., 2010). The modelling approach applied was an exploratory stepwise one using automatic variable selection and allowing for up to three-way interactions. The model included the same potential explanatory variables as used for modelling usefulness of the COP documents listed previously. The results of the modelling identified Teagasc client (p=0.001), farm economic size (p=0.009) and region (p= 0.01) as variables which were significantly associated with completion of the RAD. As with the data for use and opinions of COP documents in the previous section , 'region' was considered as a statistical blocking factor and interpretation focussed on the other significant factors and the size effects (odds ratios) for these are shown in Table 7.12. An odds ratio (OR) is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. The 95% confidence interval (CI) is used to estimate the precision of the OR. A large CI indicates a low level of precision of the OR, whereas a small CI indicates a higher precision of the OR. Unlike the P-value statistic, the 95% CI does not report a measure in statistical significance but in practice, the 95% CI is often used as a proxy for the presence of statistical significance if an OR is within the 95% CI indicating evidence of association between the exposure and outcome (Magdalena, 2010).

Table 7.12: Teagasc client membership and farm economic size effects (OR) for RAD completion

Effect	**Odds Ratio**	**Confidence Limits (95%)**	
Teagasc client (yes vs. no)	1.592	1.205	2.109
Farm economic size (ESU)	1.008	1.003	1.013

The data in Table 7.12 related to the effect (OR) of Teagasc client membership on RAD completion indicates that such membership had an OR of 1.592, meaning that Teagasc clients were 59.2 % more likely to have completed the RAD compared to the null-value of non-Teagasc client (O.R.=1). This data indicates that farmers who were Teagasc clients had a substantially higher self-reported completion of the RAD document, which was statistically significant (p=0.001).

Data in Table 7.12 indicates that the effect (OR) of farm economic size (ESU) on RAD completion was positive (OR=1.008). As ESU is a continuous variable it must be interpreted in terms of change in OR across the range of the variable of 300 ESU. The relationship between ESU and RAD completion obtained from the logistic regression modelling is shown in Figure 7.2. which describes a quadratic trend of increasing OR for RAD completion occurring with increased ESU. This means that as farm ESU increased, the odds of completion of the RAD increased quadratically with increasing ESU or as farm ESU increased the likelihood of RAD completion increased disproportionately.

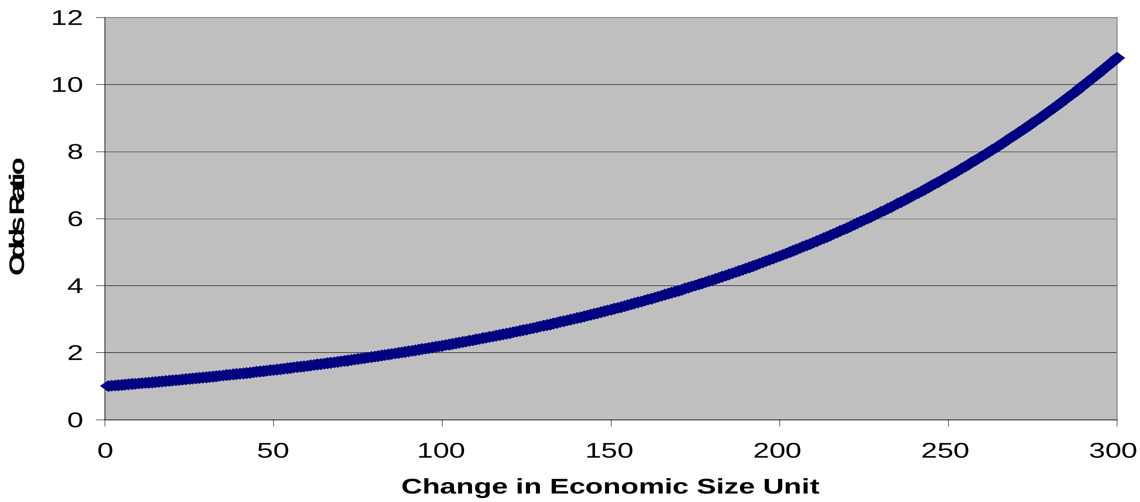

Figure 7.2. Size effect (OR) for RAD completion for change in ESU

7.2.4.3. Use of DVD circulated with COP

The NFS survey conducted in 2007 indicated that viewing the DVD circulated as a component of the COP took place among 24.8% of farm operators and among 18.6% of farm households for other members. Analysis using a multinomial logit model was conducted for farms using the same potential explanatory variables as used for modelling usefulness of the COP documents listed previously. The modelling indicated that farmer age (p=0.003), participation in REPS (p=0.015) and household number (p=0.018), were significantly associated with DVD viewing and Table 7.13 shows the size effects for these responses. The data indicates that younger farmer age (OR=0.98) and participation in REPS (OR=1.453) were associated with increased DVD viewing. Regarding household size a quadratic effect occurred where the OR increased up to 5 household size and then decreased. The data indicates that DVD viewing decreased as farmer age increased and that farmers who participated in the REPS agri-environmental scheme had a higher rate of viewing. For explanation of DVD viewing associated with household size a detailed examination of the age of household members would be required, which was not available to the study author.

Table 7.13: Size effect (OR) for viewing of DVD

Effect	Odds Ratio	Confidence Limits (95%)	
Age of farmer	0.98	0.967	0.993
REPS (yes vs. no)	1.453	1.074	1.961
Household number	1.111	1.018	1.212

In summary, the NFS survey conducted in 2007 related to completion of the COP documents, gave national estimates for farmer perception of COP documents, completion of the RAD, and viewing levels of the accompanying DVD. This provided new knowledge on farmer use and opinions of the COP documents in Ireland. Specifically, the NFS survey indicates that the COP documents were used to a greater extent among farms classified by the NFS as ‘full time’ while the opinion of the documents was broadly the same across full and part-time farmer users. The survey also indicated a 45.6% increase in use of the RAD when compared with the SAD circulated in a similar manner in 2003 (McNamara et al., 2006). This information generally concurs with the finding of Chapman et al., (1996) that farmers are interested in completing OSH self-assessments. However the NFS survey indicated that completion of the RAD was predominantly influenced by whether farmers were Teagasc clients or not and by increasing farm economic size which are new findings in Ireland. Viewing the DVD circulated nationally occurred among almost one quarter of farmer operators and 18.6% of farm households for other family members. DVD viewing decreased as farmer age increased, increased with REPS participation and increased with household size up to five persons, which also provides new information in Ireland on the uptake of this component of the COP. Overall the data obtained suggests that engagement with the COP materials was associated with farmer contact with outside influences and in particular with advisory services.

7.2.5. Summary of findings on utility of COP documents and training

The successful implementation of the pilot phase of the PI and then preparation, publication and national circulation of COP documents to farmers facilitated gaining data on use of COP and RAD in the first phase of the study assessment. Data gathered for the first phase for the study assessment has been presented and interpreted for the reader in association with the key literature in this chapter.

The methods used in the first study phase assessment, as outlined earlier in the methods section 6.4.2, were 'mixed method' in design. The consequence of using a mixed method approach is that quantitative and qualitative data may be blended by 'triangulation' to allow study hypotheses to be accepted or rejected (Easterby-Smith et al., 1991). Accordingly, broad conclusions are drawn from the data from the first phase of the study related to assessment of the utility of the RAD and associated training. This will allow hypothesis testing to be conducted later in this chapter (section 7.6) when all data from all phases of the study has been presented.

7.2.5.1. Conclusions of assessment of utility of RAD and associated training

Participants who attended RAD training had an incorrect understanding of the causes of farm accidents. The COP approach could be of assistance with accurately and objectively informing farmers of the actual causes of farm accidents with a view to their prevention.

The key challenge of implementing a COP approach among Irish farmers identified is to gain engagement with the COP documents and attendance at OSH training. The data assembled in this phase of the study indicates that COP use was associated with both increased farm scale and Teagasc client membership. Greater attendance at OSH training was also associated with younger aged farmers with larger farms.

Farmer motivation to participate in training was both to meet OSH compliance and to improve implementation of OSH on their farms.

Participants of training courses indicated high levels of satisfaction with all components of the RAD approach. This document was considered by users as both more useful in managing farm OSH and easier to complete than the other Irish legal documents (i.e. SS and SSWP). High levels of satisfaction were also reported for training provided (half-day and FETAC), by farmer participants and advisor and trainer facilitators.

Almost all farmers were motivated and willing to implement the OSH controls outlined in the RAD and the majority considered that they had no barriers to their implementation. However, almost half of participating advisors and trainers commented that farmers as a group did not follow through on their intentions and they suggested that on-going motivation of farmers is needed to gain OSH adoption.

Trainers, who had a greater background in providing OSH services than advisors were uniformly satisfied with the training they received for their role in providing RAD training. One quarter of advisors were unhappy with the training they received for their role in provision of RAD training with the principal issue being that not enough training was provided.

Farmers who had undertaken training were willing to participate in further OSH advisory and training programmes and suggested that Teagasc include this aspect of farm management in its farm advisory and training programmes. Increased advisory engagement was reported in OSH following farmer and advisor participation in RAD training, particularly at farm advisory visits and events for farmers.

7.3. Assessment of completion of the RAD by farmers

This provides the findings of the second phase of the study which aimed to assess the level of completion of the pilot RAD by farmers' who either completed it after participating in half-day training or who completed it without training. The reason for this assessment was to gain knowledge on the actual use made of the RAD by farmers. Also, for the planned phase 3 of the study involving an on-farm assessment of implementation of the RAD, a means of purposefully selecting farms to audit needed to be devised and implemented. To conduct the pilot RAD assessment, firstly a scoring system was devised and implemented where documents were scored for completeness, consistency and farm risk and secondly RAD controls identified by farmers as necessary for action on their farms were enumerated and categorised. A total of 475 RAD documents were assembled and used for this assessment, 335 were completed by farmers after half-day training attendance and 140 where no training was provided. The documents were assembled by providing RAD training participants with a stamped addressed envelope to forward the documents to the researcher and for farmers who did not undertake RAD training but were supplied with the RAD and instructions on its completion these were contacted by letter. The information gained from both approaches to RAD document assessment is now outlined.

7.3.1. Scoring of RAD's

The scoring approach for RAD's devised and used in this section has previously been described in section 6.4.3.1. and the findings of pilot RAD scoring are now presented in table 7.14 (with further data analysed by enterprise presented in Appendix 7.4.).

The results indicate that 74% and 73.4% of documents had a score assigned in the 1 and 2 categories for 'completion' and 'consistency' respectively indicating that the majority of RAD documents were completed to what was judged as a satisfactory standard. For these RAD scores the data in table 7.14 indicates that no significant difference occurred for RAD's completed following half-day training or not. Further data in Appendix 7.4 indicates that farm enterprise did not influence RAD scores. A high correlation occurred between 'completion' and 'consistency' ($r = 0.853$) and accordingly the subsequent on-farm exercise of validation of RAD score assigned focused only on 'completion'. The scoring approach applied indicates that the majority of documents were judged to be adequately and consistently completed whether training was or was not undertaken. In particular, the consistency score indicated that the majority of RAD's were completed truthfully by farmers with no major inconsistencies as determined by double checking the RAD 'action list' with previous inputs.

A ‘risk’ score was assigned to each pilot RAD document which was based on information contained in the RAD related to the farm. The information used to apply this score included: number of farm vehicles and machines, livestock types, farmyards and farm buildings and extent of workshop equipment and electrical installations on the farm. Accordingly, the risk score assigned was a subjective measure of the level of the risk from farming activity and did not indicate whether farm OSH conditions were satisfactory or not. Data in Table 7.14 indicates that risk scores allocated to RADs’ where farmers did or did not participate in half-day training were similar, suggesting that their farm profiles in terms of this measure were similar. The scores applied also suggest that there was a small proportion of both very low and very high risk farms in the study.

Scores allocated for number of controls specified indicate that a significantly higher number were specified where training occurred (p=0.000). The data in Table 7.14 indicates that for all score categories higher numbers of controls were identified following training compared to where no training took place. Further data for document scoring for controls specified by enterprise provided in Appendix 7.4 indicates that levels of controls specified were higher where training occurred for all enterprises. This data strongly indicates that farmers who participated in half-day training specified a greater level of controls than those who completed the RAD without training.

In conclusion, the data obtained from RAD scoring indicates that the pilot RADs’ were completed to a satisfactory level of ‘completion’ and ‘consistency’ by the majority of farmers whether training was or was not attended, however 26% and 26.4% of farmers did not complete the RAD to an acceptable standard for these attributes which was not influenced by training attendance (Table 7.14). Scoring for ‘farm risk’ indicated that the farms of those who did or did not attend half-day training were broadly comparable for this measure. However, scoring for level of controls specified indicated that this was significantly higher following training participation. Overall the scoring approach adopted indicates a positive utility for completion of the RAD which is increased by attendance at half-day training. Scoring also indicates a limitation to how satisfactorily the RAD was completed with or without training among a minority of farmers

Table 7.14. Percentage distribution of participants by RAD scores completed following half-day RAD training (n= 335) or no RAD training (n=140)

Score description	RAD training	Score applied (%)				Significance[4]
		1	2	3	4	
Completion[1]	Yes	29.8	44.3	20.8	5.1	p=0.538. n.s.
	No	24.1	49.6	19.7	6.6	
	Total	28.1	45.9	20.5	5.5	
Consistency[1]	Yes	30.4	42.8	22.9	3.9	p=0.120. n.s.
	No	21.2	52.6	24.1	3.1	
	Total	27.7	45.7	23.3	3.4	
Risk[2]	Yes	12.8	40.3	41.8	5.1	p=0.435. n.s.
	No	10.3	42.6	44.9	2.2	
	Total	12.1	41.0	42.7	4.2	
Number of Controls Specified [3]	Yes	33.9	28.3	19.9	17.9	p=0.000 ***
	No	40.1	43.1	9.5	7.3	
	Total	35.7	32.6	16.9	14.8	

[1] Scores applied:
Completion and Consistency: 1= very satisfactory (VS); 2=satisfactory (S); 3=unsatisfactory (US); 4= very unsatisfactory (VU).
[2] Risk: 1= very low (VL); 2= medium (M); 3= high (H); 4=very high (VH).
[3] Number of Controls specified: 1= 0-3; 2= 4-6; 3=7-9; 4=10+ controls specified.
[4] Pearson Chi-square

7.3.2. Enumeration of RAD controls specified for Action

This method of assessment by enumeration of RAD controls specified for action involved both counting and classifying the controls specified on the pilot RAD 'action list' page (page 28) of documents assembled. The objectives of this assessment were two-fold: firstly to gain knowledge on which RAD controls and their frequency were designated for action by farmers; and secondly to make a comparison of the mean

number of controls specified by farmers who did or did not participate in half-day RAD training to ascertain if provision of training influenced this variable. This comparison was quasi-experimental in design and used the 'T-test for equality of means statistic'.
As indicated in Table 7.15, a total of 1,414 control measures were identified in 475 pilot RAD documents, while the top 20 most frequently specified controls (66.8% of controls) are presented in Appendix 7.5. The majority (92.4%) of controls specified were 'physical' in nature with 7.6% being 'practice' related which made up 27.4% of pilot RAD questions.

Table 7.15: Control measures specified by farmers in RAD's (n = 475)

RAD category	**No.**	**%**
Machinery	310	22.0
Tractors, farm vehicles and ATV's	282	19.9
Livestock	206	14.7
Farmyard, buildings and slurry	180	12.6
Electricity	125	8.8
Health	126	8.8
Chemicals	94	6.8
Workshop, repairs, working with timber	71	5.0
Children and older farmers	20	1.4
Total	1414	100

By way of comparison, the data for controls specified in the RAD is somewhat similar to the findings of McNamara and Reidy (1997) who questioned farmers in Ireland on concerns about safety on their farms in a NFS survey of safety and health on Irish Farms. They found that farmers reported concerns related to farm vehicles and machinery (38.1%), electricity (12.0%), slurry related (9.0%), livestock related (9.2%) and children on the farm (7.6%) and other concerns (23.3%). It is notable that 'children on the farm' is proportionately higher in this data than in the RAD controls specified (1.4% children/ older) (table 7.15) but otherwise similarities occurred related to farm vehicles and machinery (41.9%), electricity (8.8%) and livestock (14.7%). In Australia, Pollock (2010) found that farmers predominantly perceived that farm risks were physical with 60% being in this category and among these 38% were machinery related. Among perceived risk recorded in this study, 3.5% related to children and older farmers made up of the total which is similar to the current study in terms of RAD controls specified. The Australian study indicates that the perceived risks identified by farmers are broadly similar to the RAD and previous Irish studies. The comparisons among the various studies related to farmers OSH risks indicate in particular that farmers have a high ongoing concern related to vehicle/ machinery use while childhood and older farmer safety receive limited concern.

7.3.2.1. RAD controls specified with or without half-day training

A comparison is provided in Table 7.16 of the mean number of controls specified in the RAD completed with and without half-day training participation and by enterprise. RAD's completed with training had on average, 3.32 controls specified compared to 1.95 controls without training (p=0.000). Thus the mean number of RAD controls was higher by 70% when the document was completed following half-day training than when completed without training. By enterprise, a significant difference associated with training occurred for dairy farms (p=0.002) where a mean of 4.28 controls were specified following training compared to 2.24 where no training attendance occurred. Comparable data for both tillage farmers (training 3.08, no training 2.55) and drystock farmers (training 2.60, no training 1.84) indicated a trend towards statistical significant difference in mean controls specified (p=0.09 and p=0.06, respectively). This data indicates that following half-day training, the level of RAD controls specified was higher across all enterprises but the increase was highest for dairying (91% increase), which was significant followed by drystock (41%) and then tillage (21%).

Regarding comparison of level of controls specified following RAD completion with other studies, Pollock (2010) found that farmers in Australia specified implementation of 2.4 safety controls in the previous year. Of these changes 47.4% related to machinery and equipment, 15.8% to the farm environment, 13.1% were management change and 23.7% were classified as other. The Australian data suggests that farmers annually make a relatively low level of OSH changes and they are mainly physical in nature, which is comparable to the data from this study.

