

**A STRUCTURAL EQUATION MODELING APPROACH TO FACTORS THAT
INFLUENCE FARMERS' BEHAVIOUR AND BEHAVIOURAL INTENTIONS
TOWARDS WATER POLICY CHANGES**

WENCUI ZHANG

**B.S., Hebei University of Science & Technology, 1985
MSW, The Hong Kong Polytechnic University, 2009**

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WENCUI ZHANG

Date of Defence: September 2, 2014

Dr. Henning Bjornlund Co-Supervisor	Associate Professor	Ph. D.
Dr. Kurt K. Klein Co-Supervisor	Professor	Ph. D.
Dr. Ruth G. Kalischuk Supervisory Committee Member	Professor	Ph. D.
Dr. Danny Le Roy Thesis Examination Committee Chair	Associate Professor	Ph. D.
Dr. Wei Xu Internal Examiner	Professor	Ph. D.
Dr. Elwin Smith External Examiner Agriculture & Agri-Food Canada Lethbridge Research Centre Lethbridge, Alberta	Bio-economist	Ph. D.

Abstract

The objective of this study is to develop a better understanding of farmers' behavioural intentions to possible water policy changes in Alberta. A survey of irrigators in southern Alberta was conducted in 2012 and the data were analyzed with Structural Equation Models. Findings indicate that farm business characteristics, values, attitudes, and past behaviour influenced farmers' behavioural intentions towards water policy changes. Farmers' intention to agree to volumetric water pricing was influenced negatively by business cycle and positively by values of Universalism related to nature and farming business attitudes; farmers' intention to transfer water was influenced negatively by business cycle, values of Universalism related to human and land attachment attitudes, and positively by values of Universalism related to nature. Farms' position in the business cycle was positively related to intentions to improve irrigation equipment; past behaviour was negatively related to intention to reduce irrigation water if the price of water increased.

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Chapter One Introduction

1.1 Background

It has never been more urgent to understand farmers' behaviour and behavioural intentions. With the global awakening of environmental awareness, scientists, policy makers, and governments have been attempting to understand the motivations of people regarding actions they take and their impacts on the environment. One particular group of people, farmers, work in and with the environment constantly. Decisions they make and actions they take can make a vast difference to environmental outcomes. This makes it crucially important to understand the behaviour of farmers with regard to the way they use and interact with the land and water. As noted in a report by FAO (2007), if appropriately informed and supported, managers of land can reduce the negative environmental impacts from their production activity and improve the regulating and supporting services whose effects span regionally and globally.

With growth in population and economic development, the demand for water continues to increase. When increasing supply of water is no longer an option, satisfying new demands will require water to be transferred from current to new users. It is clear that farmers currently are the biggest group of water consumers in the world. Some of the water presently used by the irrigation sector might have higher value if it could be reallocated. However, exporting water out of irrigation needs to be accomplished in a manner that reflects shared social and environmental values and is acceptable to existing water users and the wider community. Understanding farmers' objectives and the

motivations for their behaviours is likely to lead to better policy design and more successful policy implementation (Kuehne and Bjornlund, 2008).

In the last couple of decades, Integrated Water Resources Management (IWRM) has become widely accepted in the design and implementation of sustainable water policies. Guided by the Dublin Principles, the core idea of IWRM is the establishment of multi-disciplinary teams at various levels (local, regional, national and international) to communicate different perspectives on water resources, building consensus on the conservation of water resources and the maintenance of ecosystem functioning (Radif, 1999). As the biggest water users and the biggest water licence holders in many regions, farmers' roles are critical in water resources management and meeting future water needs. It is perilous for policy-makers to neglect farmers' willingness to adopt improved water management practices (Burton, 2004).

Facing increasingly urgent stress on global water scarcity, many countries around the world have searched for solutions and many reforms have been launched. However, the lack of confidence in the consequences of any new policy stymies its potential establishment and implementation. For example, water pricing policy is attracting increasing attention as a measure to reduce water used for irrigation. However, any new pricing regime might result in considerable unpredictable responses by local users (Horbulyk, 2010). Although in theory, market-pricing and tradable water rights can lead to an efficient allocation, in practice, such a solution is not so simple (Hellegers and Perry, 2006). Thus, understanding farmers' behaviour and predicting their reactions to changes in water policies is becoming an urgent priority.

Although Canada is well-known for its abundance of water, the water supplies are unevenly distributed throughout the country. As one of the Prairie Provinces, Alberta, especially the southern part of the province, faces chronic water problems. As the home of most of Canada's irrigated agriculture, Alberta has been a national pioneer in reforming water policy. In 1999, Alberta's Water Act was proclaimed. It supports and promotes the conservation and management of water, including its wise allocation and use (Government of Alberta, 2000). Responding to requirements of the Water Act, the Government of Alberta (2003, 2008, and 2009) released a series of policy documents: *Water for Life: Alberta's Strategy for Sustainability* in 2003, *Water for life: a renewal* in 2008 and *Water for Life: Action Plan* in 2009. Alberta's farmers therefore are witnessing and experiencing changes in water policies and management procedures. This process not only raises urgent needs to understand farmers' potential reactions to the policy reforms, but also provides a great opportunity to explore farmers' behaviour and behavioural intentions in response to such policy reform and learn about the factors that influence them.

1.2 Statement of the Problem

Although farmers' behaviour towards the environment has drawn increasing academic attention, understanding the main determinants of their behaviour still remains unclear. Scholars from different fields have used their own perspectives to find influential factors. It is clear that farmers hold both business and way-of-life goals (Fairweather and Keating, 1994); thus, they must be analysed under multiple perspectives. Failure to do so might lead to unreliable conclusions. Not surprisingly, the influences of many factors, including non-economic socio-demographic characteristics, have been found in many studies to

influence farmers' behaviours while studies conducted from the perspective of a single discipline have not been conclusive.

In recent decades, many scholars have suggested that behavioural research should be conducted from an interdisciplinary perspective, by bringing values into sociological (e.g., Hitlin and Piliavin, 2004, Spates, 1983) and economics research (e.g., Bruni and Sugden, 2007) and adding background factors into psychological models (e.g., Ajzen and Fishbein, 2005). Incorporating psychological variables in models of farmer behaviour is believed to lead to better predictions (Edwards-Jones et al., 1998). However, comprehensive, interdisciplinary and integrative studies have mostly remained at the conceptual phase; farmer-level empirical research is rare.

1.3 Aims and Research Questions

In order to better understand farmers' behaviour and behavioural intentions and to fill the gap between theoretical concepts and application, this dissertation aims to build a more complete model of farmer's behaviour and provide new empirical evidence to synthetically understand farmers' behaviour.

The two research questions guiding this study are:

- What are the main factors that influence farmers' behaviour?
- How do various determinants co-influence farmers' behaviour?

With the series of action plans for water management that are being discussed in Alberta, two important issues have arisen with regard to changes in water policies: water transfers

and water pricing. By focusing on Alberta's irrigators' responses to these two main issues and water saving, four behavioural intentions have been chosen for investigation:

- Intention to agree that “water pricing should be based on actual and recorded volume of water used”;
- Intention to “be willing to transfer some water that, historically, you have not used” ;
- Intention to “make any changes to your irrigation equipment in the next five years”; and
- Intention to agree that “increasing the price of water will not reduce the use of water for irrigation”.

By means of the above four irrigators' behavioural intentions, the two research questions are answered. Multiple kinds of factors that influence farmers' behavioural intentions are explored, estimated and assessed.

1.4 Research Approach and Methods

Influenced by many different authors, the conceptual model and hypotheses of this study are proposed and presented. In the proposed model, five types of factors (farmers' individual, household, and farm business characteristics, their values and attitudes, and their past behaviour) are included and used to detect their influences on behavioural intentions. Different from the four other types of factors, values and attitudes cannot be measured directly but, instead, must be measured indirectly by several indicator variables.

The hypothesized model of this study has four behavioural intentions as outcome variables and has both observed and unobserved variables simultaneously in the model.

Structural equation modelling (SEM) is regarded as a second generation data analysis technique and has been chosen as the main statistical method to test the hypothetical model in this study. SEM techniques enable researchers to answer a set of interrelated research questions by modelling the relationships among multiple independent and dependent constructs simultaneously and allow researchers to simultaneously include both continuous and categorical observed and latent variables in one model.

A structured questionnaire was designed and used to collect data that could be used to estimate and assess the proposed model in this study. A survey of irrigation households in Southern Alberta was conducted by face-to-face interviews from May to August, 2012. All the data were processed and analysed by computer software SPSS 20.0 and its allied software of AMOS (*Analysis of Moment Structures*) 20.0.

1.5 Organisation of the Dissertation

The dissertation is divided into eight chapters and each chapter is introduced as follows.

Chapter One is an introduction of the dissertation. This chapter briefly introduces the background, the problem, and the need for the research. It describes the aims, research questions, and focuses that this study addresses. It also provides a brief overview of the research methods employed in this study.

Chapter Two is a review of the study's background. With a focus on water issues in the study region, this chapter provides perspective by describing Alberta's water issues in a global context. It reviews global water scarcity trends, worldwide awakening of

environmental awareness and water policy reforms. Alberta's water strategy, action plans and relevant issues are described and highlighted. It also provides a brief overview of Alberta's irrigation agriculture and the farmers who are witnessing and experiencing changes in water policies. This chapter notes the urgent need to understand farmers' potential reactions to water policy reforms.

Chapter Three is a review of relevant published literature on the potential factors that influence behaviour, including values and attitudes, socio-demographic characteristics and past behaviour. Focusing on the aims of this study, the literature related to farmers' behaviour, especially the studies of farmers' responses to projected changes to water policies, is discussed in detail. It highlights how understanding farmers' behaviour and behavioural intentions needs to consider more influential factors. Comprehensive understanding of farmers' behaviour is needed.

Chapter Four provides the conceptual framework and methodology of the study. It presents a general conceptual model that synthesizes previous research findings. Five components including values and attitudes, personal, family and farm characteristics, and past behaviour are included in the proposed model to examine their influences on farmers' possible responses to water policy reform. SEM is the main statistical method used to estimate and assess the model in this study. Its basic concepts and practical considerations are reviewed. A brief introduction and graphical notation of AMOS, the computer software used in this study, is demonstrated.

Chapter Five presents the survey design and describes the data collection process in the study. The survey region, target population and sample pool (potential respondents) are

described along with the questionnaire structure, method of data collection and survey development. A total of 207 irrigators were interviewed and 203 valid questionnaires were obtained. A brief description of the respondents is presented in this chapter.

Chapter Six presents descriptive statistics and measurement models. It outlines and discusses the profile of the sample by providing descriptive statistics. This chapter also describes the process of data preparation and the development and tests of the measurement models required by SEM.

Chapter Seven provides structural equation modelling and results. In this chapter, the proposed model is estimated and assessed; hypotheses tests are discussed and reported; and the model results are interpreted.

Chapter Eight concludes the thesis. It outlines the strengths and limitations of the study, policy implications, contribution to the academic literature, and recommendations for future research.

Chapter Two Global Water Scarcity and Alberta Context

2.1. Introduction

Nothing is more important for human beings than water. With the development of human civilization, water has been exploited and utilized in various ways. The explosion of population, the expansion of irrigated agriculture and the growth of living standards have led to a dramatic increase in demand for water. Satisfying humanity's water demands while simultaneously protecting the ecological support functions of freshwater systems will be one of the most difficult and important challenges of the 21st century (Postel, 2000).

In this chapter, the outline of Alberta water issues is presented in the global context.

There is growing concern about potential water scarcity and its threat to the economy of Alberta and the future wellbeing of Albertans. In the South Saskatchewan River region, which is the most water scarce region in Alberta, individuals or companies can no longer apply for a new water license.

Second, this chapter reviews worldwide awakening of environmental awareness and water policy reforms. The process of changing water policy in Canada is then discussed in this global context. As a pioneer in Canada, Alberta has provisions to encourage the re-allocation of water to new and more effective/efficient/productive uses and less consumptive uses. Alberta's water strategy, action plan and relevant issues are described and highlighted.

Third, this chapter gives a brief overview of Alberta irrigated agriculture, farmers and their irrigation practices.

And finally, a summary of this chapter is represented.

2.2 Alberta water issues in global context

2.2.1 Global Water Scarcity Trends

There is a worldwide attention to water shortage. It is believed that 450 million people in the world suffer from water shortages, and it has been estimated that two out of every three people will live in water-stressed areas by the year 2025 (UNEP, 2008).

Although there is no universal standard, water scarcity is commonly defined as “when demand for freshwater exceeds supply in a specified domain (FAO, 2012a: ix).” The most widely used measure of national water scarcity is the Falkenmark indicator or “water stress index” (Falkenmark et al., 1989). This method defines water scarcity in terms of the total water resources that are available to the population of a region, and measures scarcity by the amount of renewable freshwater that is available for each person per year. If the amount of renewable water in a region falls between 1,700 m³ and 1,000 m³, the region is considered to be experiencing water stress; if between 1,000 m³ and 500 m³, to be experiencing water scarcity; and below 500 m³, to be experiencing absolute scarcity. On this criterion, Food and Agriculture Organization of the United Nations (FAO, 2013) estimates that by 2025 two-thirds of the world population could be under water stress, and 1.8 billion people are expected to be living in countries or regions with absolute water scarcity.

Overall, the world contains an estimated 1,386 million cubic kilometres of water, but only 2.5% of it is fresh water (Shiklomanov, 2000). The FAO (2012d) AQUASTAT database indicates that, on average each year, the amount of precipitation falling on land

is 108,831 km³, but only 42,370km³ is converted to renewable freshwater resources. Not only that, not all of this fresh water is accessible. The Food and Agriculture Organization emphasizes that only about 9,000-14,000 cubic kilometres are economically available for human use (Clarke, 1993; Rosegrant, 1997).

The removal of water from rivers or aquifers by installing infrastructure is commonly called water withdrawal. Although water withdrawal is different from water consumption, it is most commonly used to assess and predict water use (e.g., Alcamo et al., 1997; 2003; Rosegrant and Cai, 2002; Shiklomanov, 2000). According to FAO's estimate, global water withdrawals in 2006 totalled 3,902 cubic kilometres (FAO, 2012b). Compared with Shiklomanov (2000)'s historical estimates, water withdrawals have almost tripled in the past five decades, and have increased six-and-a-half times over the last 100 years (see detail in Table 2-1). It is predicted that total water withdrawals will reach nearly 5,000 km³ in 2025 (Shiklomanov, 2000).

Withdrawals of water for use in agriculture represents about 70% of total water withdrawn (FAO, 2012b; Shiklomanov, 2000). Agriculture is the industry with by far the largest water consumption. There is a direct link between water and agriculture. Growing crops and raising livestock need a lot of water. The world population is predicted to grow from 7.2 billion in 2013 to 9.6 billion in 2050 (UNDESA, 2013). At the same time, increased economic growth and individual wealth raise the demand for livestock products, which require more water. Globally, on average it requires 1,150m³ of water to produce one tonne of wheat (Hoekstra and Hung, 2003), but 1 tonne of beef requires 15,977 m³ water (Chapagain and Hoekstra, 2003). By 2050, food demand is predicted to increase by 70%; to satisfy that demand, an additional billion tonnes of cereals and 200 million

tonnes of meat will need to be produced annually (Bruinsma, 2009). Therefore, agricultural water use continues to increase and remain the largest, even though its proportion of total water withdrawals tends to decline (see detail in Table 2-1).

Table 2- 1 World Total Water Withdrawal by Sector

Year	Agricultural Use		Municipal Use		Industrial Use		Total
	km ³ /year	% of Total	km ³ /year	% of Total	km ³ /year	% of Total	
1900	513	88.6	22	3.8	44	7.6	579
1940	895	82.8	59	5.4	127	11.7	1081
1950	1080	78.8	87	6.3	204	14.9	1371
1960	1481	76.4	118	6.1	339	17.5	1938
1970	1743	71.1	160	6.5	547	22.3	2450
1980	2112	69.4	219	7.2	713	23.4	3044
1990	2425	70.0	305	8.8	735	21.2	3466
1995	2504	69.6	344	9.6	752	20.9	3600
2000	2605	69.2	384	10.2	776	20.6	3765
2003	2710	70.2	429	11.1	723	18.7	3862
2006	2703	69.3	468	12.0	731	18.7	3902
2010	2817	67.1	472	11.2	908	21.6	4196
2025	3189	64.2	607	12.2	1170	23.6	4966

Note: 1. Water withdrawals from three sectors come from Shiklomanov's (2000, p24) estimates with the exception of those estimates in years of 2003 and 2006. The total water withdrawals for those years are not the same as those in Shiklomanov's paper as they exclude reservoir evaporation in order to be consistent with the data in 2003 and 2006 from FAO.

