e-Agricultural Systems: Towards a Human-Centred Framework for e-Readiness and Technology Adoption

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Declaration:

The author hereby declares that, except where duly acknowledged, this thesis is entirely her own work and has not been submitted for any degree in Waterford Institute of Technology, or in any other University in Ireland.

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ABSTRACT

Rural communities particularly the farming sector are one of the most innovative in the world but uptake of new information systems to support their daily lives remains slow. In spite of decades of research into system development we still do not have a good understanding of IS innovation adoption in agricultural communities. The motivation for the research came from living in a rural area and observing the working lives of farmers. Initially the Department of Agriculture conducted a study on the adoption of technology amongst rural people, as they were concerned about the slow uptake. Findings from that study provided inspiration to further research the phenomena.

The research followed an interpretivist approach to the problem domain interviewing farm families within their own natural settings. Farm families were interviewed irrespective of farm size, enterprise and level of income. Often these characteristics were presented as barriers to technology adoption across farming research.

A new framework for information systems development was presented (RooT Model) that could improve the adoption and continued usage of such systems by synthesising across incompatible domains of knowledge to produce an appropriate human-centred solution for rural communities. The primary contribution of the research is the RooT model – the Rural Technology model that allows system designers and developers to analyse and interpret the rural context with respect to technology design and development. This will open up a new avenue of research for information systems development, informing policy in respect of e-readiness of farmers and the wider rural community, both at a national and international level.

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CHAPTER ONE INTRODUCTION AND BACKGROUND TO THE RESEARCH

1.1 Introduction

This chapter presents the research topic, justification and context of the study. Along with the aims, scope and limitation of the research study. The chapter then concludes with an outline of the thesis and direction for the next chapter.

1.2 Background and Context

In Ireland agriculture plays an important role in Irish society making a valuable contribution to the economy and society as a whole. The agri-food sector represent Ireland's largest indigenous industry, forming the backbone of rural life with notable economic, social and environmental interdependencies. Collectively, the industry employs some 150,000 people and has an annual output of over €24 billion (DAFM 2010). The land of Ireland is farmed by:

- 139,600 farms out of which 99.6% are classified as family farms.
- The average farm size is 32.7 hectares.
- 122,900 of family farm holders are male.
- Over half the farm holders are aged 55 or over with 5.9% under 35.
- 70,300 of farm holders said farming was their sole occupation.

Central Statistics Office (2010)

In 2009, the Irish economy suffered a major downturn and agriculture was viewed by the government as a key driver for recovery and set the Food Harvest 2020 agricultural agenda (Carey & Donohoe 2013). The aim was to increase output from agriculture within an environmentally sustainable manner. This was to meet environmental targets set out in European legislation (DAFM 2010).

Food Harvest 2020 suggested that the sector be *smart* with regard to the adoption of new technologies by farmers. This enabled the exploration and development of new working relationships by farmers within food production chains. The promotion of a global brand image for Irish agriculture was to be established built on environmental farming methods that respected natural resources (DAFM 2010). This was seen as a major competitive advantage

for targeting consumers and markets both nationally and internationally (DAFM 2010, IIEA 2016).

To allow farmers to remain sustainable requires the use of technologies in particular ICT's to allow Irish agriculture progress within the Food Harvest 2020 framework. Today a farmer has to be resilient to weather extremes and cognisant of production methods. This creates a dichotomous relationship between farming and the environment coined an unhappy marriage, whereby crops are battered by weather changes and greenhouse emissions contribute to climate change. Society also demands food produced in a socially and environmentally friendly manner (Tovey 2017). With increasing international concern about climate change, Irish farmers are under more pressure to remain sustainable within agreed international environmental targets (DAFM 2010). The rationale for the research was to determine the uptake and continued usage of e-agricultural systems amongst Irish farmers to aid sustainable farm enterprises.

1.2.1 Research Context

To facilitate Irish farmers produce under Food Harvest 2020 the use of ICT at the farm level becomes important. However, Irish farming communities have proven slow adopters of ICT's (CUITA 2009). To explore why this is the case the Committee on the Uptake of Information Technology in Agriculture and Rural Communities was established (CUITA 2009). Its purpose was to determine the barriers and enablers to the adoption of ICT's amongst the farming community. One of the key findings from the committee was that Irish farmer's view of ICTs was that they were not "useful to their working day" (Somers & Stapleton 2015 p. 99). A similar study undertaken in India found that rural communities there were also slower in adopting ICT's. It was found that technologies presented to farmers offered generic information that failed to recognise farm diversity and the personal and situational life of farmers (Gakuru *et al*. 2009).

At the World Summit on the Information Society (WSIS) held in Geneva in 2006, an agricultural inter-agency group known as the e-Agriculture Working Group (EAWG) was established. The group comprised of a cross-section of groups from the agricultural sector.

To establish the use of e-agriculture across the sector the group conducted a global survey of e-agricultural (i.e. farming software, e-services, or web-based applications used in farming) amongst the sector. Results from the survey revealed that whilst farmers were aware

of possible benefits from using such services for example, enhanced information access or exchange, access to markets, food security and sustainability the uptake was low.

To expand and understand these findings within an Irish context became the inspiration for the study. In the context of this research, e-agriculture was defined as the use of technology for the improvement of agricultural services, enhanced technology dissemination, and information delivery through advancements in Information and Communication Technology (ICT).

This research aimed to synthesis and explain the profile of successful information systems development methodological praxis for e-agriculture initiatives which actively supported learning and innovation in complex rural environments. It focused on the development of a new lens of analysis to improve the design and development of ICTs for the farming community. This research will highlight the barriers to the adoption and continual use of ICT's and, in turn, enhance the Irish farming enterprise.

1.2.2 Current System Development Thinking

Traditionally the principles of software development were rooted in the reductionist paradigm (Melnik & Maurer 2006). Reductionism generates knowledge and understanding of phenomena by breaking them down into basic parts and observing each part in terms of cause and effect (Flood 2010). When applied to software engineering it has promoted a conformance to a plan through upfront requirements gathering and upfront systems design. This has led to scientists and engineers to design systems for use irrespective of context of use as a social phenomenon requires a picture to be built and is not amenable to being broken into parts (Stapleton & Hersh 2004, Flood 2010). Through the lens of reductionism, software developers failed to interpret and understand real-world situations and in turn developed software with conflicting viewpoints on its value (Jackson 2001).

With the role of information technology growing in today's society, software developers find themselves challenged by the variety of stakeholders and their social systems (Dingsøyr *et al.* 2010). Software developers following a reductionist approach may develop technology which is out of touch with people and the essence of their everyday life (Flood 2010). Reductionism is often a reason for information systems failure with technologist concentrating on the technical aspects of design rather than understanding the human interactions of use (Alter 2013).

Agriculture is a particular context, with innovation coming from interactive learning networks and processes of *trial and error*. This method of problem solving often comes from the variety of complex situations faced by farmers and the need to adapt and arrive at a solution for the problem at hand (Nieuwenhuis 2002, Meijer *et al*. 2015). These dynamic exchanges in farming often come from exchanges with the weather, spread of disease and policy and regulation.

It is vital for technologists to understand the end user's working and personal life in so far as it relates to the use of the technology. Future system development praxis must construct software development models with the social artefact as the locus for technology development. This will open up a new set of possibilities, and requires systems developers and related researchers to rethink the appropriateness of the philosophical positions underlying many current technology research.

1.3 Research Aims, Objectives and Questions

This study aims to identify gaps in the information systems knowledge regarding the adoption of e-agricultural systems by rural communities and construct a methodological, conceptual framework to address such issues. This gives rise to the following research aims and objectives.

The research objectives investigate:

1. To identify the barriers for adoption of e-agricultural systems by farming communities in Ireland.
2. To construct a model that will improve the adoption of e-agricultural systems amongst farming communities in Ireland.
3. To evaluate a model in support of the adoption of future e-agricultural systems amongst farming communities in Ireland.

These objectives give rise to the following research questions.

1. What are the impediments for adoption of e-agricultural systems amongst farming communities in Ireland?
2. What key concepts comprise a conceptual model for the improvement of e-agricultural adoption and continued usage amongst farming communities in Ireland?

3. What are the key concepts that improve the continued usage of e-agricultural systems in support of rural sustainability in Ireland?

1.4 Chapter Outline and Research Map

Chapter 1 introduced the context of the research problem. The objective of the research was set out, along with the research questions and motivation behind the research.

Chapter 2 set out human centred systems theory as the reputable theoretical underpinning to understand the adoption of innovations in light of the philosophical foundations of this study.

Chapter 3 introduced a set of theoretical propositions in light of the literature and presented a tentative conceptual framework for e-agricultural systems development and adoption.

Chapter 4 identified the philosophical and methodological stance of the research and provided detail of data gathering and analyses.

Chapter 5 began with the set of findings from the data analysis, which were supported by informants' quotes. Each of the findings represented an evolving understanding of the data and contributed to the body of knowledge.

Chapter 6 presented the research findings with respect to what informants believed impacted on the continued usage of e-agricultural systems. This chapter endeavoured to explore the implications of these observations within the context of the reviewed literature and the working theory. It also described the final research outcomes and identified the activities and concepts suitable for inclusion in the conceptual framework.

Chapter 7 reflected on the research journey, it concluded the research by reviewing the contribution of the findings and the proposed conceptual model to the body of knowledge. The chapter described the relevance of the findings to rural communities in particular the farming community. Finally, the limitations of the research were detailed and future research opportunities outlined.

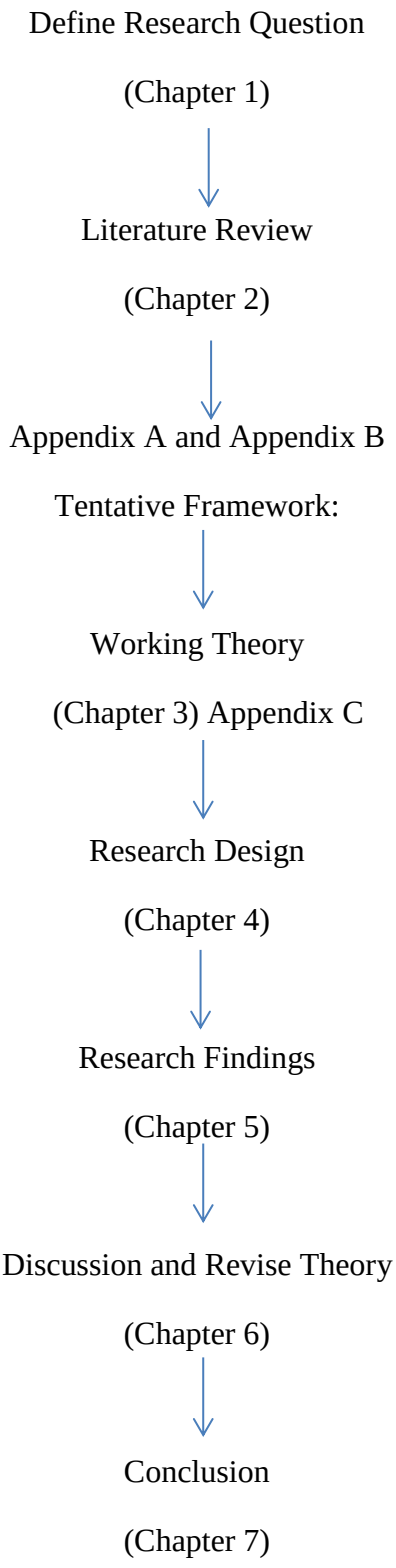


Figure 1.1 Overview of the Thesis Structure.

1.5 Conclusion

This chapter introduced the research topic. From this, research objectives and research questions were identified and summarised. Brief outlines of the thesis chapters were presented along with a research map outlining the thesis. The next chapter will contain a review of current literature.

CHAPTER TWO LITERATURE REVIEW

2.1 Introduction

This chapter will explore the information systems literature within the area of technology adoption of systems. It will then follow a review of real world examples of e-agricultural systems. From here a review of system theory and software methodologies will be undertaken that follow a human centred perspective on systems thinking. To understand a human centred perspective a review of knowledge, cultural values, institutionalism and a community of practice followed for the identification of theories or practices that guided the development of a systems development model for rural farming communities.

In the first chapter, agriculture was presented as operating at the interface between social, economic and natural environments. This made it the backbone of the rural economy but ironically dictated to by global markets, which set trade prices for produce. Farmers face unpredictable weather conditions, diseases and changes in food consumption placing the need for relevant information when making decisions. One means of presenting farming with real time information (e.g. weather forecast, mart prices) is through websites and mobile apps that can be used by farmers instantly. However, when it comes to context specific applications Irish farmers have been slow to use e-agricultural systems such as farm management software (DAFM 2010).

Mannan & Haleem (2017) believed the relationship between the innovation and the social system becomes more intricate with consumers requiring choice and variety in products making the adoption more complex. Information systems research follows two main approaches to technology uptake amongst communities: a diffusion approach or an adoption approach, each providing a perspective on innovation acceptance.

2.2 Information Systems Innovation and Adoption

The diffusion and acceptance of an innovation is one of the most important stages of system development (Mannan & Haleem 2017). Diffusion researchers describe the acceptance process at the macro-level with the dominant model being the Diffusion of Innovation (DOI) model proposed by Rogers (2003).The Diffusion of Innovation (DOI) is a theory of how, why and at what rate, new ideas and technology spread through cultures (Rogers 2003). He developed an ‘S’ curve to illustrate the different rates of innovation adoption by categorising people within social systems. Early adopters are a small subset of people who are willing to experiment with innovative methods and technologies. When the

early adopters have identified definitive advantages and tangible benefits, the majority of adopters will adopt. Finally, the innovation reaches a saturation point in the social system when the vast majority have adopted the innovation. In this model, diffusion is a normal distribution of linear sequential events, comprising of the concept of time, communication, social system and the innovation itself. Rogers (2003) suggested an individual's perception of innovation features affected the adoption rate. In the early 1980's, a comprehensive review of a number of innovation studies in various countries that applied the DOI model was conducted (Feder *et al*. 1985). It was found that adoption research viewed the adoption decision in dichotomous terms (adoption or non-adoption) but they argued that the personal situation of the non-adopter offered greater insight into understanding the adoption decision as diffusion depended on the extent to which the technology suited a person's need. Although Rogers' categorisation of adopters is useful and most of DOI was carried out in agricultural areas, there are a number of deficiencies that weakened its contribution. Firstly, as ICT is continually evolving it is hard to evaluate the diffusion of a technology at any given time. Secondly, the influence of biases between adopters and non-adopters was not addressed in an adequate manner.

Micro-level theories, on the other hand, describe and explain the acceptance decision of individual users by applying different social theories of decision-making .One of the most citied models in IS, is the Technology Acceptance Model (TAM) (Davis 1989, Straub 2009, Williams *et al*. 2011) .

2.2.1 IS Technology Acceptance Model

Davis (1989) posited the Technology Acceptance Model (TAM) to measure user acceptance of information systems, based on two variables - Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). He suggested that the two variables, when weighted by an individual, formed a clear attitude about the intention to adopt the technology. He proposed that a person's beliefs about usefulness and ease of use were the main drivers of computer technology usage. Davis's (1989) work is important because it began the conversation about the importance of individual perceptions of a technology (Straub 2009).

2.2.1.1. Criticism of the TAM

The main criticism of the TAM is its failure to acknowledge individual differences (Agarwal & Prasad 1999). Beliefs and attitudes concerning technology were influenced by more than the *perceived ease of use* and *perceived usefulness* of the innovation. With the model parsimonious in nature, it fails to address or take into account prior experience, age,

gender, and many other characteristics influencing intention to use an innovation. It is unreasonable to expect a single individual psychological model to explain decisions and behaviours across a wide range of technologies (Straub 2009, Bagozzi 2007).

To address the limitations The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed to provide a unified theoretical basis to facilitate research on Information System (IS)/Information Technology (IT) adoption and diffusion (Williams *et al*. 2011). Venkatesh *et al*. (2003) developed this theory based on review, mapping and integration of eight dominant theories and models[1].

2.2.2 The Unified Theory of Acceptance and Use of Technology (UTAUT)

To address the complex nature of adoption the salient characteristics of the eight models were brought together to form a unified model of technology acceptance, UTAUT (Venkatesh *et al*. 2003) See figure 2.1.

He proposed three determinants of behavioural intention within the model: performance expectancy, effort expectancy, and social influences.

1. Performance expectancy is *the degree to which an individual believes that using the system will help him or her to attain gains in job performance.* That is how using the systems will benefit me in my job.
2. Effort Expectancy is *the degree of ease associated with the use of the system.* That is to learn and use the system is simply achieved.
3. Social Influences is *the degree to which an individual perceives that it is important others believe he or she should use the new system.*

Two direct determinants of Use Behaviour: behavioural intention and facilitating conditions.

1. Behavioural Intention is a person's intention to use the system.
2. Facilitating conditions is *the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system.*

The model also contains four contingencies i.e. age, gender, experience and voluntaries of use (See Figure 2-1).

[1] The Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model (MM), the Theory of Planned Behaviour (TPB), a combined Theory of Planned Behaviour/Technology Acceptance Model (C-TPB-TAM), the Model of PC Utilization (MPCU), the Innovation Diffusion Theory (IDT), and the Social Cognitive Theory (SCT).

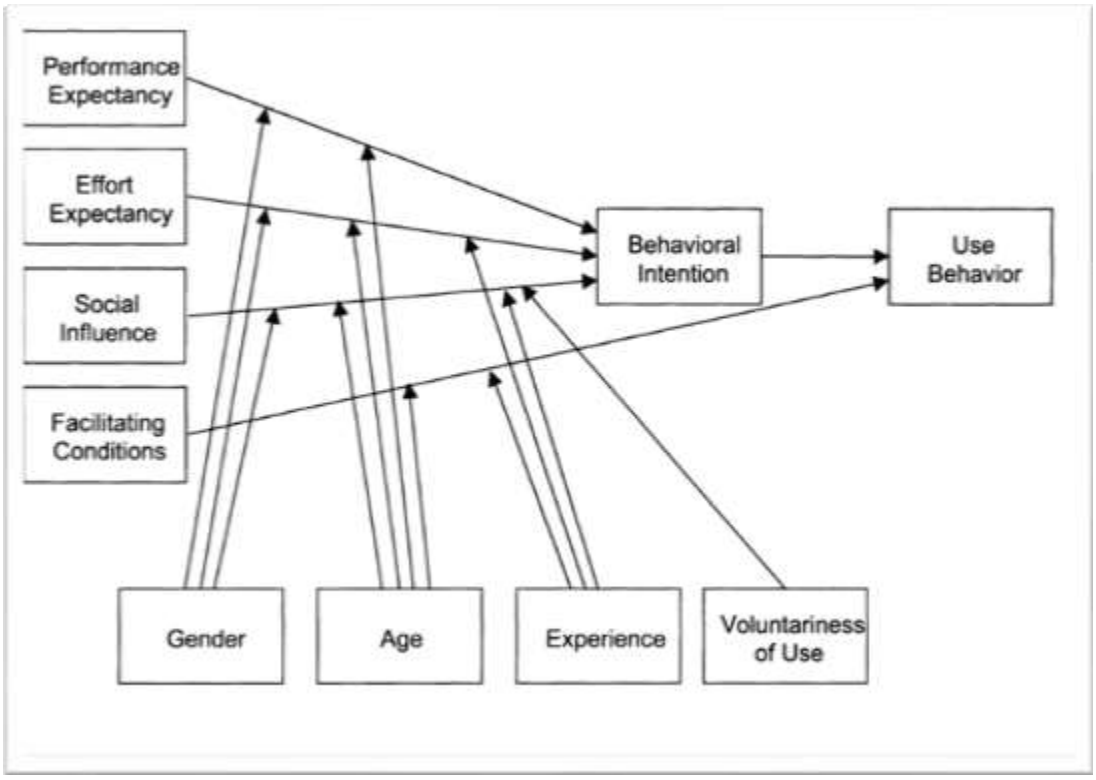


Figure 2-1 UTAUT (Venkatesh *et al*. 2003)

He suggested that performance expectancy was the determinant of intention in most situations validated within the model, but influenced by a person's gender and their age. He also believed IS researchers may be approaching the practical limits of determining individual acceptance and usage and future research within this areas should incorporate other research domains within this work (Venkatesh *et al*. 2003). As the model was mainly implemented in the United States, Venkatesh & Zhang (2010) reapplied the model to a Chinese context. They found that UTAUT did not work the same in China as in the US due to the variance in culture. The lesson of this study is that researchers have not understood fully the role of culture within technology adoption.

However the model is still used widely within the IS community as a valid adoption model. Such was the case with the Irish Department of Agriculture who applied the model in an attempt to understand ICT adoption amongst Irish rural communities.

2.2.3 Application of UTAUT in an Irish Context

In May 2007, the Irish Minister for Agriculture established a committee to examine and improve the uptake of technologies by Irish farmers and rural communities. The role of the committee was to explore ways to accelerate ICT adoption so that the agricultural sector was in a position to benefit from ICT's.

To determine technology adoption Connelly & Woods (2010) applied the UTAUT model to determine the influencing factors on farmers' behaviour towards using farming software and farming websites. A stratified sample of 1200 farmers based on county and type was used. A postal survey was sent by the Department of Agriculture out of which 165 responded. The survey was also hosted online out of which 229 responded. However, the online responses were omitted from the study as respondents failed to answer all parts of the survey and as such were deemed unreliable. Findings from the research were entirely based on the postal survey.

The main finding was the usefulness of the technology with one farmer believing the systems as "not useful to their working day". Others mentioned the seasonality of using the software. For example farmers often forgot how to use the system as they were using it when registering animal's births (in spring) or submitting online applications for the Single Farm Payment. Social influences appear to outweigh the technical aspects of the technology, though why this was the case was not thoroughly reported in the study. Similar adoption studies on the use of ICT's in particularly e-agricultural systems were undertaken elsewhere these are briefly reviewed in the next section.

2.3 Global E-agricultural systems

Gakuru *et al*. (2009) defined e-agriculture as an integration of knowledge and culture through technology, in order to improve communication and learning processes amongst relevant actors in agriculture. Brewer *et al*. (2005) reviewed the World Bank's categorisation of e-agricultural projects in less-developed countries and found that the projects implemented off-the-shelf technology designed for the industrialised world, rather than for rural contexts and this contributed to the failure of these projects. They believed projects must deal with contextualised social issues. Many attempts were made to supply ICT solutions to developing

countries, and some have been deemed a success such as the e-Choupal project in India described in the following paragraph.

2.3.1 The E-Choupal Project

The Indian Tobacco Company (ITC) began e-Choupal in 2000. The term "Choupal" is a Hindi word, meaning the meeting point in a village. ITC decided to directly reach smallholder farmers using ICT to buy their products, thus cutting out the middleman. The project was named e-Choupal to signify the use of ICT as a communication medium and was based on the knowledge-sharing found in the traditional "Choupal" model (Singh 2006). ITC supplied each farmer with an e-Choupal 'kit'; a personal computer (PC) with an operating system, multimedia kit, and connectivity interface, connection lines via either telephone or VSAT (Very Small Aperture Terminal), a power supply consisting of UPS (Uninterruptible Power Supply) and solar-powered battery backup and finally a dot-matrix printer. The hardware setup enabled farmers to access a local website for local weather information and market prices. It also and contained a question and answer section for users.

2.3.2 The National Farmers Information Service – NAFIS

In less-developed countries, technologies such as radio, television, tele-centers, mobile phones, text-messaging and the internet have all been applied as ICT solutions for farmers (Gakuru *et al*. 2009). In Africa, the National Farmers Information Service – NAFIS [www.nafis.go.ke], a voice-based service, is one such initiative. Another initiative is INFONET [www.infonet-biovission.org] a web-based service promoting organic farming. However, Gakuru *et al*. (2009) claimed that seeking information from NAFIS and INFONET became an onerous task for the farmers as it entailed ploughing through publications on-line to find the relevant information.

2.3.3 Conclusions from NAFIS and e-Choupal

NAFIS and e-Choupal are considered two successful implementations of e-agricultural systems (Singh 2006, Annamalai & Rao 2003). However, others argued that e-Choupal is not a holistic ICT development model as incomes of farmers who were part of e-Choupal increased whilst those who did not partake noted a decline in income. These is due to institutions with product-specific and platform-specific technologies driving the initiative,

with the success of the project measured solely in economic terms, ignoring the social, cultural and ecological domains, reflected in a lack of understanding of the local languages and local information (Singla 2005, Kannabiran *et al*. 2009, Dangi *et al*. 2010). Similarly, Rathod *et al*. (2016) found that the lack of customisation of ICT services to serve the specific needs of farmers, and the lack of operational knowledge impeded leveraging the potential of mobile phones in the Indian dairy sector.

2.3.4 Indian e-Government Projects

Likewise, Gorla (2008) reviewed ten e-government projects in India from the perspective of personal, economic and operational factors. Whilst operational hurdles could be addressed by infrastructural investment (telecom networks) the technologies were "unresponsive" to people's needs and did not improve citizen interactions with the Indian government. Furthermore, there was a lack of understanding about rural sectors, evidenced by presenting user interfaces in English for users illiterate in the language. Writing user "interfaces in local language" was outlined as one measure that could improve adoption and promote innovation in varying social contexts (Gorla 2008, p. 10).

2.3.5 Hungarian ICT Adoption Study

The latest wave of software solutions utilise mobile applications. A survey conducted on Hungarian farmers from the Hajdú-Bihar county reviewed their use of ICT's including mobile applications. The questionnaire focused on the availability of different devices, usage patterns and also the attitudes and opinions towards the Internet. In total 148 questionnaires were collected. Findings from the survey were as follows:

- 80% of the respondents had access to a computer at home.
- 80% said they were weekly or daily users of the web.
- The characteristics of the farm: such as farm size or level of income has no influence on the adoption of smartphones.
- Applications used were generic weather apps and calculators.

However, the main barrier to adoption cited by respondents was the lack of applications written in Hungarian. Csótó (2015) also argued that system developers' failure to satisfy the needs of farmers in the latest wave of mobile app development is acting as a

barrier to adoption. Adding ICT skills and technology cost was not a barrier to the adoption of smartphone technology (Csótó 2015).

2.3.6 Global Survey of e-Agriculture Usage

In 2007, the Food and Agriculture Organisation conducted a global analysis of e-agriculture usage, to determine if relevant stakeholders[2] could identify the benefits of e-Agricultural systems and perceived barriers (Masiello-Riome *et al*. 2008).

The survey was made available online in three languages (English, Spanish and French) to 4000 farmers in 135 countries. In total 3,400 responded but failed to answer all questions. From this 57% were unaware of the term 'e-Agriculture'. All respondents failed to completely answer all questions. The majority of respondents believed e-agriculture to be the use of ICT for the dissemination of farming techniques and practices amongst farming stakeholders. Using ICT allowed farmers to achieve broader development goals such as more secure livelihoods, reduced poverty, food security, agricultural and environmental sustainability, trade and conservation. What this survey offered to the research is that whilst the farming community appear to know and understand the term e-agriculture and its potential benefits the uptake of such services remains slow.

2.4 Adoption of e-Agriculture

What the aforementioned show is that adoption of ICTs in rural communities requires a deeper understanding of the working lives and behaviours of rural people. Technology development should capture the characteristics within particular contexts all which impacts on their adoption and diffusion (Choudrie & Dwivedi 2005). In spite of decades of research into innovation adoption, we still do not have a good understanding as to why certain sections of society adopt more quickly than others. This was evident in the case of farming innovations were the technology and knowledge presented did not match individual farm

[2] Stakeholders - Consultative Group on International Agricultural Research (CGIAR); Technical Centre for Agriculture and Rural Development (CTA); UN Department of Economic an d Social Affairs (DESA); FAO; Gesellschaft fur Technische Zusammenarbeit (GTZ); Global Forum on Agricultural Research (GFAR); Inter-American Institute for Cooperation on Agriculture (IICA); International Association of Agricultural Information Specialists (IAALD); International Centre for Communication for Development (IICD); International Fund for Agricultural Development (IFAD); International Telecommunications Union (ITU); World Bank.

conditions in Africa, Indian, Ireland and Hungry (Koutsouris 2012, Connolly & Woods 2010,Gakuru *et al*. 2009,Gorla 2008, Csótó 2015). The scientific approach to innovation-acceptance presents methodologies looking at the human as separate from its context (Orlikowski & Iacano 2001). They suggested that as both technologies and social systems become more complex traditional IS models need combining with other domains of research as to broaden understanding of the area.

Alter (2013) suggested that when system designers concentrate on the technical aspects of design rather than the users' needs it often leads to what he considered systems failure. Gasson (2003, p. 3) argued that traditional approaches to technology design deskill users and impoverish their working life. She suggested that designers view information technology as a "black box" and focus on work processes with little regard for the conditions of use.

Social phenomena are complex entities because of the complexity of human affairs; people using a system interpret it, amend it and adjust it as they see fit (Clegg 2000, Checkland 1999). In the context of e-agricultural innovations, there appears to be a need to deepen the understanding of context of use of current and future ICT innovations (Somers & Stapleton 2015). To explore this further the next section reviews Systems Theory.

2.5 Systems Theory

Flood (2010) suggested that systems thinking emerged through a critique of reductionism. Reductionism generates knowledge and understanding of phenomena by breaking them down into integral parts and studying these simple elements in terms of cause and effect (Flood 2010). Systems theory is an interdisciplinary field, encompassing every system in nature, society and several other scientific domains (Barrle & Saviano 2011). Generally, systems theorists believe that across various different sciences a single set of concepts or theoretical constructions can be applied which identifies gaps in empirical knowledge and helps define a complete system (Scott 2015). The systems thinking view is about understanding connections and interdependencies in a system and gives rise to a number of concepts: holism, transformation, variety, feedback and control (White 2015).

2.5.1 System Components

A system has a perceived *boundary* distinguishing internal and external elements, identifiable *inputs* and *outputs* relating to and emerging from the system (Barile & Saviano 2011). To facilitate interaction amongst components a system has *feedback loops* which are either negative (weakening) or positive (enforcing) (Tschiersch & Schael 2003). These feedback loops are used for the stabilisation of a system towards a goal (Skyttner 2005).

2.5.2 Technological IS Systems

Jacucci *et al*. (2006) believed that technological information systems are complex, with varying definitions as to what is understood by complex. They suggested a system has an emergent property that is composed of a number of self-organising agents, interacting in a dynamic and nonlinear fashion with a shared common path (Jacucci *et al*. 2006). Haggis (2008) expanded complexity and suggested that complex information systems imply the concept of open, dynamic systems, embedded within and partly constituting each other, whilst maintaining their own coherence. What Haggis (2008) offered was a lens of analysis for information systems in context, with individuality and differences. To focus on the interactions, rather than static categories, complexity theory makes it possible to consider the different aspects of a process.

2.5.2.1 Architecture of Complex Systems

Koestler (1970) proposed a framework to describe the architecture of complex intelligent systems. He posited the term *holon,* an element feature of a system. A *holon* is an entity that exists contextually in a nested network of holons, referred to as a *holarchy*. *A holarchy* has reciprocal power relationships between levels rather than a preponderance of power exerted from the top downwards. A *holon* of particular interest for an observer occurs in some holarchic relationships, with mutual causality guiding reciprocal interactions between one holon and contiguous holons of different scales. A systems cannot be understood by focusing on one hierarchical level (holon) but understanding comes from multiple perspectives of different scales (Kay *et al*. 1999). What this offered to this research is that all components of a system must be attended too at both the micro and macro level. As interlocking existed between hierarchies enabled by feedback.

2.5.2.2 Emergent Behaviour and Complexity

Complex systems span different levels of analysis, each with structure giving rise to varying or emergent behaviour (Mukherjee 2008). Haggis (2008) explained how things emerge at certain points in a set of multiple interactions over time, rather than as a result of generative causal structures. Emergence is based on interaction, which might be thought of as unpredictable. However, it is constrained by features of the system, its interactions with larger systems, and by environmental factors. Haggis (2008) suggested that what emerges from interactions is not mysterious but consistent with the nature and histories of the interactions involved. It allows a researcher to interpret aspects of social life as it focuses on the interactions and relationships that occur within systems (Haggis 2008).

Urry (2005) applied the metaphor of balance to the interactions between the machine and the social world, describing it as chaordic. Order and chaos he believed are often in a kind of balance where the components are neither fully locked into place but do not dissolve into anarchy – they are on the edge of chaos. Components of a system do not operate from a state of equilibrium but respond to local sources of information used to balance the system (Cilliers 2002).

2.5.2.3 Adaptation in Complex Systems

Fikentscher (1998) believed time allows for adaptation in a complex system. Adaptation is determined by whether the system is an open or closed one. A closed system is time-neutral and does not evolve over time. An open system on the other hand works across time, develops and adapts. Jost (2004) claimed that adaptation occurs when complex systems operate in an environment more complex than the system itself. Systems exist in changing environments and in order for them to evolve; they must act with a certain amount of freedom. To allow freedom, the anatomy of the system must be *adaptive* to the environment. Evolution occurs because systems are in constant interaction with environments (Jackson & Keys 1984). As Vickers (2008) suggested an open system does not exist in isolation.

Salancik & Pfeffer (1978) believed an open system in a social context perceives each individual as interacting with others. Complexity provides metaphors, concepts and theories to analyse various systems that are complex, rich and non-linear thus broadening understanding of a system (Fikentscher 1998, Urry 2005). The Viable Systems Approach (VSA) is a system theory rooted in systems thinking (Beer 1984). The VSA rejected the notion that a particular phenomenon could be understood through a reductionist approach (Polese *et al*. 2017). The VSA is a lens of interpretation for the observation of complex

phenomena, which focuses on the analysis of relationships among socio-economic entities (Bairle & Polese 2011). VSA focuses on the behaviour between the entities as they interact with their environment.

2.5.2.4 IS Systems and Complexity

The development of information systems are considered complex processes, based on the social interplay of multiple actors who attempt to interpret or *make sense* of their and others' actions, largely through the medium of language (Hirschheim & Newman, 1991, p. 30). Checkland (1999) applied complexity theory to technological information systems and methodologies and proposed an action-oriented process of inquiry to problematic situations in the everyday world. A deeper understanding of complexity could be useful to the enrichment of understanding of how human systems and technology co-evolve to meet human requirements. This language could allow system developers to interpret the lives of farming communities and in turn produce technologies that support the working lives of rural people.

2.6 The Rural Context

E-agriculture is comprised of local farming systems, which are complex and adaptive, co-evolving with human societies to satisfy human needs and fit ecological conditions (Koutsouris 2010). In technology-centred thinking, knowledge is treated as a complex information structure capable of being stored in highly sophisticated data systems and processed explicitly by intelligent, software-based technologies. This belief relies on scientific experimentation that creates a general fix for agricultural problems. General systems make it time-consuming for farmers to extract relevant information as these systems are deployed with general non-specific advice mainly written in English irrespective of the end users spoken language (Alter 2013, Koutsouris 2010, 2012, Gakuru *et al.* 2009). An exploration of a systems development approach suited to the rural context requires a deep insight into the experiences of users and developers. One such approach is socio-technical systems, aimed at addressing real-world systemic problems.

2.7 A Socio-Technical Approach to Systems Development

Gasson (2003) suggested traditional technology system design deskills users. She added technology design focuses on the technology and humans interaction instead of questioning how and why technology may support human work. This socio technical view of system design balances the requirements of two competing systems, the social system and the technical system (Gasson 2003).

A socio-technical perspective embraces the idea that all aspects of systems are interconnected and that no element of the system takes precedence over another. Socio-technical design aims to give equal weight to both social and technical issues when designing new work systems (Mumford 2006). This socio-technical approach dates back to the works of Trist and Bamforth (Geels 2005). They suggested that human and organisational outcomes were better understood when social, psychological, environmental and technological systems were assessed as a whole system. One of the founding principles of socio-technical systems theory is that both the technical sub-system and the social-physiological sub-system must be given equal weight and when this is the case, the information systems goals are met (Jackson & Keys 1984).

Socio-technical systems stress the reciprocal interrelationship between humans and machines, which in turn shapes both the technical and the social conditions of work. Flood (2010) suggested a systems approach allowed the interpretation of social phenomena. He added that a systems approach promised to construct meaning that reflected a person's experiences within the world.

2.7.1 Models of Socio-Technical Systems (STS)

Socio technical designers view complex systems design as a unified approach, taking into account the four dimensions of task, people, organisation, and technology at every stage of design. These elements are dynamically stabilised in the STS. The benefit of this approach is that it allows for change which occurs over time in complex systems. STS do not function autonomously but are the outcome of human interactions (Geels 2005). Therefore, each dimension must make sense to the actors within the context of the overall STS (Checkland 1999).

2.7.1.1 Sense making in a Social Technical System

Weick (1995) suggested sense making is a complex intersubjective, social process by which actors working together come to understand their world and form (or reform), their sense of individual and shared identity. Individuality and shared identity is seen in sharing a particular language (*jargon*), telling stories and reading the same journals all which reflects coordination within a group (Geels 2005). Sense making is a way of constructing identity and linked to deep processes of learning and knowledge. When a new technology, work practice etc. is encountered it raises questions which must be explained and understood through a process of sense making. According to Stapleton and Ovaska (2010) sense making changes environments and is cyclical. People involved in sense making activities interact with each other in order to make sense of realities and allows people to structure the unknown.

It is shown to be central to socio-technical systems design and a success factor in systems engineering (Ovaska & Stapleton 2010, Stapleton 1999, Checkland 1999). From an innovation-in-the-workplace perspective, we can infer that if some technology does not make sense in the context of knowledge use in the rest of the STS, then it will not make sense to the innovators, therefore acting as a barrier to innovation.

2.7.1.2 Dimensions of the STS

In his review of technology-enabled business in transition economies, Samolienko (2008) showed how socio-technical systems knowledge i.e. knowledge about how to effectively integrate organisational and technical processes and systems, is a key factor in the successful adoption of ICT technologies. Coakes (2002) believed that socio-technical design produces systems capable of self-modification, adaption to change, making the most of the creative capacity of the individual for the benefit of the organization. This demonstrates the capacity of the STS approach to address important features of systems complexity.