Table 7.16: Comparison of mean number of controls specified in RAD following half-day training or not by farm enterprise type
[1] T test for equality of means

Farm Enterprise	Training Participation	Mean No. of controls	[1] p value (Significance)
Dairying	Training (n=143)	4.28	0.002 **
	No training (n=58)	2.24	
Drystock	Training (n=153)	2.60	0.06 ns
	No training (n=46)	1.84	
Tillage	Training (n=39)	3.08	0.09 ns
	No training (n=36)	2.55	
All	Training (n=335)	3.32	0.00 ***
	No training (n=140)	1.95	

A further comparison of the mean number of controls specified by hazard category in the pilot RAD document is provided in Table 7.17. This indicates that following half-day training a higher number of RAD controls were specified across all categories with this difference being significant for the categories: tractors, farm vehicles and ATV's (p=0.001) and livestock. (p=0.02) and being close to significance for health (p=0.07).

While the findings of this section indicate that higher numbers of controls were specified following half-day training attendance, they also indicate that farmers made limited use of the pilot RAD as 113 controls were listed in the document while on average farmers specified 3.32 and 1.95 RAD controls after training and no training respectively which account for 2.93% and 1.73% respectively of listed pilot RAD controls. Completion of the RAD (with or without training), may influence farmers to implement controls independently of specification of controls in the document. Further research to examine if RAD completion is associated with subsequent accident occurrence has been completed and will be outlined in section 7.5 of this study.

Table 7.17: Mean number of controls specified per farm by RAD category following half-day (n=335) and no training (n=140)

RAD category	Training	No training	p value / significance[1]
Chemicals	0.23	0.13	0.13 n.s
Children and older farmers	0.05	0.03	0.24 n.s
Electricity	0.41	0.31	0.61 n.s
Farmyard, buildings and slurry	0.23	0.13	0.44 n.s.
Health	0.32	0.14	0.07 n.s
Livestock	0.49	0.29	0.02 *
Machinery	0.73	0.47	0.10 n.s.
Tractors, farm vehicles and ATV's	0.53	0.24	0.00 ***
Workshop, repairs, working with timber	0.29	0.22	0.12 n.s
Total	3.28	1.96	0.00 ***

[1] T-test for equality of means

7.3.3. Summary and conclusions on RAD completion

Overall the study findings provide data on completion of the RAD and indicate that the number of controls specified increased following attendance at half-day training. The findings also indicate that a minority of farmers did not complete the pilot RAD to a satisfactory level when scored subjectively for 'completion' and 'consistency' and this occurred with or without training. This finding motivated extending the study to the more extensive FETAC accredited training to examine the utility of this training.

Farmers emphasised specification of physical controls for action when completing the pilot RAD and attendance at half-day training resulted in an increased number of controls being specified across all categories in the RAD and, particularly among dairy farmers. However, very few of the pilot RAD controls (less than 3%) were specified for action.

The findings of the assessment of pilot RAD completion provided the basis of the next phase of the study, namely relating its completion to farm conditions and implementation of controls and these are presented in the next section.

7.4. On-farm assessment of the RAD use

This was the third phase of the study with the following objectives: firstly to assess if completion of the RAD document equated with practical on-farm OSH standards and practices and secondly to assess if implementation of controls specified in the RAD had taken place. Thus, this phase of the assessment had the following two distinct components: firstly validation was undertaken of the scores assigned to RADs' in relation to the actual farm OSH conditions; and secondly the OSH on-farm standards and practices were examined to ascertain if implementation of controls assigned for action on the RAD 'action page' had taken place and to assess farm OSH standards generally. The methods used for this study section were previously described in the methods section at 6.4.3.1.

Conducting an audit of on-farm OSH standards and practices was an essential requirement to achieve the objectives of this study phase. To audit on-farm OSH standards and practices a check-list and scoring system was developed and used which allowed attribution of an overall OSH 'safety score' and subsidiary scores for individual farm elements to be allocated to each farm. The audit document was developed by modifying and expanding one previously developed and used by Teagasc to assist with checking host farms where students undertook work placement (Teagasc, 1997) and is available in Appendix 6.16. The scores applied estimated both the overall and subsidiary levels of long-term management of OSH on the farm. The scores applied were benchmarked with compliance with SHWW legislation by using the following four point scale: 1- very satisfactory (VS); 2- satisfactory (S); 3- unsatisfactory (US); 4- very unsatisfactory (VU). The scores 3 and 4 respectively correlated with where an 'improvement notice' and 'prohibition notice' respectively would have been issued by a H.S.A inspector under the SHWW Act. Using a four-point scale also allowed for the possibility of contracting it to a two-point scale: A – satisfactory; B - unsatisfactory.

Initially, the on-farm assessment was carried out on 66 farms where RAD completion had taken place, in 49 cases where the farm operator had participated in half-day training and 17 without such training. Subsequently a further 28 farms where a person had participated in a 12.5 hour FETAC OSH course were assessed, giving a total of 94 farms audited.

7.4.1. Validation of scoring of RAD's

The initial purpose of the farm audits of a sample of farms (n=66) who submitted RAD's was to validate the scores allocated to RAD's which was completed as a desk exercise by the researcher without access to the farms. This validation accordingly was to check the accuracy of 'completion', 'consistency' and 'risk' scores applied to RAD's correlated with the actual OSH situation on farms. An 'accuracy' score using the same 1 to 4 scoring system as for document scoring was recorded for RAD scores following visiting each farm where it could be viewed and dialogue held with the farmer. Thus the accuracy score refers to the score allocated after the on-farm audit had been completed.

Data from the validation exercise conducted, presented in Table 7.18, indicates that high correlation occurred between the RAD corrected and accuracy scores for 'completion' (r=0.697) and 'consistency' (r=0.539) when the four point scale was used. When the scoring scale for these RAD attributes was contracted to a two-point scale of A (formerly1, 2) and B (formerly 3, 4), correlations remained reasonably high between the corrected and accuracy scores for 'completion' (r=0.458) and 'consistency' (r=0.401). However for the risk score, the correlation was low when the four-point scale was used and was negative (r= 0.329) when the scale was reduced to a two-point scale.

Table 7.18: Validation (n=66) of RAD scoring (%)

Document Score	Score Type[2]	%				Correlation [1]	
		1	2	3	4	1,2,3,4	A/ B
Completeness [2]	Corrected	40.9	43.9	12.1	3.1	0.697	0.458
	Accuracy	33.3	47.0	12.1	7.6		
Consistency [2]	Corrected	39.4	42.4	16.7	1.5	0.539	0.401
	Accuracy	37.9	39.4	16.7	6.0		
Risk [3]	Corrected	18.2	48.5	33.3	0	0.300	-0.329
	Accuracy	66.7	18.2	15.1	0		

[1] Correlation measured using Spearman Correlation Two-tail Test
[2] Score Type: 1= Very Satisfactory; 2=Satisfactory; 3= Unsatisfactory; 4= Very Unsatisfactory.
[3] Risk: 1= Very Low; 2= Medium; 3= High; 4= Very High.

This data indicates that corrected and accuracy scores for both ‘completion’ and ‘consistency’ had a high level of similarity and that this was retained to a lower extent when the four-point scale was reduced to a two-point one. In contrast, the corrected and accuracy ‘risk’ scores had low correlation, which became negative with the two-point scale, which means that low correlation or similarity became lack of similarity with the two-point scale.

Validation data for changes made in score class following farm scoring (Appendix 7.6) indicated that: the ‘completion’ score had 21.2 % of scores improved and 7.6% reduced; while for the ‘consistency’ score 13.6% of scores were improved and 15.1% reduced; and for the ‘risk’ score, 56% of farms were re-graded to a lower risk score (i.e. less risk) and 7.6% to a higher one. This data indicates that for the ‘completion’ score a higher percentage were regarded to a higher level of satisfactory score than reduced while in the case of the ‘consistency’ score a marginally higher reduction occurred in satisfactory score than increased. However, for the ‘risk’ score, a considerable re-ranking occurred with 40.9% of scores being improved by one risk class and 15.1% by 2 classes, while 7.6% were reduced by one class.

Overall the on-farm validation assessment revealed that the ‘completion’ score assigned to a document was either unchanged or upgraded in 92.4% of cases. High correlation also occurred between the ‘completion’ and ‘consistency’ scores (r= 0.853) which means that the two scores were very closely aligned with each other. In effect, this indicates that the two measures were similar. Accordingly from now-on, the ‘completion’ score is used solely in the study based on the knowledge that it has a high level of consistency also.

It is concluded that the high correlation between ‘completion’ and ‘consistency’ corrected and accuracy scores indicates that the pilot RAD was completed meaningfully and not by rote by farmers, who considered the actual on-farm OSH conditions as they completed the RAD. This indicates that the RAD has utility in gaining meaningful engagement by farmers completing it with the actual OSH conditions on their farms. In contrast to the ‘completion’ and ‘consistency’ scores, the ‘risk’ score assigned to the pilot RAD’s by ‘desk’ scoring proved less accurate for this measure than with on-farm scoring with 56% of farms being allocated a lower score (i.e. less risk) and 7.6% being allocated a reduced or higher score. This alteration led to the negative correlation between corrected and accuracy scores for risk when a two point scale was applied (Table 7.18.).The data available suggests that on-farm risk cannot be estimated with accuracy by scoring of the pilot RAD document (which is more an estimate of farm scale) and accordingly needs to be carried out on an on-farm basis. The implication of this conclusion is that farm risk is not related to scale of farm *per se* but to the overall organisation and management of the farm.

In phase three of this study, the ‘risk’ score applied to pilot RAD’s by ‘desk’ scoring was used to select farms for an audit visit which was a valid use of the data as this score reflected scale. However, as this score is more related to farm scale than to actual estimated farm risk and as various other objective measures (e.g. farm size, economic size) were used as part of the on-farm assessment accordingly the risk score was not used in further analysis of data in this study.

7.4.2. OSH scores for farms audited

Scoring of farm OSH standards and practices took place while auditing farms to conduct validation of the pilot RAD documents. A summary of safety scores allocated for various farm elements scored is provided in Table 7.19. A score was allocated only if the issue arose on a farm, for instance the issue of 'children' or 'older farmer' arose on-farm in 36.2% and 24.5% of cases respectively where the score was applied. Overall, the data on farm scoring indicates a high level of OSH compliance with 76.6% achieving a satisfactory Safety Score.

Table 7.19: Percentage distribution of farmers by safety score for OSH farm audit

Item scored	**No. of farms**	**% in each category** [1]				**%Satisfactory (A: 1&2)**
		1	**2**	**3**	**4**	
Tractors/vehicles	94	41.4	55.3	2.2	1.1	96.7
Machinery	91	38.4	49.5	8.8	3.3	87.9
Livestock	81	27.2	58.0	13.6	1.2	85.2
Farmyard/buildings	93	40.9	41.8	11.8	5.5	82.8
Electrical	93	32.3	49.5	15.0	3.2	81.8
Workshop	68	23.5	64.8	8.8	2.9	88.2
Chainsaw	61	6.6	78.7	13.1	1.6	85.3
Chemicals	84	25.0	59.5	15.5	0.0	84.5
Health issues	94	24.5	64.9	10.6	0.0	89.4
Protective equipment	90	26.7	56.6	16.7	0.0	83.3
Children	34	17.6	76.5	5.9	0.0	94.1
Older farmer	23	17.4	78.2	4.4	0.0	95.6
Farmer OSH attitude	92	43.5	36.9	16.3	3.3	80.4
Safety score	94	33.0	43.6	20.2	3.2	76.6

[1]Score Type: 1= Very Satisfactory; 2=Satisfactory; 3= Unsatisfactory; 4= Very Unsatisfactory.

The data in table 7.19 indicates a higher level of non-compliance to the findings from official farm inspections conducted by H.S.A. inspectors. In 2006, inspectors served either a legally binding 'prohibition' or 'improvement' notice for 15.3% and sent written advice letters to a further 22.4% of farms visited on random inspection (H.S.A., 2007a). Improvement and prohibition notice issue corresponds to a score of 3 or 4 respectively in the on-farm scoring in this study while the issue of an advice letter corresponds approximately to OSH issues associated with score 2 where improvement is advised but where a statutory breach of SHWW Act was not identified.

7.4.2.1. Association between RAD completion and farmer and farm variables

It is important to know if the manner in which the pilot RAD was completed was associated with either farmer or farm variables. Inferential statistical analysis using cross tabulations and chi-square testing were used to test if relationships existed between RAD completion (accuracy) and RAD half-day training, farmer characteristics and farm variables. The findings are presented in Table 7.20. A detailed description of the farm variables which are not self-explanatory (marked with asterisk) is provided in Appendix 7.7. In this analysis (Table 7.20), the two-point scale for 'safety' score (A, satisfactory; B, unsatisfactory) was used due to limitations arising with statistical testing associated of data using a 4 point scale.

The outcome of the cross tabulation statistical analysis indicated that the RAD 'completion' score had no statistical association with 'farm safety' scores applied. This finding indicates that the standard of RAD completion was not related to practical on-farm OSH standards and practices. However the following variables related to the farmer were significantly associated with document completion: 'completed half-day training' ($p=0.001$) 'implemented controls' ($p=0.018$). This data from the statistical analysis indicates a utility in participation in half-day training in terms of higher levels of RAD completion and also that farmers who implemented controls also had higher RAD completion scores. There was a statistical trend of lower RAD completion among farmers farming part-time and higher for this measure among those with a higher number of controls to implement. Farmer personal or farm scale or technology variables had no significant association with RAD completion. Overall the data indicates that attendance at RAD training has utility with increasing levels of RAD completion which was associated with higher levels of implementation of controls.

Table 7.20: Relationship between RAD completion (accuracy) score and selected farmer and farm variables

Variable/ Description		No.	RAD Completion Score[1] (%)		Significance[2]
			A (S)	B (US)	
Farm Safety Score	A (S)[3] (n=41)	66	83.7	16.3	p=0.65 n.s.
	B (US)[4] (n=15)		88.2	11.8	
Training Completed	None (n=17)	66	58.8	41.2	**p=0.001. ****
	Half-Day (n=49)		93.9	6.1	
Number of Controls Specified in RAD	0 (n=18)	66	77.8	22.2	p=0.143. n.s.(T)
	1-3 (n=36)		78.3	21.7	
	4 + (n=12)		96.0	4.0	
SAD/SS Previously completed	Yes (n=22)	42	100.0	0.0	p=0.335. n.s.
	No (n=20)		95.5	4.5	
Implemented controls	Yes (n=36)	63	97.4	2.6	**p=0.018 ***
	No (n=27)		75.0	25.0	
Farm Enterprise	Dairying (n=25)	66	84.0	16.0	p=0.354. n.s.
	Drystock (n=23)		78.3	21.7	
	Tillage (n=18)		94.4	5.6	
Farm Size. (Ha)	0-39 (n=13)	66	84.6	15.4	p=0.657. N.S.
	40 -79 (n=32)		81.3	18.7	
	80 + (n=21)		90.5	9.5	
Farm Economic Size* (ESU) (Est.)	0 -29 (n=18)	63	72.2	27.8	p=0.214. n.s.
	30 – 59 (n=18)		88.9	11.1	
	60+ (n=27)		90.0	10.0	
Farm Labour Units* (Est.)	0- 0.99 (n=24)	66	79.2	20.8	p=0.380. n.s.
	1-1.99 (n=24)		83.3	16.7	
	1.99 > (n=18)		94.4	5.6	
Farm Labour Status	Part-time (n=19)	66	66.7	33.3	p= 0.082. n.s. (T)
	Full time (n=36)		90.0	10.0	
	F.time worker (n=11)		90.9	9.1	
Farm Work Time*	High (n=22)	66	91.0	9.0	p=0.332 n.s.
	Low (n=44)		81.8	18.2	
Farmer Age (Years)	<45 (n=22)	66	81.8	18.2	p=0.738. n.s.
	45-55 (n=20)		90.0	10.0	
	55> (n=24)		83.3	16.7	
Has a Spouse	Yes (n=53)	66	84.9	15.1	p=0.979 n.s.
	No (n=13)		84.6	15.4	
No of Farm Vehicles	1-2 (n=35)	66	82.9	17.1	p=0.632. n.s.
	3+ (n=31)		87.1	12.9	
No. Powered Machines	0-4 (n=30)	60	80.0	20.0	p=0.316. n.s
	5+ (n=30)		88.9	11.1	

[1] Accuracy Score [2]Chi Squared test. [3]S= Satisfactory,[4]US = Unsatisfactory * variable estimated

A further analysis was undertaken comparing farmers who had previously reported completing the SS/SAD and those that had not (in the principal questionnaire) (Appendix 7.8) as regards RAD completion and farm characteristics. This analysis indicates that no significant difference arose related to RAD completion score (score A, satisfactory B, unsatisfactory) and previous completion of the SS/SAD or number of controls implemented. The limited data available indicated that farming part-time leads to a lower completion rate of SS/SAD with farming full-time and having employees having progressively higher levels of completion (p=0.025). However, this finding must be treated with caution due to the limited numbers involved in the farming part-time and having employees' categories.

At this stage of the study it was established that among farmers who completed the RAD 23.4% did not implement OSH controls satisfactorily. Accordingly, it was decided to broaden the assessment to include farms where the operator had participated in the more elaborate FETAC accredited OHS course (12.5 hours) to ascertain if this had an influence on farm safety score. The data for this assessment is now considered.

7.4.2.2. Validation of implementation of RAD controls following FETAC training

To assess implementation of RAD controls following FETAC training course participation a total of 28 farms were audited. Of the farms visited, 50% respectively had and had not availed of tutorial assistance with completion of the RAD and other OSH documents; otherwise the farmers groups were similar in terms of enterprises and scale.