2. The water withdrawals in 2003 and 2006 come from FAO AQUASTAT database (FAO, 2010; 2012c).

Similar to any other resources, the distribution of fresh water varies a lot between countries and regions. Food and Agriculture Organization AQUASTAT database provides an indicator of average total renewable freshwater resources to distinguish the geographical variability. There is a significant regional difference in the amount of annual renewable freshwater available per capita. The gap between the lowest and highest regions is more than tenfold. In Asia, the available renewable freshwater is only 2,816 m³ for each person per year, while in Oceania, the amount is 30,447 m³. Asia is

home to about 61% of the world's population but has only 28% of its renewable freshwater resources. Meanwhile, the Americas have 45% of the world renewable freshwater resources with only 14% its population (see detail in Table 2-2). The World Water Assessment Programme (WWAP, 2012: 180) indicates that “about 66% of Africa is arid or semi-arid and more than 300 of the 800 million people in sub-Saharan Africa live in a water-scarce environment.”

Table 2- 2 World Population and Internal Renewable Freshwater Resources

Category	Population (2011)		Internal renewable freshwater resources		
	Inhabitants (10 ⁶)	% of world	Volume (km ³ /per year)	% of world	Per capita in 2011 (m ³)
Africa	1044.3	15.0	3931	9.3	3764
Americas	942.4	13.5	19104	45.1	20272
Asia	4213.3	60.5	11865	28.0	2816
Europe	740.4	10.6	6578	15.5	8884
Oceania	29.3	0.4	892	2.1	30447
World	6969.7	100.0	42370	100.0	6079

Source: FAO. 2012. AQUASTAT database (FAO, 2012a; 2012b). <http://www.fao.org/nr/aquastat>.

2.2.2 Water shortage and uneven distribution in Alberta

Canada is home to roughly seven percent of the planet's renewable freshwater but with only one-half percent of its population. Although Canada is well-known for its abundance of water, the water supplies are unevenly distributed throughout the country. About 60% of Canada's freshwater drains north, while 90% of Canada's population lives in the south (Environment Canada, 1987). This abundance in water yield is distributed unequally across the country. The southern parts of the Prairie Provinces and British Columbia's Okanagan Valley are dry and face chronic water shortages (Bjornlund, 2010; NRTEE, 2010). Alberta is one of the Canadian Prairie provinces, which has only 2.2% of

Canada's freshwater, with 80% of the water located in the northern part of the province while 80% of its population live in the southern part (Alberta Environment, 2002; 2010).

Surface water is the main water source for the majority of Alberta's population and industries. Surface water refers to water found on the surface of the earth, such as rivers, lakes, and wetlands. In Alberta, there are several major rivers that start from glaciers in Banff and Jasper National Parks. Snow melt is the largest contributor to the annual flows in these rivers, followed by rainfall. They account for about 46% of the provincial river discharges. Some rivers have their headwaters in Montana (Waterton, St. Mary, Milk), British Columbia (Wapiti, Peace), and Saskatchewan (Clearwater, Cold Lake). Almost 87% of the water, including that of the four largest rivers in the province (Slave River, Peace River, Athabasca River/Lake Athabasca and the Smoky River) flows northward via the Mackenzie River Basin and ultimately into the Arctic Ocean. Thirteen percent of the water, including that in the South Saskatchewan River, North Saskatchewan River, Red Deer River, Battle River, and some significant tributaries like the Bow River, Oldman River, St. Mary River and the Brazeau River, flows via the Nelson or Churchill basins, and ultimately into Hudson Bay. About 0.1% of Alberta's Milk River and its tributaries, Lodge Creek and Battle Creek, flow via the Missouri-Mississippi basin into the Gulf of Mexico. The northern rivers in Alberta have comparatively higher discharge rates than the southern ones, which flow through a drier area.

Alberta's lakes are numerous and varied, but have distinctly different geographical features. There are relatively abundant lakes in the northern half of the province. The fourth-largest Canadian lake, Lake Athabasca, located in the northeast of the province has an area of 7,770 km²; about one-third of the lake is in Alberta and the rest is in

Saskatchewan. The largest lake that is entirely in Alberta, Lake Claire, is located just west of Lake Athabasca. It has a total area of 1,436 km². Lesser Slave Lake is the second largest lake entirely within the province; it is located northwest of Edmonton and has an area of 1,160 km². In the arid and more highly populated area of southern Alberta, there are few natural lakes so reservoirs have been built to store water for various purposes. There are two types of reservoirs built in Alberta: on-stream and off-stream. On-stream reservoirs are created by building a dam across a river, such as Gleniffer Lake, Ghost Reservoir, St. Mary Reservoir, and Glenmore Reservoir. Off-stream reservoirs are created by a dam across a natural coulee to block drainage, such as Milk River Ridge, Little Bow Lake reservoirs, and Chestermere, McGregor and Payne Lakes (Mitchell and Prepas, 1990). On-stream reservoirs in Alberta have been built for hydroelectric power generation, including Spray Lakes and Ghost reservoirs; for irrigation, water storage or municipal use, including St. Mary and Glenmore reservoirs; and flow regulation, including Gleniffer Lake and Chain Lakes Reservoir (Mitchell and Prepas, 1990). All the off-stream reservoirs in Alberta are in the southern half of the province and are primarily used to store water for irrigation, which are filled in spring, and withdrawn to irrigate crops in the summer (Mitchell and Prepas, 1990).

Wetlands are found throughout Alberta, and approximately 21% of Alberta is covered by wetlands (Alberta Environment, 2003). They also have a distinct spatial distribution. A great number of wetlands are distributed throughout northern Alberta, and most of them are permanent; in central and southern Alberta, fewer permanent wetlands are found and are usually temporary or semi-permanent (Alberta Environment, 2003). Approximately 90% of Alberta's wetlands are peatlands located in the boreal region, while about nine

percent of wetlands are non-peatlands located in Alberta's settled area, primarily in southern Alberta. Land development, industrial development and human settlement have been threatening the existence of wetlands; approximately 64 per cent of the original wetlands in the settled area of Alberta no longer exist (Alberta Environment, 2010).

The water yield is used to represent Canada's renewable freshwater resources. It is defined as the amount of freshwater derived from unregulated flow (m^3/s) measurements for a given geographic area over a defined period of time, and is used to provide estimates of stocks of water assets by the Canadian System of Environmental and Resource Accounts (CSERA) (Bemrose, et al., 2009). Bemrose, et al. (2009) concluded that the average annual thirty-year water yield for Canada from 1971 to 2000 was $3,435 \text{ km}^3$. Kienzle and Mueller (2013) developed a similar study on the mean annual water yield in Alberta for the period 1971-2000, and found that combining the effects of low annual precipitation and high evaporation losses, the mean annual water yield in Alberta was $97,000 \text{ m}^3 / \text{km}^2$. Comparing these two studies, the water yield of Alberta per square kilometre is only about 26% of the national average (taking into account the information from Natural Resource Canada that Canadian land area is $9,093,507 \text{ km}^2$). Compared to the world average, the water yield of Alberta per square kilometer is only about one third (Kienzle and Mueller, 2013). Also, the main water supplies in Alberta are not located in the area that has the highest demand. Kienzle and Mueller (2013) show that the highest water yields in Alberta are produced in the Rocky Mountains and average over one half million $\text{m}^3 \text{ km}^{-2} \text{ year}^{-1}$ while the lowest water yields are produced in the prairies and parts of central Alberta and average just under $11,000 \text{ m}^3 \text{ km}^{-2} \text{ year}^{-1}$, with even occasionally a negative yield.

Contrary to surface water, groundwater is out of sight. Although Alberta is estimated to have more groundwater than surface water, only 0.01 per cent of this groundwater is thought to be recoverable (Alberta Environment, 2010). Like surface water, groundwater supplies are not evenly distributed across the province. According to Alberta Environment (2010), approximately 215,000 wells are presently active in Alberta, and about 4,000 are added each year. Of all the water licensed for use in Alberta in 2009, approximately 3.0 per cent of the volume is from groundwater sources although groundwater licences make up 26 per cent of all licences issued. This does not include the domestic water wells used by Albertans for which licences are not required under the *Water Act*. It is reported that approximately 12% of Albertans (440,000 people), including 90% of rural Albertans, rely on unlicensed use of groundwater as their primary source of water (Beveridge and Droitsch, 2010).

To determine if an area qualifies as “water scarce” the temporal and spatial scales used to define scarcity must be taken into account (Rijsberman, 2006). With the growth in population and economic development, the demand for water in Alberta is continually increasing. Water shortage is becoming a severe issue for Albertans, especially for people who live in southern Alberta. In the most severe South Saskatchewan Region, the South Saskatchewan River Basin (SSRB) Water Management Plan was issued in August, 2006. This plan specified that no more new water licenses would be issued for the Bow, Oldman, and South Saskatchewan Rivers (AEDA, 2008). Individuals or companies in these areas can no longer apply for a new water licence.

One of the recent harbingers of Alberta’s future water insecurity involved a large commercial project in Balzac of southern Alberta, which is located in the Bow River sub-

basin. That project included a 130,000 square meter mega shopping mall and a horse racetrack with hotel and casino. The developers never thought water would be an issue; hence, in January, 2006 when they announced their business they expected to open in 2007 (D'Aliesio, 2008; Lethbridge Herald, 2006-01-08). However, with the Bow River sub-basin closed to new licences, there was no water for them when all the construction was ready to start. The developers struggled to find water when the City of Calgary refused to sell them part of their existing water licence. They eventually made an agreement with the Western Irrigation District to pipe water from its reserves. Although the irrigation district gained from the sale and the commercial development was able to meet its water needs, the application attracted significant public controversy and opposition. The transfer eventually got approved in a plebiscite held in the irrigation district, but only by the narrowest of margins (Bjornlund et al., 2013b). Difficulties (and cost) of obtaining the needed water delayed the project severely. The shopping mall opened in 2009, two years behind schedule; and the racetrack and casino just started its construction in March, 2014 (Century Casinos, 2014-03-20).

2.3 Awakening of environmental awareness and Alberta water policy reform

2.3.1 Sustainable Development and Integrated Water Resources Management

With the global awakening of environmental awareness and worldwide attention to water shortages, many countries in the world have strived to seek solutions. Many reforms have been launched in countries around the world.

In 1972, the United Nations first environmental conference was held in Stockholm, Sweden. The conference noted that ‘a point has been reached in history when we must

shape our actions throughout the world with more prudent care for their environmental consequences' (UN, 1972). The expression of sustainable development was created and, all over the world, policy makers began to re-consider water development and management. In 1987, the concept of sustainable development was promoted in the Brundtland Report to the United Nations called *Our Common Future* (WCED, 1987), and became a common goal of various countries. Simultaneously, the understanding of water resources and water management started to change all over the world. The environmental dimension of water has rapidly become a major component of water legislation (Solanes and Gonzalez-Villarreal, 1999). Sustainability also became a key point of worldwide water resources policy.

In 1992, the United Nations' international conference on water and environment was held in Dublin, Ireland. It developed the "Dublin basic principles", which provide four basic 'guiding principles': 1) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment; 2) Water development and management should be based on a participatory approach, involving users, planners, and policy makers at all levels; 3) Women play a central role in water supply, management and preservation; 4) Water has an economic value in all its competing uses and should be recognized as an economic good. "*Dublin Principles*" and the subsequent United Nations *Rio Summit, Agenda 21* (UNCED, 1992) aroused worldwide reconsideration on sustainable development. Integrated Water Resources Management (IWRM) is believed to draw its inspiration from the *Dublin Principles* (GWP, 2003), has been strongly encouraged by international organizations and has been widely accepted in implementation of sustainable water policy in the last couple of decades. The core idea of IWRM is the

establishment of multi-disciplinary teams at various levels (local, regional, national and international) to communicate different perspectives on water resources, building consensus on the conservation of water resources and the maintenance of ecosystem functioning (Radif, 1999).

As an active advocate, Global Water Partnership (GWP, 2003) developed an IWRM ToolBox, which aims to be a key reference instrument for the practical application of IWRM. Some other efforts in guiding IWRM with different views have also been made in the last two decades. For example, Savenije and Van der Zaag (2008) suggested that four dimensions need to be considered: water resources, water users, spatial scales and temporal scales (and patterns), in order to make appropriate decisions and arrangements. Rahaman and Varis (2005) have highlighted seven factors (privatization, water as an economic good, trans-boundary river basin management, restoration and ecology, fisheries and aquaculture, need to focus on past IWRM experience and lessons, and spiritual and cultural aspects of water) that are important to successfully implement IWRM. It is believed IWRM can take various forms and is best implemented at the river basin or sub-basin scale (Davis, 2007).

Although many countries have made great efforts in pushing the implementation of IWRM, the overall effect is in question. According to GWP's survey in 2005, about three quarters of all countries are at some stage of introducing IWRM as the guiding principle for water management (GWP, 2006). However, Biswas (2008) argued that its actual use has been minimal, even indiscernible. He further indicated that a few international and national institutions, which actively promoted this concept earlier, have already started to downplay it and the trend is likely to accelerate in the future (Biswas, 2008). Despite

these concerns, IWRM's influence on global water development is beyond doubt. The key concepts emphasized by IWRM, for example, integration, participation, and privatization or decentralization, have had extensive influence. Farmers as a group are the biggest consumptive users of water and hold the biggest water licences in many regions. As a result, their role and cooperation in water resources management is critical in meeting future water needs.

2.3.2 Alberta's Water Strategy and Action Plan

Under Canada's Constitution, responsibility for water allocation in Canada is shared between the provinces/territories and the federal government. The federal government has important constitutional responsibilities relating to fisheries, navigation, trans-boundary flows and Aboriginal peoples. The provinces are owners of the water resources and have wide responsibilities in their day-to-day management (Environment Canada, 2013). When environmental concerns gained public attention in the 1960s, recognizing the need for better environmental management, the federal government passed the *Canada Water Act* in 1970 and created the Department of the Environment in 1971. That Act focuses on water resources and water quality management. Under this act, water management agreements were made with provincial governments.

Canada is a federation and Canadian federalism is characterised by a high degree of decentralisation of authority, especially with respect to natural resources management, including water management (Saunders, 2008). Under the *Canada Water Act*, provinces are mainly responsible for water management in Canada. In recent years, a number of provincial governments have introduced policies, strategies and regulations for the

management of their water resources. The allocation of water is a key concern of modern water management schemes. The systems of water allocation in Canada vary from region-to-region, but they are classified under three frameworks: Prior allocation (or First in Time, First in Right (FIT-FIR)) approach, Common Law of Riparian Rights, and Civil Law (NRTEE, 2010). The Common Law Riparian Rights are effective in the provinces of Ontario, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. It developed before water rights were legislated. Under the Common Law of Riparian Rights, individuals who own or occupy land abutting lakes and rivers have the right to extract water from the natural flow of the water ways adjacent to or through their property, as long as this use left it unchanged in quantity or quality for the use of other and downstream riparian owners. Civil Law is effective only in Québec. Under Civil Law, water is not owned by anyone, but rather its use is common to all. The province therefore has a guardianship role to play to ensure the common good. The prior allocations or First in Time, First in Right (FIT-FIR) system is most widely used in Western Canada. The provinces/territories of British Columbia, Alberta, Saskatchewan, Manitoba, Yukon, Northwest Territories, and Nunavut all follow the FIT-FIR approach. FIT-FIR is based on the principle of prior allocation, which gives the licensee exclusive rights to extract water from water course according to the seniority of the license, which is the day it was issued (NRTEE, 2010).