To address complexity the STS approach gave rise to many human–centred methodologies. These include the Soft Systems Methodology (SSM) (Checkland 1999, Checkland & Scholes 1990) and, the Effective Technical and Human Implementation of Computer-based Systems (ETHICS) (Mumford 1983). Another methodological choice is Multiview, which allows flexibility to suit heterogeneous situations (Avison & Wood-Harper 1990). STS reflects a broader interest in systems thinking, placing human and human communities at the centre of advanced systems design activities.

2.7.2 Human-Centred Perspective to Systems Development

Cooley (1987) proposed the phrase 'human-centred technology' and believed people have a right and a responsibility to change technology if it does not suit their working conditions. Human-centred technology stems from a socio-technical perspective but transcends the linear notions of human and machine (Gill 2012). It shifts the emphasis from technology to human needs, purpose, skill, creativity and potential concerns which are at the heart of human organisational life (Gill 1996, Gill 2012, Brandt & Cernetic 1998). It requires us to treat knowledge in human terms, enabling individuals and communities to lead the lives they choose (World Development Report 2008). This concept has strong roots in the automation literature, based upon the notion of people first, organisations second and technical considerations third (Brandt 2002, Brandt & Cernetic 1998). It deemphasises the mechanistic paradigm by offering theoretical and methodological frameworks for the social and cultural shaping of technologies. The human-centred perspective emphasises human-machine symbiosis, creativity and innovation, participatory and cooperative design exploiting the tacit dimension of knowledge (Gill 1996).

2.8. The Human Centred Perspective: STS and Tacit Knowledge

Central to Polanyi (1966) thinking was the idea that one views the world from a centre within ourselves and speaks in a language shaped by our existence. A person's knowledge is based on the manner of encountering the world and not by scientific description.

Polanyi (1966) stressed the importance of a personal way of knowledge sharing, by knowing and the role of language in communicating knowledge. Language is a vital tool, as often we know how to do things without either knowing or being able to articulate to others, why what we do works this he termed tacit knowledge (Polanyi 1966). Some, such as Nonaka *et al*. (2005) proposed a unified model of dynamic knowledge creation; knowledge is dynamic, since it is created in interactions between individuals and organizations. It is context specific, as it depends on a particular time and space. Without context it is merely information. Information becomes knowledge interpreted, given a context and anchored in the beliefs and commitments of individuals (Nonaka *et al*. 2005). Tacit knowledge is the source of all knowledge, and particularly of innovative ideas (Nonaka *et al*. 2005).

Explicit knowledge is embodied in a code or language and verbalised, communicated, processed, transmitted and stored allowing it to be found in books, journals, newspapers, television and the internet, often in the form of data and scientific formulae (Nonaka & Takeuchi 1995).

Tacit knowledge on the other hand is personal and contextually rooted in actions, procedures, commitment, values and emotions. Kikoski & Kikoski (2004) believed it is acquired by sharing experiences, observations and imitation and not easily codified. Tacit and explicit knowledge are complementary and essential to knowledge creation (Seidler-de Alwis & Hartman 2008).

Cooley (1987) argued that the knowledge embedded in the working life of individuals is not amenable to description in a codified system such as information technology. Humans rely on informal as well as formal sources of information, and this information is contextual while data is context-free and simply the raw material to which information (meaning) may be attributed (Galliers & Newell 2003).

Angstreich & Zinnah (2007) believed tacit knowledge when combined with modern science is invaluable in agriculture and key in the development of workable solutions for agriculture: built over the centuries and shaped by natural environments. They believed local knowledge played a role in the preservation, development, and promotion of practices. This knowledge is location-specific, based on close personal observations and experiences and transmitted orally from one generation to the next. Whyte & Classen (2012) believed storytelling could be used as an instrument for the diffusion of tacit knowledge and is ideal for the transmission of knowledge.

Angstreich & Zinnah (2007) suggested agricultural professionals should improve their understanding of and communication with farmers instead of following the belief that science provides a solution for most problems. The combination of both scientific and local knowledge could make research responsive to the needs of local farmers because communication with farmers combines tacit knowledge to generate a learning process involving new knowledge (Angstreich & Zinnah 2007). Fundamental to a human-centred perspective is the design of systems that can exploit human knowledge for creativity and innovation (Gill 1996).

2.8.1 Farming Knowledge

Farming by its nature involves ambiguous and imprecise engagement with natural systems such as weather, soil, animals, and so is not amenable to precise predictable behaviour and management. Predictability however is at the heart of the functional rationalism which underpins ICT development thinking (Stapleton 2006). IT systems contain empty slots filled with abstract, de-contextualised knowledge with the user attempting to interpret the system into their situation (Brödner 2009).

2.8.1.2 Farming Education

Farming education happens over generations through the practical experience of working with the land and with animals. Knowledge is passed along through stories; through complex practices (sometimes secret knowledge such as herbal medicinal remedies) and other processes. These processes consist of both personal and experimental knowledge-transfer which is constrained by social and cultural contexts and plays a key role in forming an avenue for change within agriculture (Jorgensen 2006).

Knowledge, whether indigenous or scientific, is not a straightforward accumulation of facts, but involves ways of comprehending the world: and it is always in the making. The information needs of farmers and rural people has shifted in focus from a local agricultural centre towards participation in national and global markets and towards shared innovations, all of which may cross national boundaries (Singh 2006). Technological innovations that follow a machine-centred approach are not conducive to end–users acceptance of technology (Checkland 1999). Gill (2002) added that tacit knowledge could be lost in a machine centred view. Gourlay (2006) identified six ambiguities with tacit knowledge,

1. it is both individual and collective;
2. it is acquired through experience;
3. it is acquired with or without of others present;
4. it is a form of practical intelligence whilst also being defensive, naïve or belying incorrect theory;
5. it facilitates routine behaviours whilst also being a source of innovation; and
6. it may or may not be converted to explicit knowledge.

2.8.2 Conceptualising Tacit Knowledge

Smith *et al*. (2007) argued that the diverse knowledge needs of individual people often creates problems for extracting tacit knowledge as this type of knowledge is embedded in the norms and culture of individuals. They proposed a way of interpreting or extracting this embedded knowledge. Firstly, best practices - this type of knowledge transfer captures and leverages existing knowledge, not to generate new knowledge, but to re-use what others have learned.

Secondly, expertise includes the individuals strengths in terms of skills and capabilities or 'know-how'. Expertise comes from a small number of experts in a particular area and grows out of the combination of specific skills and experience.

Thirdly, experience is a mixture of lessons learned or casually put the "the school of hard knocks". Experience comes from cognitive assessments, relationships and preconceived ideas, combined with intelligence; transforming information into usable knowledge.

Lastly, innovation opportunities for transformation includes ways to stimulate the development of new ideas and ways to motivate people to become more responsive to change. Innovation is the biggest challenge because it requires the ability to integrate new information with existing knowledge, to create something new. Seidler-de Alwis & Hartmann (2008) believed that from tacit knowledge comes creativity and innovations. Often innovation is an avenue of change thus aiding the diffusion process.

2.9 Innovation

"Innovativeness, like efficiency, is a characteristic we want social organisms to possess" (Downs & Mohr, 1976 p.700). Innovation is important in the development of society. In human-centred system perspectives, innovations stem from teamwork, group work and life learning (Garibaldo 2011). Knowledge is shared, strategies agreed and individual competencies exploited, thus supporting societal innovations (Mumford 2000, Gill 2002). The economist Joseph Schumpeter claimed that innovation is a "process separate from invention, but where new ideas, behaviour or things.. [are].. brought into reality" (Schumpeter 2010, p. 222).

Innovation is either an adaptive response or creative response. An adaptive response is reactive, expanding or contracting current practices. Creative responses permanently change social and economic situations with no link between past and present. Creative responses are proactive and pivotal to entrepreneurial activity, giving rise to innovations (Schumpeter 2010,

p. 222). The human-centred tradition supports human creativity that leads to innovations (Gill 2002).

2.9.1 Agricultural innovations

Technological change in agriculture such as the steel plough, the thresher, and the combine harvester arose from mechanical innovations and changed the lives of farmers by saving on labour and increasing yields. Farmers tend to adopt biological innovations (new seed variations), chemical innovations (fertilizers and pesticides) animal innovations (feeding and breeding) or mechanical technology (tractors and combines) quicker than ICT's. As these innovations offer opportunities to increase production and income and provide a solution to real-farming problems, such as declining incomes, poorer crop yields and operational inefficiencies (Feder *et al*. 1985). Often such innovations emerged because of scarcity or resources and economic opportunity aiding the diffusion process (Sunding & Zilberman 2001).

Agricultural innovations often involve incremental change, adding value by reducing costs or increasing revenue (or both) to improve the lives of farmers (Fagerberg & Verspagen 2007). Akudugu *et al*. (2012) believed agricultural adoption literature suggested farm size as the first and most important determinant in adoption. However, they believed categorising factors into economic (cost, access to credit), social (age, education) and institutional (access to extension services) factors improved understanding of the adoption process. In conclusion, they stressed the presence of a serious gap in the literature which needed to be addressed to improve technology adoption among farmers.

2.9.2 Improvisation: Innovations and Knowledge

Within the IS literature, Ciborra (1996) argued improvisation is a purposeful human behaviour influenced by chance; intuition, and competence, which when combined, allowed a response to a problematic situation to generate an action. This composition of execution, thinking and doing, converged in time and gave rise to innovations.

Sunding & Zilberman (2001) suggested that knowledge about innovations comes from new methods, customs, or the devices used to perform new tasks. Organisations place an emphasis on knowledge seeing it as a valuable resource allowing for innovation and

creativity in response to changing environments through sharing (Reychav & Weisberg 2010). When individuals have a common practice, knowledge readily flows, enabling people to create social networks to support knowledge exchange and foster innovation (Brown & Duguid 2001).

In systems development the machine-oriented view focuses on the codification of knowledge which is not possible for tacit knowledge (Stapleton 2013). Socio-technical system methodologies allocate equal weight to both technical and human factors in the design process stimulating innovation. This design process encourages flexibility and intellectual growth (Baxter & Sommerville 2011). The human centred view of systems development emphasises networked societies in which shared communication and shared knowledge drives the valorisation of diversity and this valorisation facilitates shared communication and shared knowledge (Gill 2002).

It could be argued that the slow adoption of ICT in agricultural communities is, in fact, a clash of cultures. The culture of agricultural communities is rooted in dynamic responses to a fluid natural world and the use of tacit knowledge in engagement is important, linking hand and brain to combat natural forces (Cooley 1987). Peirano-Vejo & Stablein (2009) suggested in many agricultural communities, the transfer of tacit knowledge from generation to generation is in stories and myths supported by the process of sensemaking.

Tacit knowledge is not amenable to a functionally rationalist paradigm but is an important factor in successful systems implementations, even in the most advanced organisational technologies (Stapleton *et al*. 2005, Murphy *et al*. 2008). Supporting technology innovation adoption amongst rural communities, technologies must align with social processes to incorporate the knowledge embedded in the social context (Koutsouris 2010, 2012, Stapleton 2011, Gakuru *et al*. 2009).

All communities share knowledge that valorises diversity (Gill 2002). The utilisation of knowledge for technology innovation acceptance should recognise knowledge diversity within the social context, including creativity and innovative capabilities of the shared social and cultural spaces of the human dimension. Knowledge is context-based with a social and personal dimension. Gill (2002) suggested the notion of shared knowledge goes against the machine-centred approach, which ignores the complexities of social, economic and cultural realities and blurs the tacit knowledge inherent within all human cultures and social systems. Gill argued for a conceptual framework that understands the nature of knowledge and includes knowledge in the development of technology within a purposeful social context for

human improvement. To assimilate tacit knowledge the focus should be on knowledge governance that shares grass root knowledge.

Scoones (2009) believed capturing rural knowledge is difficult as it is fragmentary, partial and provisional in nature. To integrate local knowledge into scientific procedures is liable to make assumptions that rural people's knowledge represents an easily definable body of knowledge ready for extraction and incorporation. This is not the case as knowledge is inherent and emerges from a multi-dimensional universe in which diverse cultural, economic, environmental, and socio-political factors intersect and influence one another (Scoones 2009). Stapleton (2009) also described technology adoption in socio-technical terms and identified influencing factors such as culture and institutional forces.

To address the socio-technical view of external influences on communities an institutional lens could perhaps allow a deeper understanding of the forces that influence adoption of technology. Institutional theory as suggested by Scott (2013) delves into the deeper aspects of social beliefs and values.

2.10 Institutionalism and the Human Centred Perspective of Technology Adoption

Scott (2013) believed institutions comprise of regularity, normative and cultural elements that together provide stability to social life. An institution is a community where members legitimise various structures and systems providing social order and norms for cooperation within the institution and outward to other institutions.

Institutional theory presents an understanding of human behaviour focused on the role of norms, symbols, myths, belief systems and a combination of formal and informal arrangements collectively forming the organisational culture (Selznick 1996). Structures and systems are established as authoritative guidelines for social behaviour (Scott 2013). The social structures of schemas, rules, norms, and routines created, diffused, adopted and adapted over space and time, eventually fall into decline and disuse in order to create order and stability in the pursuit of social legitimacy (Scott 2013, Powell & Colyvas 2008).

Institutional legitimacy derives from the beliefs members of society hold about the normative appropriateness of government structures, officials, and processes and denoted acceptance of officials' right to govern (Levi *et al*. 2009). Stapleton (2011) added that institutional theory views organisations as social structures, that are adaptive, shaped by influences and constraints imposed by external environments. Rational individual behaviour is rooted in and reflective of multiple contexts that include culture, legal frameworks, and

agency interests and behaviour must be explained on a situational bias, with each context being different (Scott 2013).

Selznick (1996) first applied theories of institutionalism to organisations. Fouopi & Stapleton (2011) suggested institutionalism aided understanding of human behaviour within institutions Organisations tend to become homogenous in both process and structure over time, with the process known as isomorphism (Stapleton 2009). DiMaggio & Powell (1991) proposed three types of isomorphic pressures, which cause institutions to become like each other and consequently adopt similar technologies and processes:

1. Coercive isomorphism results from both formal and informal pressures exerted by powerful organisations on dependant organisations. Often pressures of this type are felt as a "force" by the lesser organisation (DiMaggio & Powell 1991, p. 32). These forces occur when governments change legislations such as tax or environmental regulations.
2. Normative: This type of isomorphism stems from professionalism, where certain institutional structures and processes become normalised and accepted as legitimate processes across communities over time. DiMaggio & Powell (1991) believed two aspects of professionalism are educational institutions and professional networks such as professional and trade organisations. They suggested this mechanism of isomorphism creates a pool of individuals who share common beliefs that transcends the position held by the controlling organisation (Radaelli 2000).
3. Mimetic isomorphism often arises from uncertainty. E.g., when technologies are poorly understood or the environment may create uncertainty. Organisations may mimic or model the behaviour or systems of other organisations held in high status in the community. This helps organisations cope when faced with uncertainty by imitating organisation perceived more successful.

Akudugu *et al*. (2012) cited the importance of institutional isomorphism in the adoption of innovations amongst organisations. By identifying these types of institutions, it will deepen understanding of technology adoption in agriculture.

2.10.1 Agricultural Institutions

In many countries, farmers enjoy the support of various institutional structures, which legitimise their work and underpin community identity. In an Irish context, there is

institutional support for agriculture by government agencies e.g. Teagasc[3], An Bord Bia and with peer-support networks such as the Irish Farmers Association (IFA) or the Irish Cattle and Sheep Farmers Association (ICSA) as well as third-party consulting and advisory bodies.

These institutions promote innovation in animal husbandry (biological innovations), machinery (mechanical innovations), and chemical innovations such as fertilizers. Across the world, farmers have adopted such innovations quickly, as they came with institutional support and scientific knowledge, promoting the potential to increase productivity and farm income (Feder *et al*. 1985). However, although these institutional agencies may promote ICT in general terms (such as an internet presence), they have given very little attention to the potential of ICT as an agency for innovation and change within agriculture. It is therefore difficult for farmers to appreciate the role of ICT in improving work out in the fields. Consequently, the institutional arrangements themselves may act as a barrier on ICT innovations adoption as was the case in less developed countries (Stapleton & Lemouchele 2011).

2.10.2 Mechanisms of Institutional Change

Dacin *et al*. (2002) suggested that institutional change arises from micro-level and sub organizational levels, macro-societal levels and global levels. It could take place briefly, and incrementally, so that observers and participants are unaware of change, or abruptly, in dramatic episodes that present large discontinuities with former patterns.

As many changes happen at micro-level observing change within an institution by the observation of an individual's daily routines of problem-solving may provide great insight into change processes (Dacin *et al* 2002). Powell & Colyvas (2008) therefore proposed a micro-level analysis of institutionalisation whereby effects on the ground prompt more visible macro-level change.

At the micro level s*ensemaking*, is the reciprocal interpretation of identity and how an environment is understood (Weick 1995). Sensemaking attends to the contingent influences of norms and role structure. Individuals are entangled in a structure of relationships, taking cues from both the situation and others enabling them to interact with their environment (Weick 1995). A sensemaking theoretical approach directs attention to the importance of institutional change (Powell & Colyvas 2008). In systems development , Ovaska & Stapleton

[3] Teagasc - The agriculture and food development authority in Ireland to support science-based innovation in the agri-food sector

(2010) suggested that within complex systems development sensemaking is important in facilitating technology development to meet the context needs.

Status expectations where individuals draw on widely shared cultural beliefs concerning status and success which acted as guides for appropriate behaviour. Status expectations complement sensemaking with external social statuses manifesting themselves in everyday activities (Powell & Colyvas 2008).

2.10.3 Institutional Adoption Process

During an institutional innovation adoption process, one deciding factor is how the innovation will improve the internal processes of the social group. Once a group accepts the innovation, then members of the wider community will adopt the technology. This process ensures the legitimacy of the innovation with the social group acting in a collective manner. A recent study of technology adoption in Kosovo showed that subsidiaries of large firms are more likely to adopt a technology if the host organisation (headquarters) has already adopted it (Stapleton 2011).

In contrast, Information Systems technology adoption literature generally focuses on how the features of a new technology interacts with the individual psychology of adopters (for example the Technology Adoption Model). However, institutional structures and processes which influence innovation and technology adoption, are receiving attention. For example, in his analysis of the adoption of supply chain technologies in Kosovo, Stapleton (2011) showed the importance of institutional factors in ICT adoption processes. In the Kosovan study, some institutional factors were more important than the factors predicated by TAM.

Meyer & Rowan (1977) claimed that cultural persistence and isomorphism meant organisations implement innovations differently, dependent on the context in which it is embedded. This indicates the importance of cultural values and perhaps another lens on analysis.

2.11 Human Centred Perspective: Culture and Values

Cultural research is complex, given the myriad of definitions, conceptualizations, and dimensions used to describe it (Straub *et al.* 2009). Culture underpins and shapes the beliefs, values, attitudes, feelings, and overt behaviour of groups. These cultural values represent the implicitly or explicitly shared ideas about what is good, right, and desirable in a society (Williams 1995).

Schein (2010) suggested that culture:

- is a pattern of basic assumptions,
- is invented, discovered, or developed by a given group,
- help groups to cope with problems of external adaptation and internal integration,
- is a learning system, this system help cultural groups learn from one generation to the next .

Culture is the basis for specific norms that tell people what is appropriate in various situations. The ways that societal institutions (e.g. the family, education, economic, political, religious systems) function, their goals and their modes of operation, express cultural value priorities.

Brennan *et al*. (2009) suggested culture consisted of elements of the past, outside influences and new locally developed elements and is a mechanism for change. McCarthy (2005) shared this view and suggested that culture is systemic in that change in any one part of a culture will be accompanied by change in the other parts and that culture groups are integrated. Culture is a binding force.

Culture is an interactive aggregation of common characteristics influencing a group's response to its environment determining the uniqueness of a human group the same way as personality determines the uniqueness of an individual (Hofstede 2003). Hofstede (2003) suggested that the uniqueness of human culture comes from the individual -the ability of people to think differently but act together he referred to this pattern of learning as mental programs that persist over entire lives. Each person carries a certain amount of mental programming which gives rise to similar behaviours in similar situations. Whilst every person's mental programming is unique, it is partially shared. Schein (2010) believed societies, organisations, and groups have ways of conserving and passing values from

generation to another helping to bind groups into a sense of identity. This identity is common among people that belong to a certain group but different from people in a different group. To understand cultural identify Schein (2010) proposed a three- level model of culture. The model allows analysis and interpretation of culture from three levels:

1. Observable artefacts, everything from physical layout, dress code, the manner in which people address each other, the smell and feel of the place.
2. Espoused beliefs and values, these represent a manifestation of culture or beliefs as to what is important to a particular cultural group. Values answer the question as to why people behave the way they do.
3. Basic underlying assumptions, culture symbolised by artefacts. Artefacts include art, technology, visible and audible behaviour patterns as well as myths, heroes, language, rituals, and ceremony. While most observable of the three, they are the hardest to decipher in terms of their underlying cultural meanings.

He argued that basic underlying assumptions were the essence of how a group functions. If challenged can cause anxiety within the group when implementing change. One avenue of change is the introduction of new technology into a group. Leidner & Kayworth (2006) suggested that culture was often to blame when organizations experience IS failure. Technology is not culturally neutral. Its development is driven by underlying assumptions about its meaning, use, and consequences (Leidner & Kayworth, 2006).

2.11.1 Technology and Culture

Idhe (1992) argued for a deeper understanding of culture in relation to technology. He believed technologies are culturally embedded with neither the technology nor the culture more dominant that the other. Carew & Stapleton (2012) suggested that technology designers should consider local culture, values and customs of a group along with the technical aspects of a technology.

Stapleton *et al*. (2008) believed technology and culture are two sides of the same coin. Ciborra (2002) suggested failure to understand both within an information systems context puts the information systems world in *krisis*. This metaphor referred to the separation between everyday life and science in the creation and development of scientific methodology. This perspective is important in today's world because it deals with two dimensions (technology and culture) united (not in krisis) and allows interpretation or representation of all that subsists in the real world of technology.

Leidner & Kayworth (2006) suggested that technology introduced into a group that embodies values that conflicted with the cultural values of the adapting group impeded adoption. They added that users often changed the system so that it is in line with their values. The next section examines these cultural beliefs of the adopter more closely.

2.11.2 Cultural Units

Brown & Duguid (2000) suggested that working, learning and innovation are human activities, compatible, interrelated, and complementary. Knowledge networks and communities of practice (CoP) are central means by which to foster and enhance learning, knowledge sharing, and integration amongst groups (Brown & Duguid 2000, Lesser & Storck 2001). Kakabadse & Kakabadse (2002) claimed that knowledge sharing is a social process out of which emerges new knowledge, new ideas and innovative practices.

Putnam (2000) viewed such networks as tools for the enhancement of individual and cultural norms that yielded improved productivity. A culture of sharing existed in environments where structures exist that were effective, flexible and responsive to change (Kakabadse & Kakabadse 2002).

Gakuru *et al*. (2009) suggested that agricultural information systems which incorporated a blended learning process through face-to-face interaction and learning by doing, allowed the learner to evaluate and experience generic information and convert it to specific knowledge. He called for the establishment of organised learning communities when dealing with ICT innovations and their implementation. These insights suggest that a theoretical lens to help understand the relationships between work, learning, and innovations in rural communities could be the Community of Practice (CoP). The next section explores what is understood about communities of practice.

2.12 Community of Practice and the Human Centred Perspective:

Originally introduced in the context of Lave and Wenger's seminal research on social learning, a Community of Practice (CoP) is an "active system" where participants share understandings of what they are doing, thereby embodying a store of common knowledge (Lave *et al*. 1991, p. 166).

It is different from a knowledge network as it is more than a set of relationships. The CoP centres on learning from which emerges a structure, complex relationships, self-organization, dynamic boundaries, and on-going negotiation of community identity and cultural meaning. It defines itself along three dimensions:

1. what it is about,
2. how it functions and
3. what capabilities it has produced.

CoP's develop around what matters to people and the practice reflects what is important to the members. These dimensions allow the CoP to self-organise and learn (Wenger 2000).

Eckert (2006) defined a community of practice as a collection of people engaged on an on-going basis in some common endeavour. The value of communities of practice to technology innovation adoption by rural people as suggested by Eckert is in the identification of a social grouping not based on shared abstract characteristics (e.g. class, gender) or simple co-presence (e.g. neighbourhood, workplace), but by way of shared practice. Shared practice defines ways of doing things, views, values, power relations, and ways of talking and acting.

This view of CoP's is a practical way to understand how to connect people and how the collecting might share new knowledge. Eckert argued that two factors must exist when conceptualizing a CoP - shared experience over time, and a commitment to shared understanding. A community of practice engages people in sensemaking about engagement in the enterprise; the forms of participation in the enterprise and with other CoP's and with the world around them. She offers the perspective of CoP's as a way of exploring technology innovation adoption by rural communities. Knowledge within CoP's is not an object of learning instead it is a lived part of their practice (Wenger 2000).

Davenport & Hall (2002) claim that a CoP denotes the level of the social world at which a particular practice is common and coordinated and where generic understandings are created and shared, and negotiation is conducted.

Social learning is important for human development and learning by observation quickened the spread of successful behaviour within society (Dyer *et al*. 2009). Knowledge networks and communities of practice foster and enhance learning, knowledge sharing and integration in organizations (Lesser & Storck 2001). Communities of practice explore concepts of social or collective knowledge (Davenport & Hall 2002). However, agricultural communities operate outside formal organisational contexts found in the private sector. It can be reasonably speculated that perhaps Community of Practice thinking offers a theoretical lens to understand the relationships between work, learning and innovations in rural communities.

The community of practice literature emphasises the transfer of embedded or tacit knowledge facilitating the construction of a social reality where users cooperate and share knowledge (Garrety *et al.* 2004, Wenger 1999, Tenkasi & Boland, 1996).

Within the information systems literature, Winner (1993) believed that technology development often neglects working structures and social origins; he further added the need for a meaningful theory of technology that was not technology focused. Mumford (2003) argued that changes in technology development approaches were difficult if a divergence exists between technologist and end-users.

2.12.1 Learning and Knowledge in a Community of Practice

Lam (2000) claimed that learning and innovation could not be separated from societal contexts. Lave *et al*. (1991) believed learning is grounded in context and artefacts, and that context is a community in which participants must learn how to handle the tasks and artefacts that are handed to them. Fleming (1994, p. 526) referred to this as situated learning, drawn from the "ordinary, everyday, finely detailed practices of participants to an activity in specific settings" (Fleming 1994, p. 525). With learning comes knowledge.

Lave (1991) believed the conditions for learning flourishes in the space of family life, in the participation of children in becoming normal adults. He claimed that learning, thinking, and knowing are relations among people engaged in activities arising from the social and cultural world they exist. Knowledge in the social world is always socially mediated and open-ended. This knowledge setting was different to formal educational settings where knowledge is standardised and alienated from everyday life (Lave 1991).

Linger and Warne (2001) believed that social learning represents an important process that contribute to a person's being able to understand information, create knowledge from

that information and share what they know. Lam (2002) shared this view and added that tacit knowledge is the origin of human knowledge which in turn is based on the social and interactive nature of learning. Davenport & Hall (2001) suggested a community of practice is a socio-technical form that can create and stimulate knowledge.

2.12.2 Innovation within a Community of Practice

Hildreth & Kimble (2004) suggested the benefit of a CoP towards innovations was the increase knowledge flows. Owen and Linger (2011) believed that participants in the CoP exploit existing knowledge and skills to create new knowledge in response to change. Interactions amongst members within the community facilitate access to expertise and experience. Sharing experiences allows the community to be a source of information and enables members to build on their own personal strengths (Hildreth & Kimble 2004). Collaborations of this type promote innovation (Jensen *et al*, 2007). What a CoP offers to this research is that it is a driver of innovation through the shared experiences and expertise of its members amongst each other. The next section summaries the contribution of the overall literature to the study.

2.13 Contributions from the Literature: Summary

The technology centric models applied in adoption study research have traditionally described slow adoption of ICTs as a problem with the end user. For example the Connolly & Woods (2010) study that applied the UTAUT model cited low educational levels, infrastructural problems, and economic status as main barriers to adoption. However, these findings are contradicted by similar studies in developing regions such as India and Africa and indeed Ireland itself.

In the studies conducted in developing countries it is interesting to note that the reasons expressed by users for slow adoption of ICTs are associated with abstract knowledge within these systems. IS adoption models (e.g UTAUT, TAM, DOI) appear limited in broadening understanding of how people interact with ICTs. As technology becomes more pervasive within society, the need for system developers to analyse and interpret the local context of the user becomes more and more important. Furthermore, in the literature, technology and culture are perceived to be two sides of the one coin. This further emphasises

the need for a deepening awareness of the context of use amongst those developing new technology.

The IS literature generally follows a mechanistic view of a system, inputs, outputs, feedback, components etc. This interpretation appears limited, as the user was understood as an inert component. System theorists have offered the notion of a holon to produce a richer interpretation of systems in context. The properties of a holon: relationships, holonic levels, nested etc. denote the individual and group in the systemic relationship in a particular context of use.

The chaordic concept sees the system as inherently destabilised so that it must strive for stability This appears to closely connect with the cultural values and beliefs of humans who were integral to socio-technical system elements. As each component within a system has its own identity, change causes instability requiring readjustment. Fundamentally, it becomes vital to understand the cultural identity of the person or community who will use a system in their working lives.

The literature clearly notes the complexity of culture. However, Scheins (1993) understanding of culture is important within this research to allow for its analysis and interpretation and perhaps allow system developers interact with proposed users and explore their lives in so far as they provide the context of use for the new system.

The literature raised questions about the scientific approach to the codification of knowledge. Knowledge present within technological systems is generic and in some cases presented in a language foreign to the user. Such systems often ignored the tacit dimension but this knowledge was clearly important to individual and group survival often leading to the creation of innovative processes for survival. Utilising this knowledge is critical in future systems development.

How people learn and share knowledge with each other would appear best reflected by the concept of a community of practice. A CoP has an identify, and is reflected in the experiences and expertise shared amongst members. This concept offers a lens of analysis for interpreting the farming community and allows an understanding of how knowledge especially tacit knowledge is preserved and exchanged.

The Common Agricultural Policy emanating from large institutions over sees regulation of the farming communities within Ireland. There is a need to explore the process of isomorphism. These institutions have a shaping influence upon farming communities often through changes in legislation or educational programs. These changes affect the individual

culture within the CoP. What these influences are need further exploring. Institutional theory allows categorisations of the various institutions that potentially could interact with agricultural communities.

Central to the human centred systems paradigm is support of innovative processes. Innovation has ensured the survival of rural communities through the adaptiveness of the community and their ability too continually learn. Exploring the innovativeness of a community will aid the development of technologies that complement their working lives. The human centred perspective may help conceptualise adoption frameworks to improve the adoption of e-agricultural systems whilst supporting the human needs and the context of use.

2.14 Conclusion

This chapter has presented what scholars within the relevant literatures have deemed important theories and findings to technology systems adoption. Each elements of the literature has the potential to contribute to a theoretical framework, which organises the important concepts in a coherent way. Figure 2.2 uses the main sections of this literature review to highlight the important theories and concepts, which might contribute to the new framework. The next chapter will set out a conceptual framework that arises from this literature.

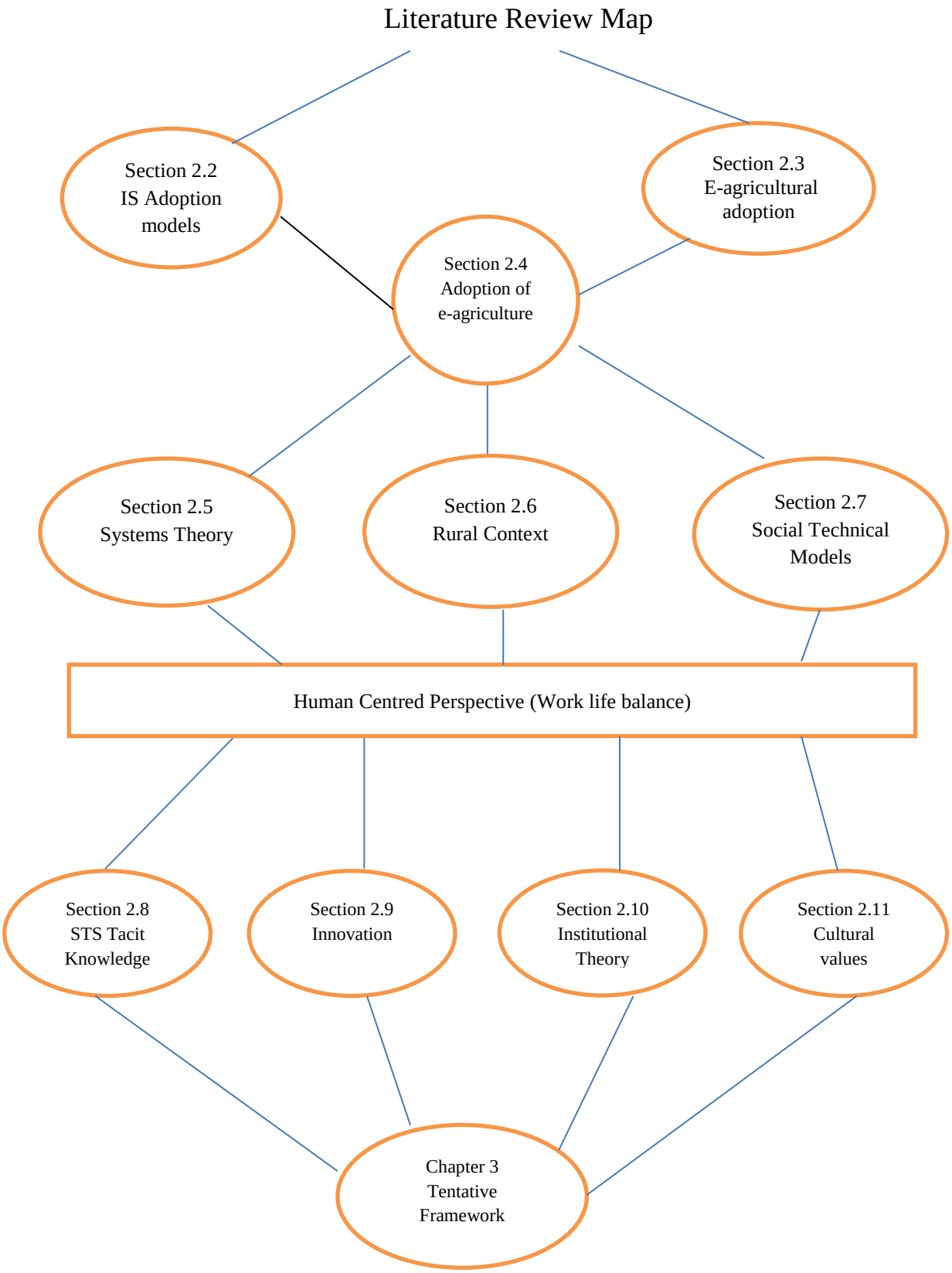


Figure 2-2 Literature Review Map

CHAPTER 3 RESEARCH PROPOSITIONS AND CONCEPTUAL FRAMEWORK

This chapter outlines the three high-level research propositions drawn from the research literature explored in Chapter 2. These are elicited in a set of working propositions and presented as a conceptual framework. The propositions will form the basis of the methodology and methods chosen to explore this topic.

3.1 Working Theoretical Discussion

The literature review defined and discussed the concept of e-agriculture that is central to this research. This opened the debate on systems theory, with the openness of a system evolving over time because of constant interaction with the environment. The systems perspective of holons presented a way of interpreting the complex arrangement between the technology, its user and the context of use. Viewing a system from as holonic perspective allowed an understanding of system relationships, interactions and the networks they reside in from multiple perspectives. This gave rises to review of socio-technical approached to systems development and the need for a human-centred paradigm in e-agriculture for systems development. The following concepts: tacit knowledge, cultural values, institutionalism and a community of practice were identified as potentially supporting a human-centred systems approach for farming communities. To validate these concepts the following propositions were proposed.

3.2 Working Theoretical Propositions

Section 2.12 introduced the concept of a community of practice as an active learning system. A CoP is a cultural unit imbued with culture forming deeply held shared community values that gives the community an identity and cultural meaning. Identity allows members to share and exchange experiences and expertise amongst members. This process of exchange is enabled by common language, thinking, cultural and social context. In section 2.12.1learning was understood to be a social phenomenon. The cultural arrangements in a CoP enhance individual and cultural norms and facilitate learning and knowledge exchange in a social setting. Based on this view, it is necessary to establish whether CoP thinking was applicable to a farm family, as this has not been addressed in the literature. This gives rise to Proposition 1 where it is proposed, that a farm family can be viewed as a community of practice with common values and identity:

Proposition 1: Evidence can be collected which indicates that the Farm Family is a Community of Practice

In section 2.11 culture was seen as underpinning and shaping the values and beliefs of individuals. Culture helps a group to learn over time. In section 2.12 a CoP was viewed as an active learning system with members sharing expertise and experience. The process of exchange and engagement is facilitated by shared views, values and ways of talking all of which stem from culture. What matters to people is instilled in this community; evident in the way that people speak, view and do things. To determine what cultural values underpin a CoP within a farming community that gives it identity is not addressed in the literature and gives rise to Proposition 2:

Proposition 2: Evidence can be collected which indicates that cultural values shape the Community of Practice.

Section 2.10 presented the view that an institution is a community comprised of social norms and behaviours. This allows institutions to be viewed as social systems whereby members legitimise beliefs about social norms and behaviour that help form guidelines for authority over individuals. Institutions are influenced by outside environments which change the norms and behaviour of the system. In section 2.10 this was referred to as isomorphism, the process of striving for homogeneity between different systems. Section 2.10.1 demonstrated how agricultural communities were impacted by institutional structures; from national governments to farmer-led associations and peer-networks. Section 2.10.2 outlined the mechanism of institutional change between systems whereby individuals within the systems interpret changes in behaviour by the process of sensemaking. As institutional thinking has not been applied to farm families it was important to address the impact of the various agricultural institutions on a CoP. To address this the three types of isomorphic pressures required proposition three to be decomposed into three sub propositions. Each was treated in turn and collectively determined proposition 3.