This assessment revealed that 71.4% of farms had a satisfactory 'safety score' while 53.6% of participants had implemented the controls they specified in the RAD. A significant difference (p=0.006) occurred between farmers who had implemented controls they specified in the RAD, with 93.3% who implemented controls receiving a satisfactory safety score compared to 46.2% who had not. Furthermore, among those who received tutorial assistance 35.7% had implemented controls compared to 71.4% of those who had not received tutorial assistance, which was close to being a significant difference (p=0.058). The data obtained from this assessment suggests that those farmers who implement controls were more likely to have satisfactory OSH standards while those who availed of tutorial assistance with OSH legal document completion were less likely to have implemented on-farm OSH controls. Overall the data suggests that a high proportion of farmers who were challenged to implement on-farm OSH controls also sought assistance with document completion, suggesting that the limitations of these farmers has several dimensions.

7.4.3. Relationship between farm safety score and farmer and farm variables

To finalise the farm audit assessment, associations between farm safety score for all farms (n=94) audited and training (either half-day or FETAC), RAD controls specified and implemented and farmer and farm variables were examined. RAD completion was not included in this assessment as a high proportion of RAD documents completed by participants at FETAC training had the benefit of tutorial assistance and accordingly it was not entirely the sole work of farmer training participants.

The percentage of satisfactory safety scores for the following training categories were: no training 88.2%; half-day training 69.4% and FETAC training 71.4%. When all the data related to safety score was combined (Appendix 7.9), it indicates that receiving RAD training (either half-day or FETAC) was not statistically associated with the safety score applied, as 88.2% of those with no RAD training compared to 70.1% of those with RAD training had a satisfactory score (p=0.126). This data indicates a statistical trend in higher safety scores associated with non-participation in RAD training which is counter intuitive to the study hypothesis, namely that participation in RAD should improve OSH implementation. The number of points relevant to this finding are now discussed. The safety score as used in this study is a measure of OSH standards of the farm, which are related to long term OSH, which may be associated with OSH standards independent of RAD training. Farmers who were audited who did not receive training had previously returned their RAD voluntarily and these may have been farmers who were confident that their OSH standards were satisfactory. Karttunen and Rautiainen (2013) recently raised the possibility of bias in OSH studies among farmers associated with voluntary reporting. As described in the methods section (Chapter 6, Section 6.4.4.) the farms chosen for audit was done on a quasi-experimental basis and the number of farms used in the comparison who did not attend training was relatively small (n=17), so the possibility of bias from these sources cannot be excluded. Thus further assessment carried out on a statistically random basis among a larger sample over a longer time-scale is warranted to investigate possible associations between training participation and OSH farm safety standards.

Safety score was statistically associated with ‘implementation of controls’ (p=0.000) in favour of those who implemented controls and having a positive attitude to OSH (p=0.000). Enterprise (p=0.011) was significantly associated with safety score with dairying having a lower and tillage having a higher satisfactory score relative to drystock and with ‘farm work time’ (p=0.001), where farmers ranked their farm as requiring high farm work time having a lower Safety Score. Farmer age significantly influenced safety score (P=0.029) with farmers in the middle age category (45-55 years) having a lower score than younger or older categories.

Further cross tabulation was undertaken between ‘implementation of controls’ and variables being close to or significantly associated with safety score (Appendix 7.10). This analysis found that a positive OSH farmer attitude (p=0.003) and increased farm size (p=0.026), were the only variables studied which influenced implementation of controls. A non-statistically significant trend (p=0.108) occurred where ‘implementation of controls’ was highest among tillage farms compared to livestock farms.

Further cross tabulations (Appendix 7.11) between ‘farmer attitude to OSH’ and ‘farm work time required’ with farm enterprise indicated that those with a dairying enterprise had a significantly lower level of ‘positive attitude’ (p=0.023) and higher ‘farm work time’ (p=006) required than for other enterprises.

7.4.4. Summary and conclusions for RAD completion

Following presentation of the detailed findings of on-farm RAD document assessment and relationship between document completeness and implementation of controls, the key findings made are summarised as follows:

- RAD scores applied to documents by ‘desk scoring’ for ‘completion’ and ‘consistency’ were relatively accurate and correlated with actual farm OSH conditions and these scores were highly correlated. with each other. The risk score applied to RAD documents was inaccurate in comparison to farm OSH standards and practice.
- Training attendance was associated with increased RAD completion scores but no statistical association was found between the completion score and the farm safety score.
- Lower farm safety scores were associated with poor farmer attitude to OSH, inadequate implementation of controls, median age category, the dairying enterprise and farms requiring high farm work time. Positive farmer attitude and increased farm size category were associated with implementation of controls. The dairying enterprise was associated with a poorer attitude to OSH and requiring high work time.
- Farmer implementation of controls specified in RAD documents was significantly associated with farm satisfactory safety score.

In conclusion, the data presented in this chapter indicates that farm safety score, which is a measure of farm OSH status, was not associated with RAD completion score, previous completion of a SS or SAD or participation in RAD Training. However farm safety score was significantly associated with both farmer attitude to OSH and with implementation of controls. This data indicates that a farmer’s disposition and motivation towards OSH is a crucial prerequisite to the on-going implementation of OSH controls at farm level. However it is notable that over 74% of farmers audited for on-farm OSH standards and practices obtained a satisfactory safety score which is in accord with official farm OSH inspection data (HSA, 2007b). However, as described in the previous methods chapter (chapter 6 section 6.4.4.3) the study could not examine actual farmer behaviour which is strongly associated with accident occurrence (as reviewed in Chapter 2, e.g. Bamber, 1990; Laflamme, 1990) so it should not be inferred from the data that farms are *per se* ‘safe’. The study data however suggests that farm OSH programmes should be focused towards OSH issues and farmers not reaching satisfactory standards.

Overall the level of implementation of RAD controls specified by farmers was 45.3% which indicates limited implementation of OSH controls by farmers which they identified. This concurs generally with scientific literature on behaviour change, for instance in a Northern Ireland study, Magee (2002) found that after a farm accident, no remedial action was taken in 66% of farms. Hettema et al., (2005), who conducted a meta-analysis of Motivational Interviewing, which is an emerging client-centered style of directive engagement to assist clients with personal behaviour change, found that the change effect associated with this approach diminished over-time. However, they noted that reinforcement has the potential to maintain up-take levels. The findings of the RAD assessment in this sub-section suggest that measures to reinforce use of the RAD over time could have potential to increase the effectiveness of control implementation by RAD users. This proposition is supported by a review of participatory training methods on ergonomic and OSH improvements of the workplace in a different cultural context by Kogi (2006) which indicated that on average 83% of controls were implemented within two week of the training course. Furthermore high rates of implementation have recently been reported in Ireland among farmers who participate in ‘discussion groups’ on OSH in farming with the Irish West Offaly Discussion Group winning the EU-OSH Award for SMEs’ (EU-OSH, 2013). The members of this group reported implementing on average 12.7 controls per farm following use of a web-based version of the RAD (www.farmsafely.com). In Ireland, participation in a ‘discussion group’ has recently been found to increase the level of on-farm technology and practice adoption related to managing the farm business (Bogue, 2013; Hennessey and Heanue, 2012).

The findings of this study phase also indicated that the dairying enterprise had a lower safety score that those for other enterprises and this was associated with reported higher work time requirement and lower positive attitude to OSH than for other enterprises.

The key finding of this on-farm component of this study is that farmer capacity or willingness to implement controls is the key component to OSH management. The data suggests that the RAD and associated training has utility to farmers who have the capacity to implement the OSH controls identified in the RAD document. Furthermore, the comparison in demand for tutorial assistance with OSH document completion following FETAC training indicates that seeking assistance is associated with low OSH controls implementation suggesting that limitations in a person's capacity can extend to several dimensions. Thus the data generally suggests that the utility of the RAD is mediated by a farmer's managerial capacity to implement OSH controls. This proposition is supported by literature which indicates that managerial capacity is associated with achievement of performance in OSH (Finnegan and Phelan, 2003; Suutarinen, 2004), with labour efficiency and economic performance (O'Brien et al, 2005) and with overall farm management capacity (Conroy and Hegarty, 1997; Frawley et al., 1983; Walsh, 1985).

As stated earlier, RAD completion with or without participation in training, may have the potential to influence accident occurrence independently of the standard of document completion. This leads to the fourth phase of the study which investigates the occurrence of farm accidents in association with RAD use.

7.5. Factors influencing farm accident occurrence

The objective of this study phase (phase 4) was to establish if completion of the RAD document influenced subsequent farm accident levels. More generally, it investigated if certain farmer and farm characteristics were associated with farm accident levels. To achieve these objectives an additional OSH survey in association with the National Farm Survey (NFS) was conducted in 2011. It was decided to wait about 6 years after the COP / RAD was circulated nationally in December 2006 and the associated half-day training was provided (2006 onwards) to conduct the OSH survey (note: the NFS survey was conducted in the September/October period of 2011 giving an approximate period of 5 years and 10 months). This was done for the following three reasons: firstly, farm accidents occur relatively infrequently (circa 2% per annum) so time must elapse to have sufficient numbers for statistical analysis; and secondly, time was needed to allow a sufficient training attendance by farmers; and thirdly, the implementation of controls by farmers is an on-going issue so time was allowed for OSH measures to be implemented.

7.5.1 OSH survey within the NFS 2011

The NFS Survey is a nationally representative survey of farms over 2 hectares in size and is nationally representative by size and system. Thus the additional OSH survey was a nationally representative one by farm size and system. In total, 891 farm survey questionnaires were completed by farmers and available for analysis, representing 87,926 farms nationally.

For the purposes of the 2011 NFS OSH survey an accident was defined as ‘an event associated with farming (including a farm work related road traffic accident) which led to physical harm causing injury’. Information was gathered on types of farm accidents as well as location; medical treatment needed as a result; and to the estimated number of work days lost. Farmers also provided a short description of the accidents that had occurred. As RAD training took place from 2006 onwards, a farm accident could have occurred before or after training attendance so to clarify timing of the accident a supplementary NFS additional question was asked where an accident was reported on the timing of accident relative to undertaking training, which indicated that 84.2% of farmers reported accidents after RAD training. Farmers were also asked if they had completed the RAD and if they had attended a training course on it.

The NFS records numerous socio-economic and farm related variables as standard which allowed for exploration of various risk factors associated with farm accidents. The OSH survey by the NFS examined a range of farmer and farm characteristics potentially associated with farm accident occurrence and the data obtained is outlined in the following sections. Definitions associated with the conduct of the NFS can be sourced at http://www.teagasc.ie/nfs/

7.5.2. Analysis of the OSH survey within the NFS data

Following initial analysis using descriptive statistics, inferential statistical methods were applied to the data with the aim of identifying significant relationships between farm accident occurrence with farmers' use of the RAD and associated training; as well as a range of personal and farm characteristics of respondents. The inferential statistical method used where variables were continuous was firstly the Kolmogrorov-Smirnov statistical test to determine if the data was normally distributed or not. This test was applied for age, farm household number, ESU; Hectares farmed, farm income, farm gross output, farm labour units, farm investment and for variables calculated on a unit basis. Among the variables tested, only age met the assumption of normality. In accordance with statistical testing protocol the independent T-test was used to explore the relationship between accident rates among farm operators and age while the Mann-Whitney U test was used to explore the relationship between accident level and the other continuous variables. For nominal variables, where data occurred in discrete categories the Pearson chi-square test was used to compare proportions of farmer operators with and without an accident occurrence.

For variables where a statistically significant or close to significant ($p<0.1$) association occurred in the first stage of statistical testing, further analysis using the Logistic Regression Analysis (LRA) technique was applied to determine Odds Ratios (OR) with 95% confidence intervals. LRA can be conducted initially at a binary level and where this was significant ($p<0.05$) it was followed by multivariate LRA to indicate variables independently associated with accident levels. As the accident data was not normally distributed it was decided to recode continuous variables into categorical variables based on dividing the data above and below the median values.

7.5.3. Findings of the NFS additional OSH survey

Among the NFS sample of farmers sampled (n=891) the prevalence of farm accidents reported by farm operators over the 6 years period covered by the survey was 7.2%

(n=64, see Table 7.21). The most frequently occurring accident type was 'trips/ fall' which included falls from heights, while accidents mainly occurred in the farmyard (68.7%). Farm accident victims sought some form of medical treatment in 95.3% of cases with 43.8% of these either being admitted to hospital and 1.6% of all accidents resulted in a fatality. The estimated number of work days lost following an accident was: 8 or more in 59.4% of cases; and in 75% of cases the accident victim lost more than 3 work days, which are statutorily reportable; while 32.8% of farmers reported that they had lost more than 30 days.

Table 7.21. Distribution of farmers by reported accidents by type, location, medical treatment and estimated work days lost (n=64)

Accident type	**n**	**%**
Farm vehicle/ machinery	10	15.6
Livestock	15	23.5
Trip/ fall	27	42.2
Chainsaw/ wood	2	3.1
Buildings	3	4.7
Other	7	10..9
Location	**n**	**%**
Farmyard	44	68.7
Farm buildings	9	14.0
Fields	7	10.9
Farm roads, lanes	3	4.7
Forest /wood	1	1.5
Accident Treatment	**n**	**%**
None	2	3.1
1st aid	1	1.6
Medical doctor	9	14.0
Hospital A/E	24	37.5
Hospital in-patient	27	42.2
Fatality	1	1.6
Estimated Work Days Lost	**n**	**%**
Zero	8	12.5
1-3	8	12.5
4-7	10	15.6
8-14	6	9.4
15-30	11	17.2
31-90	13	20.3
>90	8	12.5

Source: NFS (2011) OSH survey

Among farmers surveyed by NFS (n=891), 62.9% reported completing the RAD while 27.3% had attended a training course of half-day or longer where the RAD was explained, with 87.3% of courses being facilitated by Teagasc. Among the NFS sample (n=891) their farm enterprise was categorised as follows: dairying 33.6% (n=320), cattle rearing 17.2% (n=164), cattle other 22.4% (n=213), mainly sheep 11.1% (n=106) and, mainly tillage 9.2% (n=88). Respondents were aged between 23 and 89 years (median = 53) and farmed a median of 56.0 hectares of land and were predominantly male (97.1%).

7.5.4. Risk factors for farm accidents

In order to determine the risk factors for farm accidents a two-stage LRA process was adopted in accordance with statistical practice (Magdalena, 2010). Firstly, bivariate LRA cross tabulation of data with associated statistical testing provided findings related to association between independent variables and the dependent variable: farm accident occurrence or not to the farm operator. However, bivariate LRA with statistical testing as a technique has limitations as it cannot give rates of the effect of independent variables on the dependent variable and it does not have the potential to control for confounding variables. Thus bivariate LRA with statistical testing has been used in this study as a screening exercise to select appropriate independent variables possibly influencing the dependent variable for inclusion in multiple LRA which can overcome the limitations of bivariate LRA. The results of bivariate statistical analysis allowed selection of 16 variables which were statistically significantly associated or close to significance (within $p<0.1$) for inclusion in bivariate LRA. This analysis allowed calculation of predicted change effect of independent variables on the dependent variable using an OR value which calculates the effect of change in one unit of the independent variable relative to the indicator level of this variable. A higher or lower than one for OR value indicates a higher or lower odds of outcome of the effect of the independent on the dependent variable. In association with LRA, confidence intervals (CI) at the 95% level were calculated to estimate the precision of the OR and a wide CI indicates a low level of precision, whereas a narrow CI indicates a high precision of the OR. As CI is not a measure of statistical significance, a test for statistical significance was applied to accompany the OR and a p-value determined. Variables which were statistically (or close to) significant in bivariate LRA were then entered into the multivariate version where control of the confounding effect of variables was undertaken and a measure of the sole effect of the levels of the independent variable on the dependent variable was obtained (Szklo & Nieto, 2007). Multivariate LRA uses OR, CI, and statistical testing in the same way as the univariate version, however as other potentially confounding variables are controlled for, this analysis gives an independent measure of the effect of the independent on the dependent variable and is the end point of the statistical analysis. Magdalena (2010) states that multivariate LRA is the most suitable form of statistical analysis for 'case-control' studies where data for a case e.g. an accident and a control of no accident occurrence are compared.

In this study the findings for the cross tabulation of data and associated statistical test data for the effect of independent variables on accident occurrence among farm operators are presented in Appendix 7.12. A farm operator (F.O.) is defined as the principal operator of the farm and in the vast majority of cases was the person who completed the RAD and attended RAD training. As a high number of independent variables were included in cross tabulation,

Appendix 7.12 has been sub-divided into four component tables labelled as A, B, C and D for presentation purposes.

The 16 independent variables which were significantly associated (or close to significance) with accident occurrence selected for inclusion in LRA are listed in Table 7.22 of the next section. It is notable that the variables 'RAD completion' and 'RAD training participation' were not included in LRA as they did not meet the inclusion criteria based on cross tabulations, indicating that they were not statistically associated with F.O. accident occurrence.

However, for LRA independent variables which were continuous in the previous bivariate cross tabulation analysis were re-categorised as nominal variables by dichotomising the variable data as either 'above' or 'below' the median value for the variable. This process was conducted because with these variables normality was violated as indicated by the earlier findings of Kolmogrorov-Smirnov statistical testing.

7.5.5. Farm operator accidents

Of the 16 variables included in bivariate LRA, 13 were found to be statistically significant and these were inputted into multivariate LRA which is also shown in Table 7.22. With this analysis, for each independent variable the effect of other such variables was controlled-for and a measure of the sole effect of levels of the independent variables on the dependent variable is obtained.