The application of FIT-FIR can be traced back more than 100 years. In 1882, the region that is now Alberta became a distinct district within the Northwest Territories, where water use was governed by the “riparian rights”. However, “riparian rights” did not allow large-scale irrigation of land that was not adjacent to water sources and therefore

prevented the development of land that was distant from a watercourse (Percy, 2005).

Under influences of the American doctrine of prior appropriation (Percy, 2005), and the 1886 Water Act in the Australian State of Victoria, which vested ownership of water in the crown and then issued licenses to water users (Burchill, 1948), Canada passed the *Northwest Irrigation Act* in 1894. This made changes to the governance and management of water for irrigation and other purposes (Burchill, 1948). The *Northwest Irrigation Act* and its provincial successors provided the foundations of the basic model of prairie water law (Percy, 2005). However, this model has become increasingly complex and unable to cope with problems of emerging water scarcity (Oliver, et al., 2008).

Since the United Nations first environment conference was held in 1972, countries around the world started to re-consider water development and management. Canada, as well, began to consider new forms of water management. The federal government published its *Federal Water Policy* in 1987 (Environment Canada, 1987). The *Federal Water Policy* is a statement of the federal government's philosophy and goals for the nation's freshwater resources and of the proposed ways of achieving them (Environment Canada, 1987). It is regarded as a key federal document on water management (NRTEE, 2010). The overall objective of the policy is to encourage the use of freshwater in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations (Environment Canada, 1987). It has embodied the core idea of sustainable development.

In 1999, Alberta's *Water Act* was proclaimed. This act supports and promotes the conservation and management of water, including its wise allocation and use (Government of Alberta, 2000). Responding to requirements of the *Water Act* for

establishing a framework for water management planning, protecting the aquatic environment, and facing water shortage problems, in November 2003 the Government of Alberta released *Water for life: Alberta's Strategy for Sustainability*. After a few years' working on the strategy, the Alberta Government published *Water for life: a renewal* in 2008 and *Water for life: action plan* in 2009. Under this strategy, three goals were set up: safe, secure drinking water; healthy aquatic ecosystems; and reliable, quality water supplies for a sustainable economy (Government of Alberta, 2003, 2008, 2009). To fulfil the goals of the strategy and to meet the specific targets set out by Albertans, the strategy focuses on three key directions and actions: knowledge and research; partnerships; and water conservation (Government of Alberta, 2003). Knowledge of Alberta's water resources is considered a fundamental preparation for informing decision making and empowering partners. Partnerships are regarded as important to help with achievement of the strategy's goals (Government of Alberta, 2009). Under *Water for Life*, the Government of Alberta will join with stakeholders in three different types of partnerships: Alberta Water Council (AWC), which provides leadership, Watershed Planning and Advisory Councils (WPACs), and the watershed stewardship groups, which are volunteer-based groups or individuals (Government of Alberta, 2003). "Water conservation is a cornerstone of the Water for Life strategy (AWC, 2009: 49)." The strategy targeted a 30% improvement in overall efficiency and productivity of water use by 2015.

The water conserved through increased efficiency or productivity (and thus is "unused" under the current licence) could be used to increase consumptive water use, for reducing withdrawals, or for new economic activity and other purposes. The fate of water

conserved is closely related to water allocation. For example, the issues that emerged in the Balzac' project in Alberta is not just the challenge of water shortage, but also the political uproar over the approval process of water transfer applications. It revealed a deficiency in the corresponding water policies and insufficient understanding of public reactions to water transfers. Alberta Water Council established the Water Allocation Transfer System Upgrade Project Team in order to make recommendations for an improved water allocation transfer system that meets the social and economic needs of all Albertans, while still safeguarding the environment, now and in the future (AWC, 2009). Recommendations are adopted into the renewed strategy and action plan. "Develop and implement an enhanced water rights transfer system that supports sustainable economic development" is one of the key action plans of Alberta's water strategy (Government of Alberta, 2008; 2009). However, the lesson learned from the Balzac project shows that transfers of water rights also relies on wide public support. Based on prior allocation—or the first-in-time, first-in-right (FITFIR) principle, the earliest granted licensees (the "senior" rights holders) have historically and primarily been held by the agricultural sector. Understanding farmers' objectives and the motivations for their behaviours is likely to lead to better policy design and more successful policy implementation (Kuehne and Bjornlund, 2008).

2.4 Agriculture and Irrigators in Alberta

2.4.1 Agriculture and Irrigation

As shown in Table 2-1, worldwide agriculture is the biggest water consuming industry. In Alberta, agriculture is also one of most important industries in the general economy.

According to Agriculture Statistics Yearbook 2009 (AARD, 2010a), Alberta's primary agriculture industry generated \$5.3 billion, which accounted for 2.9 % of Alberta's real gross domestic product in 2008 (AARD, 2010a), somewhat higher than the national level (2.1%) (Statistics Canada, 2010). On an annual basis, Alberta produced about 40% of all the cattle and calves; and 29% of all the wheat in Canada. The value of Alberta agri-food exports in 2007 was \$6.6 billion, which accounted for one-fifth of the national total (\$31.7 billion). Major agri-food exports in 2007 included wheat, canola seed, beef and veal, live cattle, pork, crude canola/mustard oil, and processed potatoes.

In modern society, irrigation is a major method for improving agricultural productivity and crop diversification in the warm, semi-arid regions. In 2010, there were about 1.9 million acres of land that received irrigation across Canada; about 65% of that area was in Alberta (Statistics Canada, 2012). Irrigated agriculture occupies an important place in Alberta's economy. In Alberta, total irrigated area was 1.68 million acres in 2012, which accounts for about 5.25% of the total provincial cultivated land area (AARD, 2013a).

More than 96% of Alberta's irrigated agriculture is located within the South Saskatchewan River and Milk River Basins (AARD, 2013b). Irrigation brought more than 200 million Canadian dollars incremental gross margins in each year in the irrigation districts of Southern Alberta over the years 2004 to 2008 (Klein et al., 2012). It was estimated that irrigation directly and indirectly adds about 35,000 jobs and more than \$940 million dollars a year to the provincial economy (AARD, 2000).

Under the Alberta water management framework, there are two distinct types of irrigators: private irrigators and irrigators within irrigation districts. In 2012, there were 2,894 individual irrigation projects, irrigating approximately 312,230 acres (AARD, 2013b).

These projects were originally established under the first-in-time, first-in-right principle, which ensures that during times of water shortage, water is allocated to senior over junior license holders. According to *Alberta Irrigation Information 2012*, the private irrigation projects vary in size from one acre to several thousand acres of agricultural or horticultural production and about four-fifths of them are located in the South Saskatchewan River Basin. The majority of Alberta' irrigators operate within the thirteen irrigation districts. Irrigation districts are producer cooperatives that manage irrigation infrastructure to ensure water is available for members (Bjornlund et al., 2012). Alberta has 13 irrigation districts, all of which are located in the South Saskatchewan River Basin. More than one million acres of land can receive irrigation water through the operations of the districts. Each irrigation district operates independently and the sizes vary significantly. In 2012, St. Mary River Irrigation District had 373,835 acres on their assessment roll while the Ross Creek Irrigation District had only 1101 acres (AARD, 2013b). Irrigation districts, on behalf of their irrigators, manage the infrastructure and oversee the distribution of the licensed volume of water to the registered irrigators (Nicol and Klein, 2006). Irrigators within districts do not hold water licenses themselves; instead the irrigation districts hold the water licenses.

In Alberta, water diversions are managed primarily through a system of water licences issued by Alberta Environment under the *Water Act*. Water allocation is the maximum amount of water that a user can legally take from a water source, and does not directly reflect actual use or consumption of water. The total withdrawal over the year cannot exceed the volume of water specified in a licence. In 2009, total water allocation in the province was 9.89 billion m³, 9.59 billion m³ from surface water and 0.3 billion m³ from

groundwater (Alberta Environment, 2010). Of that, 42.5% was allocated for agriculture and irrigation (Alberta Environment, 2010). The proportion varied among the river basins. In the Bow River Sub basin, where irrigation is most prevalent, 73% of the total allocation of water was used for irrigation in 2009 (Alberta Environment, 2010). The total water demand for irrigation varies from year-to-year depending on temperature and precipitation. In 2012, about half of the licenced allocations were actually diverted from a lake or the river system by the 13 districts (AARD, 2013b).

2.4.2 Farmers and Irrigation Practices

According to the *2011 Census of Agriculture* (AARD, 2013a), Alberta has 43,234 farms run by 62,050 farm operators in 2010. Farm operators averaged 54.5 years of age.

Compared with 2001, as average farm operator age rose in every province across Canada, and has grown 9.2% from an average age of 49.9 over the past decade; this trend is continuing. Among the farm operators, 44,075 (71%) are males while 17,925 (29%) are females. However, farm women's contributions to their farm have been argued to be 'invisible', under-valued, and unrecognized in agricultural statistics (Alston, 1995; Gasson, 1992; Kubik, 2005). It is believed that most farmers' wives are involved in the farm business in some capacity (Gasson, 1992). In Alberta, about 39% of all farms are run by a single operator. Among the farm operators from one-operator farms, the overwhelming majority (91.5%) are males while those from two or more operator farms are relatively balanced in gender with 57.1% males. Tracking the historical data, the number of farms continues to decline and the number of farm operators also tends to slightly decline.

There were 3,027 farms with irrigated land in Alberta in 2010 (Statistics Canada, 2012). Cereals and forages are the primary irrigated crops in Alberta, which make up two-thirds of the total irrigated area (AARD, 2013b). The irrigated area of cereals has increased by more than 8% in the past decade from 397,162 acres of 2002 whereas the irrigated area of forages has decreased dramatically in the past decade from 669,550 acres in 2002 to 473,073 acres in 2011 (AARD, 2009; 2012). The top four crops grown in the irrigation districts in 2011 were hard spring wheat, canola, barley, and tame pasture, which accounted for about 15%, 12%, 9%, and 7%, respectively, of the total district irrigated land (AARD, 2012).

Water use efficiency differs depending on the on-farm irrigation systems used. It is believed that the water use efficiency of a traditional gravity irrigation system is only about 40-60%, while sprinkler irrigation systems are around 70-85% and drip irrigation system efficiency can be as high as 90-95% (Caswell and Zilberman, 1985; Seckler, 1996). According to the national agricultural water surveys, about 90% farms that had irrigation practices in Alberta used sprinkler irrigation systems in 2012 (Statistics Canada, 2013b). Sprinkler irrigation systems are subdivided into wheel-move, high pressure and low pressure sprinklers; the values of water use efficiency range from 60-85%, 75-90% and 75-95%, respectively (Harms, 2011). Within the irrigation districts, which occupies about four-fifths of provincial irrigated land, the low pressure centre pivot sprinkler system has become the dominant on-farm irrigation system and was used on 66% of irrigated land in Alberta in 2012 (AARD, 2013b). In Alberta, on-farm irrigation efficiency was about 78% in 2012, which was about 43% higher than the average world irrigation efficiency (AARD, 2014).

The rates of adoption of improved technologies and management practices in Southern Alberta tend to be quite variable. For example, in 2012, the proportion of land being irrigated with low pressure centre pivot sprinkler systems was 83.6% in the St. Mary River Irrigation District (SMRID) and 0% in the Mountain View Irrigation District (MVID); instead, the proportion of land being irrigated with gravity system was 2.1% in SMRID and 86.1% in MVID (AARD, 2013b). It is believed that gravity irrigation is now used most often on smaller farms and where lower-value crops are being irrigated (AARD, 2000), or where the land condition does not fit centre pivot system. Gravity irrigation in Alberta has been constantly reduced. The proportion of farms still using gravity irrigation fell significantly from about 29% in 2010 (Statistics Canada, 2013a) to 21%¹ in 2012 (Statistics Canada, 2013b). However, the proportion of acres still using gravity irrigation decreased only about a half percent each year over the years 1999 to 2012 (AARD, 2010b; 2011; 2012; 2013b). Improving on-farm irrigation technologies is likely to continue by replacement of less efficient irrigation systems with low-pressure, drop-tube pivot systems in Alberta (AARD, 2014). As the adoption of irrigation methods varies in locations, some districts might have little room to improve irrigation technologies and increase water use irrigation efficiency. A study in two irrigation districts in Alberta found that the adoption of more efficient irrigation technologies was mostly exhausted in one district (Taber): most irrigators in that district believed that they had made all the improvements that were feasible under current economic conditions (Bjornlund et al., 2009).

¹ A farm might have more than one irrigation method. Farms that use flood irrigation might use other irrigation method simultaneously.

Alberta irrigators pay a flat fee per acre for administration costs and some rehabilitation of infrastructure rather than a fee per volume used. The current rate varies by irrigation district from \$0 to about \$20.50 per acre plus \$0.10 to \$0.30 per acre (per psi) for pipeline surcharges in some irrigation districts (AARD, 2013b). Some irrigation districts levy an additional surcharge as a penalty for water consumption in excess of the annual allocation. Based on Alberta Irrigation Information (AARD, 2012), both St. Mary and Raymond Irrigation Districts charge \$100 per acre inch, i.e. \$0.972 per cubic metre for water use over the annual allocation, while the surcharge in Taber Irrigation District is \$50 per acre inch, i.e. \$0.486 per cubic metre. In the Lethbridge Northern Irrigation District, the surcharge is \$5 per acre inch, i.e. \$0.049 per cubic metre. Some other irrigation districts levy additional surcharges based on piped or pressurised water supply. Under the current water pricing mechanism, saving water is not a driving factor for the adoption of new irrigation technologies in southern Alberta, even though the adoption of modern irrigation technologies could lead to water saving. A survey from Southern Alberta showed that only 9% of irrigators rank reducing water use as the most important reason for adopting new irrigation technologies; the majority of irrigators reported the most important reasons for adopting new technologies were to increase yield and quality of crops and to save energy and/or labour costs (Nicol et al., 2008).

Generally speaking, on-farm irrigation efficiency in Alberta is relatively high, and more efficient irrigation systems are still pushing to replace gravity, wheel move, and lower efficiency high pressure centre pivot irrigation systems (AARD, 2014), though, the room for continued improvement gets smaller all the time. Bjornlund et al. (2009) argued that the objective of a 30% increase in efficiency of water use anticipated in Alberta's Water

for Life strategy is unlikely to be achieved by on-farm improvements in the short term. On the other hand, the current Alberta water pricing mechanism has no influence on saving water. Considering this reality, it is crucial to rethink farmers' intentions and willingness to adopt improved water management practices.

2.5 Summary

With the growth in population and economic development, the demand for water is continually increasing. Water shortages have become a severe worldwide concern. Although Canada is well-known for its abundance of water, the existing water supplies are unevenly distributed throughout the country. As one of the Prairie Provinces, Alberta, especially the southern part of the province, is also facing chronic water problems. The main water supplies in Alberta are not located where the demand exists.

When environmental concerns came to the attention of the public in the 1960s, policy makers began to re-consider water development and management. Integrated Water Resources Management (IWRM) has been widely accepted in implementation of sustainable water policy. While the government of Canada initiated programmes with objectives of improving national sustainability, the Alberta Government also started working on its water strategy. *Water for life: Alberta's strategy for sustainability* in 2003, *Water for life: a renewal* in 2008, and *Water for life: action plan* in 2009 were published by the Government of Alberta. The goals of these strategies were: safe, secure drinking water; healthy aquatic ecosystems; and reliable, quality water supplies for a sustainable economy (Government of Alberta, 2003, 2008, 2009). In order to achieve the goals, a set of action plans were released, two of which stated: "develop and implement conservation,

efficiency, and productivity plans” that targets “a 30% improvement in overall efficiency and productivity of water use by 2015” and “develop and implement an enhanced water rights transfer system that supports sustainable economic development”.

As a group of the biggest water consumptive users and the biggest water licence holders, farmers’ role and cooperation in water resources management is critical in meeting future water needs. In Alberta, agriculture is an important industry and includes about two-thirds of all irrigation agriculture in Canada. With the growth in population and economic development, the demand for water in Alberta is continually increasing. Satisfying new demands requires water to be transferred from farmers who have historically secure rights. The export of water out of rural areas relies on farmers’ support and participation. In order to advance an enhanced water rights transfer system, understanding farmers’ behaviour and predicting their reactions is becoming an urgent priority.