Proposition 3: Evidence can be collected which indicates Institutional Factors shape the Community of Practice

In Section 2.10 normative isomorphism came from professional organisations such as educational bodies or professional bodies offering formal education programmes. In section 2.9.1 agricultural communities adopted innovations that promoted increased productivity and increased incomes. Institutions from scientific backgrounds promoted such innovation based on these outcomes, which influenced farmer's decision to adopt. Based on the literature it can be inferred that normative isomorphism enabled e-agricultural adoption amongst farmers.

P3.1 Evidence can be collected which indicates that normative isomorphism has a significant enabling influence on the adoption of e-agricultural systems amongst farmers.

Mimetic pressures as noted in section 2.10 often come from legitimising and observing neighbours or like-minded people considered important. Individuals often adopt innovative practices by mimicking peer networks. This occurs through a process of sensemaking as noted in section 2.7.1. Sensemaking was viewed as a process of constructing identity and was linked to learning. If a technology does not make sense to the context of use is often is not adopted. When individuals share an identity based on experience and expertise they look to likeminded people for knowledge and information. If their peer networks or peoples of importance have adopted a technology then they are more likely to consider the innovation. This gave rise to proposition 3.2.

P3.2 Evidence can be collected that mimetic isomorphism can be a significant enabling influence on the adoption of e-agricultural systems amongst farmers.

In section 2.10 coercive pressures stem from political legitimacy. Informal and formal pressures are exerted by governments on lesser organisation on which they are dependent and often by social cultural expectations. These pressures are often felt as a force or strong persuasion, with organisations forced to change because of government policy. From the literature it can be inferred that technologies promoted by government are readily adopted by farming individuals and gave rise to proposition 3.3.

P3.3 Evidence can be collected that coercive isomorphism can be a significant enabling influence on the adoption of e-agricultural systems by farmers.

Section 2.8 noted how tacit knowledge reflects an individual's construction of the world. It defines a way of doing things, views, values, power relations, mannerisms and

expression when talking, enabling people to connect. Tacit knowledge is context- specific and anchored in individual beliefs. In section 2.12 a CoP was formed based on a shared identity which allowed for member engagement. From the literature, it can be inferred that an individual that shares an identity with a CoP can readily engage and interact with that social system. Both the individual and the CoP can contribute and learn from each other resulting in proposition 4.

Proposition 4: Evidence can be collected that Tacit knowledge shapes the Community of Practice.

The concepts of institutionalism, tacit knowledge and cultural values reflect the core ideas associated with a human-centred system for e-agriculture. Being an open system knowledge-flows enable knowledge creation that drives valorisation within a community to support sustainability.

From Propositions 1, 2 and 3 a series of sub-propositions formed the basis of a more detailed framework to provide a set of theoretical antecedents of e-agriculture technology adoption success.

The interplay between tacit knowledge and culture and values has an impact on technology adoption. Section 2.2.3 of the literature presented findings from an Irish study describing how lack of context specific information impacted on the adoption of e-agricultural systems. Section 2. 3 noted how the lack of customisation of services impeded adoption studies globally as systems information and assumptions tends to be general and non-specific. Section 2.8 explored the role tacit knowledge plays in shaping social collectives and work practices.

Often present in folklore and other cultural materials. Shared practices arise from knowledge that is both personal and experimental and transferred in a social context through story-telling, folklore and other cultural material. From the literature section 2.9.2 noted how agricultural communities make extensive use of tacit knowledge within their working day and gave rise to proposition 5.

P5. Evidence can be collected that E-Agricultural systems development which addresses the interaction between tacit knowledge and cultural values would have a positive influence on e-agricultural adoption by local farmers.

Section 2.3 presented examples of global e-agricultural systems. E-agriculture systems not accepted by end users were often due to the system not observing the context of use. For example in section 2.3.4 Indian e-government systems written in English and not the native language of the end user impeded the continued use of the system. From the literature, it was inferred that system development that supplies e-agricultural system with context specific information will increase their adoption and gave rise to proposition 5.1.

Proposition 5.1: Evidence can be collected which indicates that context-specific information supplied in e-agricultural systems could have an enabling influence on the adoption of e-agricultural systems by local farmers.

Section 2.8.1.2 farming knowledge was characterised as practical based and involved working with the environment and animals. The knowledge that underpinned farming was both personal and experimental. In section 2.9.2 this knowledge was transferred from one generation to another by stories and myths. When knowledge was purposeful and has meaning it allows individuals to generation action often leading to innovative practices. Whereas section 2.11.2 presented specific knowledge as being well-organised and in section 2.9.2 innovation from scientific institutions were adopted by farmers if they had institutional support and promoted increases in income and productivity. Therefore it was inferred from the literature that if an innovation ignores the knowledge built within a community it could impede the adoption process. This gave rise to proposition 5.2.

Proposition 5.2 Evidence can be collected which indicates that the separation of generational knowledge from scientific knowledge within an e-agricultural system acts as a barrier to e-agricultural adoption.

Section 2.12 noted how a community of practice was a cultural unit that supports learning, knowledge creation and could be viewed as a learning system. Section 2.12.2 noted how knowledge management processes are giving rise to innovation with a CoP. Section 2.9.2 described how a human-centred system promotes communal learning and knowledge sharing.

Institutional theory posited that organisations pursue legitimacy by conforming to isomorphic pressures in their environment, section 2.10. When a larger institution is influencing change within the structures of an organisation, this is called isomorphism. This process involves the lesser organisation interpreting and understanding the changes involved.

Section 2.10.2 sensemaking enabled reciprocal interpretation of identity and environment how it was understood as to enable the changes to meet the context needs.

In section 2.7.1 identify manifested itself in shared common language, stories and myths underpinned by cultural values. In section 2.5.2 is was noted that when components of a system are out of balance – the system was in a state of chaos. When an organisation is in an isomorphic process, their cultural identity is out of balance. To return the system back to equilibrium it must engage in a sensemaking process. From the literature, it was inferred that if institutional factors affect the cultural values of another system it could influence the mechanism of change. This gave rise to Proposition 6:

P6. Evidence can be collected which indicates that e-Agriculture systems development, which addresses the interaction between institutional factors and human culture and values, has an enabling influence on e-agriculture adoption by local farmers.

Given the three types of institutional pressures that might impinge on the adoption process, proposition 6 was broken into three sub-propositions. Section 2.10.1 described agricultural institutions as government agencies, peer support networks, advisory and educational bodies, each exerting different forces on farming communities.

Firstly, normative isomorphism occurs from educational or professional institutions that offer training or accreditations. It involves the diffusion of organisational norms through training and socialisation as well as professional networks developed through educational activities and common knowledge bases.

P6.1 Evidence can be collected which indicates that e- Agriculture systems development which addresses the interaction between normative institutional forces and human culture and values, has an enabling influence on e-agriculture adoption by local farmers.

Secondly, mimetic isomorphism when an organisation copies the practices of another organisation it perceives to be successful. In section 2.10, status expectation, was when individuals draw on shared cultural beliefs concerning status and success act as guides for appropriate behaviour. Person considered likeminded can act as an enabler for the acceptance of innovations giving rise to:

P6.2 e- Agriculture systems development, which addresses the interaction between mimetic institutional forces and human culture and values, has a positive influence e-agriculture adoption by local farmers.

Lastly, an organization experiences coercive isomorphism when another organisation on which it depends requires it to adopt a structure. Coercive isomorphism came from government bodies when shift in legislation occurred. As farming is regulated under the CAP policy, changes in legislation can influence the acceptance of innovative practices, this suggests the following proposition:

P6.3 e- Agriculture systems development, which addresses the interaction between coercive institutional forces and human culture and values, has a positive influence on e-agriculture adoption by local farmers.

Tacit knowledge is that knowledge, which is gathered, based on when people encounter their world (section 2.8). Tacit knowledge is not amenable to reductionist theories of the world. Tacit knowledge was contextually rooted and transferred by shared experiences and by imitating practices and behaviours. As institutions promote innovations by legitimising new behaviour, innovations matching the context of use should improve their adoption, giving rise to proposition 7.

P7. e- Agriculture systems development, which addresses the interaction between institutional forces and tacit knowledge positively influences e-agriculture adoption by local farmers.

Proposition seven is broken down into three sub-propositions that need to be addressed in turn to determine proposition seven.

Firstly, innovative practices from normative influences could be improved if knowledge transfer occurred in both a personal and experimental context within educational bodies(section 2.8.2). If learning happened within a social setting such as the CoP this would allow members to share experiences and expertise on innovative practices which in turn could lead to their adoption (section 2.12.1). This gives rise to proposition 7.1:

P7.1 e- Agriculture systems development, which addresses the interaction between normative institutional forces and tacit knowledge, can have a positive influence e-agriculture adoption by local farmers.

Secondly, innovations from mimetic institutions or peer-networks that are created with the end user and their working environment in mind will act as an enabler to their adoption. Persons considered likeminded and held in high esteem have a shared language and shared view of the world. Such people within farming communities will have an innate sense

of what works in their working lives on the farm. Scientific or agricultural institutions promote some new ideas, processes or technologies to farming communities (section 2.9.1)

Farming communities through a series of interactions with each other and with the practical ties of working life make sense of the new idea or innovation and this leads either to adoption as they can make sense or non-adoption as they can't make sense and gave rise to Proposition 7.2 :

P7.2 e- Agriculture systems development, which addresses the interaction between mimetic institutional forces and tacit knowledge, can have a positive influence e-agriculture adoption by local farmers.

Thirdly, innovation and innovative practices from coercive isomorphism can be often were felt as a forces by the lesser organisations (section 2.10). Tacit knowledge was transferred in a cultural context often by storytelling or imitation (section 2.8). Amongst agriculture communities knowledge was transferred from generation to generation often though stories or by imitating behaviour (section 2.9). From the literature, it can be inferred that if a coercive power is related to the working lives of the lesser organisation it will influence the behaviour to adopt an innovation and gave rise to Proposition 7.3:

P7.3 e- Agriculture systems development, which addresses the interaction between coercive agricultural organisations and tacit knowledge, could have a positive influence on e-agriculture adoption by local farmers.

Synthesising the propositions into a theoretical framework gives rise to Figure 3.1.

3.3 Conceptual Framework for E-Agricultural Systems Adoption and Development

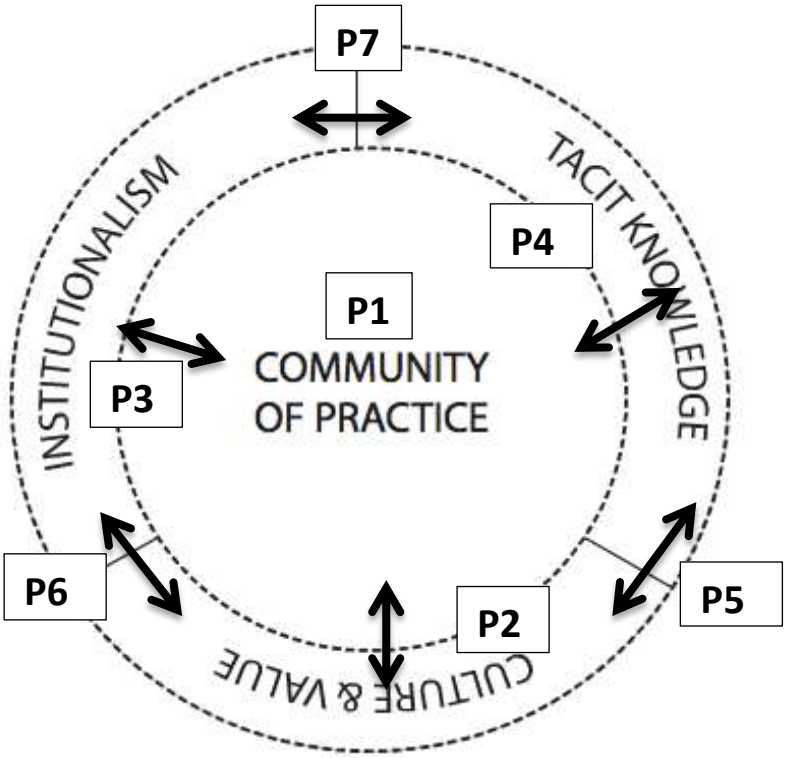


Figure 3. 1 Conceptual Framework for e-Agricultural Systems Adoption and Development

3.4 Conclusion

This chapter presented propositions based on chapter two. From these a conceptual framework was developed and presented. Agricultural communities live and work close to the land in an on-going engagement with nature. Knowledge, core values and beliefs, built up over generations contributes to the survival of agricultural communities. A lack of understanding of the realities by Information Systems (IS) research is evident in technology-adoption models which focus on the technology as opposed to these human factors.

A holistic approach to agricultural communities could potentially signal a route for future technology -adoption research. This route needs to incorporate human-centred,

cultural, institutional and technology lenses. The active participation of the agricultural community within any systems development process is necessary if we are to uncover the local knowledge that underpins successful technology innovation adoption.

The human-centred paradigm enshrines diversity, plurality, tacit knowledge and valorisation and is therefore more relevant today that it ever has been. A holistic approach, which appreciates the inter-play between the physical, cognitive and emotional aspects of human existence, allows for an understanding of human interaction in a variety of cultural contexts reflecting this theoretical perspective.

The methodology chosen to conduct this research relies on ontological and epistemological views of human nature will be discussed in detail in the following chapter.

CHAPTER 4 RESEARCH DESIGN

4.1 Introduction

Section 3 outlined the conceptual framework with proposed research propositions in Section 3.1. The subject of the chapter is to determine an appropriate research method to validate the tentative framework. This will involve determining a research philosophy to underpin the research. The latter part of the chapter argued for the data collection methods used and how the gathered data was analysed and interpreted.

4.2 Philosophical Antecedents

This section introduces the philosophical perspectives informing the research to aid understanding of the contextual nature of the farming community. TerreBlanche & Durrheim (1999) believed the research process has three dimensions: ontology, epistemology and methodology. A research paradigm is an all-encompassing system of interrelated practice and thinking that define the nature of enquiry.

Ontology is a basic description of *things* in the world (Fonseca 2007). Where as ontologies in systems design are the set of concepts and categories that for some given domain can be organised to demonstrate or model their properties and the relations between them. It is used to reason about the properties of that domain and maybe used to define the domain (Fonseca 2007). In philosophy ontology concerns what exists in reality i.e. what kind of entities are in the universe is allows researchers to "imagine how the social world should" be (Hall 2003, p. 374).

Ontologies used in agricultural systems may or may not account for the manner in which people place meaning and categories within their world (Roussey *et al* 2010). Perhaps by looking at human categories and the opening up of the human centred theories may give rise to a new language to interpret.

Therefore, the research adopted a subjective and an interpretivist view of reality. The rationale being it emphasises the world of experience as lived by people acting in social situations (Robson 2011).

The interpretivist tradition steers researchers toward a different outlook of the world and the meaning people place on events. The primary goal is not to develop theory in a narrow sense but in understanding the complex world of lived experiences from the point of view of those who live it (McGregor & Murnane 2010). The focus is to uncover structures

and meanings (Orlikowski & Baroudi 1991). Within the interpretive tradition, there are no correct and incorrect theories "but interesting and less interesting ways to view the world*"* (Walsham 1993a, p. 6).

4.2.4 Selection of a Research Paradigm

Selecting an appropriate philosophical approach is important as it dictates the research journey and is dependent upon the researcher's perspectives and the research topic itself.

4.2.5 Reductionism

Reductionism was an approach to understanding complex systems or concepts by reducing to smaller individual constituents in order to elucidate simpler ontological or explanations. It attempts to minimise the number of different constituents required in explaining a given concept (Jones 2000). However, reductionism can limit understanding of complex systems, as many interdependencies amongst system sub-components do not manifest in the components separately (section 2.2.2). In contrast to reductionism, "holism" (Section 2.3) recognises concepts that consist not only of the sum of their parts, but collectively have emergent properties. Holism offers the Aristotelian notion that a whole is greater than the sum of its individual parts. The holistic approach has led to concepts and notions such as "applied systems thinking" in various contexts (Checkland 1999). Reductionists and anti-reductionists essentially "disagree over the number of fundamental structures to reality" (Jones 2000, p. 31).

Reductionists deem reality structured by a single set of simple properties, whilst anti-reductionists envisage a pluralism of equally real properties at various levels of reality.

4.2.6 Pragmatism

In section 2.7, a human centred perspective utilising the concepts of human need, purpose, skill, creativity and potential. To address the shortcomings of reductionism a pragmatist approach in the context of this research appeared to work best within a human centered view because it:

1. Generally rejects reductionism.
2. Human enquiry is viewed analogous to experimental and scientific enquiry.
3. It endorses a strong and practical empiricism as the path to determine what works.

4. Knowledge is constructed and based on the reality of the world we experience and live in.
5. Rejected traditional dualism preferring a commonsense version of philosophical dualism based on how well they work in solving problems.

(Johnson & Onwuegbuzie 2004, p.18)

The pragmatic stand allows for capturing the lived experience of humans and a view of knowledge within the real worlds. Real world research begins in the outside world with a specific social problem. The aim is to develop a theoretically rich understanding of the problem rather than establishing the validity of a theory (Robson & McCartan 2016). With this in mind, the motivation for qualitative research came from the need to understand people in their social and cultural contexts.

4.3 Qualitative Research

A qualitative approach allows research from the point of view of participants and their particular social and institutional context, often lost when data is quantified. The qualitative method is also a common method when evaluating information technology and computer systems (Kaplan & Maxwell 2005). In computer studies, selected features of the information technology, the user, and their information needs are treated as independent, objective, and discrete entities unchanging over the course of the study. Contextual issues are added too including social, cultural and political concerns surrounding an information technology aiding understanding of processes as they emerge and allows researchers to understand the meaning and the context.

The qualitative approach also facilitates an inductive understanding of a phenomenon. It acknowledges the personal biases of the researcher and aids the development of themes, patterns and generalizations. A qualitative approach was best for this research. However, to strengthen qualitative research the issues of reliability and validity needed to be addressed.

4.3.1 Research Rigour

According to Morse et al (2002) without rigour, research is worthless; it becomes fiction and loses its utility. Guba and Lincoln (1981) state that while all research must have value, applicability, consistency, and neutrality to be considered worthwhile and that the nature of knowledge within quantitative and qualitative paradigms is different. Davies and Dodd (2002) pointed out that the application of rigour differs in quantitative and qualitative

research, but by accepting that there is a quantitative bias in the concept of rigour, a new re-conception of rigour can be developed for qualitative research that is built on the provision of reliability and validity.

4.3.2 Reliability

According to Eisner (1991) the term reliability is used predominantly in quantitative research. However, according to Stenbacka (2001) the use of reliability in qualitative research is misleading because if a qualitative study is discussed in terms of reliability, often the consequence is that it is inadequate or unsatisfactory. Seale (1999) suggests that to ensure reliability in qualitative research, an examination of trustworthiness is crucial. He stated that the trustworthiness of research lies at the heart of issues conventionally discussed in terms of reliability. Strauss and Corbin (1990, p. 250) suggested that the "usual canons of good science" apply when adjudicating qualitative research, but often these characteristics need to be redefined to fit the realities of this type of research. Patton (2002) stated that ensuring the reliability of research is important, but perhaps ensuring the validity of the study may be even more significant.

4.3.3 Validity

Winter (2000) argued that the concept of validity in qualitative research is not a single, fixed or universal concept, but rather a contingent construct, inescapably grounded in the processes and intentions of particular research methodologies and projects. McMillan and Schumacher (2006) point out that validity refers to the degree of congruence between the explanations of the phenomena and the realities of the world. They claim that although the concept of validity is traditionally associated with quantitative research, it has a place in qualitative research. Guba and Lincoln (1989) claim that validity can be viewed either internally or externally. Internal validity can be attained through the credibility of the research; whilst external validity is tested by the transferability of the findings. However, Davies and Dodd (2002) suggest that any consideration of validity in qualitative research is futile unless it is considered in conjunction with reliability.

4.3.4 Ensuring Reliability and Validity in research

Lincoln and Guba (1985) pointed out that triangulation is a suitable strategy for ensuring the validity and improving the reliability of research. Patton (2002) claimed that the use of triangulation strengthens a study by combining methods. Creswell (2003) described triangulation as a method that uses different data sources of information to build a coherent justifiable set of themes. Johnson (1997) commented that adopting multiple methods leads to more valid, reliable and diverse construction of realities. McMillan and Schumacher (2006) argued that reliability and validity are often conceptualised as trustworthiness, rigour and quality in a qualitative paradigm. They point out that these attributes can be achieved using triangulation. They offer the following combination of strategies to ensure reliability and validity in qualitative research.

Strategy No.	Strategy	Description
1.	Prolonged and persistent field work	Allow interim data analysis and corroboration to ensure match between findings and participants reality
2.	Multi-method strategies	Allow triangulation in data collection and data analysis
3.	Participant language	Verbatim accounts, obtain literal statements of participants and quotations from documents
4.	Low-inference descriptors	Record precise, almost literal, and detailed descriptions of people and situations
5.	Multiple researchers	Agreement on the descriptive data collected

		by the researcher
6.	Mechanically recorded data	Use of tape recorders, photographs, and videotapes
7.	Participant researcher	Use of participants' recorded perceptions in diaries or anecdotal records for corroboration
8.	Member checking	Check informally with participants for accuracy during data collection; frequently done in participant observation studies
9.	Participant review	Ask participants to review researcher's synthesis of interviews with person for accuracy of representation; frequently done in interview studies
10.	Negative or discrepant data	Actively search for record, analyse, and report negative or discrepant data that is an exception to patterns or that modify patterns found in data

Framework for enhancing the quality of qualitative research (Adopted from Pather (2006))

To determine an appropriate data collection method involves determining the type of data that will reflect the research topic along with practical considerations for collecting the data (Ritchie *et al*. 2013).

4.4 Data Collections Method

Common qualitative data collection methods are interviews, documents, observations, and audio-visual material (Creswell 2007). Section 2.2.2 examined the attitudes of farmers towards technology by apply the Unified Theory of Acceptance and Technology Usage (UTAUT) model (Venkatesh *et al*. 2003). The unit of analysis was the registered farmer and the data collection methods used was an online and postal survey. The postal survey was circulated by the Department of Agriculture to 1200 farmers, as this methodology assumed that farmers would be receptive to "official" interventions. This present study, as a human centred systems study could not assume these same assumptions. However, one of the main findings from the study was technology use by farmers might best be understood by in-depth interviews.

Therefore, this research employed three data collection methods document analysis, a focus group and semi-structured interviews.

4.4.1 Document Analysis

Document analysis allows the researcher in a cost efficient manner to collect data and gather insight and meaning on the language and words used by participants in their everyday lives (Creswell & Clark 2007). Within this research, it allowed the researcher to establish what types of ICTs used by the farming community.

In light of this, a desk study combined with a focus group method established the type of farming software available for use by farming communities in Ireland. Documents reviewed included the National newspapers with Farming Supplements and the Irish Farmers Journal, along with Irish Department of Agriculture publications from the Committee on the Uptake and IT in Agriculture report and census reports from the Central Statistical Office. A review of the findings from the e-Agriculture Working Group (2007)[4] an open survey on e-agriculture from the World Summit.

From these a process of triangulation identified the types of farming software potentially used by the farming community and their understanding of the term e-agriculture and its use. These findings were then validated by a focus group.

[4] https://www.itu.int/net/wsis/c7/e-agriculture/docs/survey-analysis-2007.pdf

4.4.2 Focus Group

According to Patton (1987), the primary objective of a focus group is to get high quality data in a social context, where people consider their own views in the context of others. Vaughn *et al*. (1996) suggested a focus group brings a depth of understanding to the needs, requirements and views of stakeholders. It is an informal group of knowledgeable informants whose opinion on an area is required. The goal of focus groups is to elicit group perceptions, feelings, attitudes and ideas from informants. Morgan (1997) suggested the knowledge acquired is normalised through group discussion; this facilitates the elimination of extreme and false views and aids the researcher in the validation of findings. The benefit of using focus groups for data acquisition is that it allows the interviewer to quickly obtain a wide variety of views from a range of informants with sometimes widely differing, but relevant perspectives. This appeared an ideal method of validating the desk study. The types of ICTs and understanding of the term e-agriculture was sampled on a six farmers from the Wexford and Kilkenny Irish Farmers Associations, IFA Farm Business Skillnet events. The group validated the language and verification of appropriate ICTs. Amendments were made to the interview questions to ensure clarity in the questions. This formed the stage of a preliminary study of two interviews after which further amendments were made to the interview schedule.

4.4.3 Interviews

Kvale (1996) believed an interviewer maybe seen as a miner or a traveller, where the miner represents the traditional ideas of knowledge formation and the traveller corresponds to a more postmodern approach. As a miner, the interviewer is looking for raw material, which has to be processed through some analytical technique. As a traveller, the interviewer develops an evolving level of understanding, which is acquired through the conversations between the interviewer and the informants and the traveller writes up the findings directly.

According to Remenyi (2009), an academic interview is a technique for the acquisition of spoken evidence from a knowledgeable informant that assists in answering a research question. The questions asked need careful planning and the answers supplied by the informant be meticulously recorded and directly relate to the research question(s). He argues that the informants need to be knowledgeable about the research area and be made aware that

their answers are not meant to be conclusive; rather they should further the agenda for discussion.

4.4.4 Semi-structure Interview

According to Creswell & Clark (2008) qualitative interviews implies the researcher conducts face-to-face interviews with participants, interviews by telephone. These interviews involve unstructured and generally open-ended questions few in number. The aim is to elicit views and opinions from the participants. Ritchie *et al*. (2013) suggested complex systems are best understood in an exchange between the interview and the interviewee because of the depth of focus and the need for detailed understanding. Interviews are flexible and an adaptable way of finding things out, giving a unique window into people's lives (Robson & McCartan 2016).

The unstructured interview gives a great depth of information. It does not impose any prior categorisation that may limit the data sought (Fontana & Frey 1994). It is an informal conversation flexible and multi directional. A semi-structured approach combines the two, achieving broader and better results (Fontana & Frey 1994). A common semi structured approach involves using a standardised interview format in the early part of the interview, and an unstructured approach in the later part of the interview, or combining both during the interview (Patton 2005). This study used a semi-structured interview process carried out on fifteen farm families over a period of seven months.

4.5 Unit of Analysis

To validate the proposed model the unit of analysis chosen was a family farm. Traditionally, farm research has focused on the male farmer viewing them as head of the farm. This was the unit of analysis applied in the CUITA study. Mainly in Ireland, farms are owned and managed by families. Whatmore (2016) argued that farm families comprise a wide variety of enterprises, size, geographical locations and family members. She argued that a farm family has many components: the farm itself and the household structure of those who live and work on the farm. It can be composed of patriarchal or matriarchal gender relationships, ties of marriage and other members of the household with economic ties to the farm. Therefore, in this research, a farm family is not based on a kinship of marriage but a farm owned and run by a family.

4.5.1 Population Sample

With the unit of analysis identified, the next step was to determine the population sample. The population was selected from farm families within the southeast of Ireland from counties Wexford, Kilkenny and Carlow. As the author lives in a rural part of southeast Ireland access to the population was sought by contacting the local branch chairperson of the Irish Farmers Association (IFA). From the initial contact with the IFA two interviews were arranged which formed the basis of the pilot study. The pilot study was conducted to test the interview schedule and to gain a feel for the study. As not to exclude non-IFA members from the process the first two interviews were asked to suggest other farm families who might partake in the research. Names and phone numbers were gathered and contact established over the phone. This snowballing method ensured a variety of farm families would yield rich data.

Interviews lasted on average 40-50 minutes with each recorded and transcribed.

Onwuegbuzie & Collins (2007) recommended sample sizes in qualitative research should not be too large as it is difficult to extract thick, rich data. From the transfer viva onto is was deemed fifteen farm families was an appropriate number because of the amount of data generated and the time frame of the study.

4.7 Data Analysis

There are many different approaches to qualitative data analysis. One such approach is the use of NVivo. This is a software program used for the analysis of unstructured text, audio, video, and image data, including interviews, focus groups, surveys, social media, and journal articles For this research, NVivo was chosen primarily as the software facilitates the importation of word documents and audio files. As the researcher has a Computing background, the package appeared straightforward with a comprehensive online learning facility. The software comes with a coding facility referred to as nodes that are applied to the data and made visible to the researcher. Whilst experimenting with the software the researcher applied a two-sprung approach. Interviews when typed were imported into the software and then the node generator run as to see what node the software found. At the same

time, the researcher went through the text and audio to assign nodes to the software. This allowed the researcher to reflect and understand the data captured. See Appendix A, of Nodes created by the researcher within the software. In addition, it is possible to write memos about particular aspects of documents, link these to relevant pieces of text in different documents, and run queries on the data.

4.8 Conclusion

This chapter outlined and justified the methodology employed for the study. It also outlined a number of other research design issues including data collection and data analysis. Finally, it described the design and implementation of the primary data collection instrument.

4.9 Research Map

	Time Line	Data Collection	Objective
Preliminary Study	January 2015 – September 2015	Desk Study	Establish the language and identification of farm software available for use
	October 2015	Focus group	Verification of the language and amendments to farm software
	October 2015	Initial contact with IFA branch member	Identification of knowledgeable informants
	November 2015	Interview One	Validation of the interview questions
	November 2015	Review of transcript	
	December 2015 –April 2016	Revision of research instrument	To prepare a new revised instrument on the basis of feedback from the focus groups and initial interviews
Main Study	May 2016 – April 2017	Interview process and interview transcribing in NVivo Software	Sent sample back to interviewee for member checking
	May 2017 – October 2017	Coding of interviews and generation of themes from NVivo	Organising the themes for review
	August 2017- April 2018	Synthesis of findings	Prepare result

Table 4-1Research Map

CHAPTER 5 FINDINGS

5.1 Introduction

This chapter presents the findings gathered from in depth interviews of fifteen farm families in the southeast of Ireland. The chapter begins by establishing the farm family profiles. This is followed by an overview of technologies used, in particular e-agricultural services by respondents. Then the chapter the presents the findings gathered from the interviews.

5.1.1 Demographic Profile of Respondents

In Section 4.2, the unit of analysis identified was the farm family. The sample represented all farm enterprises i.e. Sheep, Dairy, Beef, Tillage and Mixed farming (see table 5.2). Two of the samples had females registered as the farmer with the Department of Agriculture, with all other farms registered males. Three interviewees engaged in farming part- time with two of the three-registered farmers being female. All interviewees were from the South East of Ireland, mainly Wexford with two participants from Kilkenny and one from Carlow (see table 5.3). All are members of farming organisations: The Irish Farmers Association (IFA), the ICMSA (see table 5.4). Table 5.1 provides a profile of the individual participants and the family farm from which they are drawn.

Family Number	Respondent Number	Gender	Age	Farm Enterprise	Off Farm Employment
Family 1	Respondent1 Respondent2	F M	45 46	Dairy	**Yes** **No**
Family 2	Respondent3 Respondent4	F M	37 40	Sheep	**Yes** **Yes**
Family 3	Respondent 5 Respondent 6 Respondent 7	M F M	59 57 21	Tillage and Beef	**No** **Yes** **Yes**
Family 4	Respondent 8 Respondent 9	M F	46 42	Dairy	**No** **Yes**
Family 5	Respondent 10 Respondent 11	M F	48 47	Dairy and Sheep	**No** **No**
Family 6	Respondent 12 Respondent 13	M F	48 48	Dairy	**No** **Yes**
Family 7	Respondent 14	M	44	Dairy	**Yes**
Family 8	Respondent 15	M	64	Sheep	**Yes(Retired)**
Family 9	Respondent 16 Respondent 17	M M	55 27	Beef	**No** **No**
Family 10	Respondent 18 Respondent 19	M F	62 58	Beef and Sheep	**No** **Yes(Retired)**
Family 11	Respondent 20 Respondent 21	F M	44 44	Beef	**Yes** **Yes**
Family 12	Respondent 22 Respondent 23	M F	55 54	Dairy	**No** **Yes**
Family 13	Respondent 24 Respondent 25	M F	52 47	Beef	**No** **Yes**
Family 14	Respondent 26 Respondent 27	M F	45 44	Dairy	**No** **Yes**
Family 15	Respondent 28	M	47	Tillage	**No**

Table 5-1Respondent Profile

Total number of Farm Enterprises

Dairy	Beef	Sheep	Tillage	Mixed
6	3	2	1	3

Table 5-2 Number of Farm Enterprise

Location of Respondents

Wexford	Kilkenny	Carlow
12	2	1

Table 5-3 Location of Respondents

Membership of Farming Organisations

IFA	ICMSA	Both
14	0	1

Table 5-4 Member of Farming Organisations

Highest Educational Level of the Registered Farmer

	Primary Level	Junior Cert	Leaving Certificate	Higher Certificate	Ordinary Degree	Higher Degree	Masters Degree	Doctoral Degree
No of Farmers	1	2	4	1		4	2	1

Table 5-5 Educational Level of Farming Respondents

5.1.2 Technology Usage of Respondents

All respondents owned and used a personnel computer.

When asked the question - *Do you understand the term e-agriculture?*

None of the respondents had heard the term in any official capacity. However, they did associate the term with working online with all using the example of the Agfood.ie website.

When asked - *What farming systems do you use online?*

Total number of Farms	Online agricultural services
15	Agfood (Department of Agriculture)
3	Glanbia Connect (Glanbia PLC)
4	Farm Management Software
4	ICBF (Irish Cattle Breeding Federation)

Table 5-6 Online Farm Systems

The Irish Cattle Breeding Federation (ICBF)

ICBF records the genotype of all animals in the national herd. From recordings animals are giving a star rating from one to five. All farms have heard of ICBF and the website. However, two farms mentioned reading the postal correspondences from ICBF instead of accessing the information online. Three said they could use the website if they wanted but typical felt the website contained nothing of value to their farm. This is typified by the following statement.

> *But they haven't got the science to assess what is a five star bull [is]. I don't believe they have a baseline to assess these animals.*
>
> (Family 3, Respondent 5)

The majority of farms were engaging with Glanbia by post. Glanbia issues monthly statements to dairy farmers. This list the total amount of milk produced by dairy farmers to the company, its quality and sale price. All seven dairy farms received correspondents by post but three of the seven also access the online portal, mainly for checking statement.

When asked - *What other online sites do you use?*

Total number of Farms	Other sites used for farming purposes
3	Weather
8	DoneDeal (Buy and sell of farm stock)
3	Farming News sites

Table 5-7 Other Internet Sites Used For Farming

5.2 The Cultural Values of Farmers

The dimension of cultural values within the conceptual framework allows an understanding of the values held by the farming group sampled.

5.2.1 Farm Continuity: – Values of Tradition, Conservation and Historicity

Inheritance of Farm	Parents	Extended Family	Both
No of families	13	0	2

Table 5-8 Farm Continuity

Farm continuity refers to the succession mechanism in farming. In Ireland, normally the eldest son inherits the farms, unlike other businesses, which often are answerable to shareholders. All respondents inherited the farm from parents with two also inheriting the farm from an uncle (see table 5.7). Farmers viewed themselves as keepers of the land. The following response typifies this view.

> *if a farm has been handed down through generations its pride in what your predecessors done and the way I feel you know if you are farming and the herd owner you are just minding the land and keeping it going to the best you can. To keep it going to hand onto the next generation to farm if they want.*
>
> (Family 11, Respondent 20)

> *you are aware that you are only the keeper of the farm. That's the way I look at it. We never sold sites like that, that would be a major consideration for me, that I had ruined the farm that I couldn't keep it together, couldn't mind it". "In my eyes it would be the last resort I would do without and sooner give up a kidney"* [than sell land]
>
> (Family 11 Respondent 20)

5.2.2 The Value of Duty

Farming	Full time	Part time
No of farms	12	3

Table 5-9 No of Farms Farmed

Farm continuity was important to farm survival for all respondents. Three of the participants still farmed part time whilst engaging in fulltime employment off the farm (see table 5.8). The sense of duty to farm continuity was evident for example from Respondent 20 whose father, was an only son undertook the mantle without question. She recalled his sadness leaving school at eleven to farm but he did so out of duty to his parents but the need for the farm survival outweighed his choices in life. The following response is how she told her family story:

> *my dad was an only son and had two sisters. He gave up school and was only 11 when he went to farm. He cried leaving school and really farming wasn't his first love, he didn't find it easy but that was it for him. He farmed, as he was an only son*
>
> (Family 11 Respondent 20)

The duty to the farm was then expressed in a powerful way by Respondent 5 who detailed leaving secondary school in first year (at 13 years of age) to come home and farm because his mother had died.

> *1st year in the brothers* [secondary school] *and when my mother died I was brought home to farm.*
>
> (Family 3 Respondent 5)

The awareness of this responsibility also extended to parents, as typified by Respondent 26 who said

> *[My] father had put in all he had into the land so it was my turn to look after him.*
>
> (Family 14 Respondent 26)

5.2.3 Farm Sustainability and Viability

Pivotal to farm continuity is the viability of the farm enterprise. Often, farm enterprises changed from generation. This safeguarded the family farm as illustrated by Respondent 10 below. Originally the main enterprise on their farm was sheep but his father diversified,

believing he would make more money per acre from dairy farming than sheep farming and insured the sustainability of the enterprise for the next generation. When the opportunity arose, he moved into dairy farming. This move opened up another sources of income for the family and was viewed positively by his son.

my father was very progress [oriented] and was milking when he got a chance

(Family 5 Respondent 10)

5.2.4 Custodians of the Land

Land management and care were described as vital for continuity and viability with farmers conscious of sustainability allowing farming to continue over generations as expressed in the following extract:

most farmers are very good custodians of the land and they have been for hundreds of years

(Family 8 Respondent 15)

The relationship with nature came from a deep understanding and knowledge of utilising land for production. This knowledge was gather by the family over generations and by helping and observing previous generations at work instilled farming practices into the next generation. Every participant in the study described how helping his or her parents were important in their farm education. One participant expressed how he was aware of the land type and quality on his farm by working with his parents when young. Observing their practices feed into his farming practices and was expressed as follows.

you *know from your parents what would work in certain fields and that sort of way that sort of stuff*

(Family 4 Respondent 8)

Families valued the land and whilst they were dependant on it for income, they did not exhaust its value. This was reflected in the knowledge and understanding a farmer has of his land ensuring future productivity and was evident in one participant's protection of wildlife habitats on the farm. Some lands on her farm were left fallow to protect the wildlife.

we have a lot of habitats [on the farm]

(Family 11 Respondent 20)

5.2.5 Connectedness to Nature – The Value of Nature and the Environment

Forces of nature are seasonal and random with farmer adapting work practices to best utilise the environment. In winter, the land was rested by housing stock indoors allowing the land to recover so when spring came it was ready to support the stock. Technology for example agfood.ie has pushed farming forward but the farmer still has to mind the land and the animals. Family 3 Respondent 5 recalled how stock numbers and calving time of animals changed on their farm from his uncle's time. He recalled how he referred to this practice as a change in technology but acknowledged his uncle was successful in farming based what was known at the time.