The multivariate LRA found that the only variable found to be significant was OFE where both farm operator and spouse had such employment (p=0.001). The multivariate LRA indicated that engagement in OFE (farm operator and spouse) had an OR of 3.312 for the F.O. having an accident compared to the indicator level where F.O. and spouse had no OFE. Further comparison between farms where the F.O and spouse had OFE and where an accident did and did not occur using the chi square statistic indicated that the accident cohort farms had a significantly (p=0.001) higher percentage with a dairy enterprise (60% versus 13.3%) and were classified as ‘full-time’ farms (73.3 versus 23%) requiring more than 0.75 standard labour units which were also significant (p=0.001). Where the farmer and spouse had OFE, the accident farm cohort had an above median gross farm output (67.7 % versus 31.3%) and gross output per hectare (66.7% versus 31.6%) both of which were significant (p = 0.009 and p = 0.027). Overall the data indicates that the accident farms where both F.O. and spouse had OFE had greater involvement in dairying were larger in scale and these farms had higher farm output. Thus the data indicates that the elevated accident level for these farms was associated with the scale of the farm operation undertaken.

The multivariate LRA also indicated that being a Teagasc client approached significance (p=0.057) in independently predicting higher accident levels with an OR of 2.029 where the farm operator was a client compared to the indicator level of not being a Teagasc client. This data suggests, non-statistical significantly, that being a client was associated with a higher level of farm accident occurrence among farm operators than non-clients. Cross tabulations and chi-square testing indicated that client farmers had a higher participation than non-clients in enterprises as follows: dairying (81.2%) tillage (71.7%), sheep (71.7%) cattle rearing (52.4%) and cattle other (55.9%) enterprises which was significant (p=0.000). The farms of client farmers also had a higher level classified as full-time (63.4%) than non-clients and had a higher proportion with above median gross margin (69.7%) and gross margin per hectare (69.0%), with all comparisons being significant (p=0.000). This data indicates that client farmers had a higher participation in dairying, were larger in scale and were more productive than non-clients.

The multivariate LRA also indicated that participation in agricultural education approached significance (p=0.079) in independently predicting higher accident levels with an OR of 1.839 where agricultural education had been undertaken by the farm operator compared to the indicator level where agricultural education was not undertaken. Further cross tabulations and chi-square testing indicated that farmers who had participated in agricultural education had a higher participation in dairying (74.0%) and tillage (60.2%) and a lower participation in sheep (43.6%), cattle rearing (33.5%) and cattle other (39.0%) enterprises which were significant (p=0.000). The farms of those with agricultural education had a higher level classified as fulltime (70.3%) and had a higher proportion with above median gross margin (73.9%) and gross margin per hectare (68.8%), with all comparisons being significant (p=0.000). This data indicates that farmers who participated in agricultural education had a higher participation in dairying, were larger in scale and were more productive.

The multivariate LRA indicated that below median farm labour unit input was non-significantly associated with reduced farm operator accident level (p=0.162) with an OR of 0.600. When compared with the above median indicator level the risk factor for a farm operator accident was 1.667 compared to the below median value. Below median ESU per labour unit was also non-significantly associated with reduced farm operator accident risk (p=0.363) with an OR of 0.562 indicating a risk factor for a farm operator accident for the indicator level for this variable of 1.779. Below median gross output which was also non-significantly associated with reduced farm operator accident occurrence (p=0.328) with an OR of 0.494 indicating that the risk factor for a farm operator accident for the indicator level of 2.024.

The multivariate LRA however indicated that below median investment was not significantly associated with increased farm operator accident risk (p= 0.226) with an OR of 1.922. This indicated that the risk factor for the indicator level of a farm operator accident as 0.520. Overall the study data suggests (non-statistical significantly) that farm operator farm accident occurrence was associated with farms of above median economic size per labour unit, gross farm output and farm labour input. In contrast, farms with high investment had a lower risk of farm operator accident occurrence.

No other variable was associated with farm operator accident occurrence in the multivariate regression analysis including farm economic size (ESU) or ESU per hectare, farm size (Ha), gross farm output per hectare and labour unit, investment per hectare and per labour unit, off farm employment by the farm operator. It is particularly noteworthy that gross output per hectare, which is a reliable measure of farm efficiency which is a proxy for efficient farm production management, had no significant influence on farm operator accident occurrence.

In summary, the study data indicated that farm accident occurrence is statistically associated with farm operators of farms where both farm operator and spouse have off farm employment (OFE), and in general non statistically with farm operators with Agricultural Education and client membership of Teagasc and of farms with above median economic size per labour unit, gross output and use of farm labour input and below median levels of Investment.

Table 7.22. Regression Analysis data for farms of farm operators with and without Accidents (n=891)

	Bivariate Regression			Multivariate Regression		
	OR	**95% CI**	**P**	**OR**	**95% CI**	**P**
ESU						
Above median (Indicator)						
Below median	0.466	0.272 -0.800	**0.006**	1.047	0.198-5.523	0.957
ESU's per hectare						
Above median (Indicator)						
Below median	0.666	0.397-1.117	0.124			
ESU's per labour unit						
Above median (Indicator)						
Below median	0.463	0.270-0.794	**0.005**	0.562	0.162-1.946	0.363
Hectares						
Above median (Indicator)						
Below median	0.581	0.344-0.982	**0.043**	1.087	0.523-2.257	0.822
Gross output						
Above median (Indicator)						
Below median	2.009	1.178-3.425	**0.010**	0.494	0.120-2.030	0.328
Gross output per hectare						
Above median (Indicator)						
Below median	1.404	0.839-2.349	0.196			
Gross output per lab. unit						
Above median (Indicator)						
Below median	1.862	1.098-3.159	**0.021**	0.807	0.282-2.309	0.689
Labour units						
Above median (Indicator)						
Below median	0.449	0.260-0.775	**0.004**	0.600	0.294-1.227	0.162
Investment						
Above median (Indicator)						
Below median	2.741	1.563-4.807	**0.000**	1.922	0.667-5.536	0.226
Investment per hectare						
Above median (Indicator)						
Below median	2.009	1.178 -3.425	**0.010**	0.897	0.436-1.845	0.768
Investment per lab. unit						
Above median (Indicator)						
Below median	2.160	1.259-3.704	**0.005**	1.244	0.482-3.212	0.652
Standard lab U: part-time	(Indicator variable)					
full time	2.208	1.270-3.840	**0.005**	1.285	0.376-4.393	0.689
Agric. Education -no.	(Indicator variable)					
-yes	2.672	1.488-4.796	**0.001**	1.839	0.931-3.631	0.079
Teagasc client - no	(Indicator variable)					
- yes	2.166	1.135-4.135	**0.019**	2.029	0.980-4.198	0.059
OFE (F.O.) - no	(Indicator variable)					
-yes	1.920	0.931-3.958	0.077			
OFE (F.O. & Spouse) -no	(Indicator variable)					
-yes	2.744	1.474-5.107	**0.001**	3.440	1.774 -6.671	**0.001**

7.5.5.1. Farm operators accidents with limited variable inclusion

To further investigate the accident occurrence among farm operators, further multivariate LRA with reduced variable numbers than in the full model was pursued because of potential collinearity among variables included in the full model. The Likelihood Ratio (LR) test was used to conduct tests between the full model and ones which respectively included 4 and 5 or 7 variables having the lowest p - values in the full model of multivariate LRA and data from these three models is provided in Appendix 7.13. The LR test determined which of the models tested had a significantly better fit at p-value of 0.05 (chi-square 10.38: $p<0.05$) and should be preferred. This testing showed that the 7 variable models had the best fit and is presented in Table 7.23.

Table 7.23. Multivariate regression analysis of farm operator and farm data with and without accidents, with limited variable inclusion (n=891)

Variable	OR	95% CI	p
ESU's per labour unit			
Above median (Indicator Variable)			
Below median	0.554	0.22-1.395	0.210
Gross output			
Above median (Indicator Variable)			
Below median	0.474	0.159-1.415	0.181
Labour units			
Above median (Indicator Variable)			
Below median	0.593	0.309-1.138	0.116
Total investment			
Above median (Indicator Variable)			
Below median	2.050	0.862-4.876	0.104
Agr education			
No (Indicator Variable)			
Yes	1.845	0.276-1.064	0.075
Teagasc client membership			
No (Indicator Variable)			
Yes	2.003	0.971-4.132	0.060
OFE (FO & spouse)			
No (Indicator Variable)			
Yes	3.233	1.639-6.377	0.001

This model indicates that apart from OFE (F.O. and spouse) which was significantly associated with F.O. accident occurrence, no other significant associations occurred.

For farm based constructs, below ‘median total investment’ and above ‘median farm labour units’ were not significantly associated with increase accident occurrence. For F.O. personal constructs both prior participation in ‘agricultural education’ and being a Teagasc client was non significantly associated with accident occurrence.

7.6. Conclusions for influences on farm accident levels

The analysis conducted in this study phase indicated that completing the RAD or participating in accompanying RAD training did not influence subsequent accident levels among farm operators. This finding contrasts with the Danish (West Jutland) farm study where a one-day training course and farm advisory visit led to a non-statistically significant 48% reduction in injury requiring hospitalisation (Rasmussen et al., 2003). Other studies conducted (Day et al., 2009; Suutarinen, 2004; Sprince et al., 2003a; Reis and Elkind, 1997; Murphy, 1981) have found no reduction in farm accident levels associated with farm safety training. More recently, Van den Broucke (2013) in Belguim reported that training did not influence subsequent farmer safety behaviours while in New Zealand, Cryer et al., (2014) found no evidence that farm safety awareness-related training prevents farm injury.

The study finding that education level did not influence accident rates contrasts with studies from North America (Sprince et al.2003a; McGwin et al., 2000; Lewis et al.1998; Pickett et al. 1996; Lee et al. 1996) which indicate that higher educational levels are associated with increased farm accident rates. Van den Broucke and Colémont (2011) found that higher farmer education was associated with increased accident rates.
The study finding that agricultural education was not associated with reduced farm accident occurrence contrasts with the finding of Day et al., (2009) who found that vocational agricultural education was associated with reduced accident rates. In Finland, work by Suutarinen (2003) indicated a link between farmer quality of management and reduced accident rates but the current study could not confirm this.

Regarding other personal factors, this study does not support the conclusion in the literature that younger farmers have the highest probability of non-fatal farm accidents

(MacCrawford el al., 1998; Myers, et al., 1998; Suutarinen,2003) as farmer age was not statistically associated with accident rates.

This study indicated that farm operator accident occurrence was associated with farms of above median economic size per labour unit, gross output and farm labour units. These farms are expected to be relatively large scale operations with a high requirement for labour to complete farm work. Other OSH studies in Ireland generally have indicated a link between accident rate and farm workload as follows: McNamara and Reidy (1997) found a statistically significant link between number of workers employed on farms and accident rate and Finnegan (2007) found that farm accidents were associated with farm scale. International studies indicate that full-time workers on farms have the greatest accident probability (Sprince et al., 2002; McCurdy and Carroll, 2000; Lewis et al., 1998) suggesting that work time input is related to increased farm accident rate. Sprince et al., (2002 and 2003a) showed that operators working more than 50 hours per week had a higher farm accident rate, while Ferguson et al., (2005) found that farmers working more than 61 hours per week increased the probability of a tractor accident. Van den Broucke and Colémont (2011) reported that farms with an employee in addition to the farm operator had a raised accident rate.

Regarding other farm factors, the findings of this study concur with international literature which indicate that farm size (McCurdy and Carroll, 2000) or economic size ((McCurdy et al., 2004; Sprince et al., 2003; Lewis et al., 1998; Pickett et al., 1996) were not associated with farm accident rate. This study does not concur with studies which indicate that accident rate is increased on farms having farm animal enterprises (Sprince et al., 2003a; Virtanen et al., 2003; Hwang et al., 2001; McCurdy and Carroll, 2000; Browning et al., 1998; Zhou and Roseman, 1994; Zhao, Helzel and Woeste, 1995) as no significant association occurred between accident level and enterprise type.

The study multivariate LRA indicated that above median farm investment was non-significantly associated with reduced F.O. accident occurrence. However, no farm efficiency variable was independently associated with F.O. accident rate.

In this study, farms where both F.O. and spouse had OFE had a statistically significant heightened F.O. accident occurrence rate; while these farms tended to be larger in scale, more involved in the dairying enterprise and had higher farm output than non-accident farms. This finding supports the possible association between overall workload, both on and off farm, and farm accident rates. Such a link could be mediated by such behavioural factors in accident causation as hurry and fatigue. This particular cohort of farms within the study, where F.O.s and spouses have OFE, possibly represent a specific group with elevated accident rates and given the study finding, further research on the work organisation and farm infrastructure of such farms is warranted to examine specific associations with accident occurrence.

Farms where the F.O. had undertaken agricultural education or was a Teagasc client had a heightened accident occurrence rate (not significant). This finding is counter-intuitive as it would be expected that such farmers had more access to OSH information on an ongoing basis and were likely to be more engaged in the issue. Accordingly possible reasons for this finding are now considered. Firstly, for both persons with agricultural education and Teagasc clients, the study indicated that their farms on average were larger in scale and more intensive, however multivariate analysis within this study controlled for these variables. It is however possible that some other variable not included in the study could lead to higher accident levels among these categories of farmers. Examination of further F.O. variables would require further research as a follow-on to this study. Secondly, the accidents reported in this study are self-reported based on recall which is open to the possibility of bias. Karttunen and Rautiainen (2013), for instance, reported on the farmers' occupational health (and safety) service (FOHS) in Finland which provides specific services to prevent occupational injuries and diseases and found that FOHS members reported a higher level of compensated claims for both accidents and diseases. They considered as possible explanations for this that FOHS members were more informed on both their health state and of insurance benefits, which they considered suggested that knowledge gain can increase both accident/ill health reporting and making claims. Regarding accident reporting in employment sectors, levels increased with both a positive OSH climate and job security (Probst, Bararabella and Petitta, 2013; Probst and Estrada, 2010). This suggests that confidence and trust in systems in place is needed to achieve high rates of accident reporting. As reviewed in Section 4.3, trust is an essential ingredient of extension which raises the possibility that F.O.s who received agricultural education or were Teagasc client members had a higher accident reporting rate. This possibility merits further research.

Overall, multivariate LRA presented in Table 7.22 and Table 7.23 indicates that the scale and intensity of a farming operation needs to be optimally matched to labour input and investment to reduce accident risk. This suggests that the discipline of 'work organisation' where labour use and infrastructure required to operate a farm are examined has potential benefits as a component of OSH management to minimise accidents. The data in these tables indicates that more farmers with higher output and scale are in contact with education and extension services and hence the possibility to assist them to more effectively manage their farms as regards OSH is available. Dealing with farm risk is an ongoing farm management role and it is suggested that completion and updating of the RAD is association with training and extension engagement has a role to play in assisting with overall farm management. Overall Table 7.22 and Table 7.23 indicate that OSH management needs to be comprehensively integrated into overall farm management systems.

7.7. Hypothesis testing

Following the presentation of the study findings, hypothesis testing is now undertaken. For each hypothesis this involves putting forward two alternatives called the null hypothesis and an alternative. The null hypothesis is based on a proposed theory or argument and is potentially believed to be true while the alternative is the opposite and mutually exclusive proposition. In this study the hypotheses were derived from the theoretical framework and study model developed and described in chapter 5. In social science research the two competing hypotheses are then assessed in the light of the empirical study data obtained and, where possible, statistical inference testing is used to assist with accepting or rejecting each null hypothesis.

As outlined in Chapter 6, a mixed method approach using both quantitative and qualitative methods was used to gain study data. This data was triangulated to provide blended data sources to consider the study hypotheses. The mixed method approach maximises the efficiency of use of data sources in pursuing social research (Rossman and Wilson, 1985). Data to consider each study null hypothesis is presented so that each hypothesis can be accepted or rejected.

In conducting research, treatment variables are referred to as 'independent' variables which may influence a 'dependent' variable in a positive or negative way. Identification of various 'dependent' variables which are influenced by 'independent' ones is of primary interest to a researcher. Two further types of variable are of interest in research as they alter the relationship between a dependent and independent variable. These are a 'mediating' variable which facilitates and a 'moderating' variable which alters the nature of the relationship (e.g its strength or direction) between independent and dependent variable. The possible influence of independent, mediating or moderating variables on the dependent one is reflected in the examination of each study null hypothesis.

The following hypotheses which have been derived from the study model (chapter 6) are now stated and summary study data to support or otherwise the acceptance of each hypothesis is stated and the null hypothesis is then either accepted or rejected.

Hypothesis 1: That farmer personal characteristics influences use of the RAD.

The evidence in phase 1 of the research finding indicated that RAD use is not associated with farm personal characteristics (e.g. age, gender).

This hypothesis is rejected.

Hypothesis 2: That farm characteristics influences farmer use of the RAD.

The evidence in phase 1 of the research findings indicated that RAD use was statistically significantly associated with Teagasc client membership and it increased quadratically with farm economic size.

This hypothesis is accepted.

Hypothesis 3: That farmer personal and associated farm characteristic influences their opinion of the RAD and associated training.

The evidence in phase 1 indicated that farmers who represented a wide range of personal and associated farm characteristics had a uniformly positive opinion of all RAD components and associated training.

This hypothesis is accepted.

Hypothesis 4: That, among legal planning documents associated with the COP, that the RAD is the one which farmers consider has the greatest utility for them.

The evidence in phase 1 where FETAC course participants ranked the various COP documents indicated that the RAD was the document which they found had greatest usefulness and the easiest to complete.

This hypothesis is accepted.

Hypothesis 5: That participation in half-day training on the RAD increased the level of controls specified relative to completion of the RAD without training.

The evidence in phase 2 indicated that following attendance at RAD half-day training that participants specified a 70% higher level of controls than when the document was completed without training, which was a statistically significant increase (p=0.001).

This hypothesis is accepted.

Hypothesis 6: That farmer completion of the RAD in association with training facilitates a reduction in farm accident risk.

The evidence from phase 1 of the study indicated that 100% of participants at half-day training planned to make OSH improvements on their farms. However, 48% of trainers and advisors surveyed who facilitated RAD training considered that farmers generally follow-through on their intentions to a limited extent. Evidence from phase 3 indicated that implementation of OSH controls by farmers who attended training was associated with their OSH farm standards as a statistically higher proportion of farmers with prior unsatisfactory standard had a lower level of implementation of RAD controls than those with prior satisfactory standards. This suggested that reduction of risk following use of RAD at training depended on a farmer’s prior capacity to implement OSH controls.