Improving overall efficiency and productivity of water use in irrigation is expected to result in water savings in the irrigation sector, and enable the transfer of water out of irrigation without affecting overall production. However, on-farm irrigation efficiency in Alberta is not only already relatively high, but under current water pricing regimes, water saving is not a major objective of farmers’ adoption of improved irrigation technologies. Neglecting farmers’ intentions and willingness to adopt improved water management practices may lead to failure of policy implementation.

Chapter Three Factors that Influence Farmers' Behaviour and Behavioural Intentions towards Water Policy Changes

3.1 Introduction

It has been widely noted that values and attitudes play an important role in understanding and predicting human behaviour and behavioural intentions. Several theories and models related to values, attitudes, and behaviour have been developed as core concepts in psychology. Although values also are deeply rooted in the origins of classical theories of sociology and economics, the concept of values has gone in and out of fashion within them over the past decades (Bruni and Sugden, 2007; Hitlin and Piliavin, 2004; Spates, 1983). In recent decades, efforts have been made to bring values back into sociology (e.g., Hitlin and Piliavin, 2004; Spates, 1983) and economics research (e.g., Bruni and Sugden, 2007). Meanwhile, psychologists also have broadened their research to extend the area of social backgrounds. For example, Ajzen and Fishbein (2005) redefined the theories of reasoned action and planned behaviour by adding background factors. More empirical research on behaviour has been conducted from interdisciplinary perspectives.

The present study aims to uncover factors that influence farmers' responses to water policy reforms, and further develop structural models to understand the role of psychological, socio-demographic, and economic context variables on farmers' behavioural intentions. This chapter provides a literature review of previous research and theory related to the topic of this study.

First, this chapter reviews the concepts of values. Values are principles that guide individuals' lives. The definition and measurement of values are discussed in this chapter.

Rokeach's List of Values and Schwartz's List of Value Types are highlighted. Schwartz's Value Theory has not only answered questions regarding what is the value but, more importantly, it has answered what is the existing pattern of values.

Second, this chapter reviews the relationship between values, attitudes, and behaviour. Attitude is another core psychological concept, which plays an important role in influencing behaviour and behavioural intentions. The definition and measurement of attitudes, the Theory of Reasoned Action (TRA) and its extension, the Theory of Planned Behaviour (TPB), and the theory of Value-Attitude-Behaviour Hierarchy are discussed in detail.

Third, following the literature review on psychological core concepts of values and attitudes and their influences on behavioural intentions and behaviour, the influence of the background factors, sometimes called social structures, social contexts on values, attitudes, and behaviour are discussed. This section focuses especially on the influences of socio-demographic factors and past behaviour.

Fourth, focusing on the aims of this study, the literature related to farmers' behaviour, especially the studies of farmers' responses to projected changes to water policies are reviewed. Farmers' behaviour and behavioural intentions are believed to be more complex; thus more determinants need to be considered. The studies of influences of farmers' household and farm business characteristics are demonstrated in many existing studies on farmers.

Finally, this chapter provides a brief summary of this research literature. It indicates there is an urgent need for comprehensively understanding farmers' behaviour, especially their

behavioural intentions to possible water policy changes. The present study therefore is of significant importance to policy makers in Alberta, and elsewhere, who need to make decisions regarding water management issues.

3.2 Values as Principles that Guide Individuals' Lives

It has been widely noted that values and attitudes have effects on behaviour and behavioural intentions. It is well accepted that values occupy a more central position; they are more abstract and more stable; and are standards that guide one's attitudes, actions, and all aspects of one's life (Reich and Adcock, 1976). To study farmers' attitudes and behaviour, there is no doubt that farmers' values need to be understood first.

3.2.1 Definitions of Values

A growing number of scholars have explored the nature of the self and the individual's relationship to society. However, the term "values (or value)" takes many forms (Hechter et al., 1993). It seems that scholars from different fields have had a tendency to develop their own concepts (Sherif, 1936; Elfrink and Coldwell, 1993) and there seems to be little coherence among the different approaches (Hitlin and Piliavin, 2004). Therefore, not surprisingly, many non-economists' work on values begins with a discussion of the problems caused by the many meanings (Brown, 1984). Hechter et al. (1993) have summarized that, in biology, values can be constructed as the products of instincts and drives that help channel the organism's motility; in psychology, values are the motives for action, and as such, ultimately determine the specific consequences of known reinforcers; in economics, values, generally known as utilities and/or preferences, are one

of two fundamental determinants of decision making; and in sociology and anthropology, they are considered to be basic determinants of social action.

Dietz et al. (2005) suggest that we use values in everyday language by three senses: what something is worth, opinions about that worth, and moral principles (Dietz et al., 2005).

Values are so important in understanding human behaviour that the researches on these domains trace back over the last two centuries. Among the numerous scholars who contributed to value theory, American anthropologist Clyde Kluckhohn developed an outstanding position in the conceptualization of value. He is regarded as the first person who gave a systematic definition of the term 'value', and his definition is believed to be the primary orienting definition in sociology (Spates, 1983). Building on Parsons' theory of action, Kluckhohn developed his definition of value:

“A value is a conception, explicit or implicit, distinctive of an individual or characteristic of a group, of the desirable which influences the selection from available modes, means, and ends of action (Kluckhohn, 1951, p395)”.

Another influential contributor to the theory of values is American social psychologist Milton Rokeach. Rokeach is regarded as the individual whose innovative contributions are usually given major credit for significantly increasing our understanding of values and providing a much needed impetus for values research from the late 1960s (Mayton et al., 1994) . His book on *The Nature of Human Values* (1973) is widely cited by authors of values' studies (e.g., Bardi and Schwartz, 2003; Brown, 1984; Clawson and Vinson, 1978; Dietz et al., 2005; Garforth and Rehman, 2005; Grube et al., 1994; Hitlin and Piliavin, 2004; Karp, 1996; Lynne et al., 1988; Maio et al., 2006; Olson and Zanna, 1993; Poortinga et al., 2004; Reich and Adcock, 1976; Roccas and Sagiv, 2010; Schwartz, 1992;

Schwartz and Bilsky, 1987; Spates, 1983; Stern and Dietz, 1994; Stern et al., 1995).

Rokeach (1968) believes that a value is a standard or criterion that tells us how to act or what to want; what attitudes we should hold. Based on our values, we justify behaviour, morally judge, and compare ourselves with others, tell us which values, attitudes, and actions of others are worth or not worth trying to influence. His well-known definition of values is:

“A value is an enduring belief that specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence (Rokeach, 1973, p5)”.

Unlike Kluckhohn, who emphasized action, Rokeach saw values as giving meaning to action (Hitlin and Piliavin, 2004). Rokeach saw values as standards of “oughts” and “shoulds,” and as central aspects of the self-concept (Feather, 1992).

In the most recent two decades, Israeli social psychologist Shalom Schwartz has become the most influential scholar in the domain of values’ research. Building on a review of a large number of definitions of values, Schwartz and Bilsky (1987) summarized five common features for most definitions:

“Values are (a) concepts or beliefs, (b) about desirable end states or behaviors, (c) that transcend specific situations, (d) guide selection or evaluation of behavior and events, and (e) are ordered by relative importance (Schwartz and Bilsky, 1987, p551)”.

After a few years working on values trying to resolve the issue of classifying contents of values, Schwartz (1994) developed a newly modified definition:

Values are “desirable transsituational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity (Schwartz, 1994, p21)”.

As Schwartz and Sagiv (1995) claimed, this definition incorporated both the Kluckhohn (1951) and Rokeach (1973) definitions. However, Schwartz and his colleagues focused on the motivational goal embodied by each value type, the implications of priorities on one value type for priorities on others within an integrated system (Rohan, 2000).

Although there is no consensual definition of values (Hechter, 1993), the definitions are conceptually similar, and they all seem to center on a means or a method for making decisions in one’s life (Elfrink and Coldwell, 1993). Cheng and Fleischmann (2010) enumerated the above three and four other widely-used definitions (Braithwaite and Blamey, 1988; Friedman et al., 2006; Guth and Tagiuri, 1965; Hutcheon, 1972; Kluckhorn, 1951; Rokeach, 1973; Schwartz, 1994), and summarized that “values serve as guiding principles of what people consider important in life (Cheng and Fleischmann, 2010, p9).”

3.2.2 Measurement of Values

To understand how values influence people, the first thing is to know what values people possess. As with measuring many other social psychological concepts, it is not an easy task to measure values that people hold. As Hitlin and Piliavin (2004) argue, there is a distinct lack of standardization across theoretical and empirical research. Perhaps because of that, many researchers have tried to understand structure and classification of values. Since values are abstract criteria and can only be approached indirectly through observed behaviour or verbal responses (Gasson, 1973), they often are assessed by asking people

to rank or rate the importance of their values. Ranking or rating of given values are two predominant ways of measuring values. Among the numerous value studies, the two most influential and commonly used value measurement instruments were created by Rokeach (1968; 1973) and Schwartz (Schwartz and Bilsky, 1987; Schwartz, 1992).

Rokeach's List of Values

Rokeach's (1968; 1973) Value Survey (RVS) has been recognized as the original empirical work that has been not only a major value measurement instrument in academic and nonacademic research (Mayton et al., 1994), but also has become a basis of many other value measurement instruments. For example, Kahle's (1983) List of Values is similar to the terminal value list of the RVS, but is shorter and easier to administer (McCarty and Shrum, 1994); Schwartz's (1992) Value Survey (SVS) originally presented values in two lists that followed Rokeach's idea, though this distinction has been believed to be of no substantive importance in his following studies (Schwartz, 1992).

Rokeach views values as relating to preferable "modes of conduct (behaviour)" and "end-states of existence," what he calls "instrumental" and "terminal" values (Rokeach, 1968; Munson and McIntyre, 1979). The basic idea of RVS is to ask respondents to rank 18 instrumental values (ideal modes of behaviour) and 18 terminal values (ideal end states of existence) in order of importance as guiding principles in their lives. Any difference in people's values will show up by the difference of rank they assign to the same thirty-six values (Reich and Adcock, 1976). Table 3-1 shows Rokeach's List of Values.

Table 3- 1 Rokeach's List of Values

Terminal values	Instrumental values
A comfortable life (a prosperous life)	Ambitious (hard-working, aspiring)
An exciting life (a stimulating, active life)	Broadminded (open-minded)
A sense of accomplishment (lasting contribution)	Capable (competent, effective)
A world at peace (free of war and conflict)	Cheerful (lighthearted, joyful)
A world of beauty (beauty of nature and the arts)	Clean (neat, tidy)
Equality (brotherhood, equal opportunity for all)	Courageous (standing up for your beliefs)
Family security (taking care of loved ones)	Forgiving (willing to pardon others)
Freedom (independence, free choice)	Helpful (working for the welfare of others)
Happiness (contentedness)	Honest (sincere, truthful)
Inner harmony (freedom from inner conflict)	Imaginative (daring, creative)
Mature love (sexual and spiritual intimacy)	Independent (self-reliant, self-sufficient)
National security (protection from attack)	Intellectual (intelligent, reflective)
Pleasure (an enjoyable, leisurely life)	Logical (consistent, rational)
Salvation (saved, eternal life)	Loving (affectionate, tender)
Self respect (self-esteem)	Obedient (dutiful, respectful)
Social recognition (respect, admiration)	Polite (courteous, well-mannered)
True friendship (close companionship)	Responsible (dependable, reliable)
Wisdom (a mature understanding of life)	Self controlled (restrained, self-discipline)

Resource: Rokeach, M. (1968), p554.

Rankings are often viewed as conceptually more appropriate for value measurement (Rokeach, 1973) but also as relatively difficult for respondents (Rokeach, 1973). Rokeach (1973) found that individuals have a difficult time ranking eighteen values. This difficulty increases significantly when the number of items to be ranked is more than four or five (Sudman and Bradburn, 1983; McCarty and Shrum, 2000). Rokeach (1973) also noticed that respondents rank their more extreme values more reliably than the middle values. Moreover, since rankings often require the use of visual aids, or "show-cards," it is extremely difficult to gather such information using telephone survey methods (Alwin and Krosnick, 1985; Groves and Kahn, 1979; McCarty and Shrum, 2000; Sudman and Bradburn 1983).

Although the outstanding position of RVS is beyond doubt, as Rokeach (1973) noted, his selection of values' list was rather arbitrary, so predictions and explanations based on it have been criticised as typically *ad hoc* (Schwartz, 2003). Not only that, Braithwaite and Law (1985) identified four omissions in Rokeach's List of Values: values relating to "physical development and well-being (e.g., physical fitness, good health)," "individual rights (e.g., privacy, dignity)," "thriftiness (e.g., care with money, taking advantage of opportunities)," and "carefreeness (acting on impulse, spontaneity)" (Rohan, 2000). Also, "it leaves out critical content (e.g., tradition and power values)" (Schwartz, 2003).

Schwartz's List of Value Types

In the two most recent decades, Schwartz has become the most influential scholar in researching values. Schwartz's Value Survey (SVS) provides the most commonly used

measures of values (Dietz et al., 2005) and has been translated into 47 languages (Schwartz, 2006a).

Followed Rokeach's (1973) idea of ends, values and means values function, SVS presents two lists of value items differently: the first contains 30 items that describe potentially desirable end-states in noun form; the second contains 26 or 27 items that describe potentially desirable ways of acting in adjective form (noted by Schwartz (2006a) though small changes were made in the SVS list from the 1988 version to the 1994 version). Each item expresses an aspect of the motivational goal of one value (Schwartz, 1992, 1994, 2006a). The original 56 value items and their definitions can be found in the Appendix of Schwartz's (1992) study. Among them, 21 are identical to those in the Rokeach lists (Schwartz, 1992). The procedure of SVS is to ask respondents to rate the importance of each value item as a guiding principle in their life on a nine-point scale. Ratings are easier to administer and less difficult for respondents (Munson and McIntyre, 1979). However, when respondents are given a set of values to evaluate in terms of their importance, many do not differentiate greatly among the various values, which is called end-piling of ratings, and that can severely limit the usefulness of the data, making it difficult for a researcher to ascertain which values are actually important to each respondent (McCarty and Shrum, 2000).

Schwartz's Value Theory emphasises values as desirable, transsituational goals, varying in importance, that serve as guiding principles in people's lives. They have derived 10 motivationally distinct types of values intended to be comprehensive of the core values recognized in cultures around the world from universal requirements of the human condition (Schwartz and Bardi, 2001). Each is characterized by describing its central

motivational goal. Table 3-2 shows the lists of Schwartz's value types and the corresponding values. Moreover, the Schwartz Values Theory explicates a structural aspect of values, namely, the dynamic relationships among them (Schwartz, 2006b). The circular structure in Figure 3-1 portrays the total pattern of Schwartz's values system. Ten types of values with representative values are clustered in two orthogonal dimensions: one is called *Self-enhancement* vs. *Self-transcendence*, and the other is called *Openness to change* vs. *Conservation*. The former relates to *Power* and *Achievement* values that oppose *Universalism* and *Benevolence* values; the latter relates to *Self-direction* and *Stimulation* values that oppose *Security*, *Conformity* and *Tradition* values; *Hedonism* shares elements of both *Openness* and *Self-enhancement* (Schwartz, 2006b). As Schwartz (2006b) points out, the closer any two values in either direction around the circle, the more similar their underlying motivations; the more distant any two values, the more antagonistic their underlying motivations.

This value structure has been shown by Schwartz and his collaborators in cross-culture and cross-nation sample groups around the world (e.g., Bardi and Schwartz, 2003; Schwartz, 1992; 1994; Schwartz and Bardi, 2001; Schwartz and Sagie, 2000; Schwartz and Sagiv, 1995), and supported by some cross-cultural studies (e.g., Spini, 2003; Oishi et al., 1998). It seems that people may differ substantially in the rank of the ten basic types of values, but the same structure of motivational oppositions and compatibilities apparently organizes their values (Schwartz, 2006b). Although Schwartz's value system is widely cited and implicated, literature that disputes it is hard to find.