> *He* [uncle] *was successful famer in his day. Now I know I would like to apply newer technologies and newer ways of having cattle. They* [stock] *were all out doors, where I have indoors and newer stocking rates. Well then technology has moved since then – he* [uncle] *died in 1992 and he was successful. Well things change and the weather patterns change in that time you had drier frostier winters nowadays we have wetter winters.*

(Family 33 Respondent 5)

Farmers nourished land by spreading fertilizers to help build up the land for future use. If a farmer exploits the land, it will not support the enterprise in terms of grass quality to feed the stock. This is the case also with tillage farming where crop quality was dependent on nourishing the land.

Family 14 Respondent 26 typifies this by

when you take the grass off the land you take the nutrients off the land and unless you replace these nutrients your ability to grow grass in later years will be compromised

(Family 14 Respondent 26)

The pragmatic approach to natural surroundings was typified by:

in farming you have to be practical every day of the week, you have to be adaptable with the weather and adapt to grass growing.

(Family 10 Respondent 18)

> *Land must be sustainable along with location, nature, aspect and elements. With the elements you don't know what way the year will come to you*

(Family 14 Respondent 26)

Calving and lambing season was another time when farmers felt connected to nature and the fruits of the work were evident. This part of the year was viewed as the start of the New Year, new beginnings with longer brighter days. Farmers looked on the time of year as seeing how progress on the farm for example in breeding with new calves or lambs born. When winter was over the newness of spring reflected how new practices worked on the ground. One individual expressed this as:

[when winter is over] *turned the hump on the winter days, as winter is hard both on stock and animals*

(Family 14 Respondent 26)

The newness that comes with spring and the calving season fed into the mind-set of both the farm and family as illustrated by

> *what is old fashion about watching a calf being born*

(Family 11 Respondent 20)

Land maps are legal document detailing proof of land titles from the Property Registration Authority (PRA). One response suggested the enjoyment felt by farmers when he saw their holdings in maps as illustrated below.

> *But a lot of farmers would know the shape of their field, they could draw it on their hand - thats why this map is precious and they don't want to give their map to someone else and they like holding onto it ,it has a history and then they look at it and say I remember a ring forth there and my father telling me never to plough that area*

(Family 2 Respondent 4)

5.2.6 Connectedness as a Community

All farms used family members as labour units when needed viewing them as vital components of the farm. All respondents viewed the farm as a family farm linked by family, farm and nature with all the family even across generations understanding these dynamics. The following extract expressed this view

Oh sure it is [a family farm] everyone throws in [helps] when they're around like you know what I mean.

(Family 3 Respondent 5)

Other respondents believed the land was rooted in Irish farmers across many generations. One individual said in other countries farms were not connected to the family with farming opened to anyone. In Ireland the ability to farm depends on access to land, which is, not the case in other countries where individuals could farm on commercial farms and was expressed by the following view:

Land is ingrained into us. Whereas if you go to Australia your father might be a farmer but you might be a painter. Your son after you could be a bus driver and your son after you a farmer again

(Family 13 Respondent 24)

All respondents described their family as the site of work, learning and knowledge transfer. Learning to farm very much was family based with all respondents suggesting their knowledge of farming came from parents. This was typified in the following response of one part time farmer who suggested in his day job when he talks to other farmers they chat more openly to him believing that only farming people truly understand what it was to be a farmer.

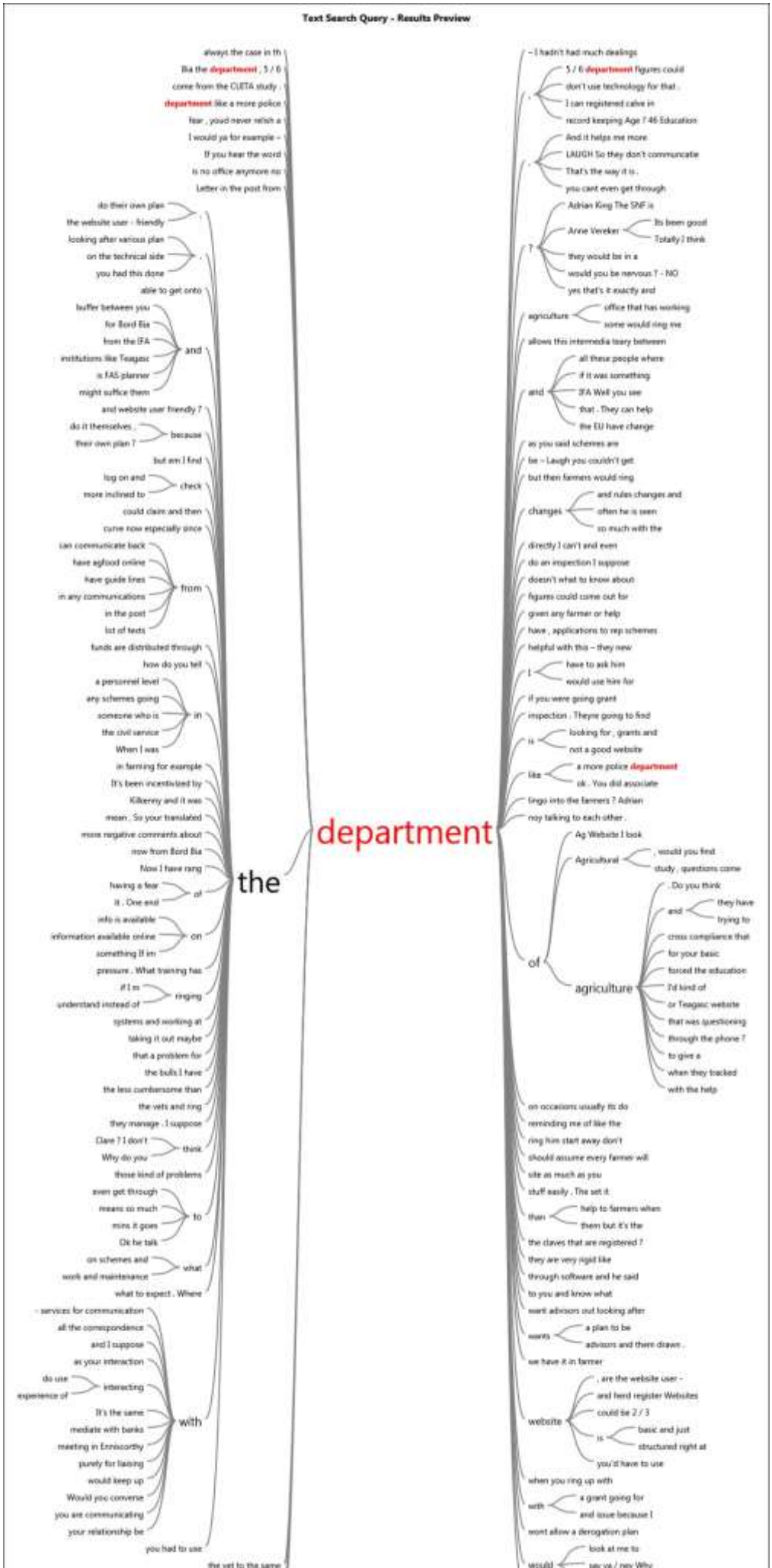
When I'm talking to farmers over the years I tell them my background and right away they have that synergy, you know you think like them … we never forget where we come from, no I feel that a real ice breaker and they feel that you understand me getting up at 6 in the morning and the trials and tribulations.

(Family 8 Respondent 15)

5.3 Farmers and Agricultural Institutions

5.3.1 Coercion from Institutional Policy

The deep understanding of natural working environments created tension between farmers and the Department of Agriculture regarding farm policies (See Figure 5.1). Here individuals expressed their relationship they had with department engagements.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fear , youd never relish a
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do their own plan
the website user - friendly
looking after various plan
on the technical side
you had this done
able to get onto
buffer between you
for Bord Bia
from the IFA
institutions like Teagasc
is FAS planner
might suffice them
and website user friendly ?
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if I m
understand instead of
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systems and working at
taking it out maybe
that a problem for
the bulls I have
the less cumbersome than
the vets and ring
they manage . I suppose
Clare ? I don't
Why do you
think
those kind of problems
even get through
means so much
mins it goes
Ok he talk
to
on schemes and
work and maintenance
what
what to expect . Where
- services for communication
all the correspondence
and I suppose
as your interaction
do use
experience of
interacting
It's the same
mediate with banks
meeting in Enniscorthy
purely for liaising
would keep up
Would you converse
you are communicating
your relationship be
with
you had to use
the vet to the same
– I hadn't had much dealings
5 / 6 department figures could
don't use technology for that .
I can registered calve in
record keeping Age ? 46 Education
And it helps me more
LAUGH So they don't communicate
That's the way it is .
you cant even get through
Adrian King The SNF is
Anne Vereker
Its been good
Totally I think
they would be in a
would you be nervous ? - NO
yes that's it exactly and
?
agriculture
office that has working
some would ring me
allows this intermedia teary between
all these people where
if it was something
IFA Well you see
that . They can help
the EU have change
and
as you said schemes are
be – Laugh you couldn't get
but then farmers would ring
changes
and rules changes and
often he is seen
so much with the
directly I can't and even
do an inspection I suppose
doesn't what to know about
figures could come out for
given any farmer or help
have , applications to rep schemes
helpful with this – they new
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I
if you were going grant
inspection . Theyre going to find
looking for , grants and
not a good website
is
a more police department
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nay talking to each other .
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they have
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and
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help to farmers when
them but it's the
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they are very rigid like
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want advisors out looking after
a plan to be
advisors and there drawn .
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and herd register Websites
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website
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a grant going for
and issue because I
with
wont allow a derogation plan
look at me to
would

Figure 5-1 Sentiment towards the Department of Agriculture

All believed the Department of Agriculture set regulations and policies that were discordant with farming practice. This was typified by one individual who said agricultural policy dictated manure (slurry) spreading and the whole of Ireland was treated as if it were the same. The Department was described as only allowing manure spreading during certain calendar months. The respondent suggested that the weather, stock numbers and land type were better indicators as to when to spread slurry than calendar months as some parts of Ireland get wetter spells of weather. Here is how he described it:

> *One thing that always bugged me was farmers have to farm by dates say for example we are closed* [cant spread manure on the land] *until the middle of January, we can't spread slurry. You know it could be a fine couple of weeks and it could be wet when they* [Policy Dates] *open it. Another reason is land in Wexford and land in the West* [of Ireland] *are chalk and cheese but we are all under the one rulebook. You couldn't put a canoe out in parts of the west and it could be perfectly fine to spread slurry here* [inWexford]
>
> (Family 14 Respondent 26)

Another participant mentioned the imbalance between policy-formers and farmers as unfair believing the push style approach was crippling farming. As a result he would not ask his son to stay at home and farm.

> *The people that are forming policies for them are so far removed from farming like its really disappointing ok and from my end I won't even ask Sean* [son] *to come home full time* [to farm fulltime] – *I think in 20 years time there will be a serious policy with land use*
>
> (Family 3 Respondent 5)

His son added that the Department did not understand the reality of how things worked on the ground and described a 'them' and 'us' relationship in the following response:

> *NO It's THEM and US ya we are not the same and not on the same level. If not they wouldn't be doing some of the things they're doing* [setting policies]
>
> (Family 3 Respondent 7)

5.3.2 Institutional Bureaucracy

The Department of Agriculture governs and regulates Irish agriculture, administering grants and payments schemes to farmers in line with the Common Agricultural Policy set by the member states of the European Union. The monitoring of the health, welfare and movement of animals also falls under the remit of the Department of Agriculture. Communication with the Department of Agriculture was viewed as stressful from all respondents and many lived in fear of being audited or a sudden inspection. For example Respondent 5 said they were fearful of

> *audits and inspection* [and] a *fear of red tape*.
>
> (Family 11 Respondent 20)

Their partner added

> *I've seen good farmers who tried hard and just gave up and it goes back to when the Single Farm Payment came in they* [the farmer] *just couldn't hack the paper work and you know it's sad because they* [the farmer] *should be able to get help off them if they want to farm*.
>
> (Family 11 Respondent 21)

> *there is too much restrictions out there too much red tape*,

Another respondent believed the increased administrated load to maintain documentation put strain on the farm. One respondent explained the situation as follows:

> *other industries don't have that – not a full farm audit- that's ridiculous. I tell you it's hard to keep the paper work up to date all the time, you would literally wanting to be sitting there* [points to the kitchen table].
>
> (Family 5 Respondent 11)

The same respondent believed the volume of paper work in farming required secretarial training.

> *I'm grand I know what I'm doing I'm a trained secretary – but what about people who don't know what they're doing, how do they manage.*
>
> (Family 5 Respondent 11)

Another felt he was constantly under pressure waiting on inspections from the department as officials were known to arrive at farms without prior notification. Inspections were understood to be important but it was felt that farming as a business operated differently than other businesses. Help was available when needed only from the immediate family but not available in a formal capacity as with other industries who enjoyed for example support of Enterprise Ireland.

Farmers get very tense they fell they are waiting on the next inspection and are watching over their shoulder. They are a business and very isolated as it is a farm business and only have the family and not like working in a company.

(Family 7 Respondent 14)

The Irish Food Board (An Bord Bia) is a government agency who operates the quality assurance scheme in the food industry. The food board audits farms annually. Another participant recalled a food quality inspection from An Bord Bia and a department inspection on the same day.

Friday 13th we had a Bord Bia inspection luckily I had everything right. The day that happened, we had a whole farm audit unannounced. Oh God

(Family 5 Respondent 11)

Family 3 Respondent 5 said the department behaved more like enforcers than an agricultural agency.

I find the department like a more police department than help to farmers

(Family 3 Respondent 5)

He added that the Common Agricultural Policy (CAP) changed the relationship the department had with farmers and gave the example of how before CAP the department was interested in his enterprise and were available when he needed:

when I started farming first – if I wanted to get land drained, build a shed they were helpful and welcoming.

(Family 3 Respondent 5)

5.3.3 Neglected by Institutions

All farmers viewed the closure of local or regional Agricultural Offices with sadness. Family 3 Respondent 5 recalled the dismay in the closure of his local department office.

there was a service like Enniscorthy (local office) now they are closed

(Family 3 Respondent 5)

Before he could talk to local officers, but now he was forced to communicate with the department over the internet.

they want to talk to you through the internet they don't want to talk to talk to farmers on a one-to-one" [and they] *don't definitely want to listen.*

(Family 3 Respondent 5)

Family 12 Respondent 22 typified this by recalling the story of going to visit the District Veterinary Office (DVO) in Enniscorthy (South East of Ireland approximately 15km from his farm) and having to speak to a departmental official via a phone in Castlebar (approx. 330km apart). He felt frustrated knowing department officials in the Enniscorthy Office could answer his query but instead directed him to use the phone connected to the Castlebar Office.

I was in the DVO district veterinary office in Enniscorthy and you pick up a phone in there and you're sent to Castlebar that's not very good you know

again some of the people working there are institutionalized and there to do a job and not concerned about whose there, they could be a bit smarter I don't know what way I'll say it but it would torment you sometimes the way they go on.

(Family 12 Respondent 22)

All respondents believed legislation and policy is pushed on them, ignoring the farmers' view. One compared the relationship akin to scolding children if they ignored rules as shown below.

no it's them and us, *they are not approachable you can't use them for information.*

They're ready to slap you on the wrist.

(Family 3 Respondent 5)

5.3.4 Farm Policy

Respondents believed farm policy disregarded farmer's ability to farm and this in turn had implications for the next generations of farmers in terms of deciding to farm on seeing the implications of policy on the ground.

people that are forming policies are so far removed from farming like it's really disappointing – I think in 20 years' time there will be a serious policy with land use.

(Family 3 Respondent 5)

Lack of understanding of farmer practices was a concern of farmers. One respondent gave the example of attending an official departmental meeting on sheep management. Here department officials gave instruction on how to record sheep through ear tagging. Family 3 Respondent 5 asked the departmental official how many sheep he had tagged in real life to which he answered emotively none this response raised emotive feelings in the respondent as reflected in the following:

[I] was at a meeting in Enniscorthy with the department and all these people were telling us how to tag ewes. The one question I asked was how many actually ever tagged a ewe and not one of them and they were up there trying to tell us how to tag ewes.
Telling us how to tag ewes. GOD SAKE STOP [emphasis of respondent].

(Family 3 Respondent 5)

Farm policy impacts on farming at local level with respondents aware of changes to the environment and how it impacted their natural environment. The view of global warming and climate change was understood by respondents. Often conflict arose in the tension between the need to have an economically sound practice and global climate change issues. One suggested if the land was left fallow people would not have food to eat and that the land is needed to feed people. Often farmers were blamed for polluting the land as typified in:

Polluting the waters it's not just farmers so that is a big concern and you really need to stop everything and say stop let's not touch the land leave it the way it is and our rivers will become pristine but that's not the way what are we going to eat like, so there is a dichotomy

there. Farmers are very conscious of climate change and global warming as well ah they still have to make a living in the country.

(Family 8, Respondent 15)

5.3.5 Buffer between Farmers and Institutions: Agricultural Advisors

Employed Agricultural Advisor	Private Advisor	Teagasc Advisor
No of Farms	14	1

Table 5.9 Hired an Agricultural Advisor

All respondents hired a third party to communicate with the Department of Agriculture and known as farm advisors (see table 5.9).

The main purpose of hiring the advisor are summarised in Table 5.10. One farm submitted the single farm payment online themselves.

Role of planner	No of Farms
Submission of Single Farm Payment	14
Advice for grant application	15

Table 5.10 Role of Advisor

All hired an agricultural advisor, as he was able to understand farming regulation and how changes to policies effected individual farms. All felt safeguarded by how he communicated this knowledge on regulation, policy and grants back to the farm. This response was typified in the following:

I suppose it's that security element he's the professional he's part of the agricultural advisory group and it's a back fall if we have problems

Adding

his stamp of approval means so much to the department. That's the way it is.

(Family 7 Respondent 14)

All respondents believed applications submitted to the Department by the advisor were written with their interest at hand and understood how best to submit applications that would meet the farm need.

He's at it every day. He has time to do the paper work and tell you what you are entitled to and what you are not entitled to [in relation to grant applications]. *That's his profession he can try and get as much as he can for you and the farmer.*

(Family 12 Respondent 22)

All believed having an advisor was a major asset to the farm. The advisor would walk around the farm seeing the operation from the farm perspective. He would communicate this to the farmer and let him make the final decision.

[farm advisor] *he walks the land* [and] *he's familiar with my farm*
YES, I think he has good communication skills [and] *I have 100% faith in what he tells me*.
(Family 11 Respondent 20)

5.3.6 Scientific Advice from Institutions

Teagasc is the Irish government's scientific funded research agency and advisory service for farming. Their new ideas in relation to farming often were difficult to implement on the ground.

Teagasc lads come up with new ideas. If the same blue print worked those lads would be out of job.

(Farmer 4 Respondent 8)

When asked to explain he gave the example of varying farm size and structure and one blue print or common approach would never work on the ground:

location is important and land mass, I have 135 acres here but it is all in the one block, say some else could have 235 acres but its divided by road frontage so he'd be in a different way [his farming methods would be different]

(Farmer 4 Respondent 8)

In relation to the abolition of milk quotas in the dairy sector, Teagasc gave advice to farmers to increase dairy herd numbers or for other farm enterprise to move into the dairy sector. One respondent disagreed with the blanket advice saying that farmers would know to expand the herd if they had the land to support an increase in stock numbers. Land size was a limitation to herd size but Teagasc were giving advice based on ignoring land availability and suggesting it was scientific advice. This respondent was unable to expand his herd as he was limited by land as expressed in the following:

Their theory on dairy is that you're going to have about 120/130 cows and milk so many days, it doesn't work that way, if you don't have land for them, their (Teagasc) system[dairy system] *is absolutely useless to me*"

(Family 5 Respondent 10)

When the sugar beet industry stopped in Ireland, tillage farmers involved in growing sugar beet were given advice from Teagasc to grow a crop called Miscanthus (commonly known as Elephant grass). One respondent described how farmers were aware that Teagasc found it difficult to grow it themselves in their research centers.

grow crops like Miscanthus which they [Teagasc] *couldn't grow in Carlow themselves in Oakpark* [Teagasc research centre in Carlow] *for farmers to grow. It was going to be a new oil field.*

(Family 3 Respondent 5)

Respondents felt they had no support from Teagasc if the scientific advice fails on their enterprise

now its gone off the system the whole thing failed they moved on

(Family 3 Respondent)

One gave the example of how Teagasc advisory changed with EU policy

they lost all that years ago Teagasc were much more focused in the like of Pat Carrolls [Teagasc Advisor] *time 90/80s they were on the ground they visited your farm. You know they brought you up to speed on a few bits and pieces*

(Family 3 Respondent 5)

All respondents voiced how Teagasc were not up to date with advice and this typified in following extract:

Now I always feel they [Teagasc] *are well behind the curve* [in terms of farm advice]

(Family 4 Respondent 8)

When Irish agriculture joined the Common Agricultural Policy (CAP) respondents felt that Teagasc gave a lot of poor planning advice resulting in many farmers losing out on CAP payments.

now especially since the department and the EU have changed, when we went from the subsidy system back to the single farm payment they gave a lot of bad advice at that stage like if in doubt don't apply [for the CAP payment] *like such crap*

(Family 3 Respondent 5)

5.4 The Farming Community

5.4.1 Grass Root Organisations

All farm families interviewed were paid members of their farming association (see table 5.4). Farms were satisfied with both the level of access and information from their association:

there is always someone in your locality involved in the IFA that you can approach and get them to talk up for you

(Family 13 Respondent 24)

One respondent who was the regional representative in the association said he was contactable at any time by all members. Local people who gave up their free time to work for the association ran these organisations.

it is farmer led and you wouldn't be doing it for money, you give your time and that's very important there is only me and Adrian for 40,000 members between us and 2 girls and they can ring me anytime

(Family 9 Respondent 16)

The same respondent suggested the IFA website was written from the farmers perspective with clear access to all documents needed for inspections by the Departmental bodies.

Well the idea is that we [IFA] interpret into less cumbersome [language]than the department, we have it in farmer language [on the website]

(Family 9 Respondent 16)

The IFA support farmers in times of difficulty when dealing with financial institutions or Co-operatives.

[if] *you run into a big problems with banks or creameries but when things are going right there is not much need for them*.

(Family 4 Respondent 8)

With the growth of the association some believed the organization had lost its association with individual member issues when speaking on behalf of farmers.

I think they (farmers) are disillusioned and feel let down by the like of the IFA because the lobbying power doesn't seem to be as strong" [and was] "*geared towards a bigger farmer*

(Family 12 Respondent 22)

5.4.2 Grass Root Publications

Ten respondents specifically mentioned buying the Farmers Journal. The weekly publication was viewed positively from farmers typified in the response:

yes its very practical and translated to on the ground

(Family 12 Respondent 22)

The paper presented information written by farmers and was a great source of topical information covering all aspects of farming life and enterprises.

> *very good value in the week*" [and] "*articles will always do the pros and cons which I find good.*" "*it's more factual you mightn't agree with everything that's in it but that's fair enough like it broadens the mind*".

(Family 3 Respondent 5)

The same respondent said he would of no problem in ringing reporters from the paper and discussing articles further.

I had a query I'd pick up the phone and ring the like of Pat O'Toole the lads who are writing [for the paper] *in that to find out the back ground and have a bit of a chat and I'd be happy enough to get to the bottom of it if I had a query*

(Family 3 Respondent 5)

5.4.3 Farming Business as a Social Hub

When buying farm supplies all farmers went to their local Glanbia co-operative branch. The local branch was a social point for farmers as seen in following response.

its [co-op branch] *nearly like the post office it's a bit of a rural hub*

(Family 12 Respondent 22)

*a lot are on their own and they mightn't see anyone from one end of the day, and then if you weren't in someone could say I'm missing Tommy and then you could call up to their house and god knows what to expec*t.

"*There is merit in those social interactions*

(Family 11 Respondent 20)

Another said the co-op was

Valuable and I rate it as keeping the village alive.

(Family 3 Respondent 5)

Farming by its nature was isolated with often wives working and children at school. One wife typified the importance of farmers interacting in the co-op as reducing loneliness. Some farmers had no one at home whom they could chat with and the local co-op was an ideal area to meet someone.

there is a social aspect to it as well, if you went down there 10/15 mins a day you could happen on someone as you've been working all day on your own. Even for the news and gossip. There is an extra value in it [going to the co-op] *farming is very isolated as most places there is only one person working on the farm and I think they need to get out and that is important"*

(Family 13 Respondent 25)

Farmers and their wives agreed isolation in farming was of concern and appreciated the existence of the co-op offering a daily outlet to farmers. The helpfulness of the staff from a

business perspective was more important to farmers than the online service from Glanbia (see table 5.5)

[I] love going down to the local plant and Joe (plant manager) understands me and might take a few bob off cos he understands me.

(Family 11 Respondent 20)

5.5 Knowledge, Learning and Innovation

5.5.1 Individual Learning Processes and Methods

Learning how to farm came from the parents or older generations who gathered their knowledge through practical experience of working with the land, animals and so forth. This personal way of learning was the foundations of farm knowledge and contextually rooted in the beliefs and lives of individuals typified in the response

How to educate him is to bring him along [pointing to his so]. *Oh ya, that's how they learn is to bring them along. And that's always the way in farming.*

(Family 5 Respondent 10)

Another respondent believed being reared on a farm allowed her to know the workings of the farm reflected in the following:

I grew up on a farm all my life

(Family 13 Respondent 25)

5.5.1.1 Learning by Observation

All respondents agreed that learning to farm came from parents or the wider family network such as bachelor uncles. This was a way of life in farming were children spent their lives around and out with their parents. Listening to them and learning from them. Children saw their parents work all the time making this an avenue of learning as illustrated in the following response:

a certain amount would of come from my father and a certain amount from my uncles they all farm too, I use to help out them.

You learn swiftly or you're not in farming to much longer. I probably would have had good guidance from my uncle, I have good neighbours

(Family 9 Respondent 16)

Another respondent gave the example of being able to handle sheep, which she gathered from helping her parents. The knowledge she believed did not come from books nor would she of referenced books to understand sheep.

Parents – generation just being reared on a farm generations but from experience.
If a ewe is yawning [ewe is lambing] *you're not going around with a book, you learned it from experience*

(Family 10 Respondent 19)

5.5.1.2 Formal Learning: Green Cert

No of Farmers	Agricultural Qualifications
15	Green Cert
1	Higher Diploma in Dairy
1	BSc in Agriculture (Hons)

Table 5.11 Agricultural Qualifications of Respondents

The Green Cert are formal academic courses offered by Teagasc which qualifies a person as a "trained farmer". Completion of a Green Cert is one of the conditions of stamp duty exemption on the transfer of a farm to a son or daughter. All respondents had the Green Cert (see table 5.13). All respondent viewed the academic programme as rudimentary and out of date and typified by the following response:

the green cert, but that was a farce. It was so basic like for start everyone that ever did the course passed it so it's not a test. I learned nothing it was so boring. Even still, the course they are giving in the ag colleges is the very same now as then. The application was the very same just tick boxes and general knowledge. It doesn't challenge a student

(Family 12 Respondent 22)

When undertaking the course students have to study away from home often the first time for many. Many viewed the course in social terms adding to the belief of the Certs lack of educational value. One respondent believed he knew more than his peers studying the course purely from farming practically.

Would you believe they learn something in the green cert most learn how to drink below in Kildalton [Agricultural College].*Discussions I had with people who have done the green cert I would probably know more than they do now, in* [terms of] *practical farming that's what I would of found. A few of my colleges in work have done it because they had to do it and found that they were at the day course and they came to me with questions because they weren't farming day to day ,they may not of grown up on a farm they didn't know the practicalities of farming .*

(Family 3 Respondent 7)

The incentive to save tax is the primary reason farmers under took the course.

You have to do it to get grants and all that like.

(Family 12 Respondent 22)

A few of my colleges in work have done it because they had to do it

(Family 3 Respondent 7)

5.5.1.3 Learning as a Social Activity (The Learning Community)

Achievement was also evident in how influential parents were in educating next generations All farmers said parents were the main source of farming knowledge and a source of guidance. These sentiments were reflected in the semantic map generated from concepts in the transcripts by NVivo (Figure 5.2).

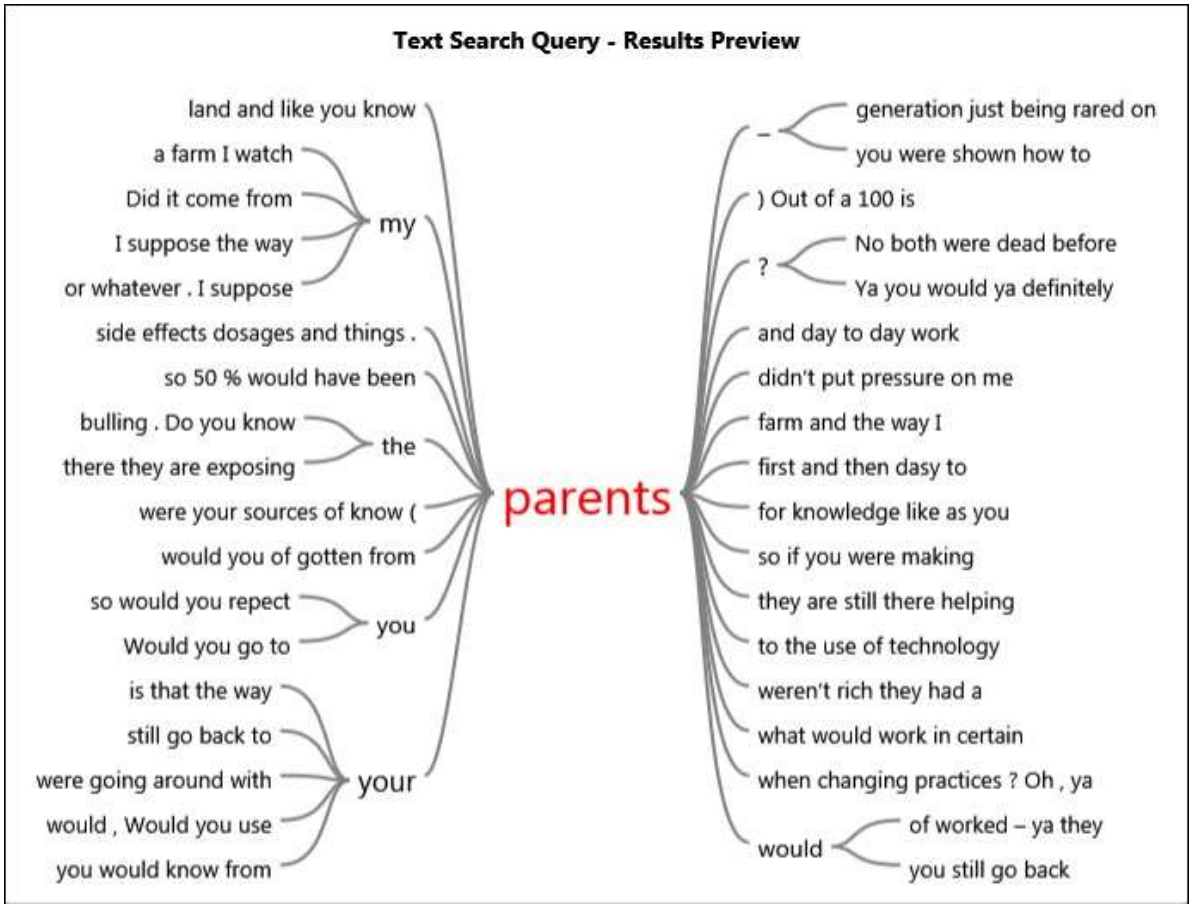

Figure 5.2 NVivo Semantic Map of Parents

Typically, respondents expressed the role of their parents in educating them in farming as follows:

Definitely you know good husbandry skills came from my upbringing definitely

(Family 1 Respondent 1)

No I wouldn't of been able to handle animals. Just being around animals and growing up with them you learn about their behaviour

(Family 1 Respondent 1)

My dad, no I think they would be the first port of cal"

(Family 14 Respondent 26)

I'd listen to them but I'm meant to be the farmer now

(Family 12 Respondents 22)

Continuing the farm and seeking advice was not limited to the family unit one farmer mentioned his uncles as supportive due to the loss of his father at an early age. My father died when he was 11 and thus went to an uncle for support saying he

probably would have had good guidance from my uncle

(Family 3 Respondent 5)

Another said farming to him was not a job but a vocation

Farming is not a job it's a vocation

(Family 5 Respondent 10)

Often tight links created tension with Family 13 Respondent 24 Male Fulltime Beef farmer saying when he returned from Agricultural College with new ideas his mother was not interested in them and said:

> *you would of come back with new ideas and they'd say that's not the way things are done around here*

(Family 13 Respondent 24)

Farm work from a very young age because of the death of his father but his mother was the registered farmer and believed he could not implement new practices, as it was her farm but he was running it.

> *Well since 10/12 and your dad hurt himself and he had a heart condition, so you had to do a lot more quicker* [work on the farm from a young age]*even on paper you weren't the farmer but you were as such.*

(Family 13 Respondent 25)

5.5.2.1 Learning from Neighbours

Figure 5.3 was a semantic map generated by NVivo setting out the relationships between concepts in the transcripts.

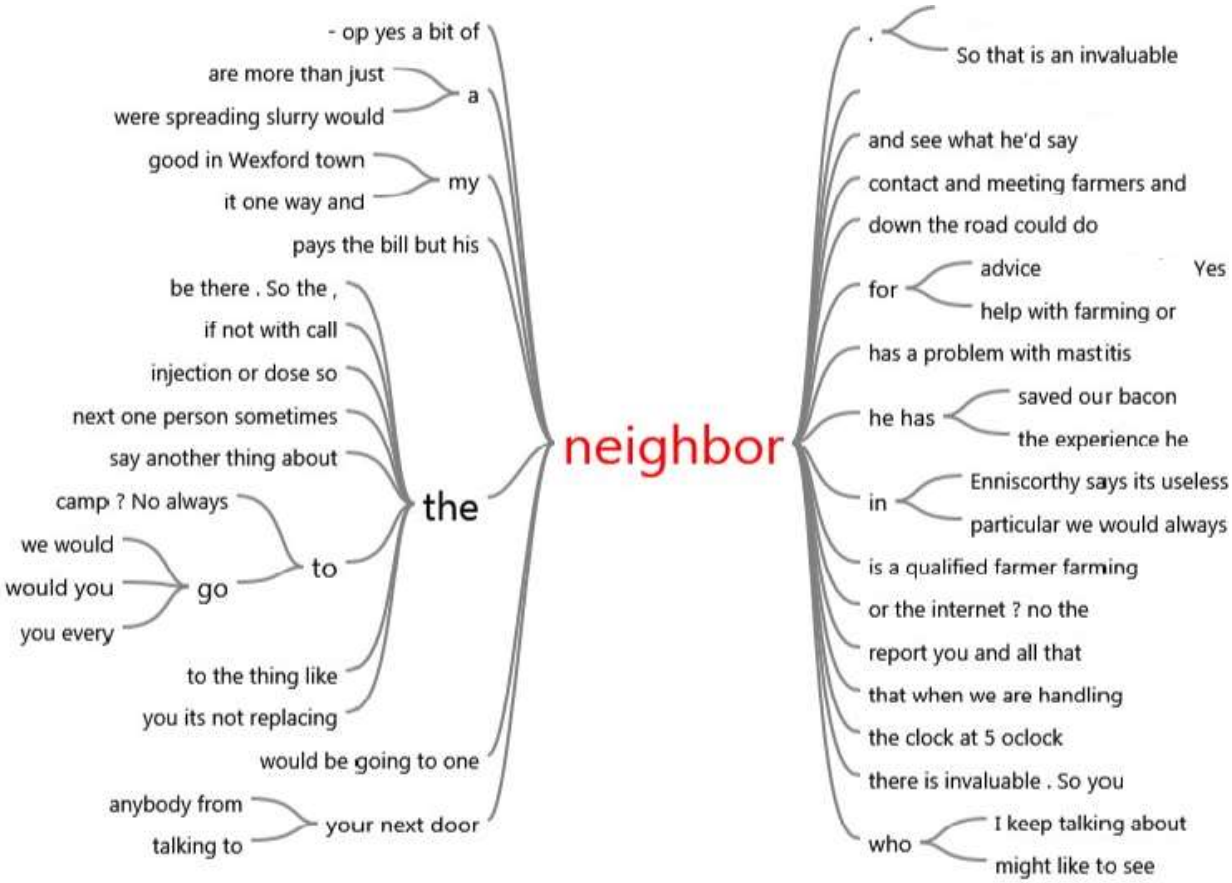

Figure 5.3 Semantic Map of Neigbour Sentiment

The neighbour was seen as an invaluable source within farming and a site for advice for sick animals or as an extra pair of hands at harvest time or with herd tests. This was typified in the following response:

I'd have to say another thing about the neighbour that when we are handling the animals if they are sick he will help up he's another pair of hands and you know my husband is on his own on the farm trying to give an injection or dose so the neighbour there is invaluable.