This hypothesis is accepted, however the mediating variable of a farmer’s capacity to implement OSH controls in follow-up to RAD use at training was identified.

Hypothesis 7: That farmer use of OSH planning documents (SAD/SS and RAD) leads to a reduction in farm accident rates.

The evidence from phase 1 where the participants of RAD training were questioned on previous SAD/SS completion and accident levels indicated that completion of the SAD/SS was not statistically associated with accident level. Further evidence in phase 4 of the study from the results of the NFS 2011 survey related to RAD completion and accident levels indicates that no statistically significant association was found for accident rate and completion of the RAD.

This hypothesis is rejected.

Hypothesis 8: That farmer use of the RAD following training leads to a reduction in accident levels.

The evidence in phase 4 of the study from the NFS 2011 survey related to RAD completion in association with training and accident levels indicated that no statistically significant association was found for accident rate and completion of the RAD in association with training.

The hypothesis is rejected.

Hypothesis 9: That specific farm characteristics combine to moderate the level of farm accidents.

The evidence in phase 4 of the study from the NFS 2011 survey related to accident levels indicated that no specific farm characteristics or combinations of characteristics was statistically significantly associated with accident rate.

The hypothesis is rejected.

Hypothesis 10: That farmer characteristics influences farm accident levels.

The evidence in phase 4 indicates that a statistically significant association occurred for farms where the F.O. and Spouse had OFE. The evidence in phase 4 also indicates that the association between farmers who previously participated in agricultural education and who were Teagasc clients and higher levels of farm accident occurrence was non-significant. Otherwise, no other statistical associations were detected.

This hypothesis is **accepted** in relation to F.O and spouse having OFE as a statistically significant higher rate of farm operator accidents occurred on such farms; however the hypothesis is rejected for other farmer characteristics.

Hypothesis 11: That participation in RAD half-day training influences the subsequent use of extension on OSH.

Advisors who participated in RAD training facilitation reported a follow-up increase in OSH advice provision among farmer participants at RAD training which was statistically significant.

This hypothesis is accepted.

Hypothesis 12: That farm efficiency performance is associated with farm accident rate. Evidence in phase 4 indicates that no examined farm efficiency measures were statistically associated with accident rate.

This hypothesis is rejected.

The core research question or overall hypotheses for this study was as follows:

That extension involving provision of training and advice involving the RAD, leads to reduced OSH risk which in turn leads to reduced Accident levels?

Overall the evidence of the study indicated that extension involving provision of short training and advice based on the RAD has potential to reduce OSH risk but the effect of extension is mediated by an individual farmer's capacity to implement OSH controls.

However, the study evidence indicated that the OSH extension based on the RAD was not associated with accident reduction as measured in the study.

Accordingly the overall hypothesis is rejected.

7.8. Interim publication of study findings

As the study was a component of the PI it was required to make its findings available to stakeholders including the H.S.A., Teagasc, the FSP, the farming community and general public. Accordingly the PI steering committee decided to produce findings of individual elements of the study on an on-going basis. This was done by presentation of the findings at international and national conferences and availability details of the papers published (6) are available at:
https://www.researchgate.net/profile/John_Mcnamara/

Chapter 8

Conclusions

8.1 Introduction

This chapter firstly recaps on the objectives of the study and on the research methodologies used. Then conclusions are drawn based on the study findings and relevant literature for the six study objectives. When the term ‘extension’ is used specifically associated with Teagasc it will be so described, when the term is used on its own it refers to extension generally, either from public or private services. In Chapter 9 discussion of the implications and recommendations for further actions and research to improve OSH among Irish farmers will follow-on from this chapter.

8.2. Objectives of study

This study set out to examine the extension approaches which facilitate farmers in Ireland to effectively manage OSH based on the then newly enacted legislation namely the Safety, Health and Welfare at Work Act 2005 which places OSH legal obligations on farmers. In particular, the legislation permits farmers employing three or less persons to comply with the duty to complete and implement a written Safety Statement (SS) by instead completing and implementing a sector specific Risk Assessment Document (RAD) prepared in association with an approved Code of Practice (COP). Such a COP and RAD (both a pilot and approved one) were prepared for the agriculture sector as a component of the PI associated with this study formed between Teagasc and the H.S.A. to develop, and to assist farmers with implementation of the COP approach in OSH for the agriculture sector.

The rationale for this research is that both in Ireland and worldwide, farmers as an occupational group have a disproportionately high level of farm accidents and specifically in Ireland they have been identified as having a relatively poor health profile. The new SHWW legislation permitting development of a COP and an associated RAD was newly adopted as the Irish state’s legislative approach to requiring persons managing enterprises with three or less employees, to manage OSH. It was decided that this new legislative approach would be developed firstly in the agriculture sector to assess its value in assisting with OSH farm management due to the high accident profile and the fact that the vast majority of enterprises in the agriculture sector involved self-employed persons or have 3 or less employees. The research could also be useful in providing knowledge of value to assist with OSH improvements in other SME and micro employment sectors generally

8.3. Summary of research methods

The research methods used in this study were devised to be compatible with and integrate with implementation of the PI and were deployed across the four distinct study phases. The first study phase obtained the opinions of farmers who participated in RAD training on the design of the pilot RAD in particular and on all of the COP documents. Farmers' opinions were obtained on components of both half-day training and FETAC OSH courses provided. Responses to an exercise conducted among participants at half-day RAD training on the 'causes of accidents' were analysed while data from the NFS (2007) related to farmers opinions of the COP documents and use of the RAD following their national circulation was analysed. In the second study phase, RADs obtained from 475 farmers were analysed. This was done firstly by scoring completion of the documents and secondly by enumerating the number and type of controls specified for action by farmers in their RADs. In the third phase, farm audits were undertaken on a total of 94 farms where the RAD had been completed. For 66 of the 94 farms, RAD completion was verified in relation to farm OSH conditions and for all 94 farms to score OSH standards, implementation of RAD controls and obtain associated socio-economic data related to each farm. In the fourth phase, data in the NFS (2011) related to farm accident occurrence, completion levels of the RAD and participation in training on this document was analysed.

8.4. Objective 1: To assess the utility of the RAD developed under Irish SHWW legislation to assist farmers to manage occupational safety, health and welfare

The study findings for this objective, presented in sub-Sections 7.2.1. – 7.2.2.12, found that the RAD from amongst the three legal documents assessed (RAD, SS, SSWP) was the one which farmers rated as the most helpful with managing farm OSH and the one they found easiest to use. Evidence from the study indicates that farmers found the check-sheet of controls in the RAD were easy to understand and that the number of questions was about right. The matrix format allowed the document to be completed easily by individual farmers for the range of farm locations, facilities and practices of individual farms and an action list for OSH actions specified as required was provided. The RAD was designed to use limited textual information and pie-charts to communicate the causes of fatal accidents and ill health, which farmers found useful. It uses pictures to illustrate controls which farmers found aided communications. The design of the RAD concurs with what the literature generally indicates is an effective document i.e. that visual means are most effective (Cole, 1997, 2002) and that farmers find self-assessment templates which are straightforward to complete as acceptable to use (Chapman et al., 1996; Kogi, 2002; 2006). However a study of structured virtual learning (Phelan and Mulhall, 2007) found that use of topic specific text using good pedagogic learning practices was rated more highly than diagrams, audio-visuals or actions, which indicates that accompanying text is also important in document design.

The study found that farmers' perceptions of accident causes tended to over-represent some hazards (e.g. P.T.O's) and under-represent others (e.g. accidents among children) relative to the actual data for fatal accidents. This finding is in accord with literature which also found that farmers' perceptions of accident causes can be inaccurate (Australian Safety and Compensation Council, 2006; Durey and Lower, 2004; Knowles, 2002; Murphy, 2003; Sandall and Reeve, 2000; Tse et al., 2014). The study concludes that the RAD is an effective means of communicating accurate OSH on the causes of fatal accidents, injuries and ill health.

The study found that the RAD was acceptable to farmers from the wide range of backgrounds who participated in RAD training and were surveyed as part of this study. This is based on the consistently positive feedback on the RAD from farmers who were from a wide range of socio-economic backgrounds. Thus the study concludes that the document is an effective instrument to transform the legal duty to conduct a risk assessment as prescribed in the SHWW Act 2005 (section19) into a practical instrument which farmers can use to implement the legal requirements. This conclusion is in accord with the work of Stave el al., (2007 & 2008) who considered that making knowledge available in a practical and accessible format is a prerequisite to effective communications necessary for gaining OSH change.

However, the NFS (2011) OSH survey conducted as part of this study found that less than half of farmers (42%) attempted RAD completion when it was circulated nationally by post. It is concluded that such RAD circulation on its own has limited utility. This is in accord with literature which indicates that circulation of documents on their own has limited utility in gaining change (Newell et al., 2002).

The NFS (2011) also found that when the RADs were circulated to farmers nationally a higher proportion of Teagasc clients completed the document and that the proportion of farmers who completed it increased quadratically with their farm economic size. It is concluded that farmers who were Teagasc clients and those with larger farms in terms of economic size had a higher uptake of the RAD.

The study found that completion of the RAD following previous completion of a SS/SAD was not associated with acceptable levels of on-farm OSH standards and practices, as no difference occurred with implementation of RAD controls on farms between those who had or had not previously completed the SS/SAD. It is concluded that the study provides no evidence of an association between completion of SS and/or SADs and implementation of on-farm OSH standards and practices.

The study also found that completion alone of the RAD, SS or SAD did not influence subsequent farm accident levels. It is therefore concluded that completion of one or more of these legal documents was not influential in reducing farm accident levels. This study finding is in accord with a study by Newell et al., (2002) who found no evidence that provision of evidence-based cancer preventative information educational material increased implementation of preventative measures advocated.

In summary, from the study findings it is concluded that the RAD has utility in positively communicating practical OSH legal requirements to farmers and providing them with a template to plan their implementation on their farms. However it is concluded that completion of the RAD or other OSH documents such as a SS or SAD on their own is insufficient to gain comprehensive implementation of OSH controls or reduction in accident levels by farmers.

8.5. Objective 2. To assess the utility of components of training made available to farmers to assist with meeting compliance with Irish SHWW legislation

The aim of the training provision associated with this study was to provide assistance, support and motivation to farmers to use the COP documents, particularly the RAD, to provide support to more effectively manage on-farm OSH. This approach is generally supported by literature which suggests that: farmers need to become more analytical and less intuitive to improve farm management (Caspi et al., 2005; Öhlmér et al., 1998; Malcolm,1990); need a structure to facilitate decision making (Baddeley,1994); need to document issues to be addressed (Sekaran, 2003) and possess motivation (Wright and Geroy, 2003) to learn and change.

Rogers (2002) stated that as participation in adult learning is essentially voluntary, that arousing a 'sense of need' to learn is a prerequisite to gain participation in training. The NFS (2011) study component found that 22% of farmers represented had participated in RAD training by that year indicating the level of training uptake. The study findings related to participants' views of training are presented in sub-Sections 7.2.2.2 – 7.2.2.9 and indicate that the main reasons for training attendance were to improve farm OSH standards and to obtain assistance with completing the COP documents. Thus it is concluded that a combination of both the internal motivator of the desire to improve their OSH management and the external one of a desire to achieve OSH legal compliance led to participation in training.

The study found that RAD training was considered worthwhile by virtually all participants who were from a wide range of socio-economic and farming backgrounds (sub-Section 7.2.2.2). Participants considered that the RAD training course learning objectives were clear and that it helped them to understand their legal OSH duties. The study found that of the training approaches used, farm accident victim testimonials and visual approaches of communication such as DVD and power point presentations were highly rated by farmers while the health messages delivered on DVD and the level of discussion during training were the least regarded. The study also found that participants in RAD training were willing to participate in further and on-going OSH extension programming. The components of RAD training used are in accord with theory of OSH adoption which advocates using a 'fear appeal', providing 'cues for action' and 'reducing barriers' to implementation (Becker, 1974; Witte, 1992, 1997; Rogers, 1983). It was found by Day et al., (2009) that having a previous farm injury was a protective factor for further injury which provides support for the training approach of using case testimonials to bring the consequences of accident occurrence to mind. It is concluded from the study that the RAD training approaches used were suitable in meeting the farmers OSH information needs.

The study found that participation in training motivated the majority of participants to plan OSH change as 78.2% planned to implement the controls they listed for action (sub-Section 7.2.2.7). The study concludes that the training brought the majority of participants to the contemplation stage of the Stages of Change Framework (Prochaska and DiClemente, 1983) and the ‘intention’ stage associated with the Theory of Planned Behaviour (Ajzen and Fishbein, 1980) which is the precursor for taking action. Farmers who attended training considered the controls presented in the RAD as largely achievable and therefore the study concludes that the majority of farmers planned implementation of OSH controls and considered that implementation of OSH standards and practices outlined in the RAD to be within their own control.

Following RAD training, the study revealed that many farmers (42.9%) implemented the controls they specified in the document as required for their farms and those who did not implement the controls had poorer farm OSH standards (Appendix 7.10). Also, non-implementation of controls was associated with seeking tutorial support with OSH document completion. This indicates that OSH non-adopters are challenged in more than one domain including both OSH implementation and document completion and suggests a limited OSH farm management capacity. Among RAD training facilitators almost half (48%) reported that farmers generally give farm OSH adoption low priority in practice which supports the study finding related to significant levels of non-adoption of RAD controls following RAD completion (reported in sub-Section 7.2.2.12.2). Literature reviewed indicated that non-implementation of known controls is a human characteristic where voluntary control is involved (Armitage and Conner, 2000; Norris et al., 2002). Thus it is concluded from the study findings that RAD training is effective among farmers with a record of OSH adoption but had limited efficacy among farmers with a poor prior record of implementing OSH controls.

This study shows a positive link between a management capacity to implement RAD controls and farm OSH standards. Finnegan and Phelan (2003) and Suutarinen (2004) reported a link between farmer OSH management and farm management quality. The study finding that management capacity influenced OSH implementation is in accord with a review by Colémont and Van der Broucke (2006) of farm OSH adoption who concluded that just having OSH knowledge alone does not necessarily gain OSH adoption, but that either internal or external stimuli are also needed. The study concludes that having OSH knowledge is not the limiting factor for OSH adoption but rather is related to farmer capacity to implement the controls.

Thus regarding RAD training provision, the overall conclusion of the study is that RAD training had a positive utility among farmers with a record of OSH implementation but is limited among those with a poor record of implementation.

8.6. Objective 3: To measure the level and nature of controls specified and implemented following RAD completion with or without participation in OSH training

The study findings presented in Section 7.3.1. show that farmers completed the RAD in a meaningful way in accord with its purpose of identifying farm OSH controls required. It also found that the RAD was completed by farmers to a limited extent whether with and without half-day training. Of all the controls listed in the pilot RAD 2.93% and 1.73% were specified for action, respectively, with and without half-day training. It is concluded that the level of RAD controls specified for implementation was low compared to the overall number (113) stated in the pilot RAD which was the number considered by the regulatory agency (H.S.A.) to be taken into account by farmers to meet legislative compliance. Possible explanations for the low level of control specification by farmers are: that farmers implemented a limited level of controls at any one time (Pollock, 2010); that a time lag occurs between obtaining information on agriculturally related OSH and adoption (Chapman, 2009); or that rational barriers occur such as conflict with other aspects of farm management (e.g. work-time or difficulty to implement, cost, inconvenience or life-stage of farmer) which limit adoption (Hallman, 2005; Vanclay and Lawrence, 1994; Vanclay, 2004). For instance in the farm audit component of this study 30% of farmers reported not having undertaken a recent ‘health check’, however when completing the RAD, just 1.8% specified requiring such a check, suggesting a time-lag or barrier in adoption of this practice. This view is supported by the Stages of Change Framework (Prochaska and Di Clemente, 1983) which indicates that persons have to be in a state of readiness for change to occur.

The study findings presented in Section 7.3.2. indicate that the level of RAD control specification was 70% higher after a farmer had undertaken half-day training. It is concluded that participation in training was associated with a higher level of control specification which suggests that training has some efficacy in motivation to adopt higher levels of OSH controls. The study also found that the controls which farmers specified in the RAD for implementation were predominantly physical (92.4%) rather than being practice related (7.6%). Controls specified for implementation mainly included: farm vehicle/ machinery (41.9%); livestock handling (14.7%); and farmyard, buildings and slurry related (12.6%) which made up 79.2% of total controls while in contrast those related to children and older farmers made up 1.4% of the total respectively. This finding is in line with findings by McNamara and Reidy (1997), Pollock (2010) and Tse et al., (2014) who found a similar pattern of farmer intention to implement physical controls related to machinery, farmyards and buildings including livestock handling facilities. The study concludes that farmers predominantly specify physical controls for implementation following RAD completion which suggests that farmers think of OSH implementation mostly in terms of making changes to physical elements of the farm.

Overall it is concluded that farmers used the RAD meaningfully to identify OSH controls but that they specified for implementation a limited level of controls on their farms which were predominantly physical in nature. In recent studies (Pollock, 2010; Tse et al., 2014) implementation of OSH controls by farmers were of a similar nature to those found in this study. It is concluded also that participation in RAD training led to an increased level of OSH controls being specified. Recent studies (Pollock, 2010; Tse et al., 2014) indicated that implementation of OSH controls by farmers were of a similar nature to those found in this study.