Table 3- 2 Schwartz's List of Value Types and Corresponding Values

Type	Definition	Value
Self-direction	Independent thought and action (choosing, creating, exploring)	Creativity, Freedom, Independent, Curious, Choosing own goals
Stimulation	Excitement, novelty, and challenge in life	Daring, A varied life, An exciting life
Hedonism	Pleasure and sensuous gratification for oneself	Pleasure, Enjoying life
Achievement	Personal success through demonstrating competence according to social standards	Successful, Capable, Ambitious, Influential
Power	Social status and prestige, control or dominance over people and resources	Social power, Authority, Wealth
Security	Safety, harmony, and stability of society, relationships, and self	Family security, National security, Social order, Clean, Reciprocation of favours
Conformity	Restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms	Self-discipline, Obedient, Politeness, Honouring parents and elders
Tradition	Respect, commitment, and acceptance of the customs and ideas that traditional culture or religion provide	Accepting one's portion in life, Humble, Devout, Respect for tradition, Moderate
Benevolence	Preservation and enhancement of the welfare of people with whom one is in frequent personal contact	Helpful, Honest, Forgiving, Loyal, Responsible
Universalism	Understanding, appreciation, tolerance, and protection for the welfare of all people and for nature	Broadminded, Wisdom, Social justice, Equality, A world at peace, A world of beauty, Unity with nature, Protecting the environment

Source: Schwartz, S. H. and G. Sagie (2000), p468.

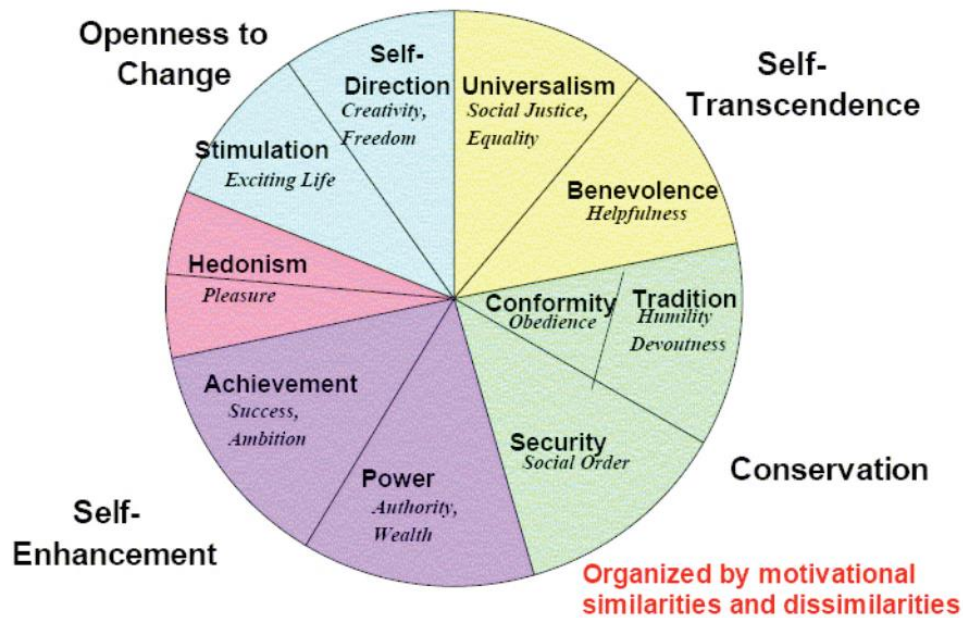


Figure 3- 1 Schwartz's model of relations among ten types of values

(From: Schwartz (2006b, p3.)

Rokeach's List or Schwartz's List

Comparing Rokeach's List with Schwartz's List, the latter has two advantages.

First of all, Schwartz's Value List is a relatively exhaustive list. It was built on Rokeach's List and inherited Rokeach's idea. However, from the perspective of this study, the main advantage of Schwartz's Value List is not so much that it has more items than Rokeach's, but more importantly that it includes more value items that are directed towards the environment, such as *Protecting the Environment* and *Unity with Nature*, which are more important for farmer and environmental studies. There is no other group of people who

are closer to nature than farmers. Farmers are believed to be the biggest group of natural resource managers on the earth (FAO, 2007). Farming practices are directly interact with the environment. Therefore, using Schwartz's value list might be a better choice for studying farmers' behaviour and behavioural intentions.

Second, Schwartz's Value Theory provides the existing pattern of values. It has greatly enhanced people's comprehension of values and provided a general principle for understanding the dynamic relationship among different types of values. For example, three values related to nature, *Unity with Nature*, *Protecting the Environment*, and *A World of Beauty* belong to *Universalism*. According to Schwartz's Value Theory, *Universalism* is close to *Benevolence* and *Self-direction*. When farmers' values related to nature are explored, it is important to also be attentive to the value items of *Creativity*, *Freedom*, *Independent*, *Curious*, *Choosing own goals*, which belong to *Self-direction*, and the value items of *Helpful*, *Honest*, *Forgiving*, *Loyal*, *Responsible*, which belong to *Benevolence*. Meanwhile, it also needs to be noticed the values of *Social Power*, *Authority*, *Wealth*, which belong to *Power*, and the value items of *Successful*, *Capable*, *Ambitious*, and *Influential*, which belong to *Achievement*, since they are in conflict with values that are related to nature (see Figure 3-1). If a farmer highly values *wealth* and *success*, he/she might care less about nature. If a farmer highly values *freedom* and *independent*, he/she might also care more about nature.

Considering the strengths of Schwartz's List, and using his approach, provides a better understanding for farmers' values, and therefore, insights into farmers' water policy responses.

3.3 The Value-Attitude-Behaviour Hierarchy

3.3.1 Attitudes and Attitude Measurement

Attitude also has been a long standing core concept (Allport, 1935) and is of continued importance to (social) psychology (Bohner and Dickel, 2011). Throughout the twentieth century, attitude has drawn a tremendous amount of attention in social science research (Eaton and Visser, 2008; Kraus, 1995). This is continuing. Despite the long history of research on attitudes, like values, hundreds of definitions exist and none is universally agreed-upon. Allport (1935, p 810) defined an attitude as “a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related”. Rokeach (1966, p530) defined an attitude as “a relatively enduring organization of beliefs about an object or situation predisposing one to respond in some preferential manner”. Fishbein and Ajzen (1975, p6) defined an attitude as “a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object”. Eagly and Chaiken (1993, p1) defined an attitude as “a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour”. Among the hundreds of definitions noted by Eagly and Chaiken (1993), theirs is regarded as the most conventional and contemporary definition (Albarracin et al., 2005).

Similarly, since attitude is a psychological tendency, it is not directly observable. If people want to know a person's attitudes, they have to find some other way of assessing them (Bohner and Wänke, 2002). Two excellent summaries of attitude measurement

methods and techniques can be found in *The Handbook of Attitudes* (Albarracin et al., 2005) and *The Psychology of Attitudes* (Eagly and Chaiken, 1993).

To measure attitudes, researchers have long been using self-report scales, which ask a respondent to directly evaluate an attitude object by checking a numeric response to single or multiple items (Bohner and Dickel, 2011; Himmelfarb, 1993). The classic direct self-report methods include Thurstone's (1928) Equal-Appearing Intervals Method, Likert's (1932) Method of Summated Ratings, and Osgood, Suci, and Tannenbaum's (1957) Semantic Differential. The rationale behind self-report scales of attitudes is that people are both willing and able to accurately report their attitudes; however, these conditions are not always met (Krosnick et al., 2005).

A variety of implicit attitude measures have been introduced over the past two decades (Fazio and Olson, 2003) and become popular in recent years (Bohner and Dickel, 2011; Krosnick et al., 2005). The implicit measurement approaches seek to provide an estimate of the construct of interest without having to directly ask the participant for a verbal report. One of the most well-known and popular implicit measurement techniques (Bohner and Dickel, 2011; Fazio and Olson, 2003; Krosnick et al., 2005) is the Implicit Association Test (IAT), which was developed by Greenwald et al. (1998). The IAT procedure seeks to measure implicit attitudes by measuring their underlying automatic evaluation (Greenwald et al., 1998). In an IAT, participants repeatedly press left or right-hand keys to sort stimuli (e.g., first names and adjectives) into dichotomous target categories (e.g., male-female) and evaluative categories (e.g., positive-negative), and the response time difference between the two critical blocks is used as an indicator of automatic evaluation (Bohner and Dickel, 2011; Greenwald et al., 1998; Krosnick et al.,

2005). This approach has been used for investigating attitudes in a broad variety of domains, including attitudes toward race and gender groups, violence among criminal offenders, the use of contraception during intercourse, and alcohol consumption (Krosnick et al., 2005). Two modified versions of the Implicit Association Test (IAT), the Go/No-go Association Task (GNAT; Nosek and Banaji, 2001) and the Extrinsic Affective Simon Task (EAST, De Houwer, 2003) have been proposed and employed in recent years.

Implicit measurement approaches are likely to be free of social desirability concerns (Fazio and Olson, 2003). Manuscripts using self-report measurement often receive critical reviews (Chan, 2009). However, self-report measurement remains the most popular choice (Paulhus and Vazire, 2007). Paulhus and Vazire (2007) argue that self-report data is rarely a serious problem in most research settings, and overall, is more effective than any alternative. The self-report method has persuasive advantages: easy interpretability, richness of information, motivation to report, causal force, and sheer practicality (Paulhus and Vazire, 2007). In some situations, using self-report data is appropriate, or even most appropriate (Chan, 2009). When a researcher is interested in self-efficacy, self-report is a must by nature; and in personality-related concepts, such as well-being, values, personal projects and life goals, self-report is the best method to obtain the data (Paulhus and Vazire, 2007).

3.3.2 Values and Attitudes

Values and attitudes are related; they are not synonymous (Reich and Adcock, 1976). Rokeach (1968) believed that attitudes and values differ from one another in three

important respects. First, a value transcends specific objects and situations, while an attitude focuses directly on specific objects and situations; second, a value, unlike an attitude, is a standard or yardstick guiding not only attitudes, but also actions, comparisons, evaluations, and justifications of self and others; third, a value, unlike an attitude, is a distinct preference for a specified mode of behaviour or for a specified end-state of existence.

Several studies involved discussions on the distinctions between the general concepts of values and attitudes (e.g., Maio and Olson, 1995; Olson and Zanna, 1993; Reich and Adcock, 1976; Rokeach, 1968). Reich and Adcock (1976) provided a clarification of these two concepts in their book *Value, Attitudes and Behaviour Change*. They assumed that one of the well-accepted distinctions is that values occupy a more central position than do attitudes (Reich and Adcock, 1976). Perhaps for this reason, values are not concerned with specific objects or persons. Rather, they are more abstract and stable; they provide some standards to guide one's attitudes, actions, and all aspects of one's life. Reich and Adcock (1976) demonstrated how people's values affect their attitudes by using honesty as an example. If one values honesty highly, then one's attempts and achievements to be honest affect positively one's self-evaluation and that person has a negative attitude towards one who consistently tells lies (Reich and Adcock, 1976). Similarly, if one values economic development highly, one may be especially likely to accept information suggesting that environmental protection will compromise economic goals; or if one values a world of beauty highly, one might accept information that supports a belief that any environmental change is a dire threat to that value (Stern and Dietz, 1994).

Values are less specific. They can be numbered in the dozens. For instance, Rokeach lists 36 values (Rokeach, 1968) and Schwartz provides categories for ten types of values (Schwartz, 1992). Because attitudes are about “a (given) object” (Rokeach, 1966; Fishbein and Ajzen, 1975), and “a particular entity” (Eagly and Chaiken, 1993), a person may have thousands or even hundreds of thousands of attitudes (Grube et al., 1994). A number of attitudes can be associated with one value (Reich and Adcock, 1976). For example, if a person puts a high value on a world at peace, s/he can have a number of attitudes that would cluster round this central value (Reich and Adcock, 1976). On the other hand, attitudes of a group of people can be associated with two or more values (Reich and Adcock, 1976). Stern and Dietz (1994) argue that attitudes of concern about environmental issues are based on a person's more general set of values and that one attitude therefore may be the outcome that a person gets after weighing a couple of values.

Values are more stable than attitudes. As values are not concerned with specific objects, they are more abstract. Reich and Adcock (1976) state that if this is so then values are perhaps more central, more deeply attached to the person's personality structure, and therefore should be more difficult to change. Stern et al. (1995) also presume values are more stable. They see values as being shaped largely by pre-adult socialization and, compared with attitudes, relatively resistant to being reshaped by information (Stern et al., 1995). Maio and Olson (1998) see values as truisms; they assume values are learned in an absolute manner—people are taught to accept values without question. Grube et al. (1994) postulate that value changes lead to widespread changes in functionally related values, attitudes, and behaviour. If these are true, it is not surprising that it is difficult for people to change their values. Rokeach and Ball-Rokeach's (1989) study on American value

priorities demonstrated the high degree of stability in an American value system as a whole. They suggest that there has been little, if any, value change occurring in American society, at least over the 13-year period under consideration.

Values are potential determinants of attitudes. According to the definition, values serve as standards, as principles that guide one's life. From this point of view, values are viewed as potential determinants of preferences and attitudes (Olson and Zanna, 1993). Attitudes and behaviour can be seen as outcomes of value orientations (Reich and Adcock, 1976).

Values have been shown to predict environmental attitudes (Schultz and Zelezny, 1999), attitude formation towards new or emerging attitude objects and specifically emerging attitude objects within the environmental field (Thøgersen and Grunert-Beckmann, 1997).

However, a review of past research has indicated that relations between values and various attitudes are often weak (Kristiansen and Hotte, 1996; Maio and Olson, 1995).

Some scholars (Kristiansen and Zanna, 1988; Maio and Olson, 1994, 1995) have clarified the relation between values and attitudes from the point of view of attitude functions.

Maio and Olson (1994, 1995) believe that values have significant relationships to attitudes only when people form attitudes specially aimed at expressing values, otherwise values will have weak or negligible relationships to attitudes.

One additional distinction between the two concepts is also demonstrated by Reich and Adcock (1976). They state that one can speak of degrees of positive or negative attitudes; however, if one holds certain values, one does not hold them a little or much, but completely (Reich and Adcock, 1976). Therefore, values and attitudes may require different kinds of tools to measure their strengths or importance for a particular person (Reich and Adcock, 1976).

3.3.3 Attitudes and Behaviour

Perhaps one of the main reasons that attitudes are so important and draw a tremendous amount of attention in social science research is because of their relationships with human behaviour. The field of social psychology was originally defined as the scientific study of attitudes (Thomas and Znaniecki, 1918) because it was assumed that attitudes were the key to understanding human behaviour (Ajzen and Fishbein, 2005). People understand that some relationships exist between human's attitudes and behaviour. "We tend to associate with people we like and avoid people we dislike, we mainly eat foods that are to our tastes, we speak out in opposition to policies we consider undesirable, and we generally seem to behave in ways that are consistent with our attitudes" (Ajzen, 1996, p52).

In the early days of attitudinal research, most investigators accepted as a given that human behaviour is guided by social attitudes (Ajzen and Fishbein, 2005). However, investigations of the attitude-behaviour relationship have become controversial. LaPiere's (1934) classic work *Attitude vs. Action* provides early evidence that demonstrates the gap between attitudes and behaviour. In the 1930s, while there was much anti-Chinese sentiment in the United States, LaPiere took a young Chinese couple with him in a motor tour across the United States. They were received at 66 hotels, auto camps, and "Tourist Homes," and were refused only once. They also were served at 184 restaurants and cafes, and received even more than ordinary consideration from 72 of them. However, when LaPiere later surveyed all the establishments at which they had stayed to ask if they would accept members of the Chinese race as guests, almost all replied negatively. This study demonstrated that people might say one thing and do another.

Wicker (1969) reviewed 32 studies of attitude-behaviour relationships conducted from 1934 to 1969 and found supporting evidence. He concluded that it is considerably more likely that attitudes will be unrelated or only slightly related to overt behaviour than that attitudes will be closely related to actions (Wicker, 1969).