(Family 11, Respondent 20)

Trustworthiness of the neighbour in terms of information and opinions was accepted as often the neighbour might have gone through similar experiences or implemented new practices and could offer an opinion on the matter as expressed by the following

he has a lot of experience and I suppose its ok getting the vet out but that's another cost and for me and it's a worry I am part time farmer, no always to the neighbour he has saved our bacon a good few times.

(Family 2, Respondent 2)

The relationship between neighbours was seen as bi-directional with farmers willing to help when asked by the neighbour. When a farmer was away on holidays and needed someone to watch the farm in his absence the neighbour would often help as expressed in the following:

it's a two way relationship and with this farmer it has been like he has taken breaks before and my husband would of looked after half his herd like the calves it does work two ways

(Family 11, Respondent 20)

Amongst all part time farmers the neighbour was pivotal as they kept a watch on the farm when at work as reflected in the following:

my circumstances my dad passed away and my mam has retired from farming so we would be going to one neighbour in particular we would always like if he could come over and see the animal and in fairness he'd watch our animals if we were at work.

(Family 11, Respondent 20)

Respondents expressed how they often would discuss farming matter when they met neighbours in social setting such as the local shop or pub.

Ah no, if you met them [neighbour] *you'd discuss with them at the counter below in Ballywilliam* [local public house] *or the co-op.*

(Family 10 Respondent 18)

5.5.2.2 Discussion groups

Discussion groups are managed by Teagasc were about fifteen farmers in a local area meet in turn at each members farm every 4 to 6 months. A Teagasc advisor facilitates the group with a set topic. The advisor introduces new practices within the areas and farms discuss their views and experiences about the matter. One respondent recalled it as:

there would be a leader and a plan or a Teagasc employee and they would say breeding was discussed on Tuesday night so you'd meet at someone's farm or field and anything that is

relevant to beef would be discussed. They would have a handout and then they would go around and get your point of view on it and I might have a point of view and you would have one and I mightn't agree and then it would discussed, and the planner would facilitate that discussion.

(Family 13 Respondent 24)

Connecting to peers and establishing links was beneficial to farmers as represented by:

Invaluable source [as] *going out and walking other people's farms you'd see things that you can bring home to your farm you could apply them to your own thing. You learnt from interacting with other farmers, and it made sense when you see it. You'd learn more from them in one after noon than you would reading paper's because you see it on the ground and how it works it makes sense*

The casualness of the groups led to interaction and exchange epitomized as follows

the meeting would be localised and I suppose I can make contacts with people like other farmers you know", "*I could say well look, your ahead with the forestry can I come and see what your plantation is like*

(Family 11 Respondent 20)

One respondent enjoyed the honest and frankness of group member positively.
People's honesty and telling you what they think tell you what they've done and what they think what went wrong and what went right and what worked for them". *In discussion groups you could knock an idea around with them*

(Family 12 Respondent 22)

Evidence of open discussion and sharing of ideas and viewpoints are part of the success of the groups. One commented on the sharing of knowledge saying

anytime you'd meet farmers in a group they all of tried something different they are never mean with their knowledge – I find that in general – that's valuable.

(Family 3 Respondent 5)

5.5.3 Learning from Generation to Generation

All respondents voiced that a great deal of their knowledge and skill in farming came from their parents. This involved working and helping them on the farm. One interviewee typified this in relation to breeding techniques learned from her father:

I would of learned it [stockmanship] *from sight and visually looking at my father with the herd.*

(Family 1 Respondent 1)

To be able to handle and understand an animal's temperament and behaviour was a skill that one respondent felt was best understood through practical exposure. They described how animals become wild if not experienced with human interaction.

animals would go wild if not handled daily

(Family 1 Respondent 1)

I suppose the way my parents farm and the way I farm is different but definitely you know good husbandry skills came from my upbringing definitely

(Family 11 Respondent 20)

Another mentioned how he was aware from his parents of the intrinsic features of his land

you would know from your parents what would work in certain fields and that sort of way

(Family 4 Respondent 8)

5.5.4 Learning and Knowledge in Context - Tacit Knowledge

Figure 5.4 was a sematic map generated about learning from the concepts in NVivo. All respondents felt that this kind of knowledge and these learning processes were important.

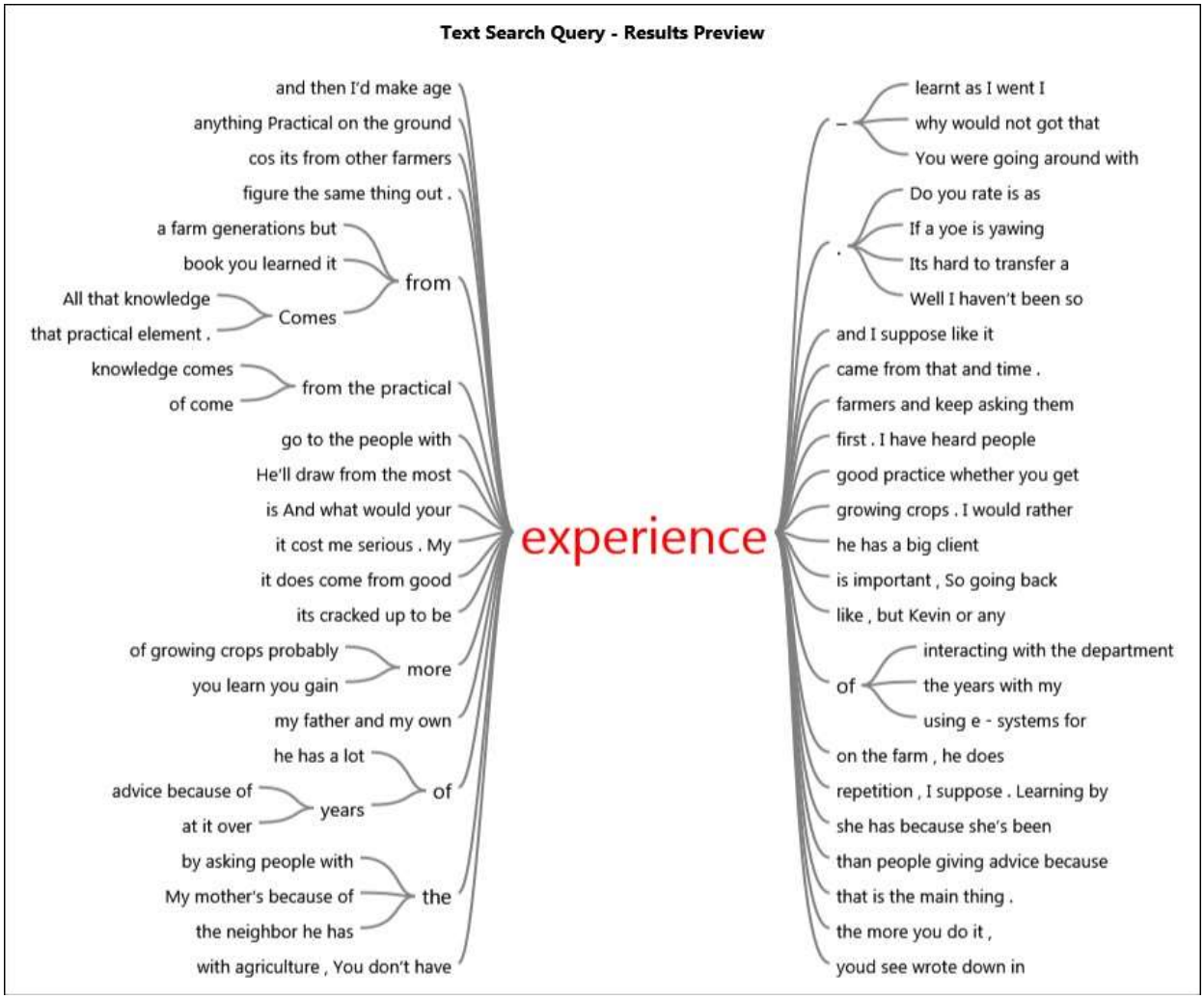

Figure 5.41 NVivo Semantic Map of Learning Sentiment

Farming knowledge was underpinned by learning in a social setting with previous generations using these setting to transfer knowledge and practical experience as expressed in the following:

when you're dealing with a live animal it's different, all that knowledge comes from experience.It's hard to transfer a book to an animal.

(Family 1 Respondent 1)

The combining of practical skills with learning from experience was evident through worked examples such as grass management:

I quote a fella – he goes out with his measuring stick to measure the grass and he figures out the cows can do 5 days in this field, his father can come out and stand over the field and

figure the same thing out. EXPERIENCE – why would you not get that –experience is important,

(Family 5 Respondent 10)

5.6 Innovation in Farming

All respondents believed farming communities are an innovative group of people with daily challenges on the farm forcing them to adapt and problem solve. One respondent typified this by suggesting farming required a range of skills in line with the diversity of daily events from soldering gates to nursing sick animals.

Every day you go out [to farm] *you learn something, it's a bad day you go out and you don't learn something a farmer is a plumber, a carpenter – you have to have a mountain of skills.*

That way I suppose you could say they are very innovative. Ya sure you have to be and very good at solving problems because you have to be good at that too. Ok

(Family 10 Respondent 18)

Diseases or weather forced farmer to adapt working practices to find solutions to unforeseen events in order to maintain the enterprise. This was evident from two bovine diseases that spread across Europe and Ireland.

5.6.1 Old Remedies and Practices

5.6.1.1 Schmallenberg virus

The Schmallenberg virus is an emergent disease that swept Ireland in 2013. The virus was classified by the DAFM (2017) as an emerging disease that manifested in ruminants as abnormalities in birth or death and drop in milk yields in cows. Little was known by the scientific community about the symptoms of the disease and its impact on farms. Living through the disease appeared harrowing for those impacted by this with one farmer recalling the devastation he and his neighbour suffered. He asserted:

The last ewe lambed just before Christmas he [neighbour] *had one* [abnormal birth] *but everyone who had it from Christmas to the 1st of February had absolute hardship beyond belief, they got totally destroyed. No one knew that year it just appeared out of nowhere – our*

ewes started lambing the 6th of February and we had 7 lambs with it [Schmallenberg sheep virus]

(Family 5 Respondent 10)

Disease brings devastation and uncertainty to farmers typified in the following extract:

you can't preempt disease – that [Schmallenberg virus] *just something that came and went in the one year. We don't know what to expect*.

(Family 5 Respondent 10)

5.6.1.2 Foot and Mouth Disease

The Foot and Mouth disease spread across Ireland in 2001. A safeguard from the disease was the use of lime baths as a preventative measure for stopping the spread of the disease. This old remedy was part of official control procedures for halting the spread of the Foot and Mouth disease as stated by one farmer:

when you take Foot and Mouth for example, the best thing that people were using was lime, people were using lime for disinfected purposes and that was used a 100 years ago and we are still using it. Probably 100 years ago, they didn't know the science of using it but those things are so important.

(Family 8 Respondent 15)

Farmers also use lime as a disinfectant inside sheds over the winter months to help stop the spread of disease.

we shake it [Lime] *under the cows when inside* [house in sheds over the winter months]

(Family 14 Respondent 26)

5.6.1.3 Bluestone

Another remedy for clearing infections in animal's feet is the use of Bluestone [Copper Sulphate]

I use it for clearing up cow's feet, but it's harder to get now

(Family 14 Respondent 26)

5.6.1.4 Dehorning animals

Dehorning of animals was suggested by one best done on or before a full moon as to help healing.

I don't dehorn animals when there's a full moon as the blood flow is too strong and the animal might bleed to death

(Family 14 Respondent 26)

5.6.2 Developing New Practices and Farming Methods

All respondents admired farmers ability to create new methods or equipment in farming. As one respondent illustrated

Absolutely no question about that. They will always find a way or solution to a problem because they have to. No, I think they are the biggest innovators out there. If there is a problem, they will find a way around it and a solution to the problem because they have to do it absolutely.

(Family 3 Respondent 5)

Another suggested agricultural shows always cased farm led innovations as in the following extract:

If there is a way of making a few extra few pounds there are farmers that are able to do anything as regards making a handy thing to make things handier for them. In the Tullamore show [Agricultural show] *there is always a farmer inventing something that makes things handier the whole time like catching calves*

(Family 4 Respondent 8)

Innovation did not always relate to commercialisation of products but many believed their daily lives on the farm and work practices allowed them to be innovative. One farmer typified innovative practice when dealing with grass management for animals as follows:

I wouldn't mind trying things and pushing out the boundaries especially with grassland management different things

(Family 12 Respondent 22)

Another dairy farmer believed he likes trying out new practices regarding grass management to maximise grass and his father was similar in his creativeness when it came to farm buildings.

Regards May, June, July the grass is gone stemmy what I did was cut the grass before they went in and they ate that which worked better. I felt, father was sort of the same he built building that other lads were building 15 years after wards. I like to tweak a bit

(Family 4 Respondent 8)

With diversity in farming farmer must adapt work practices the unforeseen as demonstrated in the following

Ya sure you have to be (Innovative) and very good at solving problems because you have to be good at that too. Ok in this type of job you get up in the morning you don't know w*hat's going to face you – something will go wrong most days*

(Family 9 Respondent 16)

5.7 Conclusion

In this chapter, a demographic profile of respondents was presented. Along, with their use of ICT's and findings from interviews were presented. The interpretations of these findings will form the basis of the next chapter.

CHAPTER 6 DISCUSSION

6.1 Introduction

Having presented the research findings with respect to what informants believed impact on their adoption and continued usage of e-agricultural systems this chapter explores the implications of these observations within the context of the reviewed literature and the working theory.

6.2 Review of Propositions in Light of the Findings

6.2.1 Farming Culture and Values in the Community of Practice.

6.2.1.1 Proposition 1: Evidence indicated that the Farm Family is a Community of Practice

The literature suggested that learning, working and innovation were human activities enabled by shared values (section 2.11.0). To foster and enhance learning the concept of a community of practice was introduced (section 2.12). A CoP was viewed as an active learning system whereby members shared experiences and expertise. In a CoP a culture of sharing existed facilitated by shared values, views and behaviour which formed the groups identity. This sense of identity was evident in farm families. All respondents mentioned accompanying and helping their parents whilst they worked in their younger days (section 5.5.1.1). The social context of learning allowed parents to share their experience and knowledge of farming to the next generation (section 5.5.1.3). One respondent mentioned a tension when he returned from agricultural college with new farming practices and how she viewed them as not relevant to their farm (section 5.5.3). Findings demonstrated that farming families' shared the same views across the population sample, irrespective of farm size, enterprise type and family profile. All described how the foundation and social aspect of their farming knowledge which came from being with their parents or other family members on the farm (section 5.5.3).

Ways in which farmers communicate with each other was consistent (section 5.5.2.1). Farmers share their ideas with each other, enabling learning and knowledge transfer with other farmers within the community. Viewing the farm family as a cultural unit of work, learning and innovation contributes to a shared understanding of the everyday working lives of farm families. This shared understanding was evident in the data in section 5.5.1.1, section

5.5.1.3, section 5.5.3 and section 5.5.2.1 it was deemed adequate to **accept Proposition 1: that the farm family was a community of practice.**

6.2.1.2 Proposition 2: Evidence indicated that cultural values shape the Community of Practice.

Having established the farm family is a community of practice in Proposition 1. Proposition 2 speculated about the influence of cultural values on this community of practice. Section 2.11 presented literature on culture as underpinned and shaped by beliefs and by shared values. These inform the identity of the social group. The value of *farm continuity* emerged in the data in the belief that the farmer was only the *keeper of the land* (section 5.2.1). Views on *conserving the farm* was expressed by changes in work practices or adapting the enterprise to open up other lines of income as to support the farm family (section 5.2.3). This enabled farms to remain viable from generation to generation and was a fundamental motivation for agricultural innovation over extended periods. Farm survival over history was expressed in the *value of duty* (section 5.2.2). Survival of the farm was prioritised over the value placed on formal education. For example in some cases sons, finished education early as help was needed on the farm because of a family death (section 5.2.2). The culture and values within Irish farming could be seen to be deeply rooted and intertwined between family and farm, with farm preservation pivotal to beliefs about family life. On this basis of the evidence set out in sections 5.2.2, 5.2.3 and 5.2.1 it was deemed adequate to **accepted Proposition 2: that cultural values shape the community of practice.**

6.2.2 Agricultural Institutions

6.2.2.1 Proposition 3: Evidence indicated that institutional factors shape the Community of Practice

Section 2.10 reviewed the literature associated with institutional forces which influence social behaviour across societies. These influences were described as isomorphic processes which ranged across society from one social collective to another. Structures and authoritative guidelines embedded in institutions influenced social structures and group behaviour. Section 2.10.1 outlined some of the instructional structures influencing Irish farming. These ranged from government departments, scientific institutions to peer-support networks. The varying types of isomorphism generated different influencing factors as the process shaped structures and behaviours which eventually become accepted into a social group. Three types of institutional isomorphism were summarised: coercive, normative and mimetic. With this is mind Proposition 3 was sub divided into three sub-propositions, and each was treated in turn.

6.2.2.1.1 P3.1 Evidence indicated that normative isomorphism was not a significant enabling influence on the adoption of e-agricultural systems amongst farmers.

Evidence of normative isomorphism was mainly seen in the relationship between farming families and state-sponsored scientific agencies, which had been established to develop and promote innovations designed to improve Irish agricultural practices and norms. The main agency tasked with this was called "Teagasc" and largely funded by the Department of Agriculture in the government. However there was not much evidence that this institutional influence from Teagasc was very strong. In section 5.3.6 a deep sense of "neglect" resonated when respondents spoke of the influence of government agricultural institutions on farming communities. Changes to farming processes arose from or proposed by scientific institutions (e.g. Teagasc) were seen as "incompetent" (section 5.3.6). For example the removal of milk quotas was described by respondents as bad advice from Teagasc (section 5.3.6). Dairy farmers believed that the advice was too generic and impractical, and could not be implemented on their farms. Tillage farmers recalled the sale of the national sugar beet industry by the Irish Government (section 5.3.6). Scientific advice about which new crops farmers should grow was viewed as "ridiculous". Respondents believed that the same institutions could not grow the crop successfully in their own research centres but advised farmers to grow it. Respondents believed that these proposals potentially placed their farms at

risk especially as the supports were not forthcoming if the innovation failed to yield a return. Often innovations from Teagasc were viewed by respondents as way of the institution justifying its existence believing they often ignored the financial costs to a family if the innovation failed. It can therefore be inferred in section 5.3.6 that government scientific agencies do not influence the adoption of e-agricultural systems by farmers. Evidence of negative and hostile feeling of farmers towards the scientific agencies leads to a **rejection of proposition 3.1 that normative isomorphism has a significant enabling influence on the potential adoption of e-agricultural systems by farmers.**

6.2.2.1.2 P3.2 Evidence indicated that mimetic isomorphism was a significant enabling influence on the adoption of e-agricultural systems amongst farmers.

All respondents were members of farming organisations; with the Irish Farmers Associations (IFA), the main organisations (see table 5.4). The reason for joining was that the association offered help and advice in times of uncertainty. For example changes in CAP or changes in beef prices the association would lobby on behalf of farmers to the government and agricultural producers. The presence of a local IFA representative is important to respondents as they "could always talk to someone in their parish" when seeking advice. Advice from the IFA helped farmer cope with uncertainty (section 5.4.1).

The IFA weekly publication, *The Farmers Journal* was considered important and an "interesting read" as it covered new farming methods and practices but more importantly "written by farmers for farmers" (section 5.4.2). Respondents believed the paper was progressive in its content about new methods in farming "presenting the arguments for and against" these innovations. More importantly it was written in their "own language". The information in the paper was both practical not bias and could be replicated on individual farms. One respondent said he would have "no problem ringing the paper and speaking" to contributors when seeking more information. The value attributed to the IFA as a body of like-minded people with local representation, was a positive avenue for technology adoption. Evidence existed in section 5.4.1 and 5.4.2. and hence **proposition 3.2 mimetic isomorphism has a significant enabling influence on the adoption of e-agricultural systems amongst farmers was accepted.**

6.2.2.1.3 P3.3 Evidence indicated that coercive isomorphism was not an enabling influence on the adoption of e-agricultural systems amongst farmers.

Farming policy and regulations was felt to be a source of deep tensions between the Department of Agriculture and farmers (section 5.3). One respondent mentioned how policy often restricted him as a farmer. Farming across Ireland fell under the same regulations and he gave the example of the nitrates directive (regulations regarding slurry spreading) as conflicting with the local conditions on his farm (section 5.3.1). He believed that sometimes, winters conditions were suitable for spreading slurry. However, under the regulations, permission to spread slurry not permitted in the winter months. One respondent viewed this as restrictive and impractical as stock was housed indoors during the winter and slurry build-up became a problem. A number of respondents also felt under pressure from the Department of Agriculture to maintain large amounts of paper work from the Department of Agriculture and Department inspections. Perceived bureaucracy was evident within the farming community (section 5.3.2). One respondent claimed that the bureaucratic burden on farmers had forced some (farmers) out of farming because of the lack of support available to help manage the new regulatory paper work. This means that coercive pressures were driving people out of farming. Other respondents highlighted the fear of audits, reinforcing the amount of red tape in farming. One respondent believed he had the feeling of being "watched" and as such needed to be "looking over his shoulder" in case of a departmental audit or inspection. Evidence of perceived coercive pressures from the Department were found in section 5.3.1 and 5.3.2. These pressures were not welcome and viewed with suspicion. Farmers did not perceive the results as being positive for them. Consequently, it was unlikely that they would adopt a technology or innovation as a result of coercion, unless forced to do so. Even then, some farmers would simply leave agriculture altogether. Evidence indicated that **proposition 3.3 that coercive isomorphism appears to be a significant enabling influence on the adoption of e-agricultural systems by farmers was rejected.**

In light of the three sub- propositions P3.1, P3.2 and P3.3 Proposition 3 was deemed to have inconclusive evidence to support that farmers were enabled by institutional forces to adopt new systems.

6.2.3 Farming Knowledge

6.2.3.1 Proposition 4: Evidence indicated that tacit knowledge shapes the community of practice.

Section 2.8.1 introduced the concept of tacit knowledge. The literature contended that tacit knowledge was both dynamic and context- specific, depending on time and space and the interactions of individuals. Tacit knowledge enabled people to communicate and interact, and was a conduit for innovative ideas. The rural context of farming (section 2.6 and 2.8.1) entailed a changeable environment for farmers. Whilst effective communication processes were critical to the diffusion of innovation, the data revealed factors which have not received much attention in the literature to date. It was evident from the findings that learning through social interaction whereby parents and often the extended family of grandparents and uncles, passed their experience and know-how of the family farm onto the next generation (section 5.5.1.1). The importance of tacit knowledge and its transfer across generations was evident from the findings (section 5.5.3). All respondents believed that the foundation of their farming knowledge comes from parents or extended family members. A customary practice in farming was for parents to bring children with them when working on the farm. From the respondents it was evident that spending time with the family enabled the children to grow into the role of farming by watching and observing parents was thoroughly valued. All the respondents respected this process of learning in a social context (section 5.5.4). The primitive form of learning enabled both farm and family survival as seen in section 5.5.1.1.

This pattern of learning contrasts with the agricultural education offered by formal educational institutions (section 5.5.1.1). All respondents expressed negative sentiments regarding the "Green Cert", and said course content was out-dated and the method or not relevant. For example, one respondent suggested he knew more than the course facilitators did. The low value placed on the course voiced by the respondents was in contrast with the respect and value respondents placed on what they had learned from family members.

Farming knowledge was clearly deeply rooted in family dynamics and contextualised within a changing natural environment. This knowledge was intertwined with both family and nature and disseminated from generation to generation, along with the farm holding. The human-centred systems approach emphasised the tacit dimension. However, with respect to the findings of this study, the dimension as conceived in human-centred systems appears too narrow for knowledge in an Irish agricultural context. Tacit knowledge generally emphasise the sharing of knowledge between generations and how this knowledge is interwoven with

knowledge of a changing natural environment. Tacit knowledge literature as described in the human-centred systems literature needs to be refined or adapted to explain agricultural knowledge and its social historical context. Therefore, **Proposition 4 Tacit knowledge shapes the Community of Practice was rejected and needs to be expanded to account for these findings**.

6.3.4 Developing e-agricultural systems for Irish Farms - the importance of the human-centred systems approach.

6.3.4.1 P5. Evidence indicated that e-Agricultural systems development which addressed the interaction between tacit knowledge and cultural values had a positive influence on e-agricultural adoption by local farmers.

Section 2.6 viewed rural systems as co-evolving, complex and adaptive. In a farming context farming life was characterised by unpredictable weather, animal welfare. Technology systems developed for farming communities contained generic information or a one fit for all. Such systems were built on predictability, which was not the case in farming lives (section 2.8.1). Section 2.8.2 conceptualised tacit knowledge as: best practices, expertise, experience and innovation. A respondent in demonstrating their sense of a *connectedness to nature*, expressed how they understand their holdings (section 5.2.5). They characterised farm working lives as caring for and nourishing the land to ensure that the farm could be passed onto future generations. This "know how" was gathered from parents and extended family (section 5.5.3). *Farm Sustainability and Viability* was a critical consideration. One respondent knew from his parents the structure of the farm in terms of land type and suitable crops to be grown in certain areas and applied this knowledge to his working day when farming the land. Section 5.6.1 presented old remedies and practices that were still used in farming today. This and other evidence suggested that the working lives of individuals must be understood when developing technologies for use (in section 5.2.4 and section 5.6). Farmers cherished what they have learned from parents, uncles etc. and view the practice of spending time with parents observing and helping, pivotal to farm viability and sustainability. One respondent who left formal education at the age of eleven explained how his ability to farm was not impeded by leaving school at such a young age because he continued to learn from uncles who offered practical, relevant guidance and knowledge, thus enabling him to farm successfully. For *Individual Learning Processes and Methods* (section 5.5.1), respondents also considered discussion groups in farming as a site of learning. The structures of the group and its constituent members all aided dissemination of new ideas and practices along with the ability to observe new farm practices in context. Knowledge sharing in these groups was open, inclusive and practical. Aside from the learning aspect, the social interaction with other farmers was of importance to farmers. Proposition 5 was broken down into two sub propositions and each treated in turn.

6.3.4.1.1 Proposition 5.1: Evidence indicates that context- specific information supplied in e-agricultural systems has an enabling influence on adoption of e-agricultural systems by local farmers.

Section 2.7 presented socio-technical systems view as balancing the social systems and the technical system. This view was broadened by the human-centred perspective which outlined knowledge diversity which allowed for creativity and innovative practices within social arrangements (section 2.7.2). Systems development that followed the reductionist paradigm produced systems populated with generic knowledge which may or may not be relevant to their context of use. In section 2.9.1, agricultural innovations arose from economic opportunities or scarcity. Situations like these forced farmers to be creative and develop solution to real-life problems giving rise to the importance of "grass root knowledge". Section 2.12 reviewed literature that contends that social learning helps the spread of new practices and innovation. The literature noted that technology development often ignored the working lives of individuals. Section 2.12 suggested that knowledge about innovative practices became easier to transfer across communities when people share locations and close family or community ties. Section 2.10.2 introduced 'sense-making' as a way to aid changes in norms and behaviour. In section 5.3.5 the agricultural advisor was viewed as making sense of farming regulations and policy and translating them back to the farm level. All respondents viewed the agricultural advisor positively and as an asset to the farm.

All respondents agreed that farmers are inventive in the way they advance their farms through new practices. For example, in section 5.6 respondents identified farmers as innovative from the developed of old farming remedies and practices to the display of farmer led inventions at agricultural shows. Innovation was a part of a farmers day which required him to adjust practices and methods depending on what he faced, for example from treating animals to fixing sheds. A common theme in all respondents, was summed up by the statement "It would be a sad day in farming when you didn't learn something new". The spectrum of what constitutes innovative practices was demonstrated in various ways by all respondents. Innovation information and praxis was always context-specific and deeply interwoven, with an awareness of the historical development of new ideas, and of reworking "old" ideas in new ways which makes sense in the specific context of the farm (section 5.6).

Proposition 5.1 evident indicated that context-specific information supplied in e-agricultural systems can have an enabling influence on adoption of e-agricultural systems by local farmers and was therefore accepted.

6.3.4.1.2 Proposition 5.2 Evidence indicated that the separation of generational knowledge and scientific knowledge in an e-agricultural system acts as a barrier to e-agricultural adoption.

Section 2.11 suggested that there was a potential cultural clash between the everyday working lives of individuals in communities and the scientific community. This may contribute to problems with technology deployment. Proposition 5.2 emphasised the value of generational knowledge to the farming community and contrasts this with scientific knowledge. Section 2.10.2 presented literature, which sets out the process of institutional change how 'sense making' enabled changed to be accepted across communities. Section 2.12 reviewed the literature on active learning groups. Within these groups knowledge was shared in a social context with members of the group sharing expertise and experience out of which emerged new knowledge. The findings revealed that the continuity of the family farm was retained by utilising, adapting and capturing knowledge held over generations and contextualised in the farm's everyday life in which people make sense of the knowledge and learning they are appropriating. This process was supported by certain key people, such as the agricultural advisor (section 5.3.5). In section 5.3.1 and 5.3.3 evidence indicated how the high value placed in tradition feeds into farm sustainability and viability. An understanding of the natural environment, farming context and family relationships were interwoven with the farmer's awareness of being a *Custodians of the Land* (section 5.2.4). In section 5.6. and 5.6.1 respondents viewed learning, for example about new diseases, as being embedded into the lived experiences of farming. The Schmallenberg Sheep Virus and the application of old remedies as treatments for this disease (section 5.6.1.2), highlighted this theme. Many respondents viewed the advice from the scientific community as poor and often the practical advice they used came from within their own community was the case with the Miscanthus grass (section 5.3.6). All this was evidence of the separation between generational knowledge which was heavily contextualised and scientific knowledge which seemed distant and even difficult to make sense of. Therefore, **Proposition 5.2 separation of generational knowledge and scientific knowledge within an e-agricultural system acts as a barrier to e-agricultural adoption was accepted.** Therefore Propositions 5.1 and 5.2 were accepted.

Testing the validity of Proposition 6 requires this to be broken down into two sub propositions 6.1 and 6.2.

6.3.4.2 P6. Evidence indicated that e-Agriculture systems development, which addresses the interaction between institutional factors and human culture and values, has an enabling influence on e-agriculture adoption by local farmers.

Section 2.10.1 agricultural institutions included government agencies, peer support networks and advisory bodies were seen to impact on farming policies farming research etc. Validating Proposition 6 depended on the validity of three sub- propositions which addressed isomorphic pressures which impinged upon farming communities by the different institutional organisations.

6.3.4.2.1 P6.1 Evidence indicated that e- Agriculture systems development which addressed the interaction between normative institutions and human culture and values does not have an enabling influence on e-agricultural adoption by local farmers.

Section 2.10 reviewed institutional theory in which structures, systems and technologies became instilled in organisations over time through a process called *isomorphism*. The government scientific body Teagasc was viewed as a government supported agency promoting innovative changes in agricultural practice and offering educational training programmes in agriculture (section 2.10.1). Respondents were deeply critical of the educational learning programmes offered in agricultural institutions for farmers. For example evidence, presented (section 5.6) showed how people praised the social side of learning to farm and how this which was in conflict with formal learning (section 5.5.1.1) made available through the national institutions such as the *Green Cert* where respondents claimed that the programme was out-dated and too basic. Respondents undertook the programme because it was needed when inheriting the farm and applying for institutional grants. The local context and everyday lives of farmers suggested that normative institutional pressures conflict with the human and cultural value of learning established within farm families These institutional pressures conflicted with more powerful influences which shape the adoption of new practices and technologies therefore **proposition 6.1 was rejected.**

6.3.4.2.2 P6.2 Evidence indicates that e-Agriculture systems development, which addresses the interaction between mimetic factors and human culture and values, has an enabling influence on e-agriculture adoption by local farmers.

Section 2.10 introduced mimetic isomorphism as a process whereby individuals or groups copy or model the behaviour of persons held in high status. In section 2.11, it was suggested that culture allowed to cope with uncertainty and allows a group to learn and adapt from generation to generation. Culture helps groups learn and adapt to problems. Culture was a binding force and this was evident with all farm families members of the Irish Farmers Association. In section 5.4.1, each IFA branch had a local representative in their locality that was from a farming background. The ease of access to support and information from the association was made easier by having the local representatives. The Association also had a Regional Office with staff also from a farming background. One respondent believed this was helpful when farmers rang the office seeking advice as again the staff would understand them as they shared same language and sense of identity (as in section 2.12). As this was a "farmer- led" organisation all correspondence, for example the website and weekly publication was written in "less cumbersome language than the department". All respondents read the weekly publication *The Farmers Journal* as it contained weekly articles about new practices and technologies in farming written by farmers (section 5.4.2). The IFA and farm families share similar values and behaviours with farmers and are more likely to mimic practices and innovations of other IFA members or seek out members when in need of advice. **Proposition 6.2: e- Agriculture systems development, which addresses the interaction between mimetic factors and human culture and values has an enabling influence on e-agriculture adoption by local farmers, and is therefore accepted.**

6.3.4.2.3 P6.3 Evidence indicated that e- Agriculture systems development, which addresses the interaction between coercive institutional change and human culture and values, has an enabling influence on e-agriculture adoption by local farmers.

Section 2.10 presented literature from coercive isomorphic processes. This often came from governments who imposed change, in the form of new regulations and policy upon a group. Often the group felt it as push of power by the lesser system. Respondents viewed changes in communication between themselves and the Department of Agriculture as increasing stress levels. This was evident by the closures of regional offices and a shift to communication by internet and telephone (section 5.3.3). Farmers described their difficulties understanding the

precise relevance of these changes for their farm. In light of this situation, all respondents hired an agricultural advisor to help with implementing and understanding farming policy and regulations (sections 5.4.5). This acted as a buffer between the farmers and helped them manage changes to policy and farming regulations. The advisor guided them and explained policy from their perspective and acted as a conduit when communicating with the Department of Agriculture on their behalf. These advisors act as a 'sense making' supports for farming communities. All respondents had confidence in and trusted their advisor to act professionally, thereby relieving the pressure associated with making sense of policy and regulation at the micro-level. Advisors had knowledge of what grants were available to farmers and the grants supports that could work within their context and improve their farms. It was evident that agricultural advisors support when interacting with the Department was highly important in understanding the adoption of changes in local farm practices. E-agricultural systems development methods will need to include these sense- making processes in their socio technical systems approaches. This was sufficient evidence to accept Proposition 6.3, with modifications to the framework. The modification is required to emphasise the importance of sense- making support in the theory. Therefore, **P6.3 evidence indicated that e- Agriculture systems development, which addresses the interaction between coercive institutional change and human culture and values, has an enabling influence on e-agriculture adoption by local farmers if the sense making process is included and was accepted as a proposition with modification.**

Based on evidence for P6.1,P6.2 and P6.3 proposition 6 was accepted with modifications.

6.3.4.3 P7. Evidence indicates that e- Agriculture systems development, which addresses the interaction between institutional factors and tacit knowledge has an enabling influence on e-agriculture adoption by local farmers.

Section 2.10 of the literature presented the process of isomorphism (coercive, normative and mimetic) whereby institutions and social groups become homogenous. To address the type of institutional isomorphism Proposition 7 is broken into three sub propositions, based on the three isomorphic types.

6.3.4.3.1 P7.1 Evidence indicated that e-Agriculture systems development, which addresses the interaction between normative isomorphism and tacit knowledge, had an enabling influence on e-agriculture adoption by local farmers.

Respondents repeatedly criticised the way Teagasc promoted new farm practices. They stated that the advice given to farmers in the dairy sector, regarding abolition of the milk quota system was impractical, costly and unworkable. One respondent suggested that Teagasc advice on dairy farming was based on a blue-print disconnected from real-world farming. Another respondent gave the example of sugar beet farmers who were given advice from Teagasc to grow new crops in lieu of sugar beet, following the closure of the sugar beet industry. He felt that asking farmers to grow on their land a crop not easily grown by scientists in their research centres as "shameful" (section 5.3.6). All respondents believed the new practices presented by scientific institutions incur major costs to farm enterprises and if the new system fails, farmers find it difficult to get further support from the same institutions. Some suggested that when Teagasc advisors did "walk the farm" they got a better insight into how to educate a farmer in new farming methods based on his farm. This practice was discontinued and respondents viewed the institutions as removed from practices on the ground. Respondents described the importance of a co-op presence within the community (section 5.4.3), for example, the local co-operative branch of the international food producing company Glanbia. Respondents value going to the local branch of this firm and transacting with the staff, as opposed to using the online service offered by the same company. One wife was concerned about the loneliness of farming so the social engagement of the co-op is vital in light of the isolation farmers sometimes experience (section 5.5.1.3). Another respondent believed the presence of a local branch gave vibrancy to rural communities, with farmers often discussing farm- related topics informally at the branch (section 5.5.2.1). One respondent stated that he obtained practical advice from another farmer, which was more valuable than scientific advice. The ease of social exchange within this social setting offers a platform for the exchange of ideas and information for farmers. This evidence supports Proposition 7.1 which was accepted. However, it needs modifications. Informal peer-networks work as avenues for the adoption of innovative practices, with farmers seeking and exchanging knowledge. The support networks within this community appeared to support vibrancy and connectedness in rural areas and needs to be incorporated in a socio-technical systems development approach to e-agricultural systems development.

P7.1 Evidence indicated that e- Agriculture systems development, which addresses the interaction between normative isomorphism and tacit knowledge, had an enabling influence on e-agriculture adoption by local farmers is accepted with modification.

6.3.4.3.2 P7.2 Evidence indicated that e-Agriculture systems development, which addresses the interaction between mimetic isomorphism and tacit knowledge, has an enabling influence on e-agriculture systems adoption by local farmers.