8.7 Objective 4: To evaluate the utility of extension service provision in OSH from the perspective of provision of RAD half-day training and follow-up extension to farmers

The study findings presented in sub-Sections 7.2.2.2. and 7.2.4.2. show that the client relationship between extension services provided by Teagasc and farmers was the major influence on their participation in RAD training. This finding is based on the percentage who attended training following receiving a Teagasc letter or newsletter and possibly follow-up direct contact inviting attendance (79.6%) compared to seeing or hearing advertisements in the farming media (20.4%). This is in accord with adoption theory which indicates that interpersonal communication is far more influential than media in gaining adoption (Mahajan, Muller and Bass, 1980). Earlier research by Finnegan and Phelan (2003) indicated that the majority of Irish farmers (67%) would seek OSH information from Teagasc. The trust of service users in service providers has been emphasised as a key driver of successful extension (Neufeld and Cinnamon, 2004; Van den Ban and Hawkins, 1996; Hon and Grunig, 1999). Knowles (2002) in the UK found that enforcement of SHWW legislation compromised farmers' willingness to seek OSH advice from the HSE who had a dual enforcement and advisory role. He recommended that to facilitate farmer advice-seeking that OSH advice provision and enforcement need to be operated as separate functions. Further research by Knowles (2006) supports his conclusion that independent advice provision is associated with improvement in farm OSH standards and practices. With SME's, Hasle and Limburg (2006) emphasised the importance of having personal contacts and trustful relationships while at the same time having understanding of the work environment of the service user as being the crucial requirements for successful provision of OSH guidance services. It is concluded from the study findings that extension services, which provide OSH advice on an independent basis have a considerable potential role to play in assisting farmers with OSH management due to the nature of their relationship with clients.

The study found from feedback from participants (see sub-Sections 7.2.2.5.&6 and 7.2.2.8&9) and facilitators (see sub-Sections 7.2.2.12.1 to 4) that all parties involved in RAD training were satisfied with the training structure and accompanying resource materials. This finding is particularly relevant as various authors have considered that having a sound structure and accompanying resource materials are a prerequisite to effective delivery of educational programmes in OSH (Bruening, Hoover and Radhakrishna, 1993; Carrabba et al., 2001; Chapman et al., 1995) and in adult education generally (Ajani and Onwubuya, 2012; Boyle, 1981). It can be concluded from the findings of this study that an extension service can effectively deliver OSH training to farmers when adequate levels of training of extension staff is provided and an adequate suite of training resources to assist with training are in place. Evidence for this conclusion is provided by the study finding that 95% of training facilitators considered that farmer RAD training was well structured.

The study found that RAD training was influential in assisting participants with gaining OSH knowledge by providing a framework for considering what OSH controls were required on individual farms and providing the motivation to implement OSH controls on their farms. The components of training delivery considered to be most effective by facilitators were the use of victim testimonials and visual means of communication such as use of DVD to show OSH controls and power point presentations to show accident causes and prevention. Farmer participants' views on these aspects of the RAD training (identified in response to objective 2) were consistent with the facilitators' views. Facilitators considered that it was important to the effectiveness of training that practical OSH messages which farmers could apply were provided and they considered that the training approaches used positively influenced participants attitudes towards farm OSH. These findings are in accord with the literature which indicates that visual approaches are most often used to trigger mental images (Wilson-Mendenhall, Barrett and Barsalou**,** 2013**)** and that farmers are well-disposed to receiving practical messages (Lees and Reeve, 1991). The challenges identified with training delivery included: the on-going difficulty of securing farmer attendance, particularly among those not clients of the extension service involved in this study; limited interest in OSH among farmers who attended solely for compliance reasons; and limited interest and engagement with the issue of farmers' health. It is concluded that the RAD training provided has utility in motivating farmers to consider adoption of farm OSH, particularly the practical OSH messages given and the appropriateness of visual communications approaches used. It is also concluded that there are limitations to the capability of an extension service to assist farmers with OSH management through training based on limitations to attract participation by farmers, particularly those not in contact with an extension service and among farmers who attend training with the principal interest in OSH legislative documentary compliance.

The study found that 62% of advisors (see sub-Section 7.2.2.12.4) and 96% of trainers (see sub-Section 7.2.2.12.6) were satisfied with the in-service training they received to support their roles in facilitating RAD training. Among advisors who were not satisfied with the training received, their main criticism was that it was too short in duration which was expressed by 58% of advisors who were not satisfied with the RAD training. The study also found that 63% of advisors considered that it would be worthwhile to follow-up with a farm-walk based on the RAD. Research by Pettit (2001) related to Teagasc advisory staff engagement with farmers indicates that both staff motivation and programme prioritisation are required for effective advisory service engagement in Ireland. Wright and Geroy (2001) strongly advocate that facilitator training be followed by training application which leads to gaining feedback from participants and to internalisation of the training content among both participants and training providers. The study concludes that the fact that the majority of Teagasc advisory and training staff had positive views towards providing OSH training and follow-up extension to farmers based on the RAD indicates that they were motivated to engage with OSH as an issue in their work. This indicates that extension services can potentially provide a considerable resource in the area of OSH service provision to farmers provided it has the mandate and resources to engage in this area.

The study found (see sub-Section 7.2.2.12.5) that the majority of advisors were engaged in OSH advice provision prior to being involved in RAD training and that this involvement increased following their participation in RAD training. Provision of OSH advice to farmers occurred most frequently while advisors were on farm visits and during advisory events on farms where communications are based on actual farm conditions, which indicates engagement with practical OSH issues. The study concludes that the majority of advisors were engaged in the provision of OSH advice and that advisors' involvement in RAD training provision led to increased levels of OSH advice provision to farmers.

However the study also found that securing farmer attendance at RAD training is challenging as just 40% of education officers regarded it as easy to gain such attendance. Thus it is concluded that gaining farmer engagement in OSH extension is challenging, particularly if an incentive for farmers to participate is absent, such as a commitment not to receive an inspection visit for a set time period after training attendance, as was available for the pilot phase of the PI. Research on providing a financial incentive to retrofit ROPS on tractors (Hallman, 2005) found that a 75%

and 100% subsidy had a 40% and 80% acceptance rate respectively indicating that incentive provision can have some success. Also, follow-up OSH queries after RAD training by farmers were limited with 12% of advisors receiving a high level of queries in the aftermath of training and 5% within the following year. It is concluded that farmer follow-up through queries after RAD training is limited.

The study concludes that the Teagasc service of delivering RAD half-day training and follow-up advice is of value in assisting farmers to improve farm OSH. The approach adopted by the Irish public extension service was in accord with relevant literature related to successful farm extension OSH provision (Burton and Sharp 1991; Chapman et al., 2006) and with SME's which have similar characteristics (Hasle and Limborg, 2005). This literature indicates that the ability of extension to provide an OSH service is associated with implementing the following key requirements of successful programming as outlined by Boyle (1981), namely: providing leadership and follow-up project implementation; marketing of the particular OSH services; provision of documents and training resources; provision of training to staff; having a trustful relationship with participants, understanding the work environment of farmers and being available to provide follow-up advice. Bruce and Carter (1967) considered that leadership in particular profoundly influences extension effectiveness while Boyle (1981) also considered that successful extension requires efficient and effective programme implementation. Overall it is concluded that while the extension services assisted participating farmers to manage farm OSH through the provision of training and advice, that challenges existed in gaining farmer participation with such a service and with gaining increased levels of on-going farmer engagement in OSH advice seeking. It is also acknowledged that the study did not provide evidence of accident reduction due to RAD usage.

8.8. Objective 5: To estimate the level of accidents in relation to RAD completion with or without training and associated farmer and farm characteristics

The study found (see sub-Sections 7.2.2.10. and 7.5.5.) that farm accident levels were not influenced by completion of the RAD or participation in RAD training. This finding is in line with other studies which found that training on farm OSH did not influence accident levels (Cryer et al., 2014; Suutarinen, 2004; Sprince et al., 2003a,b; Reis and Elkind, 1997; Murphy, 1981). Rasmussen et al., (2003) however did report that a one-day training course and an accompanying farm advisory visit were associated, non-statistically, with reduced farm accidents leading to hospitalisation. It is concluded, in common with the overall literature on this topic, that this study does not provide evidence that completion of the RAD with or without short training has reduced accident levels on farms. However in Ireland farm OSH information is made publically available so diffusion of OSH adoption and behavioural effects could occur throughout a population (Lund and Aarø, 2004). Additionally, a known feature of extension is that an adoption time-lag occurs in response to obtaining information and uptake of new practices (Chapman et al., 2009; Phelan, 1987). Thus it is concluded that caution needs to be exercised in definitively stating that RAD completion and training had little or no impact on accident levels.

This study found (see sub-Section 7.5.5.) that the only examined variable statistically associated with farm operator accident occurrence was the presence of OFE for the farm operator and spouse. With this variable among farms where the farm operator and spouse had OFE, accidents occurred on farms that were larger in scale than on comparable farms not reporting a F.O. accident. The study transformed continuous farm variable data into two nominal variables based on above and below median values which indicated in particular that the above median farm labour input value and below the median value for farm investment independently had non-statistically higher farm operator accident levels. This indicates that higher farm labour input and lower investment levels were most closely associated with higher farm operator accident levels, apart from where the F.O. and spouse had OFE. These study findings are in broad accord with international literature which indicates that farms with high labour input and where long hours are worked are more likely to have accidents (Ferguson et al., 2005; Sprince et al., 2002 and 2003a). In Ireland, McNamara and Reidy (1997) reported that large farms with a high labour input had a disproportionately high level of accidents. The indication that a lower investment level was associated non-statistically with farm operator accident level is novel and could indicate that accident levels are associated with insufficient or depreciated and hence older and dated farm infrastructure. It is concluded in particular that farm accident levels were associated with farmer and spouse having off-farm employment, who had farms of larger scale.

The study(see Section 7.5.5.) found that being either a Teagasc client or having received agricultural education was non-statistically associated with lower farm accident levels. The farms of both Teagasc client farmers and those who received agricultural education were larger in scale and had higher output and efficiency and it would have been expected that they were more likely to receive OSH messages. This finding indicates that farm scale and output levels could be more influential in determining farm accident levels than agricultural education or extension contact. The finding related to agricultural education, contrasts with a finding of Day et al., (2009) who found that vocational agricultural education for farming was associated with reduced accident levels. As discussed in Chapter 7, the data on accident occurrence in this study is self-reported in nature and the possibility of reporting bias was considered and such a bias is likely to favour higher reporting by those with agricultural education and or Teagasc client membership. Thus it is concluded that farmers who were Teagasc clients and who had agricultural education did not have lower farm accident levels. However, their farms were larger in scale and had higher output and efficiency and the possibility of self-reporting bias exists which warrants further research using methods controlling for this possible factor.

The study (see Section 7.5.3.) indicated that 82.7% of accidents occurred in the farmyard(s) or in a farm building and the majority (81.3%) were associated with the following: a trip/fall (42.2%); livestock (23.5%) or farm vehicles or machinery (15.6%). Regarding data on farm accidents in Ireland, over three previous national farm surveys conducted in years 1991, 1996 and 2002 where data was collected for the five previous years reported by McNamara and Reidy (1992, 1997) and Finnegan and Phelan (2003), it showed that accidents with farm vehicles and machinery had declined in proportional terms from 29.7% to 19.4% of the total while trips, falls, and blows had increased from 38.6% to 47.7%; and livestock-related accidents had increased from 22.6% to 27.6% of the total (Finnegan and Phelan, 2003; McNamara and Reidy, 1992, 1997). It is concluded that the study data on farm accidents is in line with the previously conducted NFS surveys.

8.9. Objective 6: To consider the findings of the study in an integrated manner, to devise knowledge of value in promoting OSH for use in Ireland and to add to the knowledge available internationally on this issue

The purpose of completion of the RAD was to assist farmers to effectively manage farm OSH. Accordingly a key measure of its utility is whether farmers who completed the RAD implemented the controls they specified in the document. The study found (see Section 7.4.2.1) that among farmers who had implemented the controls they had specified in the RAD, a statistically significant higher proportion of their farms had satisfactory OSH standards when compared with farms of those who had not implemented the RAD controls they specified. Implementing controls on farms also was associated with positive farmer attitude to farm OSH. The study concludes that availability of OSH-related knowledge is not the limiting factor for OSH adoption. This conclusion is supported by feedback from RAD training facilitators who reported that farmers in general in practice give OSH a low priority as well as the literature which suggests that non-implementation of known controls is a human characteristic where voluntary control is involved (Armitage and Conner, 2000; Norris et al., 2002; Tse et al., 2014).

The study also found (see sub-Section 7.4.2.1.) that farms with a dairying enterprise, where high levels of work time was the norm and where farmers were in the 45-55 year old age category were associated with having lower levels of satisfactory OSH standards. The finding that farms using high levels of work-time had lower levels of satisfactory OSH standards correlates with the accident data (see Section 7.5.4.) which indicates that farms with a high labour input had higher levels of accidents. It is concluded therefore that having a high farm labour input is associated overall with both lower standards of OSH and increased accidents on farms.

The study identifies three broad challenges for extension to support improvement in farm OSH. Firstly gaining engagement by farmers with the RAD among document non-users is required. Secondly, there is a challenge to devise and use methods which secure increased and on-going adoption of OSH standards among farmers who are challenged to implement OSH controls. Thirdly, farms requiring high levels of work-time are associated with lower OSH standards and higher accident levels, suggesting that altering farm facilities and practices associated with labour use would assist with accident reduction and provide necessary time to manage OSH.

8.10. Overall conclusions of study

This study in common with reviews of the role of education/ training in farm accident prevention (DeRoo and Rautiainen, 2000; Rautiainen et al., 2008) and more recent studies (Cryer et al., 2014; Day et al., 2009) produced no evidence that education/ training influenced accident rates. Van den Broucke (2013) also recently reported that farm OSH training did not influence subsequent farmer safety behaviours. Hignett et al., (2002) in an examination of training in prevention of musculoskeletal disorders (MSDs') among care workers also found limited evidence of the benefit of training in the absence of workplace adaptation. The current study also indicated that vocational agricultural training or contact with the Irish extension service was not associated with reduced accident risk. In contrast Day et al., (2009) found a protective effect associated with vocational agricultural training in Australia. In the USA, research by Whitman and Field (1995) indicated that formal training programmes and extension ranked lowly (9%) among the most important influences on safety beliefs among 'senior' farmers, with 'personal experience' and influence of family and friends (73%) being the greatest. This suggests that training and extension may have limited influence on safety beliefs. It is concluded that education/ training in OSH on its own has limited efficacy with accident reduction and therefore requires to be used in conjunction with other approaches to increase its efficacy.

The study findings regarding extension and training indicate that seeking approaches which motivate increased OSH adoption is identified as the key challenge in gaining improved on-farm OSH management. The so-called '3E' approach involving a combination of' 'enforcement, engineering and education' which has been influential in reducing accident levels in industrial sectors (Murphy, 2002) but has limitations in the agriculture sector where farmers are predominantly self-employed. These limitations are summarised as follows: regarding 'enforcement' in a legal sense - it is both resource intensive and challenging to implement (Barnetson, 2012, Griffin, 2007). Regarding 'engineering' or improving OSH of the farm physical environment and systems, while partially influenced by external factors to the farmer, (e.g. state schemes) this component of farm management is considerably under the influence and control of individual self-employed farmers. Regarding 'education', participation among self-employed persons in adult learning is essentially voluntary while uptake of learning in terms of implementation is also voluntary and to be successful it needs to tap into each individual's personal sense of need to apply the learning (Knowles,1977). The '3E' approach has been operationalised generally in Irish and EU OSH legislation through inclusion of the 'principles of prevention' also referred to as the 'hierarchy of controls' in the legislative approach applied. This approach involves legislative oversight including external and internal enforcement, adapting the work to the person using 'engineering' including physical measures and systems and 'education' involving training and instruction. With this approach, 'engineering' or workplace adaption is given preference over 'education' because of its greater effectiveness. A recent study of a twenty-year programme to achieve 'zero accidents' in a heavy industry (Young, 2014) attributed its relative success to assiduous application of hierarchy of control methodology with a particularly strong ergonomic focus of adapting the workplace to the person rather than the reverse. A recent study of safety culture within organisations found that perceptions of individual staff directly influence OSH performance (Smith and Wandsworth, 2009). These studies suggest both the merit of workplace adaption and the limitation of relying principally on persons actions regarding OSH implementation. Thus the study concludes that influencing individual farmer's OSH management capabilities has a disproportionately large influence on farm OSH implementation when compared to employment sectors where the hierarchy of controls can be more fully implemented.

Mitchie et al., (2011) recently reviewed and characterised behaviour change interventions and proposed a new framework for designing these. These authors depicted their framework as a 'behaviour change wheel' and at the hub are the three essential human conditions they considered for behaviour change as motivation (automatic and reflective), capability (physical and psychological) and opportunity (social and physical) which interact to generate behaviour change. These authors particularly identified the approaches of education and training, persuasion and incentivisation to gain behaviour change among persons self-managing their work. Van der Broucke, (2013) also advocated providing incentives for encouraging desired OSH behaviour.

As a way of improving OSH in SME's which have similar characteristics to farming, Sinclair et al., (2012) emphasised the worth of initiator organisations such as regulatory organisations which seek to lead change in developing networks among intermediary organisations to provide OSH interpretation and implementation for such sectors. Such networks would provide knowledge, motivation and engage in OSH prevention with the sector. These authors stated that initiator organisations must both understand and cultivate both intermediary organisations and the sector involved. The intermediary must have the capacity to deliver OSH programmes, by developing messages, selecting channels and engaging with the sector. Crucially, the intermediary organisations as well as engaging in interventions based on health behavior theories must also be able to place emphasis to adapting the workplace to influence OSH. These authors considered the advantages of such an approach as networking to eliminate isolation, improve motivation, and providing a cost-effective and technically appropriate service on an exchange basis where each party would gain on a business-to-business basis, with shared power. The broad approach advocated by Sinclair et al., (2012) indicates a strong role for extension being in a position to provide a strong OSH role to farmers.