Nonetheless, Wicker's suggestion was criticized as "too uncritical an averaging of investigations that differ widely in relevance, merit, and ease of summary" (Schuman and Johnson, 1976, p162). There are several later reviews and meta-analyses (e.g., Ajzen and Fishbein, 1977; Glasman and Albarracín, 2006; Kim and Hunter, 1993; Kraus, 1995; Schuman and Johnson, 1976) that are against Wicker's review. They all show that attitudes and behaviour tend to be highly correlated. Not only that, it has also been pointed out that sporadic studies finding negative evidence regarding the attitude-behaviour relation is relatively easy to dismiss because they have methodological flaws (Ajzen and Fishbein, 2005).

However, relationships between attitudes and behaviour are not so simple. Wicker's suggestion impels psychologists to rethink the way attitudes affect behaviour. When researchers show strong relationships between attitudes and behaviour, they have specified conditions (e.g., Glasman and Albarracín, 2006; Kim and Hunter, 1993; Kraus, 1995). Kim and Hunter (1993) claim their meta-analysis of 138 attitude-behaviour studies shows a strong overall attitude-behaviour relationship and a correlation coefficient of 0.79 when methodological artefacts were eliminated. Kraus (1995) claims his meta-analysis of 88 attitude-behaviour studies reveals that attitudes significantly and substantially predict future behaviour, and the correlation coefficient is more than 0.5 on average if they are measured at corresponding levels of specificity. Glasman and

Albarracín (2006) claim their meta-analysis of 29 research reports indicate that attitudes correlated with a future behaviour more strongly when they were easy to recall (accessible) and stable over time.

Reviews of studies of the relationships between attitudes and behaviour, or the prediction of behaviour from attitude measures, identified that several psychological models have been proposed to account for the attitude-behaviour relationship (e.g., Ajzen, 1991; Fishbein and Ajzen, 1975; Triandis, 1977; Fazio, 1986; 1990). The theory of reasoned action and its extension, the theory of planned behaviour, are arguably the most dominant model of attitude-behaviour relations (Armitage and Christian, 2003; Olson and Zanna, 1993). They are simple, parsimonious, easy to operationalize and applicable to a wide range of behavioural domains (Leone et al., 1999). In the theory of reasoned action (Ajzen and Fishbein, 1973; Fishbein, 1967; Fishbein and Ajzen, 1975), Fishbein and Ajzen assume that behavioural intention is the best predictor of behaviour, and propose that attitudes and subjective norms combine to determine behavioural intentions, which in turn cause volitional behaviour. Fishbein and Ajzen (1975, p380) claimed that “Since much human behaviour is under volitional control, most behaviour can be accurately predicted from an appropriate measure of the individual's intention to perform the behaviour in question.” The theory of planned behaviour (Ajzen, 1991) is regarded as an extended and enlarged theory of reasoned action. The theory of planned behaviour adds perceived behavioural control as a third determinant that influences both behavioural intentions and behaviour. Some scholars have found that the theory of planned behaviour has a greater predictive power of behaviour than the theory of reasoned action (Armitage and Christian, 2003; Madden et al, 1992).

Triandis' interpersonal behaviour model was proposed in 1977 and developed further in 1980. It is believed that considerable similarity exists between the Fishbein-Ajzen's theory of reasoned action and the Triandis attitude-behaviour model (Bamberg and Schmidt, 2003; Boyd and Wandersman, 1991; Eagly and Himmelfarb, 1978). Triandis (1977, 1980) recognised the key role played by both social factors and emotions in forming intentions, and highlighted the importance of past behaviour, or habits, on present behaviour. In research of attitude-behavioural relationships, the theory of reasoned action and the theory of planned behaviour take the lead; Triandis' theory of interpersonal behaviour has received little attention until two decades after its development (Bamberg and Schmidt, 2003). Bamberg and Schmidt (2003) believe that Triandis' theory of interpersonal behaviour is reviving, perhaps both because of a new interest in exploring the influence of habitualization on everyday behaviour and the increasing empirical incapability of explaining all kinds of social behaviour by the theory of reasoned action and the theory of planned behaviour.

Although attitudes no doubt sometimes relate to behaviour, attitudes as predictors of behaviour are not always reliable. Fazio (1990) claimed that there are two different mechanisms by which attitudes can influence behaviour. One is that behaviour is thoughtfully planned in advance of its actual performance; another is that behaviour is a spontaneous reaction to a person's perception of the immediate situation. It is believed (Fazio, 1990; Fazio and Roskos-Ewoldsen, 2005) that the former is the essence of theory of reasoned action, and the latter is depicted in Fazio's (1986) model of the attitude-to-behaviour process. According to Fazio's attitude-to-behaviour process model (Fazio, 1986) the initiation of the attitude-to-behaviour process depends on whether the attitude

is activated from memory. It proposes that a number of steps must occur for behaviour toward an object to be influenced by the individual's attitude. First and foremost, the attitude must be accessed, or activated from memory when the individual encounters the attitude object. Only if the step of attitude activation occurs, will the attitude "guide" the behaviour. Then the attitude will serve as a "filter" to guide the individual to selectively produce perceptions of the object in the immediate situation that are consistent with the attitude. Unlike Ajzen and Fishbein's theories, Fazio's process model proposes that the definition of the event determines the direction and nature of the behaviour (Fazio, 1986). Besides the attitudes and subsequent perceptions, he claims norms may affect the individual's definition of the situation, and then the individual's definition of the event. If norms are counter to the individual's attitude, it may result in a definition of the event that does not permit the attitude to be expressed behaviourally; if norms do not dictate, the definition of the event will be attitudinally congruent (Fazio, 1986).

It should be noted that an attitude always targets "a particular entity" or "a given object". For example, the application of theories of reasoned action and planned behaviour highly emphasise compatibility, and require that attitude, subjective norm, perceived behavioural control, and intention should be defined in terms of exactly the same elements of Target, Action, Context, and Time (TACT) (Ajzen, 2002). However, when the behaviour of interest is supporting or objecting to a likely future policy, defining its exact TACT elements becomes difficult. Considering the purpose of this study is to understand and predict farmers' potential responses to proposed water policy changes, focusing only on the influences of attitudes is obviously not enough as it must include

values, which more deeply, more centrally, and more stably influence one's attitudes and behaviour, into the study.

3.3.4 Value, Attitudes and Behaviour

Some researchers describe value, attitude and behaviour in short words: values are what people believe, attitudes are what they think or feel, and behaviour is what they do (Rhindress et al., 2008). According to that definition, values serve as standards and principles that guide one's life. From this point of view, values are viewed as potential determinants of preferences and attitudes (Olson and Zanna, 1993). Attitudes and behaviour can be seen as outcomes of value orientations (Reich and Adcock, 1976).

Roccas and Sagiv (2010) reviewed many studies and pointed out that values have been found to be associated with a large variety of behaviour and behavioural intentions. Eyal et al. (2009) found that values predict behavioural intentions for the more distant future regardless of whether the behaviour is hypothetical or actual. However, the effects of values may be complex (Dietz et al., 2005). They influence behaviour through a number of other determinants (e.g., Eagly and Chaiken, 1993; Homer and Kahle, 1988; Stem et al., 1995). Vaske and Donnelly (1999) argue that values are unlikely to account for much of the variability in specific attitudes and behaviour and they influence attitudes and behaviour indirectly via other components in the cognitive hierarchy.

Fulton et al. (1996) illustrated the cognitive hierarchy structure as an inverted pyramid with values forming the foundation. The cognitive hierarchy structure consists of values, basic beliefs, attitudes, norms, behavioural intentions, and behaviour (Ball-Rokeach et al., 1984; Fulton et al., 1996; Homer and Kahle 1988; Rokeach, 1973). According to Fulton

et al. (1996) each of these cognitive elements is theorized to build upon one another. Next to actual behaviour, behavioural intentions are the highest order constructs; they are close antecedents of behaviour and the best predictors of actual behaviour. The higher order attitudes and norms are the next highest constructs; they proceed in the cognitive hierarchy by more general attitudes toward and beliefs about relatively abstract concepts. The general attitudes and beliefs are hypothesized to affect behavioural intentions through their impacts on more specific attitudes. Fundamental values are first-order cognitions that form the foundation of the cognitive hierarchy; they transcend specific situations and influence behaviour, attitudes, norms and beliefs across the broad array of experiences in life (Fulton et al., 1996).

Homer and Kahle (1988) developed a values-attitude-behaviour hierarchical model by studying a survey of 831 food shoppers. They claim that within a given situation, a value-attitude-behaviour hierarchy exists, that is, the influence should theoretically flow from abstract values to midrange attitudes to specific behaviour (Homer and Kahle, 1988). Their findings show that values are associated more strongly with nutritional attitudes than with shopping behaviour, supporting the mediating role of attitudes, and found that nutritional attitudes significantly influenced natural food shopping behaviour (Homer and Kahle, 1988). Homer and Kahle's model has been applied and tested in a variety of areas (e.g., McCarty and Shrum, 1994; Shim, et al., 1999; Thøgersen and Grunert Beckmann, 1997; Vaske and Donnelly, 1999) and cultures (Milfont et al., 2010). For example, values directly influence attitudes towards the inconvenience and importance of recycling, and attitudes about the inconvenience of recycling were found to have a negative relationship with recycling behaviour (McCarty and Shrum, 1994). Respondent's pro-wildland

preservation values were found to have fully mediated the relationship between value orientation and behavioural intention to vote for wildland preservation (Vaske and Donnelly, 1999). Environmental attitudes were found to have a positive influence on buying organic products (Grunert and Juhl, 1995).

With the worldwide environmental movement, the relationship between value and concerns about environmental issues are focused (e.g., Corraliza and Berenguer, 2000; Dietz et al., 2005; Karp, 1996; McCarty and Shrum, 1994; Schultz and Zelezny, 1998, 1999, 2003; Steg et al., 2014; Stern and Dietz, 1994; Stern et al., 1993, 1995, 1998, 1999; Stern, 2000; Vlek and Steg, 2007). Among Schwartz's value system, one type of value has been labelled *Universalism* and clustered on the dimension of *Self-enhancement* vs. *Self-transcendence*, which relates values for understanding, appreciation, tolerance, and protection of the welfare of all people and nature (Schwartz, 1992). Scientists have found that environmental concerns (or, attitudes) are positively correlated with *Self-transcendence* and negatively correlated with *Self-enhancement* (Schultz and Zelezny, 1999; Stern et al. 1999). Self-reported pro-environmental behaviour has been found to be positively correlated with *Self-transcendence* (Karp 1996; Nordlund and Garvill, 2002; Schultz and Zelezny, 1998).

Stern and his colleagues proposed a value-basis theory (Stern and Dietz, 1994; Stern et al., 1995, 1998, 1999), later called the value-belief-norm theory (Stern et al., 1999).

According to Stern and Dietz (1994), people would commit themselves to action when pro-environmental personal norms were activated by beliefs that an environmental condition has adverse consequences for self and close kin (in the egoistic value orientation), for other human beings (in the social-altruistic orientation), or for other

species or ecological systems (in the biospheric orientation), and by ascription of responsibility to themselves for preventing those consequences. Value orientations, and particularly *Self-transcendent* or biospheric-altruistic values, have explanatory power for individuals' beliefs about environmental conditions and their willingness to take action in response to them (Stern et al., 1995). Stern's value-basis theory has been demonstrated in studies by Schultz and his team. They showed that the type of environmental concerns an individual develops is based on the degree to which s/he perceives an interconnection between themselves and other people (altruistic), or between themselves and nature (biospheric) (Schultz, 2001).

As some research has indicated, the relationships between values, attitudes and behaviour are often weak (Kristiansen and Hotte, 1996). Maio and Olson (1995) introduced attitude function as a moderator variable into the values-attitude-behaviour relationship to improve the ability of values to predict attitudes and behaviour. According to Katz (1960), attitudes serve four functions: the utilitarian function of satisfying utilitarian needs, the ego-defensive function of handling internal conflicts, the value-expressive function of maintaining self-identity and enhancing self-image, and the knowledge function of giving understanding and meaning to the ambiguities of the world about us. Maio and Olson (1995) claim that values might predict behavioural intentions when people have value-expressive attitudes, but not when people have utilitarian attitudes. They also indicate that the prediction of behavioural intentions by values might be independent of attitudes, norms, and perceived control because values partly reflect a sense of moral obligation to perform the behaviour (Maio and Olson, 1995). Hedlund (2011) also confirmed that *Universalism* is related to environmental concerns, and environmental concerns are

positively related to the willingness to accept economic sacrifices to protect the environment and intentions to buy ecologically sustainable tourism alternatives.

3.4 Influences of Background Factors on Values, Attitudes and Behaviour

In recent decades, scholars have re-focused attention on the relationship between background factors (social structures, social contexts, or life circumstances) and values and attitudes (e.g., Ajzen and Fishbein, 2005; Hitlin and Piliavin, 2004; House and Mortimer, 1990; Morgan and Schwalbe, 1990; Schwartz, 2006b). Since human thinking occurs with alternating reference to internal representations and external objects or between the person and the environment, Morgan and Schwalbe (1990) state that understanding what and how people think must take into account the social context in which their mental activities occur. Likewise, House and Mortimer (1990), considering the ways in which individuals might shape social structures and processes, emphasize that more attention must be paid to persons' endogenous attributes when trying to explain social or psychological phenomena. Hitlin and Piliavin (2004) hold a similar point of view. They state that “Personal values are developed and internalized in patterned ways by gender, social class, nation of origin, and a host of other socio-demographic variables” (Hitlin and Piliavin, 2004, p383-384). House and Mortimer (1990) called those variables endogenous attributes, indicating individuals' location in a particular societal context at a single point in time or by nation and historical period (House and Mortimer, 1990). They “operate psychologically by affecting values (e.g., through the socialization process)” (Stern and Dietz, 1994, p79) and associate with value orientation, attitudes, and behaviours.

3.4.1 The Influences of Socio-demographic Variables

Hitlin and Piliavin (2004) reviewed broad empirical findings and found that both birth right and ascribed demographic characteristics generally influence or are influenced by values. Poortinga et al. (2004) studied household domestic energy use and transport, and found that pro-environmental behaviour was associated with socio-demographic variables rather than variables of values and attitudes alone. Schwartz (2006b) claims that people adapt their values to their life circumstances, that is, people's age, education, gender, and other characteristics largely determine their life circumstances and that, in turn, affects their values. Schwartz and Bardi (1997) suggest that people increase the importance of values they are able to attain and downgrade the importance of those they cannot attain. Ajzen and Fishbein (2005) also claim that the behavioural, normative, and control beliefs people hold about performance of a given behaviour are influenced by a wide variety of cultural, personal, and situational factors. They redefined the theories of reasoned action and planned behaviour by adding background factors (Ajzen and Fishbein, 2005).

Gender

A large number of studies demonstrate strong relationships between gender and values, attitudes, and behaviour. Schwartz (2006b) declares that women attribute more importance than men to *Benevolence*, *Universalism*, *Conformity*, and *Security* values. Women are often found to be somewhat more concerned about the environment than are men (e.g., Dietz et al., 2002; Mohai, 1992; Stern et al., 1993). Zelezny et al. (2000) reviewed research published from 1988 to 1998 on gender differences in environmental attitudes and behaviour. They found that women reported significantly more general

environmental concerns and greater participation in pro-environmental behaviour/activism than men. However, some studies also found that the difference was not great and women are not more environmentally active than men (Blocker and Eckberg, 1997; Mohai, 1992). Blocker and Eckberg (1997) found that gender differences in environmental orientations are not strong and do not extend to environmental actions. Mohai (1992) even reported that women are substantially less likely to be environmentally concerned. Although most research demonstrates that women have relatively stronger attitudes toward sustainable agriculture and environmental protection than male farmers (e.g., Karami and Mansoorabadi, 2008; McBeth and Foster, 1994), the overall effect seems to be small (Zelezny et al., 2000).