The literature contended that mimetic isomorphism occurred when one system models another system, adopting aspects of prior behaviour or processes. Discussion groups were generally managed by a Teagasc advisor in a social setting, but with contributions and behaviours very much farmer-led (Section 5.5.2.2). Discussion groups were held on farms and ideal for seeing new practices in action. The group size was set at ten and respondents described how all participated in the discussions. All respondents in this study were members of these discussion groups and remarked how beneficial it was to "walk the land" and exchange ideas and opinions. Some described their appreciation of the openness of participants who allowed members to see their farms and what worked for them when applying new practices in their farm setting. The neighbour was also critically important for some respondents who described them as a person who helped them when asked and acted as a valuable source of information. Farmers felt they could talk freely to their neighbour regarding farming matters. Whilst large institutions promoted discussion groups they were very much farmer led. The mimetic influences were therefore somewhat more complex then outlined in the literature, but were evident sometimes as enablers of innovation adoption. This was evidence for **Proposition 7.2 that e- Agriculture systems development, which addresses the interaction between mimetic isomorphism and tacit knowledge, has an enabling influence on e-agriculture systems adoption by local farmers and was accepted as a valid proposition.**

6.3.4.3.3 P7.3 Evidence indicates that e- Agriculture systems development, which addresses the interaction between coercive institutions and tacit knowledge, is an enabling influence on e-agriculture adoption by local farmers.

Section 2.10 of the literature review summarised the importance of coercive pressures from external institutions. Respondents described how farm policy was "pushed on" farmers with their own opinions ignored (section 5.3.4). Farmers concerns about climate change for example in relation to flooding, were evident in the findings. However, they also felt there was a danger that inappropriate climate policies damaged the viability of the farm as it tried to sustain the family and produce food to feed the growing population. Respondents felt that global policy makers needed to listen to farmers. If policy was inappropriate farmers would be forced to leave their farms and a respondent cited example of this (section 5.3.4).

Given the knowledge curated within farm families about how to care for the environment, farmers felt they should have a strong voice in setting future policy and agendas for farming (section 5.3.4). The evidence that coercive institutional pressures take into account tacit knowledge was not conclusive, and it is difficult to draw conclusions about coercive institutional and tacit knowledge acting as an enabling influence on e-agriculture adoption by local farmers. Therefore **P7.3 was rejected as a valid proposition**.
Based on P7.1 and P7.2 and P7.3 proposition 7 was rejected as a valid proposition.

6.3 Review of Theoretical Framework

6.3.1 Review of the Original Framework

Human- centred systems perspective transcend a linear predictive view adopted by human and machine systems. These human-centred systems emphasise user-involvement in order to support human needs, purpose, skill, creativity and potential, enabling individuals and communities to lead the lives they chose. From this perspective, knowledge embedded in the working life of individuals built over the centuries and shaped by natural environments combined with modern science is a key element in the development of agricultural solutions. To understand the community of practice central to the framework, institutionalism allows a deeper look at the social structures influencing the processes, rules, routines established in farming and the importance at the micro-level social system of the family. Accompanying these social structure are the cultural values established over generations. These dimensions interleave, giving rise to the following framework which was proposed in Chapter 3 and tested by the field research.

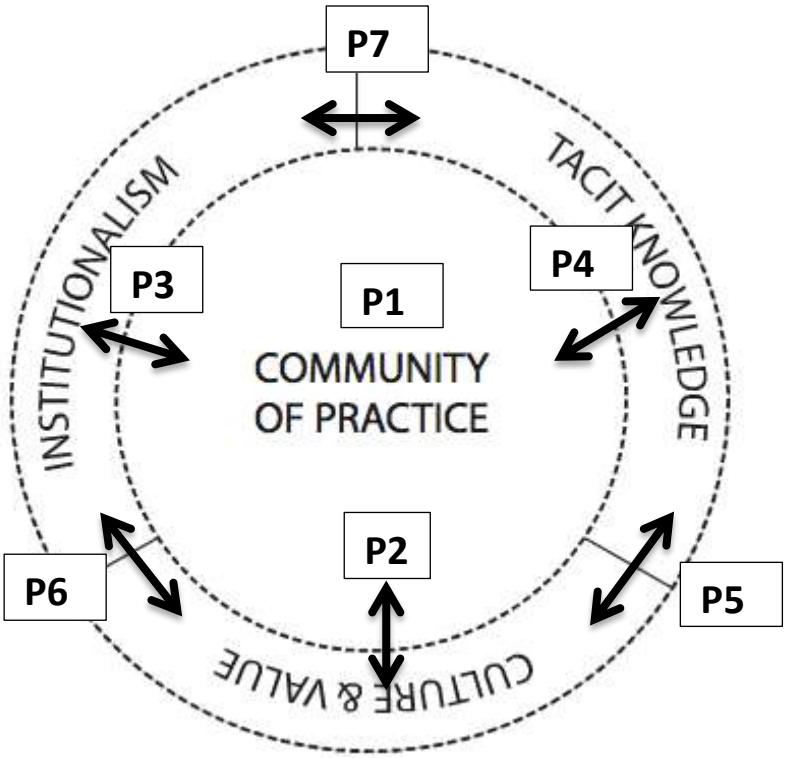

Figure 6-1 Conceptual Framework for E-Agricultural Systems Adoption and Development

The following Table 6.1 summarises the evidence for each of the components of the framework, where each component was expressed as a proposition for testing.

Proposition	Comment	Accept/Reject	Summary of Modifications To Proposed Theory
P1: A Farm Family is a Community of Practice	Values of tradition, conservation and historicity were important by all respondents and support the concept of the farm family as a cultural unit of shared values, acting as a community of practice.	Accepted	No modification as evidence exists to support P1 in section 5.5.1.1, section 5.5.1.3, section 5.5.3 and section 5.5.2.1.
P2: Cultural values shape the Community of Practice	The values evident within the community of practice are a duty to conserve the farm and family viability	Accepted	Evidence existed supporting P2 from section 5.2.1, 5.2.3 and section 5.2.2
P3: Institutional factors shape the Community of Practice	Institutional norms and beliefs, rules and structures influence a community of practice	Rejected (Inconclusive)	P3 is decomposed into 3 sub propositions and based on the revision to sub proposition 3.3.
P3.1 Normative isomorphism positively influences the diffusion of an innovation across a community of practice.	Claims of institutional neglect (closures of agricultural offices and lack of support from scientific institutions impacted of innovation diffusion).	Rejected	P3.1 is rejected based on findings in Section 5.3.6
P3.2 Mimetic isomorphism positively influences the diffusion of an innovation across a community of practice.	Isomorphic pressures from peer networks were viewed positively by all respondents (likeminded people who understand farming).	Accepted	P3.1 is accepted based on findings in sections 5.4 section 5.4.1 and section 5.4.2
P3.3 Coercive isomorphism has a positive effect on the adoption of e-agricultural systems amongst farmers.	Coercive pressures from larger organisations or lesser organisations force adoption and changes to the norm. The coercive nature of institutional policy places pressure on farms generating large volumes	Rejected	P3.3 is rejected based on section 5.3,section 5.3.1 and section 5.3.2.

Proposition	Comment	Accept/Reject	Summary of Modifications To Proposed Theory
	of paper work and regulations, often in conflict with the farm daily routines.		
P4: Tacit knowledge shapes the Community of Practice.	Tacit knowledge resonated through generational learning process in farming and contextually rooted in the farm insuring survival of the family and farm.	Rejected (limited)	Reject original proposition and revise theory to include Section 5.5.3 ,section 5.5.4 and section 5.5.1.1
P5. E-Agricultural systems development which addresses the interaction between tacit knowledge and cultural values would have a positive influence on e-agricultural adoption amongst local farmers.	The mechanistic view of technology development fails to acknowledge the body of knowledge used within our daily lives. The social learning process within farming encompasses learning about the natural environment in order to ensure farm continuity.	Accepted	P5 was accepted with no modifications as evidence for the concept was supported in section 5.2.5, section 5.5.3.section 5.2.4,section 5.6.1,section 5.6 and section 5.5.1
P5.1: Context specific information supplied in e-agricultural systems would have a positive influence on adoption of e-agricultural systems amongst local farmers.	The use of old farming practices and methods in farming today is evident from respondents. The unpredictable nature of farming entails that farmers must constantly learn.	Accepted	P5.1 was accepted as evidence for the proposition was found in section 5.3.5 and section 5.6
P5.2 Separation of generational knowledge and scientific knowledge within an e-agricultural system has a negative effect on its adoption.	Supporting innovative change ensures the survival of groups with well-organised learning networks to allow knowledge flows. Learning in context enabling people to make sense of new practices	Accepted	Evidence existed in section 5.2,section 5.3.5,section 5.3.1,section 5.3.3, section 5.2.4,section 5.6,5.6.1,5.6.1.2 and section 5.3.6
P6. e- Agriculture systems development, which addresses the interaction between institutional factors and human culture and values, would have a positive influence e-	Agriculture is supported by institutional organisations: scientific government and grass root institutions each legitimising certain structures and behaviours	Accepted with modifications	P6 is decomposed into 3 sub propositions and as such P6 accepted based revision to sub proposition 6.3.

Proposition	Comment	Accept/Reject	Summary of Modifications To Proposed Theory
agriculture adoption amongst local farmers.	(isomorphism). Each of the institutions are represented in the sub-propositions of P6.		
P6.1 e- Agriculture systems development, which addresses the interaction between normative isomorphism and human culture and values, would have a positive influence e-agriculture adoption amongst local farmers.	Scientific government institutions aid the legitimising of certain structures and behaviours.	Rejected	In section 5.6 and section 5.5.1.1
P6.2 e- Agriculture systems development, which addresses the interaction between mimetic isomorphism and human culture and values, have a positive influence e-agriculture adoption amongst local farmers.		Accepted	Evidence in support of P6.2 existed in section 5.4.1 and section 5.4.2
P6.3 e- Agriculture systems development, which addresses the interaction between coercive isomorphism and human culture and values, have a positive influence e-agriculture adoption amongst local farmers.	Government policy and regulation impact on farming	Accepted (with modification)	Evidence existed in section 5.3.3 and section 5.4.2
P7. e- Agriculture systems development, which addresses the interaction between institutional factors and tacit knowledge positively influences e-agriculture adoption amongst local farmers.	Isomorphic pressures influence technology adoption with different institutional types exerting their own pressures	Accepted	P7 was accepted as in section 5.3.6, section5.4.3,section 5.5.1.3 and section 5.5.2.1
P7.1 e- Agriculture systems development,	Normative pressures influence technology	Accepted	Evidence existed in section 5.5.2.2

Proposition	Comment	Accept/Reject	Summary of Modifications To Proposed Theory
which addresses the interaction between normative ismorhism and tacit knowledge positively influences e-agriculture adoption amongst local farmers .	adoption		
P7.2 e- Agriculture systems development, which addresses the interaction between mimetic ismorphism and tacit knowledge positively, influences e-agriculture adoption amongst local farmers.	Mimetic pressures influence technology adoption	Accepted	In section 5.3.4
P7.3 e- Agriculture systems development, which addresses the interaction between coercive isomorphism and tacit knowledge positively, influences e-agriculture adoption amongst local farmers.	Coercive pressures influence technology adoption.	Rejected	In section 5.3.4

Table 6-1 Table of Propositions in Light of the Evidence

Based on the above summary of propositions and findings, a refined theoretical framework was adopted. This is synthesised in the Figure 6.2

6.3.2 Revised Theoretical Framework

This section attempts to revise Figure 6.1 and offers a new theoretical framework informed by the evidence summarised in chapter 5. The human-centred paradigm provided a rich level of analysis in contrast to the mechanistic view of the world which informs much e-agricultural systems development thinking. The symbiotic relationship between the human and machine is central to the human-centred tradition. It moderates modern science and technology by mitigating the functional approach to systems thinking. It provides concepts such as human purpose, diversity, participation, social responsibility, and equality, providing a theoretical and methodological framework for the social and cultural shaping of technology and the society in which the technology is deployed.

System development approaches that make assumptions about an economic or functional reality may miss many important factors that are revealed in this study. System developers must begin to take account of the behaviours associated with the conditions, values, beliefs and techniques of everyday lives in farms. Given the importance of information systems both today and into the future, it is clearly important to understand and contextualise the social behaviour of actors. For example, in Irish farming communities the *sense of duty* to *family* and the *environment* informs the very texture of farming lives. The adoption and continued usage of ICT's among farming communities may require systems developers to use tools and knowledge which provide a richer understanding of technology in context. In light of these factors, the framework shown Figure 6.1 is extended and modified using a human- centred perspective, but adjusted for certain particular aspects of the evidence gathered in this study.

6.3.2.1 Expanding the Tacit Knowledge Dimension

Tacit knowledge as defined in section 2.7.1 was found to be very important. System developers need to understand, interpret and appreciate the role of tacit knowledge. The literature defines tacit knowledge as embedded in the best practice, experience, expertise and innovation. This definition appeared too narrow to account for all the evidence associated with tacit knowledge gathered within this study.

The most important learning within farming communities happened within the family context. The family is a body of knowledge residing in a natural environment. A farm is not only a commercial entity but is socially embedded in the family which itself is intertwined

with the natural environment as well as the larger farming community. This “eco-system of knowledge” is the site of practices and values associated with the know-how and expertise exchanged between family members and across the farming community. This method of learning gives a solid foundation for educating farmers and is deeply valued. It is firmly rooted in the interaction of nature and nurture expressed in various ecological settings. Information exchanges occur in the most basic human relationship of parent and child. This active engagement occurs by accompanying and observing family members and assigned duties, in the most humble of settings. Skills such as husbandry skills, land management and the farming way are instilled in this way. The critical importance of intergenerational knowledge exchange ensures farm viability and continuity over time. Engagement in the cyclical nature of farming from animal birthing to harvesting crops also helped a farmer to learn. Family expertise is treasured and built upon in later life by farmers. The local co-operative or Teagasc supported discussion groups also facilitated this learning and knowledge transfer, whilst more formal institutional arrangement were not so effective. Online communication techniques may undermine these deep human processes and systems, and may even contribute to the demise of some family farms.

6.3.2.2 Connectedness to Nature

The appreciation of the land and nature is intertwined within farm practices. The land must be nourished to future proof the farm. The resilience of the community was expressed by respondents who recalled weather events and disasters such as the spread of disease. The environment challenges them to adapt and learn from such events. Often future events were best prevented or eased by implementing old traditions learned long ago such as the use of lime to halt the spread of Foot and Mouth disease. The shared mind set amongst respondents revealed that farmers expected such challenges but learned and adapted to safeguard future impacts. Systems development needs to be cognisant of, and pay respect to, these ancient and deeply imbedded learning processes if new technology such as e-agricultural systems is to take a foothold in Ireland.

6.3.2.2 Utilisation of Sensemaking Processes

Underpinning change and adaption is the process of sensemaking allowing the farm family return to a state of equilibrium when forced into a chaordic state. When a social systems

culture is challenged it is forced into chaos. To return to equilibrium learning must occurs. Often the learning trajectory is not known or guided by unplanned events and a sensemaking process must occur and occurred at many levels with the farming community. From the spread of diseases with no known cures e.g The Foot and Mouth forced the agricultural community to arrive at solutions to the problems at hand. Coercive isomorphism appeared as a force to the farming community forcing them into a chaordic state. For the farming community to understand and interpret changes to farming regulation and policy all employed the services of an agricultural advisor.The advisor was seen as conduit for interpreting policy and regulation for the farmer allowing him to understand and address policy from his perspective. Another example was when respondents suggested that farm practices had changed from one generation to the next often because of interactions with their natural environment. For example one respondent said their practice had changes due to changes in winter weather.

6.4 Institutional Isomorphic Influences on Technology Adoption

Institutional isomorphism was an important shaping influence in the innovation adoption. The implications of its three main dimensions: coercive, normative and mimetic are concluded below.

6.4.1 Coercive isomorphism

Coercive isomorphism was rejected as an important factor which could enable farms to adopt new a-agricultural technologies. The role of government departments and agencies in setting regulation and forming policy caused stress to farmers particularly with the volume of paperwork required. Coercive pressures to adopt new technologies was therefore likely to be resisted and when coercive pressured intensified there was a real issue with farming families leaving agriculture. With regulations set at European level many respondents claimed it took away the flexibility needed to farm from the farmers as strategic decisions were not embedded in understanding of daily experience and practices. Respondents spoke of changes to the diary quota system and the sale of the sugar beet industry in Ireland as examples of agenda setting that conflicted with farming realities. All respondents felt neglected and isolated by the regulatory authorities. Often respondents found it difficult to speak one-to-one to institutional representatives when seeking advice. They hired agricultural advisors to act as buffers between the farmer and the Department of Agriculture. All

respondents had confidence in the advisors' ability and knowledge of farming policy and felt the advisor was accessible, and understood their concerns and needs when liaising with the Department of Agriculture. Critical to this was the way advisors engaged in the everyday experience of farming families. They walked the land with farmers, a practice which was once common but which few officials and government agencies now practice.

The government and environmental policies acted as constraints and a barrier to creativity and innovation. Families they had to maintain more paper work to cope with the changes in legislation and markets regulations. This resulted in some farmers leaving farming as the paper work had become unmanageable. Coercive isomorphism has a possible negative effect on innovative practices and but needs consideration within system development practices for rural users if agriculture is not to suffer.

6.4.2 Normative isomorphism

Normative isomorphic pressures come from professional and educational bodies offering formal academic credentials. However, respondents felt that these bodies generally conflicted as they expected farming communities everywhere in Ireland to behave the same way, leading to homogeneity. In Irish agricultural research generic models of farming along with what respondents believed to be the outdated Green Cert offered by professional bodies were viewed as impractical for real world environments. Filtering of personal knowledge back into the field was important but this practice had changed with the European policy initiative, CAP. Respondents enjoyed the social contact at the local branch co-op viewing it as an informal place to chat to other farmers and a forum to seek advice and opinions about farming matters. Farmers looked to other farmers for information. For example, their opinion on pesticides for crops, manure for land to name but a few. To encourage innovation and diffusion farmers sought out likeminded individuals for support and information. The human centred systems approach with its socio technical perspective can be extended to include living systems more generally and introduce new metaphors which better fit the agricultural context and allow system developers to interpret these problem domains.

6.5 Extending Human-Centred Systems Thinking

6.5.1 Viable Systems Approach

The discrete components of Figure 6.1 can be expressed by the intertwining of concepts influenced by social forces from the various institutions. This is a richer expression of the holons and links between the knowledge types and better incorporates family and societal influences.

A viable living system approach with dynamic organic relationship is an alternative way to conceive this socio-technical systems context and to apply a longer term view rather than a short view of technology innovations and even human centred systems. The Viable System Approach (VSA) advocates a self-regulating system adjusting itself to turbulent complex environments whilst maintaining a separate but independent existence within systems. As the farming community were mindful of both the natural environments and social environments. The VSA could support the interpretation and analysis of this community and its eco-socio- relationships.

6.5.2 Application of the Hospitality Metaphor

Scientific knowledge focuses on rational understanding and knowing of universal principles and this rationality is given revered status within Irish society generally. However, what arose within the farming community was a rationality much more associated with tacit knowledge, historical knowledge, cultural and social factors and relationships. Metaphors assist in the interpretation of situations and express interactive subtleties not obvious to traditional system development models. With this in mind the metaphor of *hospitality* as proposed by Ciborra (2002) for information systems development methodologies more adequately capture these ideas. He believed systems development methods failed to understand the *actors* or other persons who have vested interest in the system and the systems development process often ignored important insights about the context in which technology is deployed. When applied to farming systems, developers must become aware of the farm, the relationships between family over long periods of time and outwards into the environment in which the system will become embedded. Generational knowledge and community learning in context was paramount for the survival of the family farm for these respondents. With this in mind system developers need a rich understanding of rural working lives and context in which important knowledge is acquired, located, disseminated and applied.

Ciborra (2002) believed *hospitality* was an ancient way of merging cultures and allowing the integration of *alien* cultures which is how he viewed the introduction of new

technologies into a pre-existing social space. This metaphor provides a language for the interpretation or discourse which is located closer to the real everyday lives of people in which the relationship between technology, institutions and farmers is framed. *Hospitality* provides a way to explore the intrinsic complexity of society and identify what is missing or omitted from current approaches to e-agricultural system design and implementation. These ideas are synthesised in Figure 6.2 which revised Figure 6.1.

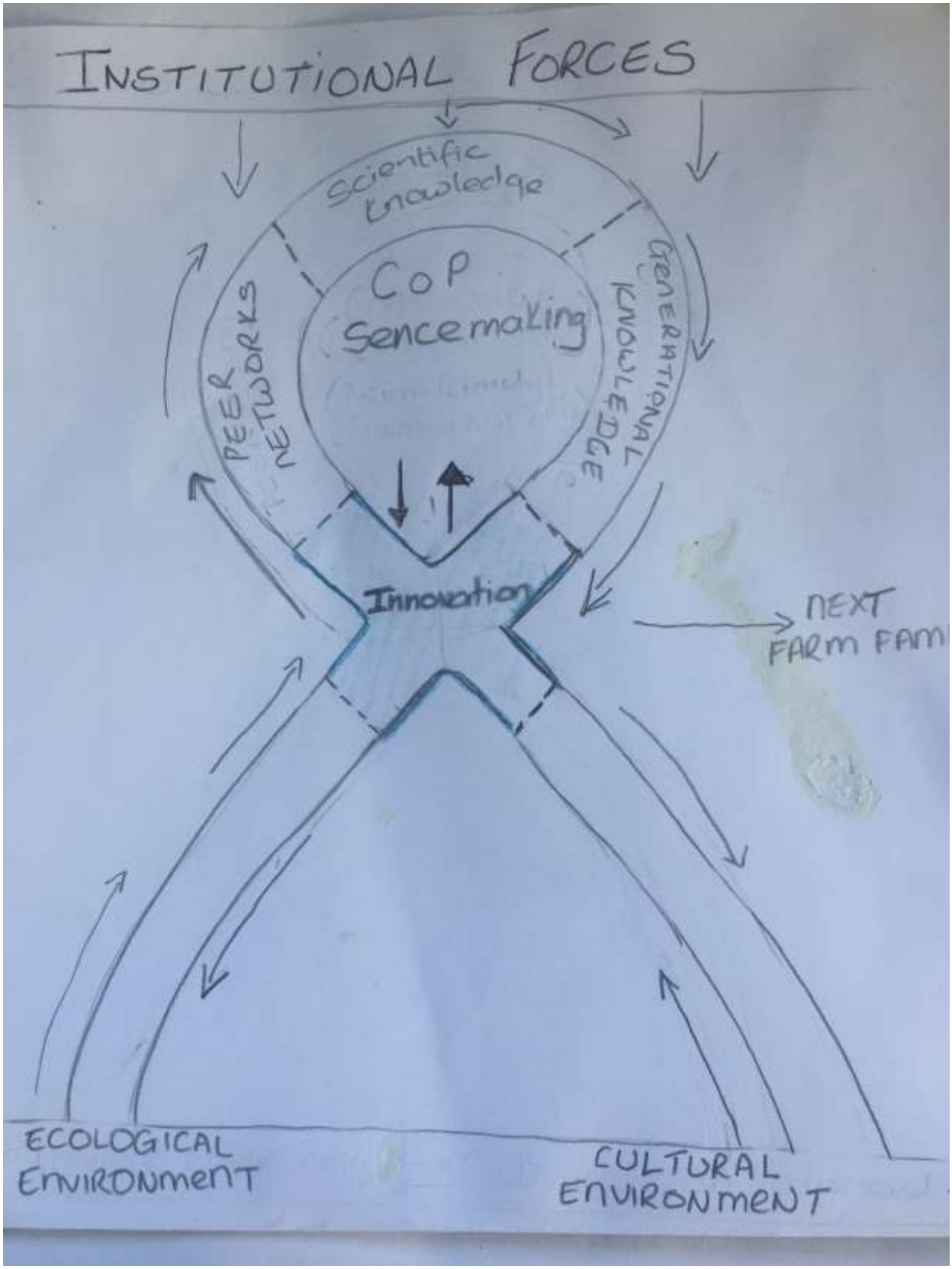

Figure 6-2 Rural Technology Framework (RooT)

6.5 Summary and Conclusion

In this chapter, the propositions presented in Chapter 3 have been assessed in light of the research findings set out in Chapter 5 and the literature assisted to determine how the theory might be refined or modified. From this, a modified theoretical framework presented. The final chapter revisits the research objectives and questions, highlights limitations of the study and possible future directions of the research.

CHAPTER 7 CONCLUSION

7.1 Introduction

This final chapter presents a discussion of the outcomes of the research in relation to the research objectives and the limitations of the study. Presented are the key contributions to theory, practice and research methodology. The chapter concludes with implications for future research.

7.2 The Outcome of the Project in Relation to the Research Objectives

The purpose of the study was to identify gaps in the information systems literature regarding the adoption of e-agricultural systems by rural communities in particular farm families in Ireland. In this investigation key factors where identified that allowed for the construction of a methodological conceptual framework. This model was known as the RooT model, *Rural Technology Model.* This model will have implications for both the research communities and rural communities as a whole.

7.2.1 Overall Aims of the Study

The landscape of Irish agriculture continues to evolve, adapting itself to change whilst being influenced by shifts in global food markets, policy and regulations. Farm families understand change and unpredictability but need ways to ensure the adaptability and flexibility of their farms. In an attempt to support farm enterprises e-agricultural systems are seen as a way to support Irish farming. However, using such technologies can create its own challenges to users as seen in the CUITA report. To understand and interpret this phenomena the following research question where proposed.

7.2.2 Research questions

1. *What key concepts comprise a conceptual model for the improvement of e-agricultural systems adoption and continued usage amongst farming communities in Ireland?*

Evidence for key concepts were presented in Chapter 5 and synthesised into theoretical concepts in Chapter 6. The study has shown that the overarching concepts within the project were the interaction with the environment and socio-cultural relationships with the families. The community of practice (farm family) is firmly rooted in these two main concepts enabling both the farm and the family to adapt, survive and evolve over time. The community of practice is interconnected to the wider agricultural community and can be viewed as a

living system. It is nourished by the knowledge flows that circulate the system. Allowing it to grow, adapt, and evolve within its cultural and natural environments. This resonated from the cultural concepts of sense of duty, universalism and custodianship. Such ideas are not from a scientific rationalism, which has dominated the general approach of the scientific and government agencies towards technological innovations in farming.

What are the impediments for adoption of e-agricultural systems amongst farming communities in Ireland?

Routinely Irish farmers are called to begin new farming practices stemming from technology development within scientific institutions. Such developments are passed by means of intermediaries as in the case of Teagasc. The RooT model places a new emphasis on technology transfer by reconceptualising this process. The model is composed of concepts that collectively support the adoption of e-agricultural systems. This places a new light aiding the identification of gaps in current literature. The role of institutional factors that shape the community of practice often created tensions that constrain or force the community of practice into a chaordic state. This study found tension often arose from regulation and policy formation. Here coercive pressures were viewed as tightening and restricting workings on the farm. Conflict also arose around the various knowledge sources used in farming whereby normative institutional forces failed to nurture the generational or local knowledge within the CoP. The value added by these norm-setting institutions appeared to fall short from the farmer's perspective. The CoP within farming appeared to self-organise itself around the local resources such as extended family and peer networks. Such networks are informed by cultural practices facilitating social learning through a sense making process. Failure of normative institutions to utilise such resources already in play appeared to significantly influence technology adoption amongst Irish farmers.

What are the key concepts that improve the adoption and continued usage of e-agricultural systems in support of rural sustainability in Ireland?

The human centred lens appeared too narrow to truly appreciate the interleaving and dynamics between the relevant systems at play within farming communities. The relationships that existed amongst concepts in this eco-system are living in which communities learn from generational knowledge and peer-networks. These exchanges happen within their natural environment. The social intertwining was evident in the respect and

appreciation voiced by respondents for their parents and natural environment. Knowledge from the human side is often lost or misinterpreted in translations for technical platforms. The social collectives of family and neighbours were pivotal to fostering learning and could act as an enabler for the adoption of e-agricultural systems. Systems developers need to utilise the community of practices and the process of sense making that enables the farming community to grow and adapt.

7.3 Limitations of the Research

All research has limitations that are dependent on the researcher and the context of the investigation. The limitations that are applicable to this research are discussed in this section.

Firstly, time is a problem in all research, in particular when the work has to be conducted part time as was the case for this piece of work. This was a part time study following a qualitative approach and with time constraints was limited to farm families within the southeast of Ireland. The population sampling technique applied was snowballing, with farm families suggesting other farmers within their peer network that might participate within the study. This proved valuable to gaining access to families however to replicate this process nationally would be too complex to manage in terms of the practical side and time required to travel and interview respondent. Therefore, to conduct a national study would require more consideration when choosing the population sampling technique.

Secondly, as there have only been a small number of research projects and peer-reviewed papers in this area published by Irish academics over the past 15 years, it limited the material available for the literature review.

7.4 Contribution of the study

Aside from the limitations, the study acknowledges how knowledge from the human side is lost from these social collectives in technology led development. The study also gave an insight and voice to sometimes marginalised elements of society and made contributions in the following:

7.4.1 Theoretical Contributions

Firstly, the study applied a human centred systems theoretical approach to understanding the slow adoption of e-agricultural systems amongst Irish farming communities. E-agricultural systems where re-cast as socio-technical or human-centred systems. This refocused system thinking so that the study viewed the challenge of building e-agricultural systems as a human-machine symbiosis challenge, rather than a technical challenge only. This re-casting of the problem of e-agricultural systems development and adoption broadened the scope of traditional research into e-agricultural systems.

The findings emanating from this research provided support for the basic premise of a human centred systems theory, in that, systems developers must take into account and complement the human skills of such users in the development process. The study highlighted the turbulent environments these people operate and how the linear approach often applied in systems development was failing to handle these complex arrangements. In turn when research follows the technical adoption models, it fails to explain the reasons of slow adoption amongst such group.

Firstly, a major contribution of this study is to extend human centred systems thinking. For example it was clear that the farm family is a holon, the scientific community is a holon and the human centred systems approach helps to understand and appreciate not only the interconnections but perhaps more importantly the gaps between the holons. This breaks into a new very important field and extends the legacy of foundational thinkers in the human centred systems such as Micheal Cooley in that a new subversive and revolutionary approach is needed which values non linearity engagements with the holons and see e-agricultural technology through the lens of everyday lived, everyday experiences, contextualised in the landscape and natural environments. The notion of the holon suggests the interconnectedness of the relationships between the human system and the other parts it interacts with. This supports an understanding of interconnectedness and differences in which diversity is valorised. The ability to translate and progress on one level of analysis to another aids understanding of multiple level processes and explanation of the links between levels. Application of the holon allows for illustration of complexity within these social arrangements.

Another major contribution of the RooT model and theoretical lens is that it can be used in other community contexts such as health services and education. The RooT framework highlights the reality that the most important knowledge and praxis is generated in

farming communities themselves and not in scientific and institutional communities indeed this is where the real problems arise in the ground in context rooted in everyday experience. As farming families attempt to make sense of agriculture in a complex changeable world.

Secondly, the application of the hospitality metaphor allows a language of interpretation within such complex arrangements. The metaphor humanises systems and allows users to explain their lived experience.

Finally, the research presented the role of agricultural institutions in the adoption and continued usage of e-agricultural systems. Peer networks appeared valuable in educating and facilitating information exchange amongst rural communities. Farmers appeared to locate such networks when seeking advice and help in matters. Pooling together of these social arrangements could perhaps lessen the chaordic or turbulent states that occur when new practices or behaviours are implemented. Often science and technology misses the point of the ability to innovate and generate new ideas within social systems. Complex arrangement can occur in lives generating turbulent environments. Technology is not the panacea; often presenting solutions to reduce this chaos lies in the point of origin, as seen by the use of old farming practices as used in farming today.

This results of this research could perhaps lessen the linear approach applied to systems design and development and strengthen the human-centred systems approach. This could lessen the impoverishment of traditional social systems such as families and neighbours which appear fundamental within farming communities.

7.4.2 Contributions to Practice

Modern living has in certain areas led to impoverishment rather than improvement of the human condition with rural people often left excluded or isolated. Technologist aims to bring progress advocating improvement to the human condition. Whilst some technologies might be impressive, technological progress has led to changes in social behaviour that some people experience as oppressive. Following the human centred system perspective allows synthesise across incompatible domains of knowledge that enables the pooling of resources and knowledge which support innovative practices.

The development of new learning programmes for agriculture might benefit from moving to contexts based programmes. This builds on the initial foundation of learning from

within the family that appeared deeply respected by the community. Perhaps a shift in practice based models of learning might be explored.

The research also allows the voice of rural people to be expressed within their own personnel settings. The sentiments raised could aid the setting of future policy and agendas for rural communities and lessen the tensions that arise between policy makers and farming communities. The need for policy makers to understand rural life becomes increasingly more important within the EU with the United Kingdom exiting the union. Irish farming is one sector facing uncertainty as trading policies and regulations are still under negotiation.

7.4.3 Methodological Contributions

This research has also made a substantial contribution to methodology, particularly in the areas of information systems design. Human centredness is committed to designing purposive technology. Following this view gave rise to findings presented in the RooT model. The model aids understanding of the complex nature of the overlapping and intersecting context of social, cultural and function within farming communities. The methodology adopted for this study proved useful, as it allowed the researcher to follow a systematic approach that guaranteed a coherent design for data collection, analysis and interpretation, resulting in a rich and insightful understanding of the complicated phenomenon under investigation. Agricultural and Information Studies regarding technology adoption have mainly applied quantitative research methods to studies perhaps due to the lack of qualitative frameworks to guide such research (Dooley 2007). Both Agricultural and ISD research have been overly dominated by the functionalist perspective with most ISD research taking a positive approach towards carrying out research. While these approaches were very important in identifying the steps and measuring the effects and their impacts, it failed to take into account an understanding of process research for very complex phenomenon. To understand these issues, ISD research must move towards more interpretivist research, particularly if complex issues that impact the development of systems within varying environments are to be explored in ISD literature. The interpretivist methodological approach would widen the literature on ISD and lessen the gap that existed between ISD theory and practice.

7.5 Future Research

A direction that future research could take concerns the framework developed in this research and whether these findings can be applied beyond the project. This might include extending the RooT framework to other contexts such as health services, education and technology adoption in developing regions. In computer science the RooT framework especially the identification of holons, holon interconnections and interdependencies and other elements of this human centred systems model could be addressed and in-deed operationalised using machine intelligence. Many of the components of the knowledge model developed in this thesis can be mapped for example to artificial intelligence solutions using fuzzy cognitive maps (Vergini & Groumpos 2016). This will help findings and theoretical models offered here to be applied more broadly beyond agriculture and the Irish south-east region.

Future work will therefore extend the research methodology itself beyond the interpretivist approach developed here to other analytical and experimental tools. This study has significant implications for both agricultural science and computer science education. It is clear that new models are needed which root learners in a human centred systems appreciation of how knowledge is generated and consumed, curated and nurtured in agricultural communities. At the very minimum the knowledge of farmers handed from generations to generations and located in the context of lived experience must be central to this education and treasured as a unique resource and is the heart beat of rural life. In computer science education and research learning algorithms associated with deep machine learning and data analytics need to be revisited. Whilst they offer some opportunities for development in agriculture this needs to be balanced against the significant threats these technologies pose for farming. Threats which need urgent attention and far greater scrutiny. It is envisaged that future research will include multi-disciplinary teams such as the artificial intelligence and control group in the University of Patras the Human Systems Group (INSYTE) in Ireland and others to address the specific threats posed by this technology and to identify for examples ways to curate intergenerational knowledge, so important to a sustainable agricultural community.

Another area of future research is to exam possible ways computer science can bridge the gap between local context and the tacit knowledge (so important in that context) and the knowledge generated by institutional agencies and scientific communities more generally. From a technological point of view

- Knowledge systems engineering using ontologies and semantic web technology .
- Interactive learning models both provide potential technical capabilities to bridge this gap.

It will also help policy makers to rethink sustainability and better align human values with system design. Furthermore future research should explore meta-research methodologies which better align human values with methodological approaches and from there value driven systems design.

All of this work will help us better understand how emerging digital technologies will help sustain agricultural communities and ensure that our models and data sets are validated and grounded in farming communities. This challenges us to get a better balance between reductionist approaches which help us focus attention on key theoretical dimensions but can result in a loss of information when not counter balanced with a human centred systems approach which engages with the complexity that is farming.

7.6 Conclusion

This study ignites new thinking about the role of digital technology in everyday life in rural communities. The finding and contribution involves revisiting fundamental ideas about how we understand the role of technology in society aligning core community values with situated “symbiosis” of human systems and machine systems in context. This is a critical challenge at this historical moment in technology proliferation and dramatic even epic social change.

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APPENDIX A JOURNAL PAPER

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E-Agriculture Innovation Using a Human Centred Systems Lens, proposed conceptual framework

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Abstract:

Historically, farmers have been amongst the most innovative people in the world. However, agriculture now lags behind other sectors in its uptake of new information technologies for the control and automation of farming systems. In spite of decades of research into innovation, we still do not have a good understanding as to why this is the case. With the globalisation of food markets, IT adoption in agricultural commnities is perceived to be increasingly important by policy makers. As the most marginalised of rural communities, it is self-evident that agricultural communities in less developed countries are most in need of these systems. This paper proposes a new integral systems framework of e-Agriculture adoption and innovation in less developed countries. It opens up a new avenue of research for control and automation systems theory and practice, which informs policy in respect of e-readiness of rural communities.

Keywords: agriculture, innovation, technology adoption, intuitionalism, human culture and values, community of practice.

Introduction

Agricultural communities are a mainstay of socio-economic activity in almost every region of the world. As well as providing food and other commodities, they are an important socio-economic group, which hold together the fabric of rural communities. Technologies and innovations, which affect the economic and social viability of farming, is an important issue for international stability research. The World Bank (2008) report on agricultural development suggests that a global food shortage is likely if agricultural communities do not adopt ICT interventions. ICT allows the sharing of the scientific information necessary to address problems of food shortage and has a role to play in disseminating information to farmers. Innovative strategies for combining Internet, telecommunications, video, and print technologies at appropriate levels are bridging this gap and empowering farmers to make better production and marketing decisions. However, agricultural communities both in less developed countries and in more developed countries remain reticent to adopt IT (so called "e-Agriculture" solutions).