Lund and Aarø (2004) reviewed accident prevention generally based on human, structural and cultural factors and concluded that well designed counselling schemes and behavioural programmes have produced positive effects, particularly when they are based on two-way communications which are carried out in small groups, and are tailor-made to the actual risk in question. Fowler and Christakis (2008) considered that for health-gain, group-level interventions may be more effective than individual ones and that they offered the potential to use the capacity of people who influence others. Elliot et al., (2007), Kogi (1995), Hignett (2005) and Toseland (1990) all reported gains in risk reduction using participatory approaches in OSH. In Ireland, the particular example of farmer discussion groups brings together the approach recently advocated for more effective engagement with farmers on OSH. Farmer discussion groups are conducted using the principles of social learning and have been shown to increase farm practice adoption in Ireland (Bogue, 2013; Hennessy and Heanue 2012) and in one reported case has reported increased farm OSH engagement (EU-OSH,2013). The Motivation Interviewing approach is a further example of a behavioural intervention discussed in the literature which has been shown to improve adoption levels at an individual level (Miller and Rollnick, 2002; Thevos et al., 2000). This approach seeks to resolve a person's ambivalence related to adoption through communication techniques based on establishing a person's readiness to change (Miller and Rollnick, 2002; Thevos et al., 2000). The technique is based on a facilitator's empathetic style which is used to facilitate a person's own decision to choose to adopt improved behaviour.

Overall it is concluded that the model proposed by Slater (1999) of integrating strategies based on the theory of communications, persuasion and behaviour change and social cognitive engagement in association with the stages of change framework is a broadly based and valid approach to seek adoption of OSH among a dispersed and self-employed population, such as farmers. However, in the context of increasing the effectiveness of the RAD adoption measures, it is concluded that strengthening the social cognitive theory component of this model through extension approaches with greater participative engagement of farmers in groups has the greatest likely potential in improving farm OSH.

8.11. Reflections on the study theoretical framework

The literature suggests that to understand human developments the entire ecological system in which development can occur must be considered (Bronfenbrenner, 1993; Jaffee, 1998; Runyan, 2003). This approach is justified in the field of OSH prevention as Haddon (1980a) reported that it has long been established that a diversity of strategies are required to make progress including: changing individual unsafe behaviours and social norms; making the physical environment, products and equipment less hazardous through engineering and design changes; convincing policymakers to take action through education and to establish safety standards, regulations and guidelines and apply legislation extension and enforcement tools to motivate change and compliance.

The theoretical framework (TF) used for this study (Figure 5.1. in Chapter 5) followed the 'levels of analysis framework' (LAF) approach advocated for social scientific studies by Jaffee (1998) which provides a framework to allow the issue to be analysed at different levels. In this study the micro-level focuses on individual farmer OSH adoption behaviour. The micro-level in turn is surrounded by the meso-level where factors that directly influence farmers are located including OSH culture, compliance, education and extension. This in turn is surrounded by the macro-level where factors influencing the meso-level are located including OSH and agricultural sector legislation, policy and the macro-economic situation affecting farmers.

A review of conclusions that can be drawn related to each level in the TF is now undertaken before making a conclusion on its overall appropriateness for the study.

8.11.1. Micro-level of theoretical framework

It has been concluded that farmer management of OSH is a crucial component of improving the OSH record of the sector which is most proximate to work activity and hence potential accident and ill health situations that could arise. However, the study data and literature reviewed indicates that variables at the meso and macro-levels have strong supportive roles to play in supporting OSH related actions of farmers. Accordingly conclusions are now drawn from these levels in the TF, both from the study findings and literature reviewed.

Further, a recent study conducted among farmers in Ireland to determine the psycho-social factors which influence risk taking behaviour (HSA/Tse et al., 2014) is reviewed as it is directly relevant to the study conclusions. The findings of this study indicated that farmers reported in 72% and 85% respectively for their present circumstances or if finance was not limited that physical changes to the farm as regards OSH were needed. Stakeholders who participated in the study had a lower opinion on the level of OSH implementation on farms than participating farmers. Among farmers, a high social norm as regards expectation to work safely was found except for young farmers (under age 23) which suggests a cultural limitation in transmitting safety values. Farmers sought mainly awareness raising approaches and financial incentives to improve farm infrastructure, as means of improving OSH.

8.11.2. Meso-level variables of the theoretical framework

The study TF in common with OSH prevention frameworks in the literature (Gielen and Sleet, 2003; Green and Kreuter, 2005) reviewed in chapter 3 indicated that to support adoption of OSH change, persons are likely to need support at both individual and collective levels. The stages of change theory (Prochaska and

DiClemente, 1983) indicates that individuals within a population are likely to be at a range of stages of change and Slater (1999) advocated blending media, persuasion and behaviour change theories into strategy to maximise the change effect in an efficient way. The meso-level of the TF is where possibilities exist to support farmers to manage OSH actions and variables listed in the provisional TF are now further considered in terms of the following: culture and its change; promotion of OSH: compliance and enforcement; and provision of education, training and extension.

8.11.2.1 Farmer culture and its change

This study found that the majority of farmers have a positive attitude to farm OSH. This finding is supported by earlier Irish farm OSH research (McNamara and Reidy, 1992, 1997) and the recent Irish psycho-social factors study (HSA/Tse et al., 2014). A positive culture presents a huge advantage in progressing OSH change as it leads to acceptance of messages and limited resistance to change (Thu, 1999). Both Irish studies, however, indicated that the majority of farmers could improve their OSH standards indicating a cultural acceptance of OSH risk. As Thu (1999) concluded that cultural change must be communicated and be behaviourally acceptable to a population, it is concluded that the approach being pursued in Ireland of consultation with the farming population and promotion of practical and achievable standards using the RAD and associated means is the correct approach and needs to be continued and strengthened.

8.11.2.2. Farm OSH promotion

OSH in agriculture is characterised by having a wide range of possible hazards on a high number of dispersed farms (Field and Toromehlen, 2006). Promotion of farm OSH represents a low-cost approach to influence on an on-going basis, farmers' perception of risk which is correlated with willingness to take action (Sandall and Reeve, 1999). Conroy (1994) considered that to succeed, clear and consistent OSH messages need to be promoted. The study concluded that the RAD meets these requirements both in design and content and can provide the basis for on-going OSH promotion. The literature indicates that social marketing using promotion and incentives can be successful on a gradual basis in gaining OSH change among farmers related to ROPS retrofitting to tractors (Hallman, 2005; Sorensen, 2009).

This study concludes that on-going promotion of OSH is required to assist farmers to implement change. This study indicated that farmers' health needed further promotion and a booklet on this issue has since been developed and circulated to farmers (Richardson, 2014).

8.11.2.3. OSH compliance and enforcement

The study found that endeavouring to meet OSH compliance was an incentive for farmers to participate in RAD training. This arose because the incentive of not being inspected for a period was offered during the pilot RAD training and for FETAC training having OSH documents completed to meet compliance with SHWW legislation was reported by farmers as one of their main reasons for course attendance. The recent study by HSA/Tse et al., (2014) in Ireland found almost no demand for OSH training from farmers which suggests that incentives are needed to pursue this approach. Enforcement is a necessary component of facilitating 'enforced self-regulation' as is being undertaken with the COP approach to farm OSH in Ireland. However an enforcement approach has limitations in practice due to the self-employed and geographically dispersed nature of the farming sector (Barnetson, 2012: Griffin, 2007). Also, Wilde (1994) considered that OSH law is ineffective in changing risk-taking behaviours. Thus the study concludes that while legislation and its enforcement are valuable tools to gain farmer OSH engagement, on their own they have limitations related to resources required for a self-employment sector and their limited capacity to influence on-going behaviour change.

8.11.2.4. Farmer education, training and extension

This study did not indicate a reduction in farm accident levels based on farmers' general education level, agricultural education or RAD training participation. This finding is in line with the international literature on this issue (Cryer et al., 2014; Day et al., 2009; DeRoo and Rautiainen, 2000; Rautiainen et al., 2008). This suggests that the efficacy of such approaches needs to be further considered and researched. A study by Sorensen (2009) on uptake of ROPS retrofitting found that 'social norms' was the most significant of the TPB precedents to changes in intention to act, suggesting that including the use of the influence of the 'social norm' approach in education, training and extension on an on-going basis has potential to improve their efficacy. This suggests using on-going education, training and extension in socially supportive groups which provide a social norm dimension should be assessed as this approach has already been shown to improve farm technology adoption in Ireland (Bogue,2010; Läpple et al.,2013**;** Hennessy and Heanue, 2012).

A further issue associated with providing education, training or extension is gaining participation. The literature related to social marketing indicates that provision of an incentive to gain uptake of behaviour is an effective approach (Hallman, 2005; Sorensen, 2009). Having OSH legislation in place has particularly incentivised participation in RAD training, however it is concluded, based on the study findings that further incentives are needed to gain further participation in OSH training.

It is concluded from both the study data and from the literature review, that at the meso-level of the TF, both incentivising OSH training engagement and providing facilitation of OSH change on an on-going basis through farm discussion groups represents a positive extension means to support improved adoption in OSH.

8.11.2.5. Farm characteristics

Farm characteristics including farm technology, labour use, scale and profitability are all considered together as change in any of these variables may affect the other variables. For instance to improve labour efficiency changes in farm technology are likely to be required which may be contingent on farm profitability levels. The study found that accidents were associated (non-statistically significant) with farms having above median labour use and below median investment. Further, in the recent Irish psycho-social risk factors study (HSA/Tse et al., 2014), a high proportion (73.1%) of farmers indicated that physical and financial limitations led to poor standards of equipment, buildings and facilities and increased workload leading to tiredness and stress as farm accident risk factors. The finding of the HSA/Tse et al (2014) study contrasts with the study finding among RAD training participants (sub-Section 7.2.2.7.) where 21.5% of participants felt they would have a difficulty implementing RAD controls and of the two thirds who outlined their concerns 58% referred to infrastructural issues or costs associated with implementing controls.

It is concluded from this study and the work of HSA/Tse et al., (2014) that development of farm OSH risk reduction strategies should give consideration to farm related factors including farm scale, labour use, facilities and technology used and resources available and their inter- relationship. Due to the diversity between farms in terms of farm characteristics, such consideration needs to be given to risk reduction at an individual farm level and this is a role in which extension can provide a service to farmers. Regarding the issue reported in the HSA/Tse et al., (2014) study of farmers seeking financial incentives to improve facilities as regards OSH, it is suggested that farm profitability which NFS data indicates is highly variable in Ireland is to an extent under an individual farmer's management control. Extension can be of assistance to farmers in making improvements in farm profitability. Also, farmers can lobby through their representative organisations on farm profitability as an issue. It is concluded based on the study data and relevant Irish literature that at the TF meso-level, extension services related to both improving the physical infrastructure and farm management decision-making related to profitability could support OSH implementation and needs further extension level attention.

8.11.2.6. Summary related to meso-level variables

Meso-level variables are important to influence on-going OSH adoption among farmers. Firstly enhancing OSH culture, which is largely positive, is continuously required and this should be done in association with the farming community and by proposing practical OSH standards. Having OSH legislation related to the agriculture sector is a positive asset but literature available indicates that it has limitations in altering risk-taking behaviours. Provision of education, training and extension also have limitations but the literature indicates that use of socially supportive groups to facilitate OSH change presents a possible means of improving OSH adoption based on the RAD. Regarding farm characteristics including farm technology, labour use, scale and profitability these need consideration related to their potential impact on OSH. Thus the study concludes that variables identified in the meso-level of the study TF are important in supporting farmers with OSH adoption and potential exists to enhance their effectiveness. However, further research is required to assess the effectiveness of the approaches proposed.

8.11.3. Macro-level variables of the theoretical framework

At the macro-level, variables influencing the meso-level are identified including legislation, policy and the macro-economic situation which influence the meso-level where variables directly influencing farm OSH are located. Macro-level variables related to regulation and associated policy arise mainly out of public interest where both OSH regulation and agricultural regulation and development are considered to be in the public interest as uncontrolled OSH conditions could lead to unacceptable unsafe behaviour at variance with the public interest (Baldwin and Cave, 1999). This is the case, for instance, in USA where 92% of the farming population is not covered by OSH legislation and a specific example of an uncontrolled condition is provided by the absence of a requirement to have ROPS fitted on agricultural tractors (Sorensen, 2009). In contrast to the USA, in Europe broadly based OSH legislation affecting all parties at work but excluding the self-employed is specified by the EU framework directive (89/391/EEC). In Ireland, inclusion of the agriculture sector including self-employed farmers under OSH legislation has provided the mandate and resource for the PI on which this study is based. Also in Ireland, due to the relative importance of the agriculture sector, the State has maintained a relatively strong public extension service which provides resources to assist farmers with farm development and management including OSH adoption.

It is concluded that both having an OSH legislative mandate and an established extension service in place provided a mandate, structures (i.e. the H.S.A. and Teagasc etc.) and resources to facilitate the development, implementation and assessment of the farm OSH COP Prevention Initiative and provide meso-level support for farmers in implementing the COP requirement.

However, OSH regulatory approaches on their own have limitations with altering risk perceptions necessary to gain ‘self-regulation’ and implementation of controls on an on-going basis (Rich, 1999). Two particular approaches that have shown benefit in motivating persons to implement controls are:

- Utilising the influence of the ‘social norm’ to motivate actions and behaviour change. In an extension context, inclusion of OSH in ‘discussion groups’ presents a constructive way of implementing this approach and it is recommended that it be assessed.

- Providing incentives for change. The study indicates that many farmers have not engaged with the COP and an incentive to seek their participation in RAD training is advised.

The recent EU Rural Development regulation, which lays down the legislative framework for the CAP for 2014-2020 includes a requirement for farm advisory services to provide advice on farm safety standards which could possibly provide a means to support provision of an OSH service to farmers.

The study findings guided by the TF indicate that farm OSH is directly influenced by the management of the farm operator, which in turn can be influenced by meso- and macro-level variables. Having reviewed the TF at this the conclusion stage of the study, it can be said that it presents an appropriate framework to assist the study of farm OSH change.

8.12. Conclusions related to promoting OSH

Having reviewed the utility of the TF in the previous section, the appropriateness of the various theories related to accident causation and prevention are now re-considered along with issues related to using the study findings to promote OSH among farmers in Ireland.

Firstly the range of accident causation and prevention models which were reviewed in Chapter 2 and are summarised here: The Multiple Causation Theory (MCT) describes where a number of causes combine in time and place to lead to the accident (Bamber, 1990; Laflamme, 1990) and where a hazardous ‘energy transfer’ leads to injury (Wigglesworth, 1972); The Epidemiological Model is analogous to the MCT and suggests that an accident is caused by the interaction of the victim, agent and environment in time and place; The Systems Model suggests that a system disturbance leads to accident causation (Hollnagel, 2001). The Danish Model of farm accident causation proposed that accident situations arise due to both personal and environmental implementation factors (Glasscock et al., 1997) with farmer stress affecting both types of behaviour. With regard to prevention, the social-ecologic framework defines various levels of intrapersonal, institutional, and cultural elements involved in accident reduction (Bronfenbrenner,1979; Runyan,2003). Dunne (2000) considered that accidents could be prevented by: safety management of human interactions with technology; and a better understanding of the attitudes, beliefs and motivations of persons at work. Taylor et al., (2004) and Reason (1997) considered that accident prevention is based on a capacity to manage error factors. Cooper and Germain (1974) proposed that a lack of ability, lack of knowledge and lack of proper attitudes were the reasons for mistakes and accidents, however, more recent thinking gets away from the concept of individual blame and instead focuses on correcting hazardous work situations, including human factors. This approach is reflected in the hierarchy of controls approach which underpins OSH legislation in Ireland. This study in particular suggests that there is validity in the range of accident causation and prevention models which were reviewed in Chapter 2. This study indicates that the 'hierarchy of controls' approach which combines components of various theories and which underpins OSH legislation in Ireland, provides a valid approach to managing OSH in agriculture. The agriculture sector mainly involves self-employment and implementing the 'hierarchy of controls' at farm level requires co-ordinated and on-going action from a range of actors including government, regulators, extension to assist farmers with OSH management.

With regard to using the findings of this study to promote farm OSH, it is suggested that the evidence based health communications (EBHC) principles (Boland et al., 2005; Brown, 2006; Kerps 2000; Rogers, 1994; Sharf, 1999) described in Chapter 2, which advocate translating research evidence into policy and practical programmes and which target those most in need (Sim and Mackie, 2006) is the most appropriate approach to adopt. The study findings specifically indicated raised farm accident rates where both the F.O. and spouse had OFE and for farms with lower levels of investment and higher levels of farm labour. These findings can be made available both to policy makers and to extension services management to devise measures to reduce accident rates such as farm safety grant schemes and targeted extension.

With regard to study findings which do not appear intuitive which arose in several instances (e.g. efficacy of RAD training, accident levels among Teagasc clients and those who received agricultural education) it is suggested that further research be conducted to validate these findings and that caution be exercised in disseminating the findings until they are confirmed.

With regard to promoting farmers' health, which was identified in the study as being poorer than other occupational groups, it is suggested that this can be actively promoted in association with health promotion agencies in parallel with promoting farm safety.

Chapter 9

Implications and recommendations

9.1. Introduction

This chapter presents implications that can be drawn from the study findings and goes on to make recommendations based on these implications. The recommendations focus on how to assist farmers to more effectively manage farm OSH with reference to the COP documents currently in place. The study recommendations are assumed to be relevant to persons engaged in OSH change in agriculture in Ireland, firstly at a farm operator and farm family level and then among farm leaders and those involved at a legislative and policy level in organisations including the Health and Safety Authority, Teagasc, the Farm Safety Partnership as well as research and knowledge transfer professionals. The main conclusion of this study is that the Risk Assessment Document (RAD) used on its own or in association with short training for farmers or participation in vocational agricultural education or being a Teagasc client was not associated with reduced farm accident rates. This raises the question as to how education and training and extension can be better utilised to assist farmers to achieve improved OSH standards and the adoption of good practices. Specific implications are now made regarding gaining OSH adoption followed by associated recommendations at the end of each section.

9.2. Implications and recommendations

The study implications followed by recommendations are now presented on how to assist farmers to improve farm OSH management by implementing the COP legislative approach through extension based on the major themes which emerged from the study conclusions. The themes considered relate to building on positive farmer attitudes to OSH followed by the role of OSH legislation and provision of RAD training to farmers. Then themes are considered related to extension engagement in OSH programming and to education and training of extension staff in OSH and then extension related to farmer health and well-being. Following presentation and discussion of the implications and recommendations related to each theme, the study will conclude with a presentation of recommendations for future research in the final sub-chapter of the study.