Age

There is also some evidence that demonstrates the relationships between age and values, attitudes, and behaviour. Schwartz (2006b) claims that age correlates positively with *Security, Tradition, and Conformity* values, but negatively with *Stimulation, Hedonism, Achievement, and Power* values. Younger people tend to give greater priority to *Hedonism, Stimulation, Self-direction*, and, possibly, *Universalism* values, but less priority to *Security, Tradition, and Conformity* values (Schwartz, 2006b).

Age as a factor that influences farmers' attitudes and behaviour is even more controversial. Knowler and Bradshaw (2007) found that age has been regularly assessed in studies of the adoption of conservation agriculture. Surveys from Austria (Vogel, 1996) and Ontario, Canada (Filson, 1993) demonstrated that younger respondents tend to have a more environmentally conscious attitude. A survey from Louisiana in the United States

(Basarir and Gillespie, 2006) showed that older beef and dairy producers are relatively more environmentally concerned and see the need to maintain and conserve land to be more important. Although younger people reported having more general environmental concerns, no particularly strong association between age and pro-environmental behaviour has been found. A contradictory conclusion emerged in McBeth and Foster's (1994) study. They found that older rural residents value environmental features more but express lesser concern for the environmental impact of industrial development than do their younger counterparts (McBeth and Foster, 1994). Similarly, Kantola et al. (1982) found that older people had less intention to conserve water.

Education-level

Education-level is one of the important socio-demographic variables. It is regarded to have important effects on values, attitudes, and behaviour (e.g., Kohn, 1976; Schwartz, 2006b; Xiao, 2000). Schwartz (2006b) believes that the associations of education with values are largely linear, with the exception of *Universalism* values. Since *Universalism* values are assumed to arise only in the last years of secondary school, they are substantially higher among those who attend university (Schwartz, 2006b). Education often shows a closer association with attitudes than with any other aspect of socioeconomic status (Kiecolt, 1988). Focusing on parental values of *Conformity* and *Self-direction* (e.g., Kohn, 1976; Kohn et al., 1986; Kohn et al., 1990; Xiao, 2000), studies have found that education and occupation shape parental values (Kohn, 1976; Xiao, 2000). Xiao (2000, p796) perceives that "one of the major functions of education is to teach people to think for themselves". The more educated the individuals, the more likely they desire their children also to be independent and autonomous (Xiao, 2000).

The influences of education are often found in studies of farmers' environmental attitudes and behaviour. It has been found that education has positive impacts on concerns about the seriousness of rural environmental degradation (Filson, 1993), adoption of soil conservation technology (Ervin and Ervin, 1982), and adoption of improved maize seed (Nkonya et al., 1997). Although Knowler and Bradshaw's (2007) review agrees that education commonly correlates positively with the adoption of conservation agriculture practices, they also point out that some analyses have found education to be an insignificant factor, or even to negatively correlate with adoption. Vogel (1996) suggests that education has both direct and indirect influences on environmental behaviour. His study found that respondents with higher education had a greater environmental attitude with respect to specific attitudinal components such as "feeling of stress" and "problem-based knowledge" but not with respect to general attitudes towards the environment (Vogel, 1996).

Income and Farmers' Off-farm Employment

In addition to the above factors, income level is also regarded as one of the socio-demographic variables that influence environmental attitudes and behaviour. Vaske et al. (2001) found that income had a significant influence on the value orientation among Colorado residents. Individuals with higher income tended to be more supportive of national forest preservation than those with lower earnings (Vaske et al., 2001). Income also has been shown to influence household energy use (Poortinga et al., 2004) and participation in a premium-priced, green electricity program (Clark et al., 2003). However, it was also reported that income did not predict recycling (Derksen and Gartrell, 1993).

Studies of farmers' behaviour often focus on off-farm employment and/or income. Evidence has shown that farmers with higher incomes are more oriented to monetary goals and economic success than are low income farmers (Pemberton and Craddock, 1979) and tend to have weak attitudes favouring conservation action (Lynne and Rola, 1988). Off-farm employment can increase farmers' income that could provide financing support for conservation efforts. Ryan et al. (2003) found that part-time farmers were significantly more likely than full-time farmers to consider adopting conservation practices as part-time farmers are less dependent on their land for income. However, Knowler and Bradshaw (2007) synthesized studies on farmers' adoption of conservation agriculture and found that the influence of off-farm activities/income could be positive (e.g., Fuglie, 1999; Napier and Camboni, 1993), negative (e.g., Okoye, 1998; Swinton, 2000), or insignificant (e.g., Nowak, 1987; Smit and Smithers, 1992).

3.4.2 The Influences of Past Behaviour

It is well known that past behaviour can be a good predictor of later actions. The influence of past behaviour on predicting intentions and future behaviour has attracted considerable attention. Many studies have focused on habitual or repeated behaviour in predictions of current behaviour in a number of everyday life situations, especially those that are health-related (e.g., Conner et al., 2000); pro-environmental (e.g., Dahlstrand and Biel, 1997; Knussen et al., 2004); exercise (e.g., Hagger et al., 2001; Norman et al., 2000; Rhodes and Courneya, 2003); and travel mode (e.g., Bamberg et al., 2003; Verplanken et al., 1997). Although Ajzen and Fishbein (2005) recognized that adding past behaviour to prediction equations can increase the proportion of explained variance, they do not agree to add it to their theories of reasoned action and planned behaviour. They argue that past

behaviour is best treated not as a measure of habit but as a reflection of all factors that determine the behaviour of interest (Ajzen, 1991; Ajzen and Fishbein, 2005). However, some scholars have argued that the effects of past behaviour cannot be attributed to these potential confounding influences (Ouellette and Wood, 1998). Past behaviour has been used to predict intentions directly and indirectly through self-efficacy and attitude (Hagger et al., 2001). It might be useful to include past behaviour within the theory of planned behaviour (Conner and Armitage, 1998; Rhodes and Courneya, 2003).

Consistent with Ouellette and Wood's (1998) argument that behaviour is unlikely to always become habitual and automatic, Fielding et al. (2008) found that farmers' riparian zone management comprised a complex set of practices that are unlikely to be performed daily or frequently. They believe that past behaviour emerges as a significant predictor of intentions but not of behaviour itself. Wheeler et al. (2013) developed the concept of a sum of expansive strategies in planned or adaptation behaviour created over a five year period. They found that farmers' past behaviour has one of the largest impacts on their future behaviour (Wheeler et al., 2013). On the other hand, most farmers' farming practices represent sequential behaviour as changes in farmers' behaviour and decision making often depend on the current situation. For example, improvement of irrigation equipment generally depends on the irrigation equipment that farmers currently are using. For example, already using all water saving practices was identified as the most important reason for not implementing adoption of improved irrigation technology and management practices in Southern Alberta (Bjornlund et al., 2009). In this sense, farmers' past behaviour also can be regarded as antecedents of their future behaviour. Farmers' behaviour is complex. The influence of farmers' past behaviour should never be ignored

in predicting their future behaviour or behavioural intentions.

3.5 Farmers' Behaviour and Behavioural Intentions to Water Policy Changes

3.5.1 Greater Complexity of Farmers' Behaviour

With the global awakening of environmental awareness and worldwide attention to water shortages, farmers' behaviour towards the environment has been drawing increasing academic attention. Economists, sociologists and psychologists have made efforts to understand farmers' behaviour.

As important determinants, values and attitudes also have drawn attention in studies of farmers' behaviour and behavioural intentions. The differences in farming practices can be linked back to the farmers' basic convictions regarding nature and sustainability, or the basic values that they hold (Schoon and Grotenhuis, 2000). Among the studies on farmers' behaviour, Gasson's (1973) study on Cambridgeshire farmers has been regarded as path-breaking empirical research (Garforth and Rehman, 2005). According to Gasson's (1973) classification, all farmers in her survey placed high value on independence and intrinsic aspects of work. This conclusion has been widely supported (e.g., Ilbery, 1983; Harper and Eastman, 1980; Kliebenstein et al., 1980; Kuehne and Bjornlund, 2006). The importance of non-economic values in agriculture breaks the assumption of simple profit maximizing behaviour. It has shown that farmers' behavioural types can be distinguished by their values (e.g., Brodt et al., 2006; Fairweather and Keating, 1994; Garforth, 2010; Kuehne et al., 2007; Walter, 1997). It also has been shown that farmers' behaviour is influenced by their attitudes, which could

be interpreted by the theory of planned behaviour (e.g., Beedell and Rehman, 1999; 2000; Blackstock et al., 2010) or the theory of reasoned action (e.g., Luzar and Diagne, 1999).

It should be noted that instead of values and attitudes, economists and sociologists also have widely used farmers' goals and objectives to explain farmers' behaviour. Bergevoet et al. (2004) provided a parallel analysis to the theory of planned behaviour with business literature. They assumed that goals and objectives correspond to attitudes that stem from psychology (Bergevoet et al., 2004). Öhlmer et al. (1998) also confirmed that the terms of objectives, goals and values often are used interchangeably in the literature on farmers' motives and their relationships with behaviour (Garforth and Rehman, 2005; Willock et al., 1999).

As noted in the previous section, there also are many concerns about the influences of farmers' background factors on their values, attitudes and behaviour. Differences in behaviour due to gender, age, education-level, income, off-farm employment, past behaviour, and other aspects often have been demonstrated. Generally speaking, younger, well-educated farmers, and females, are more concerned about the environment and are more willing to adopt new technologies that have smaller impacts on the environment (e.g., McBeth and Foster, 1994; Gould et al., 1989; Traoré et al., 1998). Farmers with a higher income also may show increased adoption of conservation techniques due to greater financial stability (e.g., Gould et al. 1989). However, the effect of their influence seems to be unclear and sometimes conflicting. For example, Ahnström et al. (2009) stated that the younger and more educated farmers often tend to be more business-minded together with more environmentally concerned, and, thus, not surprisingly, might take seemingly conflicting actions: more pesticides but also more conservation actions. Lynne

and Rola (1988) found that farmers with higher incomes had stronger conservation attitudes, but they also tended to rank a comfortable life higher in their value scheme, were willing to tolerate more soil erosion, and tended to have weaker attitudes towards conservation action.

Being a farmer is not simply a profession but a way of life and thus money and life are all important. Gasson et al. (1988) provided a multidisciplinary review that integrated some of the contributions made by economics, social anthropology, history and rural sociology to the study of farm families and family businesses. They emphasised that a farm is a family business and policy makers need to be cautious about the relationship between farm family and farm business when agricultural policies are being reshaped (Gasson et al., 1988). A farm is not just a money-making enterprise; it also is about family cohesion, solidarity and succession (Edwards et al., 2011). The business cannot be disentangled from the farmer's family. Farmers might co-hold business and way of life goals (Fairweather and Keating, 1994). Therefore, as Gasson et al. (1988) emphasized, the farm family may be too complex to understand from any single perspective.

Considering the complexity of farmers' behaviour, more influential factors should be considered for understanding and predicting it. Edwards-Jones (2006) suggests that farmers' decisions are influenced not only by the psychological make-up of the farmer, such as farmers' values and attitudes and socio-demographic characteristics, but also by the characteristics of the farm household, structure of the farm business, the wider social milieu and characteristics of the innovation to be adopted. Farmers' decisions and their behaviour with respect to their farm, farming practices and decisions should not be seen only in the context of the individual farmer, but must be understood in the context of the

whole family and whole farm.

3.5.2 The Influences of Farmers' Household Characteristics

Since farming often is a family engagement, family members' and family unit's characteristics doubtlessly affect farming practices and farm decisions. Some demographic variables, for example, the age of the household head, size of household, life cycle stage, off-farm work status of farm operator's spouse, the duration of residence, the number of working age adults, and the number of dependent children, etc. have been used as household characteristics to examine their influence on farmers' behaviour (e.g., Lambert et al., 2007; Perz, 2001; Perz and Walker, 2002; Perz et al., 2006)

Somewhat like Glick's (1947; 1955) division of life cycle into three stages of marriage, birth of children, and children leaving home, Nalson differentiated farmers' life cycle into early, middle and late phases according to their children's ages (Nalson, 1968; Gasson et al., 1988). These phases have proven useful for examining the impacts of family development on the farm business (Gasson et al., 1988). By 'location' of a farm household's position in the life cycle in the Amazon, Perz (2001), Perz and Walker (2002), and Perz et al. (2006) referred to a set of demographic characteristics of a domestic group that includes the age of individual members, their collective age composition, and the length of time spent at their present residence. They showed that life cycle position exerts significant effects on farms' land use and second-growth forest in the Amazon (Perz, 2001; Perz and Walker, 2002; Perz et al., 2006). They also found household duration of residence had a strong positive impact on the extent of secondary growth (Perz et al., 2006). Vaske et al. (2001) also suggested that individuals' duration of

residence significantly influenced their environmental value orientations and normative beliefs about national forest management in Colorado. Burton (2006) found that the average age of family members working on the farm is a relatively better indicator of farm structural and managerial features than the age of the principal decision-maker.

Family size is another common factor to represent family characteristics and often has been shown to influence farmers' behaviour (Adesina and Chianu, 2002; Amsalu and Graaff, 2007; Bekele and Drake, 2003). Two studies on soil and water conservation from Ethiopia demonstrated that family size has a significantly negative influence (Amsalu and Graaff, 2007; Bekele and Drake, 2003). Both studies showed that labour is diverted away from conservation because of competition for labour to feed more people. Other studies have shown that family size has a significantly positive correlation with farmers' adoption and adaptation of alley farming technology in Nigeria (Adesina and Chianu, 2002) and the adoption of water conservation practices by small-scale farmers in Central Chile (Jara-Rojas et al., 2012). The reason for this phenomenon has been believed to be abundant labour within larger families (Adesina and Chianu, 2002; Jara-Rojas et al., 2012). For example, Adesina and Chianu (2002) stated that larger families have more labour to prune the trees more often than recommended by researchers. Therefore, family size influences farmer behaviour and or decision making but the effects also depend on the context.

Considering that a farm is a family business, a farmer's spouse almost always participates in the farm business in various ways. The contribution that farmers' wives make to the farm business has been recognized in several studies (Alston, 1995; Gasson, 1980; 1992; Kubik, 2005; Lyson, 1985; Zepeda et al., 1997). Farmers' wives participate in labour and

decisions related to the farm. It has been found that most farmers' wives are involved in the farm business in some capacity; many were responsible for farm records and accounts, and most were expected to deal with callers, run errands and help in emergencies, besides being drawn into business discussions (Gasson, 1992). Lambert et al. (2007) included information of whether the farm operator, the farm operator's spouse, or both the operator and spouse work off-farm to present one of the household characteristics in their study that examined the determinants of US farm households' adoption of conservation-compatible practices. They showed that the influence of whether the farm operator's spouse works off-farm on decision aids was significant.

3.5.3 The Influences of Farm Business Characteristics

A lot of evidence indicates that farmer behaviour is related to farm characteristics. Differences in behaviour due to farm size, trajectories of farm business development and successor plans have most often been identified. Ahnström et al. (2009) suggested that examining the influence of farm characteristics, such as farm size, farm history and plans for the future would be helpful to provide a better understanding of farmers' decision-making.

Following Gasson's (1973) paper, several studies detected the relationship between farmers' value orientations and the size of farm business. Gasson (1973) found that those with smaller farms value intrinsic aspects of farming more highly than do farmers with medium or larger farms, and the latter place more emphasis on instrumental and social aspects. However, evidence has shown that farmers' value orientations can differ for those with larger or smaller farms (e.g., Gasson, 1973; Wallace and Moss, 2002), while

there can also be no difference between the size of farm businesses (e.g., Austin et al., 1996; Ilbery, 1983). Similarly, although farmers' irrigation practices tend to be different according to farms' size, the effects seem to be unclear. Negri and Brooks (1990) found a negative farm scale effect on sprinkler adoption (farmers with larger irrigated acreage tended to use gravity irrigation) but Skaggs and Samani (2005) showed that large farms use water more efficiently. There are no simple answers to the question of how farm size and farmers' conservation actions are related (Ahnström et al., 2009). The overall impact of farm size is clearly inconclusive (Knowler and Bradshaw, 2007).