In 2012, Somers and Stapleton proposed a new paradigm for technology innovation adoption among rural communities. The key question is:

What are the key dimensions of a new theory of information technology adoption, which might explain the reasons why ICT control and automation systems are not the site of agricultural innovation?

They suggested a three-dimensional lens approach that does not follow traditional approaches to systems development. The proposed model incorporated Tacit Knowledge as defined in Social Technical Systems theory, Institutional Theory, and Community Culture and Values. Carew and Stapleton (2012) reviewed a number of software development paradigms, exposing the different philosophical assumptions and goals underlying systems development. They advocated a human centred approach to systems development that focused on a combination of personal, community, and technical factors. Gill (2002) also proposed a human centred systems approach and believed in the need for technology innovations to support new forms of work life and living environments. He suggested that the challenge for technology design was to be able to respond to changes in culture and shifts in working and living environments. It set out important neglected dimensions that influence IT adoption in agricultural communities globally.

The paper begins by setting out the importance of ICT in agriculture and then exploring important influential theories of technology adoption and innovation. The paper will then proceed by speculating as to important gaps in these theories and posits three important, neglected theoretical dimensions, which might shed light on e-agriculture innovation. The paper then presents a theoretical framework based upon these dimensions.

Agriculture and ICT

Within the European Union, Agriculture is subject to government intervention under the Common Agricultural Policy (CAP). This policy aims to stabilise the incomes of the sector while at the same time promoting safe food production. Under CAP2 farmers are being encouraged to diversify and seek new opportunities both on and off the farm. In developing countries, the promotion of ICT as a source of agricultural innovations systems is also encouraged (World Bank Report 2008). To support this process ICT will become essential. With the improvement in telecommunications access, coupled with the reduced cost of computer equipment ICT adoption within agriculture remains slow. However,

farmers could benefit from the use of ICT such as improved farm management, communications flows, information access, and personal leisure. Like many other countries (Gelb and Voet 2009), Irish farmers (Connolly 2010) are slow to adopt and use technology innovation. The main barrier expressed by Irish farmers towards ICT innovations was how *useless they were to their working day*. Warren (2004) also found that Welsh farmers believed that ICT did not suit their working day. How can farmers be encouraged to use ICT and why is it important to them?

Why e-Agriculture?

The main use of agricultural land is for the production of food. Apart from this task, farming plays a hand in maintaining the social fabric of rural life along with adding economic viability to rural areas. Corea (2000) suggested that social systems could encourage a change in behaviour towards technologies which in turn would motivate people to continually use them. Warschauer (2004) also believed that to improve ICT adoption fixing the physical problems or the 'digital divide' was not the answer. He suggested a shift in emphasis to the social context could improve technology usage. Gakuru et al (2009) further added that technology innovations should take into account the individual context and information needs.

Agricultural Innovations

Agricultural communities are no stranger to innovation and have been quick to adopt innovations namely: biological innovations (new seed variations), chemical innovations (fertilizers and pesticides) animal innovations (feeding and breeding) or mechanical technology (tractors and combines). The main reason for the adoption of these innovations was that they offered farmers opportunities to increase production and income (Feder and Umali 1993). In other words, these innovations offered solutions to real-farming problems, like declining income, poor crop yields, and operational inefficiencies. Joseph Schumpeter (2009) argued that innovation was simply a new way of doing old things. Nelson and Winters (1982) also added that innovation was inherent in all people and was important in the development of society. These views suggest that the potential to innovate is perhaps within us all, so what makes an individual adopt innovations? Perhaps the problem lies with the technologists' development approach towards innovations.

Technology Adoption

Most technology adoption studies have applied the IS adoption models to determine IT adoption the most disputed one being the Technology Adoption Model (Davis 1989); Davis based predication to adopt on the technical functions of the innovation rather than influences from social systems. In contract to this, Rogers (2003) focused on the diffusion process of an innovation. He suggested that social systems influenced the adoption process and proposed a model called the Diffusion of Innovations (DOI).

At a micro level, Davis (1989) posited the Technology Acceptance Model (TAM) to measure user acceptance of information systems based on the identification of two variables Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). He suggested the two variables when weighted by an individual formed an attitude about the intention to adopt the technology. He proposed that a person's beliefs about usefulness and ease of use were the drivers of computer usage. Within agricultural literature, Gelb and Voet (2009) shared this view and believed that farmer's perceived usefulness was the main driver of behavioural intention independent of age and social setting. When the technology is easy to use and useful to the job at hand then in accordance with Davis, Gelb and Parker adoption will

occur. Perhaps farmers do not view IT innovations as easy to use and useful to their working day. Both Prokopy et al. (2008) and Feder and Umali (1985) believed that human capital such as age, education, financial capital, income, farm size, access to information and land ownership are positively associated with farmers likelihood to adopt new technologies. With these other dimensions, the social system of farmers could perhaps aid its diffusion.

Diffusion of Innovation (DOI)

Rogers proposed a macro-level philosophical approach to innovation diffusion. He incorporated the work of prominent innovation diffusion scholars such as Ryan and Gross (1943); Tarde (1903); Katz (1956) into his research and developed the Diffusion of Innovation theory (2003). The theory of Diffusion of Innovation (DOI) enunciated by Rogers (1962) was a 'normal distribution' of an ordered sequence of events, which comprised the concept of 'time', 'communication', the 'social system' and 'innovation' itself. Rogers gathered information on innovation characteristics: the adopters, the adopter learning needs about the innovation and the decision process of adopting the innovation. He shared Davis's view and suggested that an individual's perception of the attributes of an innovation had a greater impact on innovation adoption, which in turn influenced the rate of adoption. Rogers divided the social system into different adopter categories based on the rate in which a person adopted an innovation. He believed that within each adopter category the rate of innovation-decision process acceptance was different. Tornatzky and Klien (1982) suggested that idiosyncrasies of innovations would mean that technologist could not apply a generic innovation adoption model. This was supported by Gakuru et al (2009) on the use of ICT's in agricultural who found that a *one fit system* where the adopters were seen by technologist as having *generic information needs* effected the continue use of ICT's. He along with Stapleton (2011) suggest that there is evidently something different going on with information technology innovations for agriculture, which theories such as the TAM and the Diffusion of Innovation cannot explain, as they are technology-centred approaches to innovation. Perhaps a theoretical approach that centres upon agriculture as a human activity system i.e. a human-centred systems approach is the way. Cooley (1987) and Rosenbrock (1990) formulated a human-centred system concept where the machine (computer) was a tool for the creation of a work environment in which the user interacted with but remained in control of the device. Based on the belief that through the richness of the human skill and the calculation capacity of the machine a work place model creation that lead to enhanced productivity and enriched human expertise by the combination technology innovation and human ingenuity (Gill 2012). Rasmussen (2007) further added that technology should enhance and not impoverish human life. Gill (2012) believed that the human-centred symbiotic is a lived phenomenon. So how can a human-centred approach to e-agricultural innovations be constructed?

Towards a Theory of E-Agricultural Innovation

The proposed model draws on three main dimensions that are interrelated, these are:

1. Tacit Knowledge in the Socio-Technical Work Environment
2. Institutionalism
3. Community of Practices

7.1 Socio-Technical Work Design & the Tacit Knowledge Dimension

Checkland (2001) argued that social phenomena are complex entities. Within scientific method, this complexity gave rise to methodologies that had too many variables that produced a variance in the nature of data. This was due to the observations within the scientific method that looked at the human artefact as separate from its context (Orlikowski and Iacano 2001). Garibaldo and Rebecchi (2012) suggested that this method produced systems that followed substitution of old systems with improvements and referred them as technological innovations. Stapleton et al (2005) argued that this design approach led to systems that ignored the local context and gave rise to problems on the ground in terms of adoption. Socio-Technical system (STS) engineering viewed the problem of work design as a drawback of systems stabilisation (Mumford 2003). She argued that a socio-technical system would be effective if the four dimensions of task, people, organisation, and technology were stabilised. Checkland (1999) further added that the subsystem associated with each dimension must make sense to the actors within the context of the overall STS. This sense making was a complex intersubjective, social process by which actors working together come to understand their world and form (or reform) their sense of individual and shared identity (Weick 1995; Stapleton 1999). These processes have shown to be central to socio-technical systems design and a success factor in systems engineering (Ovaska & Stapleton 2010; Stapleton 2003; Checkland 1999). From an innovation-in-the-workplace perspective, we can speculate that if some technology does not make sense in the context of knowledge use in the rest of the STS, then it will not make sense to the innovators and be a poor site of innovation within the overall system. This acts as a barrier to innovation. How do actors in agricultural STS make sense of their working world?

Within organisations, the adoption of new technologies must acquire important control systems knowledge, and be able to apply this knowledge effectively into business operations across the four dimensions of the STS. This helped provide a dynamically stable STS. In his review of technology-enabled business in transition economies, Samolienko (2008) showed how this 'sociotechnical systems' knowledge i.e. knowledge about how to effectively integrate organisational and technical processes and systems, was a key factor in the successful adoption of ICT technologies.

In technology-centred thinking, systems engineering knowledge is treated as a complex information structure where knowledge can be stored in highly sophisticated data systems and processed explicitly by intelligent, software-based technologies. Stapleton, Smith and Murphy (2005) argued that an emphasis upon knowledge as information (or even data) based upon a form of rationalism in contrast to this functional rationality, which is inappropriate for any comprehensive treatment of knowledge in the context of human-centred systems thinking. A human centred perspective requires us to treat knowledge in human terms. Cooley (1987) argued that there is a kind of knowledge embedded in the working life of individuals and that is not amenable to description in a codified system such as IT. The embodiment of tacit knowledge within human actors forms their identity within the STS.

7.2 STS and Tacit Knowledge

Polanyi (1958, 1966) posited that all knowledge was either tacit or explicit and stressed the importance of a ''personal'' way of communicating knowledge. Farmers make extensive use of tacit knowledge in their engagement with the

complex, fluid, ambiguous and imprecise engagement with natural systems. Weather, soil, animals, and so on are not amenable to very precise predictable behaviour and management, which is at the heart of the functional rationalism, which underpins ICT (Stapleton 2006). Its development happens over generations through practical experience of working with the soil and animals. The passing of which happens through stories, through complex practices (sometimes secret knowledge such as herbal medicinal remedies) and other processes. Jorgensen (2006) believed that tacit knowledge played a key role in forming an avenue for change within agriculture. The tacit dimension consisted of both personal and experimental knowledge and its transfer was constrained by social and cultural contexts. Tacit knowledge is not amenable to a functionally rationalist paradigm but research has shown it to be an important factor in successful systems implementations, even in the most advanced organisational technologies (Stapleton, Smith and Murphy 2005; Murphy & Stapleton 2005; Murphy 2008). Therefore the slow adoption of ICT in agricultural communities on the ground is, in fact, a clash of cultures. The culture of agricultural communities is firmly rooted in dynamic responses to a fluid natural world, and the use of tacit knowledge in that engagement is vitally important, linking hand and brain to combat natural forces (Cooley 1987). In many agricultural communities, the transfer of tacit knowledge from generation to generation, in stories and myths is the case, instead of through textbooks and databases.

Stapleton (2013) believed that it is self-evident that the functional rationalism, machine oriented view of systems engineering methodology finds the codification of tacit knowledge difficult. As Borgmann (2000) citied "everything is information nothing it nothing" the need to capture tacit knowledge within technology devices becomes paramount. The socio-technical approach equally weights both technical and human factor in the design process, which promoted an environment of innovation, as the design process supported flexibility and intellectual growth (Baxter and Summerville 2011). Therefore, it can be theorised that a new framework for e-agriculture innovation must include the STS approach, which specifically addresses the tacit knowledge dimension.

7.3 Institutionalism

The word "institution" describes customs and behaviours important to a particular social group. An institution is a community in which members consider various structures and systems legitimate, provide social order and norms for cooperation within the institution and with other institutions. These structures and systems regulate the behaviour of community members and help to organise the community (Selznick 1996; Scott 2001).

During an institutional innovation adoption process, one deciding factor will be how the innovation will improve the internal processes of the social group. For example, within a business, organisational members need to be convinced that institutional arrangements within the organisation will legitimise and improve along the lines that wider society expects. Once the innovative practice or technology was accepted, the members of the wider community will adopt the technology. This process insures the legitimacy of the innovation and that the social group is acting in a collective manner. A recent study of EDI adoption in Kosovo showed that subsidiaries of large firms were more likely to adopt a technology if the host organisation (headquarters) had already adopted it (Stapleton 2011).

In contrast, Information Systems technology adoption literature has generally focussed upon the ways in which the features of new technology interact with the individual psychology of adopters: the so-called Technology Adoption

Model (TAM). Institutional structures and processes, which influence innovation and technology adoption, are receiving attention. For example, in his analysis of the adoption of supply chain technologies in Kosovo, Stapleton (2011) showed the importance of institutional factors in the ICT adoption processes. In the Kosovan study, some institutional factors were more important than factors, which the TAM predicted.

7.3.1 Agricultural Institutions in Ireland

In many countries, farmers enjoy the support of various institutional structures, which legitimise their work and underpin community identity. In an Irish context, the provision of institutional support in the form of government agencies (Teagasc[5] for example) and peer-support networks (IFA[6]) as well as third party consulting and advisory bodies is the norm.

These institutions promote innovation in animal husbandry (biological innovations), machinery (mechanical innovations), and chemical innovations such as fertilizers. Irish farmers are typically quick to adopt these innovations as they come with institutional support and scientific knowledge that has the potential to increase productivity and farm income (Feder et al 1985). However, although agencies may promote ICT in general terms (such as an internet presence), these institutions have given very little attention to the potential of ICT as an agency for innovation and change within agriculture. It is therefore difficult for farmers to appreciate the role of ICT in improving their work out in the fields. How could ICT devices add value to their work individually or at a community level? Consequently, the institutional arrangements themselves act as a kind of barrier by legitimising certain innovation dimensions against other, less legitimised dimensions like ICT. ICT innovations especially in less developed countries were proof of this (Stapleton & Lemouchele 2011).

7.4 Culture and Values

Carew and Stapleton (2012) suggested that technology design should not only be concerned with technical feasibility but also with social desirability that should consider local cultural values and customs. Organisations institutionally develop a culture as a way of binding members into a shared sense of identity (Schein 1993). Culture is what a group learns over time to solve its problem of survival and to provide security. Culture underpins and shapes the beliefs, values, attitudes, feelings, and overt behaviour of groups. Garibaldo and Rebecchi (2012) believed human beings think and feel, share concepts and emotions all of which feeds into their culture. Bultz et al (2012) agreed and further added that this action informed both individual and group behaviour. Technology and culture are two sides of the same coin, where modern advanced information technologies express cultural values (Stapleton & Byrne 2008; Freeman, Stapleton & Byrne 2008). Researchers have begun to explore the ICT development community as a cultural unit, which shares certain patterns of beliefs. Brown and Duguid(1991) suggested that within an organisational setting working, learning and innovation were human activities that were compatible, interrelated and complementary and that the relationship between them could determine the success or failure of an organisation. Knowledge networks and communities of

[5] Irish Scientific Research Institute www.teagasc.ie
[6] Irish Farmers Association www.IFA.ie

practice have been seen as central means to foster and enhance learning, knowledge sharing, and integration in organizations (e.g. Brown and Duguid 1991; Lesser and Storck 2001). Gakuru et al (2009) suggested that agricultural information systems were a blended learning process in which face-to-face interaction, learning by doing, learning through evaluation and experience were generic information converted into specific knowledge. He further added for the establishment of what he called *well-organised* learning community when dealing with ICT innovations. Perhaps a theoretical lens to help understand the relationships between work, learning, and innovations in rural communities could be addresses through a Community of Practice (CoP).

7.5 *Community of Practice*

Checkland (2001) believed that the STS design approach was an organised learning system that created and generated knowledge. Originally introduced in the context of Lave and Wenger's seminal research on a social theory of learning, a Community of Practice (CoP) was seen as an ''active system about which participants share understandings concerning what they are doing and what that means'' (Lave and Wenger 1991: 98). They further added that out of learning emerged a structure, complex relationships, self-organization, dynamic boundaries, ongoing negotiation of community identity and cultural meaning which all give rise to a CoP. Eckert (2006) defined a community of practice as a collection of people who engaged on an ongoing basis in some common endeavor. The value of communities of practice to technology innovation adoption by rural people as suggested by Eckert was in the identification of a social grouping not in virtue of shared abstract characteristics (e.g. class, gender) or simple co-presence (e.g. neighborhood, workplace), but in virtue of shared practice. Shared practice she believed defined ways of doing things, views, values, power relations, and ways of talking. This view of CoP's is a practical way to connect people, share tacit knowledge, and create new knowledge.

Eckert argued that two factors must exist when conceptualizing a CoP - shared experience over time, and a commitment to shared understanding. A community of practice engaged people in sense making – about the engagement in the enterprise and the forms of participation in the enterprise and with other CoP's and with the world around them. She offered a different perspective of CoP's for the exploration into technology innovation adoption by rural communities and thus will be what is referred to as a CoP. Knowledge within CoP's was not an object but a lived part of their practice (Wenger 1999). Langdon (1993) agreed that technology developed often neglected the workings structures and social origin; he further added the need for a meaningful theory of technology that was not technology focused. Mumford (2003) argued that technology change was difficult and that if a divergence existed between technologist and end-users, problems happened with system implementation.

Theoretical Framework

This paper develops a more holistic understanding of e-Agriculture adoption as a human-centred system. In 1984 Jackson and Keys suggested that more open systems (like this present system) evolve over time and evolution occurred because systems were in constant interaction with the environment. Sociotechnical systems are open and fluid across multiple dimensions (a definitive feature of complex systems). In order for these systems to evolve the anatomy of the

system must be adaptive to the environment. A theory of e-Agriculture adoption must comprise integral systems and subsystems and simultaneously capture this openness. Boundaries can distinguish internal system elements and interfaces as well as inputs and outputs (Barile 2012). In our approach interface flows between key elements will be as important as the system components themselves, in order to emphasise the importance of knowledge creation and generation within the system and knowledge flows between the system and its environment.

Due to the sheer complexity of these sociotechnical systems an integral systems approach is adopted here. An integral systems approach means identifying those system elements and dimensions which are integral to the whole, rather than breaking down the system into smaller and smaller independently treated subsystems as is more usual in scientific systems analysis. That is, those primary subsystems which complete the e-Agriculture adoption system in less developed regions from a policy perspective. Integral systems analysis implies looking at these subsystems both independently and together (i.e. the flows within and between subsystems and across systems interfaces).

Integral systems analysis is closely related to human machine symbiotic theory in human centred systems thinking (e.g. Gill 2012). In human-machine symbiosis analysis focuses upon an integrated vision of a human-machine system which improves the performance of each subsystem in light of the synergy of the entire socio-technical system. Integral systems' thinking has also been used by Wilber to understand cultural flows in human society (Wilber 2001). Martin (2012) used integral systems thinking to develop a new economic model which addresses questions of sustainability and viability across living systems generally (including environmental, biological and socio-economic systems). A similar approach is adopted by Carew to formulate a comprehensive vision of privacy in technology development (Carew and Stapleton (2008), later deployed in the development of theories of e-privacy for psychiatric wards (Ramli et al (2012)).

This paper attempts to construct an integral systems theory of e-Agriculture i.e. it infers the key dimensions of a theory of e-Agriculture technology adoption which, when taken together, comprise essential subsystems of an e-Agriculture technology adoption system for communities in less developed regions.

8.1 Theoretical Discussion

Our literature review implies a series of factors which will deeply influence levels of e-Agriculture adoption in less developed regions. These factors are organised into working propositions set out below. If empirical evidence can be gathered to support these propositions, it would demonstrate the major dimensions of policy interventions which create conditions for e-Agriculture adoption in rural communities in less developed countries. This in itself would be a major step towards creating effective, integral systems for e-Agriculture initiatives. The interactions set out in the figure suggest several theoretical propositions.

A. Institutional factors shape the Community of Practice

Institutional structures form the identity of the community of practice. For example social order, behavioural norms that underpin the community of practice come from institutional structures. Shape here refers to the influence of institutional processes and structures upon communities of practice. These influences have been summarised earlier

in the paper and would need to be taken each in turn drawing from former studies on institutional influences upon IT adoption in LDCs (e.g. Stapleton (2011)).

B. Tacit knowledge shapes the Community of Practice.

Tacit knowledge defines ways of doing things, views, values, power relations, and ways of talking and is a practical way to connect people, share knowledge, and create new knowledge thus forming the community of practice. Tacit knowledge is embedded in community identity. A set of sub-propositions for testing can be drawn from previous studies which examine the role of tacit knowledge in systems development such as Murphy and Stapleton (2005).

C. Culture and values shape the Community of Practice.

Communities of practice are imbued with culture. For the purposes of this framework, we can surmise that cultures are underpinned by systems of deeply held, shared values (Kroeber (1952) p. 6). Therefore we can surmise that human values will shape the community of practice.

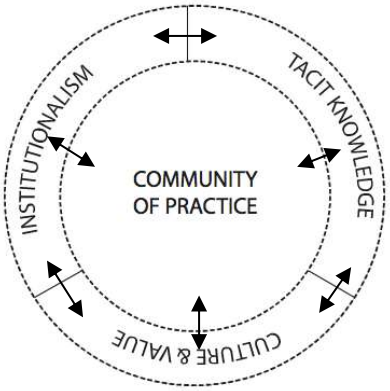

Figure 1 Theoretical Framework for e-Agriculture Technology Adoption in Developing Countries

Figure 1 is a graphical representation of the proposed e-Agriculture Technology Adoption framework for developing regions. The essential subsystems include Institutionalism, Tacit Knowledge and Cultural Values and are viewed through the CoP lens.

Our integral systems theory of e-agricultural technology adoption model includes institutionalism, tacit and cultural values. This gives rise to further theoretical propositions which are the subject of the next section.

8.2 Theoretical propositions

From figure 1 and the above propositions A, B and C we will now attempt to construct a series of propositions to form the basis of a more detailed theory.

For the purposes of this study, we assume that the role of policy is to provide a set of underlying conditions which will maximise the possibility of e-Agriculture technology adoption success. It is possible to draw up propositions which

predict that interventions based on policies which are informed by the above integral systems components are more likely to succeed. Each of the above three propositions have implications for policy.

Proposition A: *Institutionalism shapes the Community of Practice* implies theoretical proposition P1- E-*Agriculture policy that addresses institutional factors improves e-Agriculture adoption in the community of practice in less developed countries.*

Institutionalism describes the customs and behaviours of a social group, which makes up the community of practice. This in turns provides structure for the community of practice. For example, a decisive technology adoption factor within the community of practice is how the innovation will improve current norms. Therefore, an e-agriculture policy that addresses institutionalism could improve the usage of ICT innovations within a CoP.

Proposition B, *Tacit knowledge shapes the Community of Practice*, implies P2 - *E-agriculture policy that addresses tacit knowledge in the community of practice improves e-agriculture adoption in less developed countries.*

The community of practice arises out of shared practices which are imbued with knowledge that is deeply integrated into the shared identity through folklore and other cultural materials. Shared practices derive from knowledge that is both personal and experimental and is transferred in a social context (story-telling etc.). E-Agricultural communities make extensive use of tacit knowledge within their working day. E-Agricultural policy that addresses tacit knowledge will improve technology adoption.

Proposition C *Culture and values shape the Community of Practice*, implies P3 - *E-Agriculture policy that addresses human values in the community of practice improves e-agriculture adoption in less developed countries.*

Human values shape the beliefs, values, attitudes in the adopting community, attitudes which will come to bear upon e-agriculture adoption initiatives. The community of practice identity arises out of a shared human culture which are in turn determined and underpinned by shared values. In other words, the CoP is a shared system of learning fed by human values. E-Agricultural policy that addresses these values systematically could improve e-agricultural adoption.

The proposed model implies an integral system that is open and adaptive (i.e. a learning system) and comprises the sharing and creation of knowledge. Therefore, the following theoretical propositions reflect the relationship between the dimensions.

P4. *E-Agriculture policy, which addresses the interaction between institutional factors and tacit knowledge in the community of practice, improves e-Agriculture adoption in less developed countries.*

The personal way of communicating knowledge among the community of practice influences the institutional structure established by the group. To observe this relationship within a model is important.

P5. *E-Agriculture policy, which addresses the interaction between tacit knowledge and human and cultural values in the community of practice, improves e-agriculture adoption in less developed countries.*

Again, the personal way of communicating comes from human culture and values, which in turn feeds, into group behaviour. To examine this relationship could improve e-agricultural adoption.

P6. *E-Agriculture policy, which addresses the interaction between institutional factors and human culture and values in the community of practice, improves e-agriculture adoption in less developed countries.*

A model that presents an understanding of how human values influence the institutional structures of the CoP could improve e-agricultural innovation adoption.

Summary

Propositions 1 to 6 are the primary propositions for our theoretical framework that is summarised in figure 1. This is the basis for a new, more comprehensive social technical theory of e-agriculture adoption. The theory could be used to develop both methodologies for e-agriculture STS development and perhaps more importantly inform policy intervention in less developed countries. Further studies which can demonstrate evidence in support of these propositions will significantly improve our policy frameworks and mean that important donor support for LDCs can be targeted at developing integral community-based systems which ensure that communities benefit more from the opportunities that e-Agriculture presents. On the other hand, if the propositions are rejected on the basis of empirical evidence, then the theory can be refined and improved, or replaced by better theory. Either way rural communities in less developed regions will benefit more from the opportunities that e-Agriculture presents.

Conclusions and Final Comments

The tentative theory potentially delves deep into the substrate of human activity systems involved in technology adoption amongst agricultural communities representing an attempt to understand and incorporate the deep meaning systems, which influence e-agriculture development.

In recent years, some researchers have used empirical studies to identify the values that underpin the systems engineering community specifically and the Information Society more generally (Carew, Stapleton & Byrne 2011;Stapleton 2013). This research has demonstrated many underlying tensions in the information society. Cooley (1987) predicted these tensions, which are a result of conflicting values, and an underlying conflict between *who* human beings are, as evolved cultural beings, and the technologically-mediated world we are creating. Stapleton (2013) believed that culture and technology go hand in hand, and that culture holds the reins of technology, rather the other way around. Agricultural communities are close to the land and live their lives in on going engagement with nature. They have established over the years knowledge, core values, and beliefs, ensuring survival. The lack of understanding of such communities within Information Systems (IS) research is evident in technology adoption models.

Perhaps a holistic approach to analysing and strategising agricultural communities' potential could be possible to chart a route for technology adoption research going forward. This route needs to incorporate a human-centred, cultural, institutional and technology lenses. Future work is needed which takes the above dimensions as a basis for developing a new, e-Agriculture technology adoption policy framework.

The active participation of the agricultural community within any systems development process is necessary to uncover the local knowledge that will underpin successful technology innovation adoption. Gill (2012) argued that the human-centred vision, which enshrines diversity, plurality, tacit knowledge and valorisation more relevant today that it ever has been.

To understand and validate the tentative framework interviews will have to be conducted. A schedule is present to reflect the proposed work.

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A Human-Centred approach to e-Agricultural systems

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Abstract:

Within business enterprises farmers lags behind in the uptake of new information technologies for the control and automation of farming systems. In spite of decades of research into technology acceptance we still do not have a good understanding as to why this is the case. IT adoption in agricultural communities is perceived to be increasingly important by policy makers as a means of adapting to changes within agriculture. This paper proposes preliminary findings to validate a new systems framework of e- Agriculture adoption and innovation that will open new avenues of research for control and automation systems theory and practice informing policy in respect of e-readiness of ruralcommunities.

Keywords**:** Technology adoption, agriculture, intuitionalism, human culture and values, community of practice.

1. INTRODUCTION

E-agricultural systems refer to the use of technology for the improvement of agricultural services, enhanced technology dissemination, and information delivery through advancements in Information and Communication Technology (ICT). A sustainable agriculture sector depends on farmer's capacity for adapting to markets situations and seizing opportunities, with many agencies advocating e-agriculture systems as an avenue for change (EIFTA (2009),World Bank (2008),DAFF(2009)). Rural communities are slower to adopt e-systems within their working day as technologies presented offered generic information that fails to address farm diversity with translation needed to make it relevant to the personal and situational life of the farmers Gakuru et al (2009). This paper adapts a formerly proposed theory (Somers and Stapleton, 2014) and presents some preliminary results from an on-going empirical study. The paper will

1. Identify gaps in the information systems literature regarding the adoption of e-agricultural systems by rural communities and

2. Proposes a new lens of analysis for e-agricultural systems and a new position of thinking to systems development.

Understanding slow adoption of e-agricultural systems goes beyond technology, to the integration of knowledge and culture aiming to improve communication and learning processes within agriculture amongst all stakeholders.

2. E-AGRICULTURAL INFORMATION SYSTEMS

Gakuru et al (2009) believed e-agricultural systems was an integration of knowledge and culture, aimed at the improvement of communication and learning processes among relevant actors in agriculture. Koutsouris (2006) suggested they were local farming systems, completive adaptive which co-evolved with human societies to fit ecological conditions which satisfied human needs.

For the development of such systems future studies should focus on the mechanism of the information systems, which was the interaction between components and activities and specifically the information requirements of farmers Demiryurek (2010).

Currently systems development following the reductionist paradigm fails to understand the human experience. The knowledge requirements, the culture and values embedded in the knowledge, and the working, and learning environment of the individual (Somers and Stapleton, 2013). To focus technology more to the human required a human-centred approach to systems development. This was a development trajectory that generated a conceptual framework for technology innovations that understood the nature of knowledge and its purpose in a societal context. The human centred approach interplayed between the notions of purpose, symbiosis, cohesion, diversity, and valorisation all of which were the fundamentals for shaping the trajectory. This interplay allowed communities to build networks of users, producers, and creators of knowledge acting, as a tool for creating innovations (Gill, 2002) .Agricultural knowledge was communal with learning or knowledge becoming sites for innovation. Krisis of the information systems world resulted in the separation between people and science ensuing from the separation of everyday life in the creation and development of any scientific methodology (Ciborro, 2002). This was evident in agriculture where adoption of e-systems remains poor relative to other communities and theories such as the TAM,UTAUT and the Diffusion of Innovation cannot explain (Somers and Stapleton(2012),Stapleton and Fouopi (2011).

2.1 UNDERSTANDING THE RURAL CONTEXT

Information systems theory concerns itself with the use of an artefact in human-machine systems linking the natural world, the social world and the artificial world of human construction (Gregor, 2006). Agriculture is the only sector of European society that is governed by a single policy, the Common Agricultural Policy (CAP). Governments within the EU have modernise and optimised interactions between themselves and farmers through e-systems as a means of implementing policy (Ntaliani et al,2010). However, the farming sector was one area where e-systems were not seen as sites of innovation by farmers (Somers and Stapleton,). Agriculture forms the backbone of rural life in terms of economics and social fabric making its survival of importance (Pyysiäinen et al, 2006). Many have argued that for sustainable agricultural practices farmers will have to adopt innovative technologies to complement traditional practices (Mackrell et al (2009). The World Bank (2008) suggested e-systems offered farmers' innovative practice and Jorgensen (2006) believed they were an avenue for change. To support e-agricultural innovations a deeper understanding of their context of use is needed, especially the social context (Somers and Stapleton, 2013). Waldrop (1992) and Cillers (2001) believed that alternative IS methodology accounting for system complexity could provide an understanding to encourage

innovation and learning within e-systems. Could a methodology specific to an e-agricultural context and catering for the human system improve e-agriculture adoption? As a first step to supporting innovative agricultural workflow a new theory is needed catering for the complexity of a rural social system (agriculture), and emergent behaviours that are present with technology interaction. However many existing information systems adoption models fail to offer insight to systems developers as to why E-Systems are not sites of innovation.

3. LITERATURE REVIEW

Acceptance and use of information systems is one of the most mature streams of information systems research (Benbasat and Barki 2007; Venkatesh et al. 2007). Despite the popularity of adoption research, no one-adoption model can yet identify and organise into a coherent model all the factors that influence innovation adoption among individuals and in communities. Models that have been presented were either too complex (Tornatzky and Klein 1982) or too simplistic and technology-centred (Davis 1989). However two major models have appeared: TAM and UTAUT. The first model the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989) was a causal model. Davis believed that two determinants perceived usefulness (PU) and perceived ease of use (PEOU) could predict the adoption and continued usage of a technology. PU was the belief that using a particular technology would enhance job performance. PEOU was the extent to which a person believes that using a new technology was free from effort (Davis, 1989). Leeuwis (2003) argued the model was applied to numerous agricultural studies ((Flett et al,2004; Rezaei-Moghaddam et al,2010;Lee et al,2010)) and on review of these he noted the difference in magnitude and scope of the innovations. Leeuwis (2003) categorised farming innovations as regular or architectural innovations. Regular innovations do not challenge the main technological and social-organisational characteristics of the farming system, whereas architectural innovations require fundamental reorganisation of social relationships, technical principles and rules. Based on Leeuwis (2003) classification the studies focused on regular innovations from soil sampling to fertilizers. The authors believed the model was successful in predicating continued usage of such innovations. Innovation in animal husbandry (biological innovations), machinery (mechanical innovations), and chemical innovations such as fertilizers were adopted quicker by farmers as these innovations as they come with institutional support and scientific knowledge that has the potential to increase productivity and farm income (Feder et al 1985).

The UTAUT model was proposed by Venkatesh (2003) in an attempt to formulate a unified model for adoption. The model was based on eight prominent models within the IS field; the Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Technology Acceptance Model (TAM), the Motivational Model, a model combining the TRA and the TPB, the model of PC utilisation, the Diffusion of Innovation (DOI) and Social Cognitive Theory. Venkatesh (2003) proposed three determinants of intention to use, performance expectancy, effort expectancy, and social influences and two direct determinants of usage behaviour: intention and facilitating conditions. Performance expectancy appeared to be a determinant of intention in most situations; however it was influenced by gender and age. (Venkatesh,2003). From his study he suggested that the determinant of intention and behaviour evolve over time and influenced by gender and age

3.1 Information Systems Adoption Theories applied to Rural Contexts

In Ireland Connolly et al (2009) applied the UTAUT model (Venkatesh, 2003) to determine influencing factors on farmers' behaviour of adoption and usage of farming software and farming websites. Empirical findings about social influence were important to farmers as influencers in adoption. Her research exposed theoretical gaps which failed to comprehensively understand adoption behaviours of Irish farmers and revealed the importance of social effects over and above technological and automatic systems features. Findings from the study proved farmers did not adopt e-systems because they were not useful to their working day. These micro-level models fail to regard individual farm conditions as was also the case in Africa where continued usage of ICTs failed because the working lives of rural people were not understood by system developers (Gakuru et al (2009), (Koutsouris, 2012)).

The reductionist paradigm ignores the social and natural environments of the farmer concentrating on the technical aspects of design rather than understanding the user's needs ((Alter, 2008), Leeuwis(2004)). To address these shortcoming a human-centred approach to e-agricultural systems was proposed by Somers and Stapleton (2013) aiming to improve the adoption and continued usage of e-systems.

To facilitate innovation and learning a technology adoption model for e-agricultural includes the following theoretical lens:

1. Tacit Knowledge in the Socio-Technical Work Environment
2. Institutionalism
3. Culture & Value Systems
4. Community of Practices

Presented is a conceptual model to improve technology adoption within agriculture and rural communities (Somers and Stapleton,2013).

4. PROPOSED CONCEPTUAL FRAMEWWORK

Figure 1captures the proposed framework to improve the adoption of e-agricultural innovations adoption.

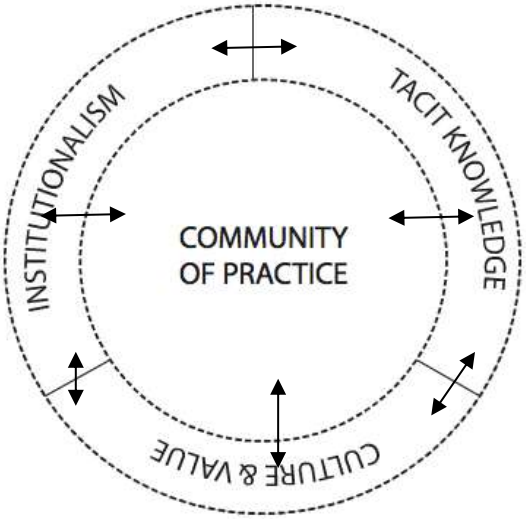

Figure 1 Theoretical Framework for e-Agriculture Technology Adoption

To guide the research proposition where constructed from the model dimensions.

4.1 Theoretical Propositions Arising from the Model

As referred in the literature a human-centred system must complement the knowledge with the societal context. A human – centred approach aids transfer of technologies as such technologies were more like cultures than tools (Idhe, 1995). Reflecting the culture and values within farming gives rise to dimension 1.

Dimension 1: E-Agriculture policy that addresses human values in the community of practice improves e-agriculture adoption.

The concept of 'identity' deals with who we are and who others are. The way we speak about men and women on farms may not correspond to the way they really are. (Brandt et al,1967). This gives rise to:

Proposition 1.1: Farmer's identity is important as a human value in a community of practice.

Proposition 1.2: The farm family are learning sources of new technologies.

A human centred perspective requires us to treat knowledge in human terms. Cooley (1987) argued that knowledge embedded in the working life of individuals was not amenable to description in a codified system such as IT. To capture the tacit knowledge with it context gave rise to :

Dimension 2: E-agriculture policy that addresses tacit knowledge in the community of practice improves e-agriculture adoption.

Proposition 2.1: Generational knowledge is a site of information for farmers.

Farmers across the EU are treated under a common agricultural policy implemented by member states. Failure to address the policy within E-Systems development impacts on the benefit of the technology to the farmer.

Dimension 3: E-Agriculture policy that addresses institutional factors improves e-Agriculture adoption in the community of practice.