9.2.1. Building on positive farmer attitudes to OSH

This study found that farmers who participated in RAD training considered OSH an important component of farm management, which is in agreement with the findings of previous studies on farm OSH in Ireland (McNamara and Reidy, 1992, 1997). The implication of this finding is that farmers realise that OSH is an important issue for them and they are open to being influenced to adopt change in this area which is a major enabling factor to effect change (Kaustell et al., 2011).

The study recommends that continued promotion of practical farm OSH issues takes place in the media to continue to influence farmers positively towards farm OSH. This recommendation is in accord with the work of Slater (1999) which indicated that the use of the media is a major resource for conditioning targeted populations to consider change. Messages need to be framed to suggest practical solutions to suit the farmers' mind-set (Knowles, 2002, H.S.A./Tse et al., 2014). In Ireland the farm labour force has 247,700 persons (C.S.O., 2007b) and over 400,000 persons living on farms dispersed throughout the country, which makes the use of the media a valuable instrument to both reach and influence persons towards OSH improvement.

The study in common with international literature (Australian Safety and Compensation Council, 2006; Durey and Lower, 2004; Knowles, 2002; Murphy, 2003; Sandall and Reeve, 2000) found that farmers have an incorrect perception of the range of causes of fatal and serious accidents and ill health. The implication of this is that to inform farmers adequately of OSH risks with a view to reducing accidents and ill health, media communications and training needs to be correctly framed based on objective data. Due to the multiple causes of farm accidents and ill health this represents a considerable and on-going communications challenge. The study recommends that farm OSH specialists who communicate with farmers should base their campaigns and media messages on objective OSH data.

The study finding that farmers are most influenced by victim 'case testimonials' indicates that this element of human testimony is a highly motivating component of OSH communications. The literature indicates that changing farmers' perception of risk is crucial to changing risk-taking behaviour. However the literature related to risk-taking indicates that a considerable challenge exists to gain behaviour change.

Stuthridge and Field (2012) reported that farmers have a strong culture of prioritisation of work task completion over safety. Hasle et al., (2009) found that accidents and near misses do not have an educating effect without decreasing the associated defensive attribution. This knowledge indicates that after an accident people tend to be defensive about their roles (e.g. prefer to forget what happened, ignore errors made) and without overcoming this human attribute, learning about future prevention is unlikely. Finnegan (2007) in Irish OSH research found that farmers as a group did not believe they are working in a dangerous work environment and take risks because of their rare negative consequences and that risk-taking could be rewarding in many instances. When persons do not believe that they are at risk, they do not tend to heed advice and exhortations (Dunne 2000). Accordingly the study recommends that a 'victim testimonial' component be strongly included in OSH communications and training strategies to increase farmer perceptions of the consequences of accidents and risks in an authentic way. Additionally, it is recommended that farmers need to be supported to progress from awareness to making appropriate changes by using frameworks such as the RAD and by using training techniques such as Fault Tree Analysis (Kingman and Field, 2005**,** Malaise and Grosjean, 1990) which can motivate adoption. This analysis technique facilitates training by charting all accident causes logically from occurrence to their antecedents in a logical way, in contrast to the defensive approach described.

9.2.2. Role of OSH legislation

The study findings indicate that OSH legislation applied to the agriculture sector using the COP approach acts as a positive facilitator for farmer engagement with extension on OSH in the following respects: firstly the legislation provides a mandate for OSH programming and permits setting-up operational and consultative structures and allocation of resources to implement extension programmes; secondly the COP approach permits transposing legal principles into practical requirements which are directly related to farm practice and which farmers relate to and consider implementable; and thirdly, the legislation provides motivation to farmers to engage in OSH implementation and in training and follow-up extension. In particular the study found that farmers found the RAD among the COP documents was the document that had the most utility for them in assisting with farm OSH management.

It is recommended that the OSH legislative approach being adopted in Ireland is the correct and most appropriate approach. The challenge now is to further utilise the COP and RAD to maximise their potential in gaining OSH change among farmers rather than making substantive changes to these documents (other than updating). In particular, it is recommended that incentivisation should be considered for farmer involvement with training and extension. For instance, the incentive of having a non-inspection period for those who attend training could be considered on a programmed basis in areas with high accident rates, as took place and was successful in achieving attendance in the pilot component of this study. It is notable that the recent H.S.A. commissioned study (Tse et al., 2014) also recommended incentivisation of farm OSH while Sorensen (2009) considered that social marketing including incentivisation offers a framework for promoting farm OSH.

9.2.3 Provision of RAD training

This study found that farmers specified a higher level of controls when the RAD was completed with half-day training than when completed without such training. The implication of this finding is that the RAD is more effective in motivating specification of controls for implementation when it is used in conjunction with training. The study recommends that future extension programming should focus on provision of RAD training rather than circulating the document without training. However, this recommendation is nuanced by the fact that the COP and RAD are now publically available documents.

The study found that provision of RAD training was provided overwhelmingly by public extension (Teagasc) to their clients. It is therefore recommended that promotion of RAD training among Teagasc clients continue but that additionally this training should be made available and promoted to non Teagasc clients for example through agricultural consultants, rural development networks and men’s health social networks (known in Ireland as ‘men’s sheds’).

The study found that the RAD when considered both with or without training was used minimally by farmers and resulted in a limited number of controls being specified related mainly to physical hazards. The finding that farmers’ implement a limited number and range of controls at any one time period was found also by

Pollock (2010) and its implication is that a means is needed to motivate farmer engagement in adoption of both more and a wider range of OSH controls on an on-going basis. It is recommended that to motivate more adoption of controls that the RAD usage be extended to include circulation to farmers with specific messages and pages of the RAD for review with instructions for these to be kept as part of their COP file on an on-going basis. For instance, a circulation of EU single farm payment documents related to farm regulatory requirements is undertaken by the DAFM annually and in 2014 it was also used to circulate OSH material on behalf of the H.S.A., which could be used for the above suggested purpose of circulating RAD material.

9.2.4. Extension engagement in OSH related programming

The study found that of farms audited in this study, 33% were classified in the very satisfactory category, and 23.4% had a legal OSH breach after completion of the RAD. The implication of this finding is that considerable potential exists to improve farm OSH on the majority of farms and that further extension engagement over and above provision of RAD training could benefit the majority of farmers but particularly so for those not in OSH compliance. The implication of this finding is that current extension OSH services could be reviewed to seek ways to gain greater service efficacy. Farmers however make low demands on extension in Ireland for OSH advice (Finnegan, 2007). The study found that the majority of extension officers were positive to OSH delivery so the challenge is how to make OSH service delivery more efficient and effective. Recently, Sinclair et al., (2012) emphasised the worth of regulatory organisations in developing networks of intermediary organisations such as extension to provide OSH interpretation and implementation based on their trustful working relationships with the sectors they are engaged-in. Such networks could provide knowledge, motivation and more efficient engagement in OSH prevention within a sector.

It is recommended that extension services in Ireland currently review their role in providing OSH service to farmers with a view to considering more efficient and effective service delivery. In particular it is recommended that a check-sheet be designed to be completed prior to on farm events and farm visits to serve as an instrument to bring key OSH messages to farmers' attention. The study also recommends that OSH as a topic be particularly included and integrated in farmer discussion group programmes as these have been shown to be efficient and effective means of technology and practice adoption in Ireland (Bogue, 2013; Läpple et al., 2013; Hennessy and Heanue 2012). This is due to their practical on-farm interactive peer discussion and facilitated format where potential to engage in OSH extension over time exists. Elliot et al., (2007), Hignett (2005), Kogi (1995, 2006), Lund and Aarø (2004) and Toseland et al., (1990) all reported gains in risk reduction using participatory approaches with small groups. The group approach is in accord with the framework of change theory integration put forward by Slater (1999) who considered that social theory has a particular role in gaining on-going adoption. Thus the study findings indicate that on-going and socially supportive OSH extension services rather than once-off ones are needed to achieve implementation of satisfactory OSH standards on many farms.

The study found that farms with high labour use and lower investment levels had higher accident levels. This implies that farm workplace conditions are associated with accident levels. A recent study conducted in Ireland has indicated that fatigue as a consequence of workload as a possible cause of farm accidents (Tse et al., 2014). Phelan et al., (2007) found that farm safety management was indicated to be a function of a farmer's ability to successfully manage all aspects of the farm business. Farm labour studies conducted in Ireland also indicated that a considerable range occurs in farm work time and that both technology and practice adoption can be used to reduce farm work time (Connolly, 2000; Leahy, 2003; O'Brien et al., 2006; Ruane et al., 2007). Both Franks et al., (2002) and O'Brien et al., (2006) found that farm economic efficiency was widely dispersed among similar sized farms leading to variable levels of availability of resources to invest in the farm. Research by Gleeson and Kinsella (2003) also indicated that significant investment was required in order to modernise and to increase farm scale. The study recommends that extension services in programmes attend to work organisation on farms which is related to design infrastructure and work practices associated with the use of farm work time. This approach presents the possibility of making farm labour more efficient and effective and consequently reduce hurry and allows more time for farm management. While Teagasc has developed a training module in this area (McNamara, 2006) on-going updating of such modules is needed to take account of the current and anticipated changes related to farm development. Overall it is suggested that extension has a strong potential role in influencing OSH through its holistic role in assisting farmers with farm management, including farm work organisation efficiency and profitability. As agriculture in Ireland is set to expand production in accordance with the Food Harvest 2020 targets (DAFM, 2010), there are potential consequences for farm OSH associated with expansion so enhanced extension engagement for issues associated with OSH would be timely.

The study found that farmers predominantly specify physical controls for implementation following RAD completion which suggests that farmers think of OSH mainly in terms of addressing a limited number of on-farm physical elements. It is recommended that extension services in Ireland continue to integrate OSH messages into its programmes to widen the scope of farmers thinking on OSH risk reduction and risk management. An example of this approach, for instance is integrating livestock docility planning into animal breeding extension work. Also promotion should be conducted on OSH themes not widely considered by farmers when using the RAD such as children and elder farmer safety and farmers' health.

A relatively small proportion of farms (3.2%) received a very unsatisfactory score in farm OSH audits. These farmers are likely to need on-going advice and assistance to implement satisfactory OSH. However, extension services in Ireland operate on a voluntary basis where a farmer requests a service and advisors can only deal with unsatisfactory OSH on a farm on an informal basis if it is not requested by a client. A confidential referral system has operated between the national public agricultural extension service (Teagasc) and another state agency related to problematic implementation of certain farm management issues by a small minority of farmers. It is recommended that devising a referral system to extension be considered to assist farmers with OSH management problems. Such farmers would be referred with their consent to extension by various state and farming organisations for advice and support to assist them to rectify and actively manage their OSH problems.

9.2.5. Education and training of extension staff in OSH

The study found that the majority of extension staff in general were positively disposed to providing OSH services to farmers. The implication of this finding is that such staff provide a considerable potential resource to assist farmers with OSH management due to the working relationship and trust that exists between extension staff and farmer clients. However, it was notable that in the study pilot phase, education officers who had a considerable background in OSH training and farm auditing related to host farms (Teagasc, 1997a) were particularly comfortable with their role in providing RAD training. In contrast, a significant proportion (26 %) of the advisors (with no previous formal OSH training or role) felt that they had not received sufficient training for their OSH role. The implication of this finding is that sufficient OSH training needs to be provided and updated on a continuing basis to gain on-going engagement with OSH by extension staff. Wright and Geroy (2001) suggest that training needs to be practically implemented to attain internalisation, implying that extension OSH training must be followed up by programme implementation to have utility.

Farm OSH involves both technical and organisational issues and there is an accompanying legal dimension to this work. Accordingly extension staff needs to have adequate OSH resource material to support this work such as the COP documents, implying that such documents have a considerable role in facilitating OSH extension programming.

It is recommended that comprehensive education and training in OSH be provided to future extension officers in Ireland. This should be done at undergraduate level for persons who may progress to a career in farm extension services. This would provide a grounding and understanding of the principles and practice related to OSH management in agriculture which they can apply throughout their careers. The study also recommends that on-going in-service training be provided to extension officers so that they have up-to-date knowledge, skills and motivation to deliver an appropriate and up-to-date service in OSH to their clients. Such training should be complimentary to extension officers' general training in such areas as technical updating and advisory techniques such as group facilitation skills training. It is recommended that extension management give high priority to delivery of OSH extension programming for farm OSH in Ireland in terms of developing and updating knowledge and methods, liaising with stakeholders, promoting and publicising programmes and provision of staff in-service training. Actual delivery of an OSH programme key performance indicators (e.g. provision of RAD training etc.) to farmers is a key requirement and the study recommends that these be managed to ensure delivery. This recommendation is justified based on the ‘public good’ role of extension in OSH and the fact that farmers, while valuing an OSH service, tend not to demand such a service.

Provision of an OSH service to farmers is relatively expensive to deliver. This study advocates delivery of such a service as a component of general extension services. Moreover, the findings of the study principally advocate group approaches such as provision of training or participation in discussion groups. These approaches are relatively cost effective when compared to individual visits to farms and also have the benefit of engaging farmers in peer dialogue and learning which has been shown to be effective in motivating OSH change.

9.2.6. Farmer health and well-being

Components of both occupational and personal health were included in the COP and RAD and it was identified that uptake of the health messages delivered was limited. Evidence is available that farmers in Ireland have a poor record related to health issues (Hope et al., 1999; O’Shea, 1997; Smyth et al., 2013). Mirowsky et al., (1990) reported that physical and mental health are often highly correlated and share common causes and affect each other. Research by Melberg (2003) indicated that the three most predominant sources of farmer stress are injury and ill health disablement, problematic work conditions and economic hardship. Whelan et al., (2009) in Ireland, reported lower farm income and OFE associated with farmer disability mainly associated with preventable injury or ill health. Also elevated farm accident rates have been shown to be associated with poor health (Rautiainen et al., 2004; Suutarinen, 2004). The implication of the information presented is that farm OSH management can potentially influence farmer well-being and long-term health prospects and that this could be interrelated with farm viability. It is recommended that both personal and occupational health be accorded greater promotional priority in extension programmes for farmers. This should be done in a multidisciplinary basis between extension and health professionals.

9.3. Future Farm related OSH research

Based on the study findings further research on OSH adoption by farmers in Ireland is recommended. Prior to considering what research is required the issue of minimising the effect of bias in research is discussed

The following areas of further research into farmer OSH research adoption in Ireland are recommended:

9.3.1. Farmer use and re-use of the RAD document

It is recommended that investigation should take place on the availability and capacity of organisations in addition to Teagasc to assist farmers with RAD completion and implementation. Also, as it is a specific legal requirement to update the document on an on-going basis, research is required into the levels of this occurrence and what assistance farmers require and would work best with this task.

9.3.2. RAD training for farmers

It is suggested that further interventions based on farmer discussion group methods be undertaken and research on their utility in assisting farmers with OSH change be conducted. Such research should be conducted on an intervention inclusion and control basis and involve subgroups of farmers in the intervention with various levels of OSH adoption and management levels to test potential differential impacts on various subgroups.

9.3.3. Training in OSH for extension staff

As extension staff, who were found to be positively disposed to providing OSH services and have considerable access to farmers and thus have potential to positively influence them as regards OSH, research should be conducted into determining the optimal professional and on-going OSH education and training for such professionals so that they can effectively promote good OSH practices and standards in their work with farmers.

9.3.4. Agricultural education

As the study found that those who had some level of agricultural education did not have a significantly lower level of accident occurrence, research is recommended on the content and delivery of the OSH component in current agricultural education programmes to assess its potential for enhancing farmer engagement to adopt and better manage farm-based OSH.

9.3.5. Farm management as regards OSH

The study data indicated that accidents are associated with larger farms with high economic size and scale and high labour use and low investment indicating that accidents are associated with farm management standards. Further research is recommended into the components of farm business management which are associated with OSH adoption and how extension assistance could be provided to farmers to enhance their OSH management to effect positive change.

9.3.6. Accident causation

The study considered the frequency and causes of farm accidents which was based on national surveys of farm accidents. It is recommended that further national surveys of accident occurrence be conducted at 5-yearly intervals as a means of obtaining on-going data and monitoring of on-farm accident levels and causation.

It is acknowledged that this study was not in a position to investigate the detailed causes of such accidents based on the data available from the national farm surveys conducted. Accidents generally have multiple causes and knowing the relative importance of the various factors is necessary to improve future OSH programmes. Further research is recommended to investigate farm accident causes and it is suggested that this could be conducted on a qualitative case-study basis involving multidisciplinary research.

The association between accident causation and stress was not examined in this research as it was not within the disciplinary competence of the researcher. However, as the issue of stress was raised by the recent Irish study on psycho-social factors associated with farm accidents (HSA/ Tse et al.,, 2014), further study of this issue in an Irish context is warranted.

9.3.7. Farmer health

The study found limited uptake of health messages among farmers in this study while a recent Irish study indicated a higher level of premature deaths among farmers than some other occupational groups. Given its importance to farmer well-being and farm business viability and also the low prominence this topic has received to-date in Ireland from extension, further research on farmer health behaviours and the role of extension in influencing these is warranted. Such research would provide information for development of influential extension programmes and provide benchmarks to measure progress over time. Further research could also clarify the cost-benefit of extension engagement in accident prevention and health promotion among farmers.

9.4. Recommendation for minimising bias in farm OSH research

Regarding research methods, this study has identified the challenge of both devising and implementing research methods which minimise bias. Such bias can arise from two principal areas: self-reporting; and selection bias when unobserved factors affect the outcome variable of interest. Future research needs to consider the potential for bias at the research design stage and use methods which minimise its effect. One method of minimising the effect of selection bias is ‘endogenous switching regression’ as recently discussed by Läpple et al. (2013).

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