Proposition 3.1: Policy driven E-Systems negatively influences farmers.

Proposition 3.2: Farmer led policy positively influences use of E-Systems.

5. RESEARCH METHODOLOGY

5.1 Data gathering techniques

This paper is a preliminary study to validate the themes theoretical sensitivity as proposed within the conceptual framework Strauss and Corbin (1990:41–47) The decisions on how best to query people about those topics are rich sources of a priori themes (Dey 1993:98)comes from the questions in an interview (Coffey and Atkinson 1996:34). By the nature of farming a focus group and interviews were conducted. This method was deem appropriate as previous studies on farmers adoption of E-Systems noted that to understand the phenomena required more depth which would best be served by these approaches. To gather data the author undertook a focus group of 8 farmers from the south east of Ireland who were engage in different farm enterprises. Findings from this study where complement with 3 interview from working farmers. In line with the literature review questions from an existing survey where included to the process. Questions about a farmers understanding of what an e-systems was and what constituted the term e-agriculture where taken from a global survey of e-agriculture.

6. FINDINGS

Proposition 1.1: Farmer's identity is important as a human value in a community of practice.

Farmer's culture when expresses as identity was important to all the respondents. Outside of their peers when a farmer is in conversation and becomes aware that the other person is a farmer or from a farming background they said they "open up to people like themselves" as they know "what they are talking about".

Proposition 1.2: Interactions with neighbours are sources of learning for farmers.

Amongst their peers farmers would seek farming advice from their neighbours and help. However the interaction appear very high level as farmers don't "like their neighbours knowing their business". This was the case when dealing with the Department of Agriculture. However help would be sought with a practical or labour such as help with "moving cattle" or borrowing farm equipment. To understand the level or type of interaction requires further analysis.

Proposition 1.3: The farm family are learning sources of new technologies.

In Ireland farmers children planning on taking over the family farm are now undertaking third level courses in agriculture. Many of these course offer training specifically in e-government portals and are "well-able to manage their way around" these sites. Whilst these children are not the registered owners of the farmers they actively partake in the paper work on the farm. What is interesting about the family unit is the average age of registers farmers in Ireland are considered "old" being in the 70 years of age category wanting to "hang on for as long as they can". However they allow their children to engage with the department of agriculture through government portals.

Proposition 2.1: Generational knowledge is a site of information for farmers.

Leading on from the family unit farm knowledge passed from generation to generation are sources of information for farmers. Within the practical element of farming children of farmers believed they "learned a lot from their fathers". One respondent said that learning animal behaviour was gathered from "being around them" otherwise she wouldn't be able to "handle them" (animals). One respondent believed farming can't be learnt in college alone as "knowledge is missing" by not being "around the farm" and family. Nephews of bachelor farmers inheriting a farm found the paper work easier but couldn't "handle the practical" side because they "didn't grow up on a farm".

Proposition 3.1: Policy driven E-Systems negatively influences farmers.

For a farmer to receive their Single Farm Payment(SFP) which comes the Common Agricultural Policy they are required to submit details of their farming practices online. Submitting payment on behalf of a farmer is permitted through a registered Farm Advisor. All respondents hired a farm advisor to interact with the department on their behalf as this insures the farmer if they are penalised on their SFP. Farmers expressed fear in using this e-service as it equated to "loss of money". Loss of money was viewed as a negative out come from using the service.

Proposition 3.2: Farmer led policy positively influences use of E-Systems.

Within Ireland the Irish Farmers Association (IFA) is a farm led institution who are a "strong united "group providing the "strength" and financial resources for Irish farmers. This "grass roots" organisation is viewed positively by farmers as they believe that there is always "someone at the end of a phone who understands me". Besides be used as support for farming services they are also concerned with the well-being of the farmer and farm family and address issues such as depression amongst farmers.

DISCUSSION

Initial interviews are starting to reflect the research lens of the proposed framework. Evidence of culture expressed in identity is seen as important to farmer. Along with community links, interaction with neighbours and the relevance of generational knowledge all enforce the human element of the working lives of farmers and strengthen the argument for a new thinking to systems development for agriculture. For technologist to understand the end user in terms of their working life and personal life is vital. Strengthening the belief that a one –size fit will not suit all farmers or farm types. This approach also was wider implications for other communities, rural or urban.

FUTURE WORK

To improve understanding of the interactions of the proposed theory complexity theory could help unpack the emergent behaviours that are present when technology and humans interact. This theory when taken together would comprise the essential holons of an e-Agriculture technology adoption system for communities. That will explain the profile of successful information systems development methodological praxis for e-Agriculture initiatives that supports learning and innovations in a complex environment.

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The Complex Context of E-Agricultural Deployment

A Preliminary Study in South-East Ireland of Farming Families

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Abstract

Rural communities particularly the farming sector are one of the most innovative in the world but uptake of new information systems to support their daily lives remains slow. In spite of decades of research into system development we still do not have a good understanding of IS innovation adoption. This paper proposes a new framework for information systems development that could improve continued usage of such systems by synthesising across incompatible domains of knowledge to produce appropriate human-centred solution for real communities. This will open up a new avenue of research for information systems development informing policy in respect of e-readiness of farmers and the wider rural community, both at a national and international level.

Keywords: Information systems, technology adoption, rural communities.

INTRODUCTION

Agriculture is a viable part life and often the platform for economic diversification in rural areas. A sustainable agriculture sector depends on farmer's capacity to adapt to markets situations and seize new opportunities. E-agriculture systems are one such avenue for change. The concept of e-agriculture goes beyond technology, to the integration of knowledge and culture, aimed at improving communication and learning processes within agriculture amongst all stakeholders. However, e-agricultural systems development following the reductionist paradigm resulted in technology and knowledge transfer disregarding local context proven to impact on continued usage. This paper identifies gaps in the ISD literature regarding the adoption of e-agricultural systems by rural communities and presents a new lens of analysis for e-agricultural systems development along with preliminary findings. It is hoped researchers will review their work in technology development and deployment particular within rural communities and that future e-agriculture systems will become sites for innovation and learning.

BACKGROUND

Being the backbone of rural life in terms of economics and social fabric the survival of agriculture is important [24]. For a sustainable agricultural practices farmers will have to adopt innovative technologies such as e-agriculture systems to complement traditional practices [19][29][38][3]. Within the paper e-agricultural systems are defined as the use of technology for the improvement of agricultural services, enhanced technology dissemination, and information delivery through advancements in Information and Communication Technology (ICT). Farmers are quick to adopt new technologies that involve biological innovations (new seed variations), chemical innovations (fertilizers and pesticides) animal innovations (feeding and breeding) or mechanical technology (tractors and combines) offering opportunities to increase production and income [12].

The e-Agriculture Working Group (EAWG) conducted a global survey of e-agricultural use (i.e farming software, e-services, or web-based applications) and found whilst farmers are aware of e-agriculture benefits[7] using them in their daily lives remains slow [11].

Agricultural systems evolved from global and local forces: agricultural technologies, agricultural, environmental, and rural development policies collectively designed to contribute to agricultural sustainability giving rise to technologies to support agricultural practices whilst ignoring micro level issues such as social aspect (employment, quality of life, income distribution etc) and institutional factors hampering the use of new technologies [41]. The *traditional linear model* approach to systems development ignores farmers experience and knowledge presenting technologies with general advice not reflecting individual farm conditions and in turn affect continued usage [22][14]. To understand the social and cultural *triggers* that influence farmers behaviour was important to promote change at the farm-level [26]. Evidently something different is happening with information technology innovations for agriculture [36]. One of the main reasons for information systems failure was a tendency to concentrate on the technical aspects of design rather than understanding the business needs [1]. E-agriculture is a particular context and information systems developments following a technology centric approach have not increased understanding of IS deployment and continued usage [14]. Changing food requirements effecting global markets, extreme weather conditions, and animal diseases all give rise to complex working conditions. Farmers learn through a process of *trial and error* caused by daily expose to difficult situations and comes the need to adapt and learn to arrive at solutions to problems at hand [29][26].

To support e-agricultural innovations raises the need for a deeper understanding of context of use. A human-centred view would infer the key dimensions of a theory of e-agriculture technology adoption which, when taken together, comprise essential subsystems of an e-Agriculture technology adoption system for communities [36]. A series of primary propositions underlying the theoretical framework are presented, which is the basis for a new, more comprehensive theory of e-agriculture adoption. The paper aims to synthesis and explain the profile of successful information systems development methodological praxis for e-agriculture initiatives supporting learning and innovations in complex environments.

LITERATURE REVIEW

Agrarian science focused on a process-oriented or a *one-fix* all model approach to IS innovation diffusion and adoption. This relies on scientific experiment to create a *fix* for agricultural problems addressing the general needs of farmers [20]. Understanding the adoption of IS innovations followed two approaches; a diffusion approach, or an adoption approach, each providing a directional perspective to innovation acceptance. Firstly, diffusion researchers described the acceptance process at the macro-level the dominant model being the Diffusion of Innovation (DOI) model proposed by Rogers [32]. The DOI enunciated by him was a 'normal distribution' of a linear sequence of events, which comprised the concept of 'time', 'communication', the 'social system' and 'innovation' itself. He believed an individual's perception of innovation attributes influenced the rate of adoption. In 1985, Feder et al conducted a comprehensive reviewed of previous innovation studies that applied the DOI model focusing on adoption or non-adoption [13]. He argued that diffusion depended on the extent to which the technology suited the conditions under which the farmer operated and the narrow lens applied in previous research impacted on understanding. The personal situation of the non-adopter offered more insight into understanding technology adoption.

In Ireland a micro level approach to technology adoption of e-agricultural systems applied the Unified Theory of Acceptance and use of Technology (UTAUT)[8]. As the model was technology-centric continued usage of a technology was measured by *perceived usefulness* and *perceived ease of use*. Findings from the study proved the system was not a success, as farmers believed the technology was *not useful to their working day*.

[7] Enhanced information access or exchange, communication with farming stakeholder groups, access to markets, food security and sustainability.

These models acknowledged a farmer's experience and knowledge, as a one fit all however they did not match individual farm conditions [22]. This affected the continued use of ICT's by farmers [14]. From the literature, the reductionist paradigm ignores the working environments of the farmer when applied to e-agricultural systems. One of the main reasons for information systems failure was a tendency to concentrate on the technical aspects of design rather than understanding the user's needs [1]. Given the difficulties and criticisms associated with the reductionist approach in technology transfer researchers need a new set of assumptions [37]. Perhaps a deeper understanding as to what an e-agricultural system is could improve technology transfer.

E-Agricultural Information Systems

E-agricultural systems integrate knowledge and culture, aimed at improvement of communication and learning processes among relevant actors in agriculture [14]. They are local farming systems, completive adaptive co-evolving with human societies to fit ecological conditions which satisfied human needs [22]. To reflect the local farming system, future IS studies should focus on the mechanism of the information systems i.e the interaction between components and activity and specifically the information requirements of farmers [11].

Evidently, the reductionist paradigm fails to understand the human experience, knowledge requirements, the culture and values embedded in the knowledge, working and learning environment of individuals. Many argued technology innovation and adoption in agriculture remains poor relative to other innovations and communities, and theories that apply a technology-centred approaches to innovation cannot explain [36]. They proposed a theoretical approach centred upon agriculture as a human activity system as a way to improve technology adoption within agriculture proposing a conceptual framework for IS development within rural communities. Human centeredness places human need, skills, creativity and potentiality at the center of technology systems, taking a socio-technical view balancing the requirements of two systems i.e. the social system and technical rule-based system of technology [16].

Discussion on the Tentative Framework

The framework draws on three main interrelated dimensions with a human centred perspective that goes beyond modelling human interaction with a technical artefact:

5.1 Tacit Knowledge in the Socio-Technical Work Environment

A kind of knowledge embedded in the working life of individuals was not amenable to description in codified systems such as IS [9]. Managing tacit knowledge within ISD was important in organisations to maintain a competitive advantage by enabling users to generate better decisions [28]. They reviewed ISD methodologies (such as UML, SSADM, SSM and ETHICS) based on tacit knowledge characteristic and acquisition dimension and presented gaps between ISD methodologies used and tacit knowledge. Tacit knowledge was important for the successful development of an information system, as it identifies the rationality behind the decision being made by the user.

Human beings rely on informal as well as formal sources of information and this information was 'both enabling and contextual', 'data was context-free and simply the raw material from which information (meaning) may be attributed ' [15]. The value of tacit knowledge and knowledge built over the centuries and shaped by natural environments when combined with modern science was a key element in the development of workable solutions for agriculture [2]. Agricultural professionals should improve understanding of and communication with farmers as the combination of both would make research responsive to the needs of farmers and local communities [2].

Farmers are expert in their own eyes, classing information as irrelevant if it did not relate to their experience or socio conditions. Local knowledge played a role in the preservation, development,

and promotion of practices was location-specific, based on close personal observation and experience over generations [2]. A farmers knowledge encompasses social relations and rituals (know-who), livelihood practices (know-how) embedded in the cultural traditions of local communities and reflected communities' interests [38]. Therefore, IS developers should communicate with farmers combine tacit knowledge as to create a learning process of innovations [44].

5.2 Institutionalism

An institution was a community in which members consider various structures and systems legitimate, provide social order and norms for cooperation within and with other institutions. Intuitional theory presented an understanding of human behaviour focusing on the role of norms, symbols, myths, beliefs systems, and informal arrangements collectively forming organisational culture and authoritative guidelines for social behaviour [35][36]. Intuitional forces shaped individuals interests and desires and determined whether behaviour resulted in persistence change [32].

In many countries, farmers enjoy the support of various institutional structures, legitimising work and underpin community identity. They promote innovation in animal husbandry (biological innovations), machinery (mechanical innovations), and chemical innovations by agricultural extensions. Farmers are quick to adopt innovations coming with institutional support and scientific knowledge promoting the potential to increase productivity and farm income [13]. However, although agencies may promote ICT in general terms (such as an internet presence), institutions give little attention to the potential of ICT as an agency for innovation and change within agriculture. It is therefore difficult for farmers to appreciate the role of ICT in improving their work out in the fields and add value to work individually or at a community level [37]. Consequently, the institutional arrangements themselves act as a kind of barrier by legitimising certain innovation dimensions against other, less legitimised dimensions like ICT. ICT innovations especially in less developed countries were proof of this [38].

5.3 Community of Practices and Culture & Value Systems

Knowledge networks and communities of practice (CoP) were central means to foster and enhance learning, knowledge sharing, and integration in organizations [5][23].

Agricultural information systems supported blended learning process in which face-to-face interaction, learning by doing, learning through evaluation and experience converting general knowledge into specific knowledge. When dealing with ICT innovations well-organised learning communities could offer a solution as people gain information from interactions with others [3] [14]. New knowledge resulted from interplay between individual effort and social interaction often giving rise to the conception of an idea that led to an innovation [21]. Social learning was important for human development, as the complexity of the social environment implied the inability to learn everything by trial and error but by observation, quickening the spread of successful behaviour [22].

These dimensions where captured in a framework (see Figure 1) addressing the short fall of the reductionist paradigm approach to e-agricultural innovations development and adoption.

Figure 1 Tentative Theoretical Framework for e-Agriculture Technology Development and Adoption

5.4 Working Theoretical Propositions

Based on the tentative theoretical framework the following propositions arose:

Proposition A: Institutional factors shape the Community of Practice.
The community of practice is moulded by institutional influences; social orders, behavioural norms all underpinning the identity of the community of practice.

Proposition B: Tacit knowledge shapes the Community of Practice.
Tacit knowledge defines ways or habits of doing things, views, values, power relations, ways of talking and connecting to people, sharing knowledge, creating new knowledge and is embedded in community identity.

Proposition C: Culture and values shape the Community of Practice.
Communities of practice imbued with culture underpinned by systems of deeply held, shared values that shape the community of practice.

Proposition D: *An e-agricultural system should reflect the community of practice.*

At the high level, the concepts of institutionalism, tacit knowledge and cultural values reflect a human-centred system for e-agricultural systems development. The fluidity of the boundaries gives rise to knowledge flows between all and further theoretical propositions.

From the above a series of sub-propositions were constructed forming the basis of a more detailed theory to provide a set of underlying conditions to maximise the possibility of e-agriculture technology adoption success.

Proposition B implies P1.Supporting *tacit knowledge flows within an e-agricultural system improve adoption in Ireland.*
Proposition B and Proposition A imply P2. *E-agricultural systems development that addresses the interaction between institutional factors and tacit knowledge in the community of practice, improves e-Agriculture adoption in Ireland.*

Proposition B and Proposition C imply P3. *Agriculture systems, which addresses the interaction between tacit knowledge and human and cultural values in the community of practice, improves e-agriculture adoption in Ireland.*
Proposition A and Proposition C imply P4.*Agriculture systems development, which addresses the interaction between institutional factors and human culture and values in the community of practice, improves e-agriculture adoption in Ireland.*
Proposition A implies P5. *Representation of Institutional factors within e-agricultural systems improved its adoption in Ireland.*
Proposition C implies P6.*Representation of Cultures and Values within an e-agricultural system improved its adoption in Ireland.*

To validate the proposition a mixed method approach is proposed.

Research Methodology

Mixed methods research termed the third methodological movement (paradigm) came from the desire for researchers to add either breadth (quantative research) or depth (qualitative research) to analysis [26].Quantitative and qualitative data were mutually informing in a pluralist study [26]. A pluralist approach allowed for development of rich insights into various phenomena not understood using only a quantitative or a qualitative method within IS [45]. Pluralism allowed for advancement and diversity in IS research creating a cumulative body of knowledge [47]. With this in mind, methodological pluralism appeared to be well suited to researching the adoption of e-agricultural systems in Ireland as previous studies applied a micro-level approach to adoption failing to provide a deeper understanding.

6.1 Unit of Analysis

The proposed model is underpinned from a human-centred systems view advocating people first, organisations second and technical third. Stilled viewed the farm family as the unit of agricultural production despite extensive restructuring [48]. Traditionally farm research focused on the male farmer viewing them as head of the farm family. However, this has changed with the recognition of the composite social construct of the family now considered as a unit of common interest believing the social landscape of farming has changed. To speak about men and women on a farm is not a reflection of the working reality [49]. Much of the agricultural data collected in Europe fails to capture the family farm, raising the question of reliability of current knowledge of farm structures [28]. Hence, the unit of analysis chosen is the family farm.

The paper present early findings to validate the themes theoretical sensitivity as proposed within the conceptual framework. By the nature of farming and to capture the farm family interviews were conducted. This method was deem appropriate as previous studies on farmers adoption of e-systems noted that to understand the phenomena required more depth which would best be served by these approaches. To gather data the author interviewed 8 farm families from the south east of Ireland engaged in different farm enterprises.

6.2 Preliminary findings

In Ireland, the Irish Farmers Association (IFA) is a *farm family led* institution. Membership is open to both farmer and farm families. All respondents spoke of the group in positive terms believing it is a "grass roots" organisation offering farming support and support for wider social concerns. This was reflective in the organisation having a local presence in communities, a national presence and an EU presence in Brussels. Farm families view the organisation approachable and accessible with one

respondent saying there is “always someone at the end of a phone who understands me”. Hence this gave rise to

Proposition A: Institutional factors shape the Community of Practice

All respondents viewed generational knowledge as a source of information for farmers. The majority of farmer quantified as a third of their farming knowledge came from mediate families. As farming is labour intensive children of farmers learn by doing suggesting they “ learned a lot from their fathers”. One respondent said that learning animal behaviour was gathered from “being around them” otherwise, she would not have been able to “handle them” (animals). One respondent believed farming cannot be learnt in college alone as “knowledge is missing” by not being “around the farm and family”. Nephews of bachelor farmers inheriting a farm found the paper work easier but could not “handle the practical” side because they “didn’t grow up on a farm”. Giving rise to

Proposition B: Tacit knowledge shapes the Community of Practice.

Farmer’s culture when expresses as identity was important to all the respondents. Outside of their peers when a farmer is in conversation and becomes aware that the other person is a farmer or from a farming background they said they “open up to people like themselves” as they know “what they are talking about”. Amongst their peers farmers would seek farming advice from their neighbours and help. Help is often sought from neighbours with “moving cattle” or borrowing farm equipment. To understand the level or type of interaction requires further analysis and could be validated by:

Proposition C: Culture and values shape the Community of Practice.

In Ireland farmers, children planning on taking over the family farm are now undertaking third level courses in agriculture. Many of these course offer training specifically in e-government portals and many “well-able to manage their way around” these sites. Whilst these children are not the registered farm owners they actively partake in the “paper work” on the farm. What is interesting about the family unit is the average age of registers farmers according to the Department of Agriculture are considered “old” being in the 70 years of age category as the want to “hang on for as long as they can”. Many admit to allowing their children to engage with the department of agriculture through government portals on their behalf.

Proposition D: An e-agricultural system should reflect the community of practice.

Discussion and Future Work

The very brief analyses of results presented in the paper are starting to reflect the research lens of the proposed framework. Evidence of culture expressed in identity is important along with community links, interaction with neighbours and the relevance of generational knowledge all enforce the human element of the working lives of farmers strengthening the argument for a new thinking to systems development for agriculture. For technologist to understand the end user in terms of their working life and personal life is vital. Future ISD research must construct software development model with the social artefact as the locus for technology development. This will open up a whole new set of possibilities, and requires systems developers and related research to rethink the appropriateness of the philosophical positions underlying many current research trajectories.

Conclusion

In conclusion, this paper has highlighted the importance of new ISD dimensions of analysis within a rural context in order to improve continued usage. It argued how the reductionist approach failed to capture the social context of use which influences adoption of e-agricultural systems. It stressed the importance of the sector in both global and local economies and how ISD must manage the social and technical systems to support learning and innovations. It is important that this sector remain innovators and future IS technologies support real world environments. To recap the literature reviewed the technology centred approach to technology adoption within ISD and proposed a new lens of analysis for e-agricultural system for rural innovations along with preliminary findings.

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APPENDIX C NVivo Nodes

NVivo allowed the generation of nodes from interpretation of the transcripts. Nodes are central to understanding and working with NVivo. They allow related material to be gathered in one place and check for emerging patterns within transcripts. This allows the researcher to organise ideas and taught processes. Below were the nodes generated.

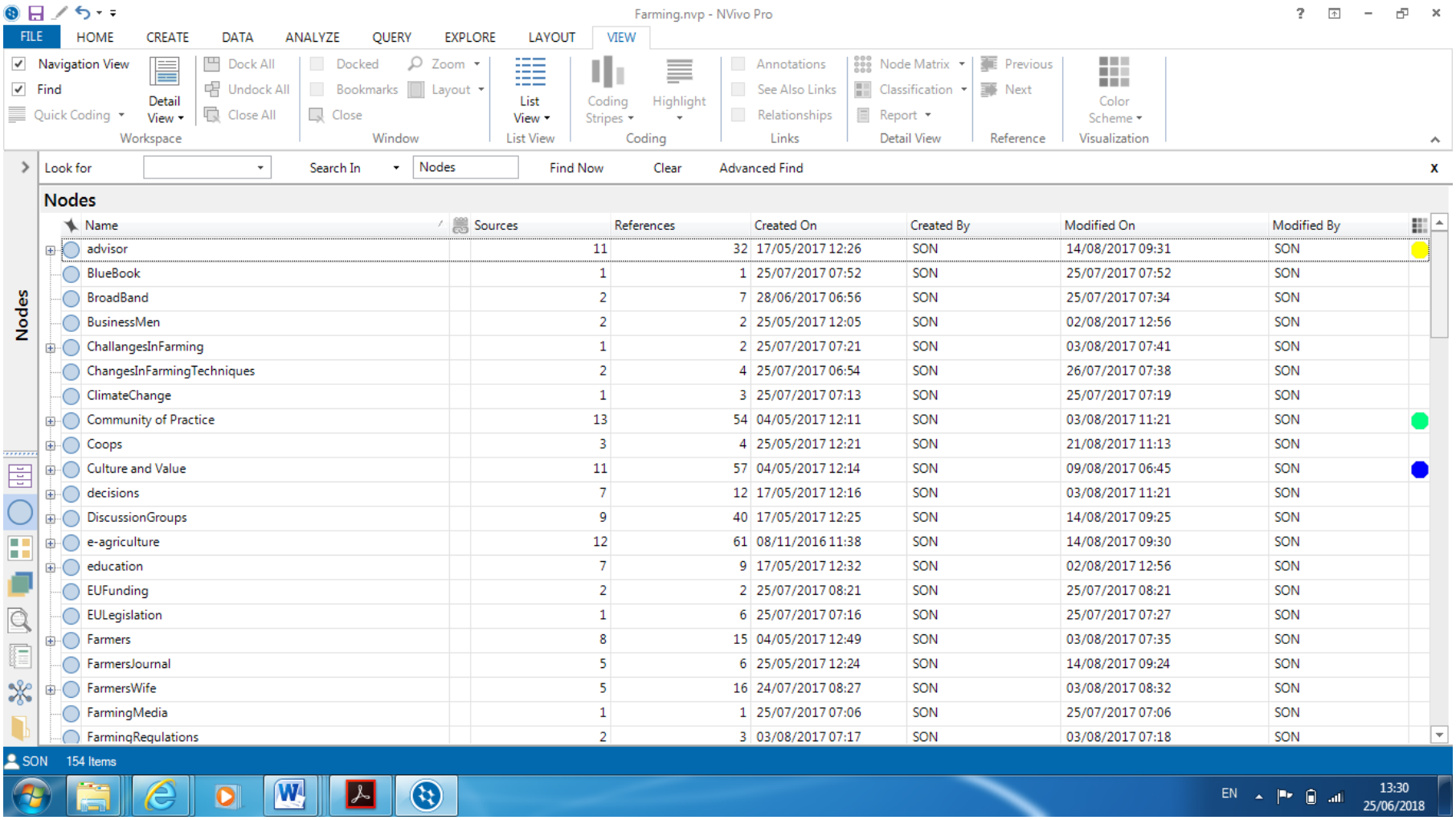

Figure Appendix C-1 NVivo Concept Nodes from Transcipts

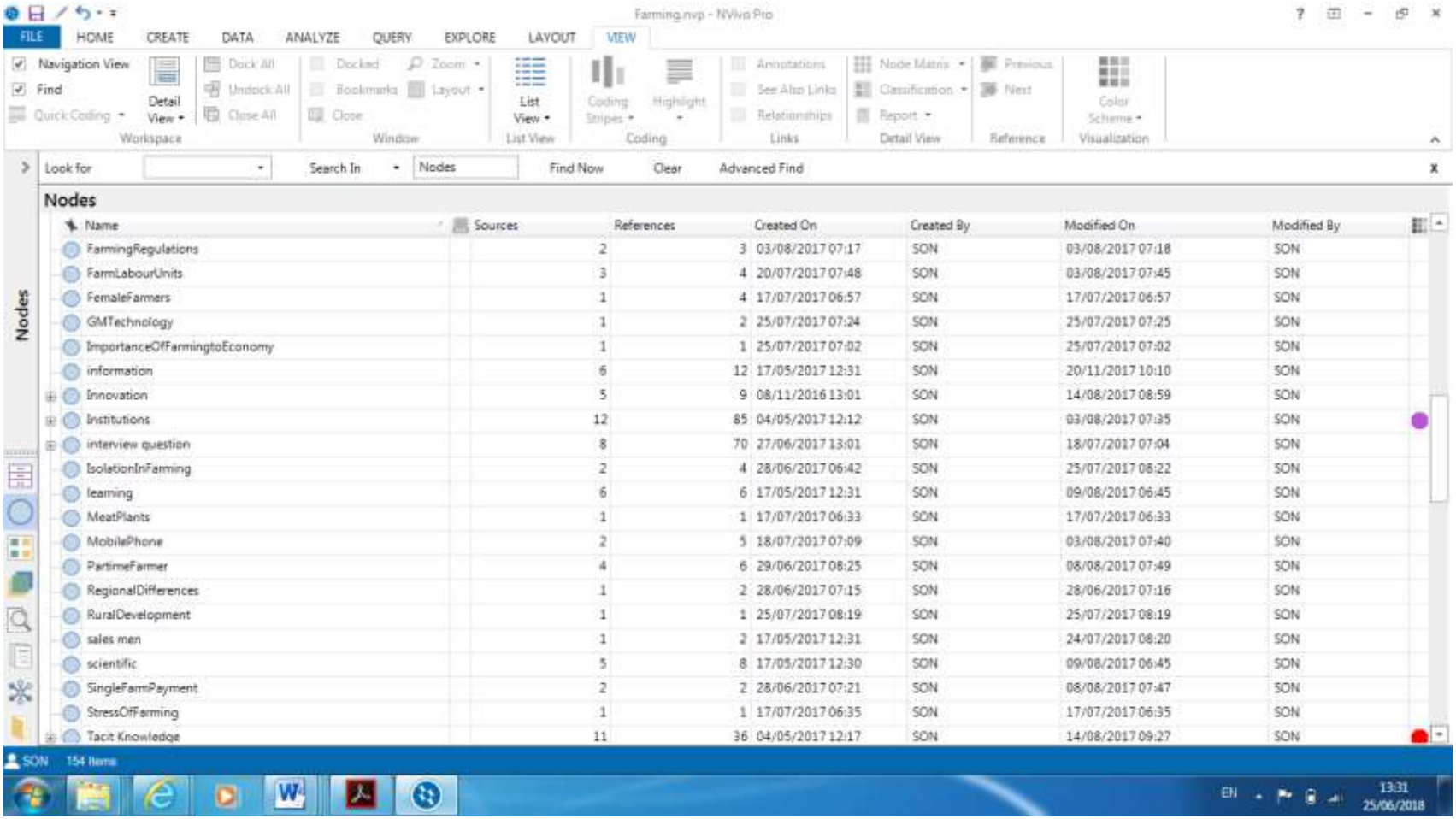

Figure Appendix C-2 NVivo Concept Nodes from Transcripts

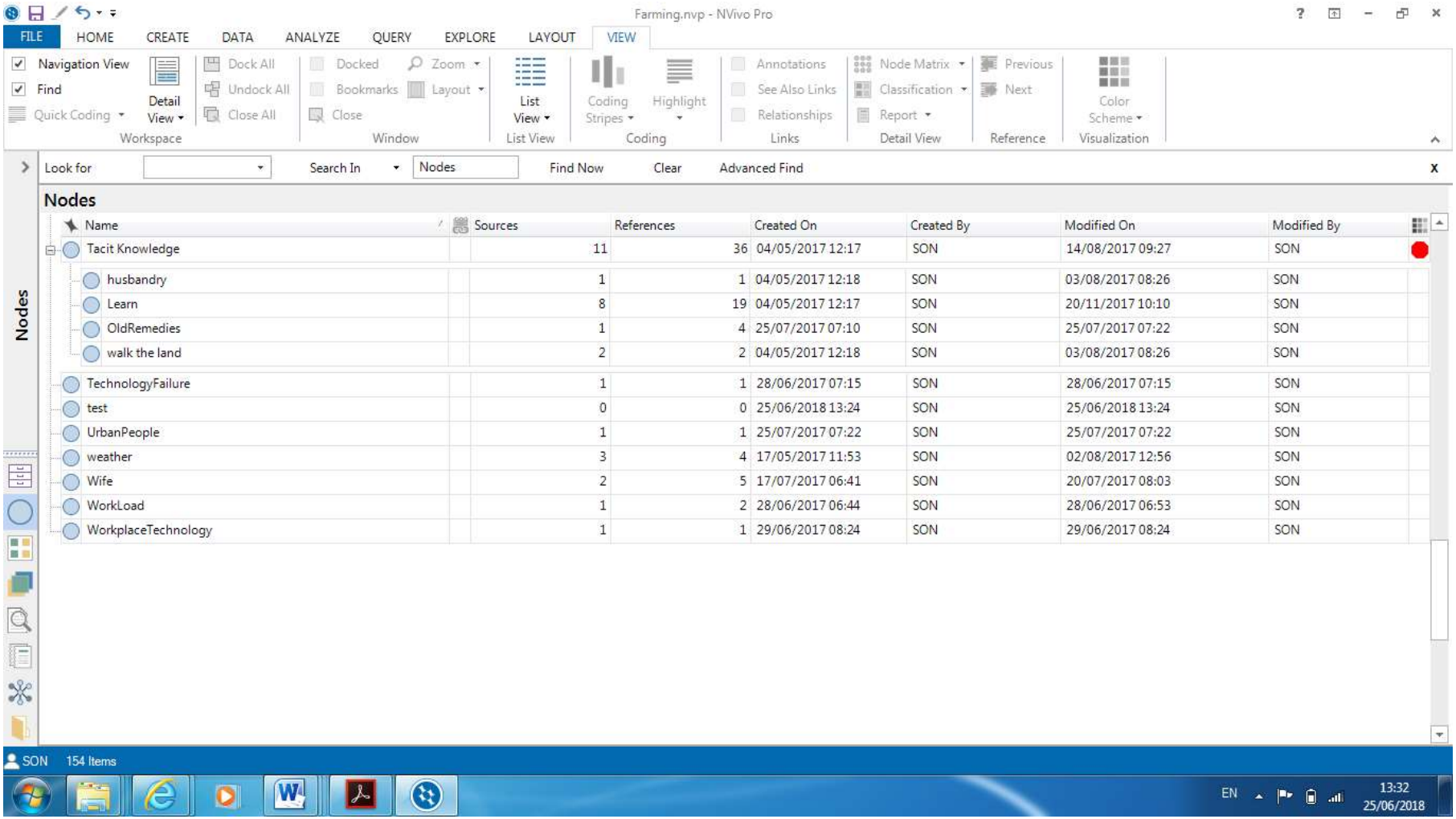

Figure Appendix C-3 NVivo Concept Nodes from Transcripts

APPENDIX D INTERVIEW SCHEDULE

These are from the CUITA study

What type of farming do you engage in?

How many people work on your farm?

What age are you?

Education level?

Have you taken any computer literacy course?

Do you have a job outside farming?

Do you access farm information online?

Using your mobile phone?

PC ?

What is E-Agriculture and to identify levels of e-agricultural activities taking place?

Do you understand the term e-agriculture?

What does the term e-agriculture mean?

What e-agricultural systems do you use? And for what

Do you find they support your farm enterprise?

Would you prefer to ask your peers for advice?

How often do you use these systems?

Agfood.ie website

Initially why did you register for agfood.ie?

Do you find agfood.ie of benefit to you in farming?

Have you registered but did not use it?

Why didn't you use the site?

Information gathering online – Follow into the TACIT dimension.

Where did your knowledge of farming come from? - Father, farm, course or other?

Do you think that agricultural advisor have an understanding of your daily life, community etc?

Do you believe local knowledge or knowledge from other farmers helped influences what you deem relevant in your work?

Does local knowledge help in the development and implementation of farming practices?

Most of the information comes from farming institutions – Teasgasc, IFA ,Glanbia?

From the CUITA study *ease of access to information* was a reason most farmers use e-systems.

What type of farming information do you look for online?

Would you prefer information to be localised or community based?

What type of farm information sites do you access?

Is the information that you obtain online of relevance to your work practices?

Do you find that you get to much information?

Is the information easily available online, in terms of easy to search, relevant?

Would you discuss the new information with your peers?

Do you use your parents (as previous owners of the farm) when needing an opinion on something or on your work practices?

When making major decisions of the farm do you use information from e-agricultural sites as part of your decision making?

Not using farm software

Why don't you use farm software?

CUITA response farmers mentioned time as a reason?

Of that their farm was too small for farm software?

Do you leave your business records to someone else?

Have your neighbours or farm discussion group advised the use of farm software?

If you were not confident in using the software would you ask your neighbour for help or stop using the software?

Would you prefer if your partner or father would use the system on your behalf?

Do you think farming needs software applications to support the enterprise?

How often do you use the farm software? Nightly, weekly

How do you maintain information on the farm, in your head, notebook?

When calving how do you record the births when they happen, on paper?

APPENDIX E: CONFIDENTIALITY AGREEMENT

Instructions:

To be read out by the researcher before the beginning of the interview.
One copy of the form to be left with the interviewee;
A second copy is to be signed by the interviewee and kept by the researcher.

My name is Sinead O'Neill. I am doing research on a project that is looking at the use of ICTs technology by the farming community. I am a member of the ISYTE research group within Waterford Institute of Technology, Waterford. This research is being conducted under the supervision of Dr Larry Stapleton, and either of us can be contacted (see below) should you have any questions.

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Phone: 051 302100
Email: lstapleton@wit.ie

Thank you for agreeing to take part in the project. Before we start I would like to emphasise that:
_ Your participation is entirely voluntary;
_ You are free to refuse to answer any question;
_ You are free to withdraw at any time.

The interview will be kept strictly confidential and will be available only to my supervisor, Dr Stapleton & myself. Excerpts from the interview may be made part of the final research thesis, but these will be anonymous. Under no circumstances will your name or any identifying characteristics of you or the organization appear in the thesis.

Please sign & date this form to show that I have read these contents to you.
_____ *(Signed)*
_____ *(Printed)*
_____ *(Dated)*

APPENDIX F: CONSENT RELEASE FORM

<Interviewers Name>
<Address>
<Date>

Dear ***<First_Name>***

Please accept my sincere appreciation for all the information and help you provided. I would appreciate very much if you could read over the findings that I have compiled from our interviews. If you wish to make any alterations or add anything please do not hesitate to do so and send me back the changes in the pre-paid envelope provided. I will make the required changes, and will subsequently forward you on the up-dated version of the findings.

If you find that when you have read over the findings and that you do not wish to make any changes, please fill in the Consent Release Form enclosed, giving me permission to use extracts of your information in my thesis and further publications. If you have any queries or questions please do not hesitate to contact me at: smoneill@wit.ie or <mobile number>.

Yours sincerely

_____

Sinead O'Neill

CONSENT RELEASE FORM

I, ***<FULL_NAME>,*** have read the findings chapter sent to me on <Date> and I am satisfied that what transpired in that chapter has been accurately recorded and can be used the PhD thesis and further publications.

_____ (*Signed*)
_____ (*Printed*)

_____ (*Dated*)