The trajectories of farm business development have been considered as a means to understand the nature and causes of farm-level changes (Potter and Lobley, 1996; Smithers and Johnson 2004). Families in different stages of the farm business cycle might have different strategies on farming practises. Potter and Lobley (1996) divided the farm business cycle into five stages: Recent Developers, Consolidators, Stabilisers, Disengagers, and Withdrawers. Farmers in the Recent Developers stage have recently invested in land improvement, land use intensification, and more efficient irrigation from a low base in order to increase the income earning capacity of their core agricultural business. Farmers in the Consolidators stage carry out land improvement and intensification from an already high base, again with a view to make the core farm business more profitable. Farmers in the Stabilisers stage make few, if any, changes to land use or farm layout, maintaining a stable or holding pattern of farm business development. Farmers in the Disengagers stage seek actively to reduce household dependence on the agricultural business through diversification and/or taking up off-farm employment. Farmers in the Withdrawers stage experience a decline in income from

agriculture and take no actions to reverse this or to seek new income sources. Similarly, three simplified phases among Ontario farmers have been identified by Smithers and Johnson (2004) as Expanding, Stable and Contracting. They found that active farm development seems more likely to occur early in both the family life cycle and enterprise cycle.

The presence of a successor also has been identified as an important factor that influences farmers' behaviour and decision-making (Potter and Lobley, 1992, 1996; Sottomayor et al., 2011; Wheeler et al., 2012; Wilson, 1996). Farmers with successors seem to be more interested in environmentally-friendly farming practices for the sake of their successors (Wilson, 1996), more likely to purchase water entitlements and land, and more likely to adopt efficient irrigation infrastructure (Wheeler et al., 2012). Farmers without successors might lack the incentive and motivation to continue expanding the business and accumulating capital into old age (Potter and Lobley, 1992; 1996).

3.5.4 Farmers' Behaviour and Behavioural Intentions to Water Transfer and Water Pricing

Following the Alberta Water for Life strategy, a series of action plans have been developed. Two important issues have arisen with regard to changes in water policies: water transfer and water pricing. They are also the focus of this study. Although both of these issues are important topics that have drawn widespread concerns, empirical evidence of potential farm-level responses is lacking.

Farmers' Behaviour and Behavioural Intentions to Water Transfer

With growing water demand, satisfying new demands will require water to be transferred

from farmers who have historically secure water rights (Kuehne and Bjornlund, 2008). Such export of water out of rural areas therefore largely relies on gaining farmers' support. For this reason, it is crucially important to understand farmers' attitudes and motivations with respect to possible changes in water policies and management processes.

There has been substantial research on water markets since Australia and the United States introduced market-oriented water policies in water management in recent years. Farm-level studies, including factors behind the differences between participators and non-participators, buyers and sellers, and temporarily and permanently transferring water in these and other jurisdictions have been studied (e.g., Bjornlund and McKay, 1998; 2000; Bjornlund, 2002; 2003; Edwards et al., 2008; Hadjigeorgalis, 2008; Nieuwoudt and Armitage, 2004; Nicol and Klein, 2006). Wheeler et al. (2009) pointed out that farmers' participation in water transfers is similar to the adoption of general agricultural innovations and is influenced by demographic, socioeconomic, attitudinal, and physical factors.

Demographic and socioeconomic factors have been used to differentiate the participants in water markets. Generally speaking, female, older and higher educated farmers, and farmers with larger irrigated areas, higher operating surplus, more assets and a farm plan were more likely to enter the water market to trade (Wheeler et al., 2009). Some studies also found that the value of the crop grown might lead a farmer to make a different decision about participating in water transfers (e.g., Nieuwoudt and Armitage, 2004; Nicol and Klein, 2006). Nicol and Klein (2006) found that a great majority of water buyers were using pivots, the most efficient irrigation system, and a great majority of water sellers were not using pivots.

Psychological factors of values and attitudes have been shown to play an important role in understanding and predicting farmers' behaviour. Seven factors have been identified that influence farmers' preferences for temporary trading: tax treatment, impact on property capital value, policy uncertainty, administrative complexity, degree of commercialization of water, irrigation adjustment pressure and income need (Bjornlund, 2003). No doubt the influence of these factors is determined to a great extent by the individual's cognition. However, studies that detect the influence of values and attitudes on farmers' participation in water transfers are rare. Two studies from Australia considered the impacts of psychological factors. Based on goals, objectives and attitudes that Namoi Valley irrigators hold, Kuehne and Bjornlund (2008) categorized them into two groups of Investors and Custodians. They found that irrigators' attitudes towards land and water were clearly different between the two groups. For Investors, water and land is tradable, and they are more likely to participate in water trading. Custodians desire to keep the water and land and are less likely to participate in water transfers (Kuehne and Bjornlund, 2008). Tisdell and Ward (2003) focused on farmers' and community members' perceptions and attitudes to water trading. They found that farmers in the Goulburn-Broken catchment of Victoria were reluctant to sell their water entitlements because they always viewed the water as being connected to the land, and suggested that optimal market-based redistribution of water needs to take into account their social and cultural attitudes toward water.

It is obvious that, in existing studies, not enough attention has been paid to the influence of farmers' values and attitudes. Although studies by Kuehne and Bjornlund (2008) and Tisdell and Ward (2003) have made good attempts, they have neither built a direct

relationship between farmers' attitudes and value orientations and their behaviour or behavioural intentions, nor considered the influences of other demographic or socioeconomic factors. Some studies that focused mainly on the influences of demographic, socioeconomic factors also explored limited cognitive differences, such as the reasons why farmers buy, sell or do not participate in trading water (e.g., Bjornlund, 2006; Nicol and Klein, 2006). However, most studies that involved the analysis of demographic, socioeconomic factors have largely ignored the role of psychological factors.

Farmers' Behaviour and Behavioural Intentions in response to new Water Pricing policies

Scholars have shown growing concerns about the impacts of water pricing on farm-level practices. Two types of impacts have been highlighted. First, increases in water prices might induce adoption of modern irrigation technologies that lead to substantial water saving. For example, Caswell and Zilberman (1985) found fruit growers in the Central Valley of California were more likely to use drip and sprinkler irrigation systems when water costs increase. However, Carey and Zilberman (2002) found that farmers in California will not invest in modern irrigation technologies until the expected benefits of investment exceed the costs. It also has been found that water price is not the most important factor that influences the adoption of improved irrigation technologies (e.g., Green et al., 1996; Ørum et al., 2010; Varela-Ortega et al., 1998). Secondly, high water prices could induce changes in cropping patterns, substituting existing crops with less water demanding crops that result in decreasing water consumption (Moore et al., 1994; Ørum et al., 2010; Speelman et al., 2009; Tsur and Dinar, 1997; Varela-Ortega et al.,

1998). Berbel and Gómez-Limón (2000) argue that reducing agricultural water consumption by changing cropping patterns does not happen until prices reach a threshold level that will negatively affect farm income and agricultural employment. However, the existing literature indicates that most analyses of farmers' water pricing responses are based on optimizing behaviour in mathematical programming models. Although these studies can offer major insights into farmers' optimal behaviour, most have the weakness of assuming simple profit maximizing behaviour. Obviously, maximization of profit is not the only objective of farmers. Farmers' behaviour is not motivated only by economic or financial gains. Although pursuing economic profits is an important goal for farm businesses, ignoring farmers' other goals might result in failure to understand their responses to changes in water policies. Edwards-Jones et al. (1998) claimed that incorporating psychological variables in models of farmer behaviour can lead to better predictions. However, almost all existing farmer-level studies on responses to changes in water pricing take account of only one or two groups of the above factors. For example, Gómez-Limón and Riesgo (2004) analysed farmers' reactions to water pricing based on farmers' age and factors related to the structure of the farm business. Poussin et al. (2008) considered only the differences in the structure of farm business (the patterns of the cropping and livestock enterprises).

3.6 Summary

Farmers are the biggest group of natural resource managers on the earth (FAO, 2007). With the global awakening of environmental awareness and worldwide attention to water shortages, farmers' behaviour towards the environment has drawn increasing academic

attention. However, understanding which factors influence farmers' behaviour and behavioural intentions and by how much remains at a low level.

Many scholars have suggested that behavioural research should be conducted from an interdisciplinary perspective, by bringing values back into sociological (e.g., Hitlin and Piliavin, 2004, Spates, 1983) and economics research (e.g., Bruni and Sugden, 2007) and adding background factors into psychological models (e.g., Ajzen and Fishbein, 2005).

Values are so important in understanding human behaviour and research on that domain can be traced back two centuries. There are basic principles that guide individuals' lives.

In recent decades, new contributions to value theory and measurement have been made by Rokeach (1968; 1973) and Schwartz (1992) that facilitates the application of values in the study of human behaviour. Rokeach views values as relating to preferable "modes of conduct (behaviour)" and "end-states of existence," what he calls "instrumental" and "terminal" values (Rokeach, 1968; Munson and McIntyre, 1979). Rokeach's Value Survey List includes 36 value items, and rankings are used to measure the value items.

Schwartz Value Theory emphasises that values are desirable, transsituational goals, varying in importance, that serve as guiding principles in people's lives. The pattern of Schwartz's values system is portrayed in a circular structure. Ten motivationally distinct types of representative values are clustered with two orthogonal dimensions: one named *Self-enhancement* vs. *Self-transcendence* and the other *Openness to change* vs.

Conservation. The former relates *Power* and *Achievement* values, which oppose *Universalism* and *Benevolence* values; the latter relates *Self-direction* and *Stimulation* values, which oppose *Security*, *Conformity* and *Tradition* values. *Hedonism* shares elements of both *Openness to change* and *Self-enhancement* (Schwartz, 2006b).

Schwartz's Value Survey List includes 56 value items, and ratings are used to measure the value items.

The literature related to attitudes and relationships among value, attitude and behaviour was reviewed in this chapter. Attitude is another core concept in (social) psychology. It is the key to understanding human behaviour (Ajzen and Fishbein, 2005). Because attitudes are closely related to behaviour and behavioural intentions, more studies have used attitudes to predict or explain human behaviour. The theory of reasoned action and its extension, the theory of planned behaviour are the most dominant models of attitude-behaviour and have been used in many studies. However, their application highly emphasises compatibility and require that all elements in the models be defined in terms of exactly the same elements of Target, Action, Context, and Time (TACT) (Ajzen, 2002). However, when the behaviour of interest is supporting or objecting a likely future policy, defining its exact TACT elements is difficult. Unlike attitudes, values are more abstract, de-contextualized mental constructs, and more likely are applied to more distant future situations that guide behavioural intentions (Eyal et al., 2009).

A Value-Attitude-Behaviour hierarchy exists. Behavioural intentions are the close antecedents of behaviour and the best predictors of actual behaviour. The general attitudes and beliefs are hypothesized to affect behavioural intentions through their impacts on more specific attitudes. Fundamental values transcend specific situations and influence behaviour, attitudes, norms and beliefs across the broad array of experiences in life (Fulton et al., 1996). Schwartz's Value Theory has often been used in studies related to environmental concerns and pro-environmental behaviour and influence of value has been shown.

Morgan and Schwalbe (1990) have stated that understanding what and how people think must take into account the social context in which their mental activities occur. This chapter has reviewed the influences of socio-demographic variables and past behaviour on individuals' behaviour and behavioural intentions. Socio-demographic variables, such as gender, age, education and income largely determine their life circumstances and affect their values, attitudes, and behaviour. Focusing on studies related to farmers and their environment, the influences of those socio-demographic variables were made obvious in many studies but the effects are not conclusive. Past behaviour can be a good predictor of later action. Many studies have focused on habitual or repeated behaviour in the prediction of behaviour in a number of everyday life situations. Studies related to farmer's behaviour have been shown to be a significant predictor of intentions (Fielding et al., 2008) and have one of the largest impacts on their future behaviour (Wheeler et al., 2013). Not only can that, farmers' past behaviour can be regarded as antecedents of their future behaviour to some extent.

Focusing on the aims of the present study, several studies related to farmers' responses to water transfer and water pricing were reviewed. Although these two issues have drawn widespread concern, little empirical evidence was found of expected farmer behaviour under major changes to water policies. Considering the complexity of farmers' behaviour, all influential factors should be considered for understanding and predicting it. Studies of the influences of farm household and farm business characteristics were reviewed. The literature shows clearly that farmers' behaviour are influenced by household characteristics, such as family life cycle, and family size, and also influenced by farm business characteristics, such as size of farm business, trajectories of farm business, and

successor plan. Again, most effects of these household and farm characteristics have not been found to be conclusive.

Studies related to farmers' responses to water transfer and water pricing were reviewed.

In previous studies, not enough attention has been paid to the influence of farmers' values and attitudes. It is hard to find studies from an interdisciplinary perspective, especially studies that explore the influence of values on farmers' responses to water transfer and water pricing.

This chapter shows that farmers' behaviour is very complex because of the nature of the farming business. In order to better understand farmers' behaviour and behavioural intentions, more influential factors, including values and attitudes, family and farm characteristics, and past behaviour, need to be considered. However, comprehensive, interdisciplinary and integrative studies are rare. With increasing awareness of environmental issues and worldwide attention on potential water shortages, many reforms related to water policy have been promoted or launched around the world.

Comprehensive understanding of farmers' behaviour, especially their behavioural intentions to water policy changes, is an urgent need and of significant importance.

Chapter Four Conceptual Framework and Methodology

4.1 Introduction

The literature review of the previous chapter showed that farmers' behaviour is very complex. In order to better understand farmers' behaviour and behavioural intentions, more influential factors, including values and attitudes, personal, family and farm characteristics, and past behaviour, need to be considered. It also argued that comprehensive, interdisciplinary and integrative studies are rare, and the influence of each of these kinds of factors is unclear and sometimes conflicting. This means that farmers' behaviour and behavioural intentions remains insufficiently understood.

With reforms related to water policy promoted or launched around the world, there is an urgent need for a better understanding of farmers' behaviour, especially their behavioural intentions to possible water policy changes, in order to lead to better policy design and more successful policy implementation. However, the knowledge of farmers' behaviour and behavioural intentions is far behind the actual needs. Previous studies have shown that policy makers and water managers' lack of understanding of what drives irrigators' behaviour have been major reasons why many previous attempts to facilitate water sharing have met vocal opposition (Bjornlund et al., 2013a).

Alberta, especially the southern part of the province, is facing chronic water problems. It is also home to most of Canada's irrigated agriculture, and is a national pioneer in reforming water policy. Based on the above theoretical and practical needs, this study was designed to focus on Alberta's irrigators. Taking Alberta's irrigators' responses to water policy reform as an example and using first-hand investigation, this study aims to

explore the factors that influence farmers' behavioural intentions. Understanding Alberta's irrigators' reactions to water policy reforms not only provides guidance for local policy design and implementation, it also provides a case study to other areas that face water shortages.

This chapter presents the conceptual framework and hypothesised relationships that emerge from the proposed framework. To gain a better and more complete understanding of irrigators' behavioural intentions towards water policy changes, the present study introduces a general conceptual model that synthesizes previous research findings. Five components, including values and attitudes, individual, family and farm characteristics, and past behaviour are included in the proposed model to examine their influences on farmers' possible responses to water policy reform. They are discussed in detail in section 4.2. Also, the measurement of values and attitudes and the relation between values and attitudes are presented in that section.

As discussed in the previous chapter, farmers' behaviour is complex; the proposed model in this study includes multiple outcome variables and observed and unobserved variables. Structural Equation Modelling (SEM) is a large set of techniques based on the general linear model and has become increasingly popular in recent years (Ullman, 2006). Considering the main features of the conceptual model, SEM was chosen as the main statistical method to estimate and assess the model in this study. The basic concepts of SEM and its practical considerations are reviewed in section 4.3.

Several computer programs specifically constructed for SEM are available for use and further development and revisions to SEM computer software. AMOS (Analysis of

MOment Structure) is one of the popular specialized SEM software programs (Byrne, 2001; 2010; 2012). With an easy-to-use graphical interface and a clear representation of models, and other advantages, such as extensive bootstrapping capabilities (Arbuckle, 2011; Byrne, 2010; 2012; Tabachnick and Fidell, 2007), AMOS is used in this study to estimate and assess the proposed models. In section 4.4, a brief introduction and graphical notation of AMOS is shown.

The last section of this chapter contains a short summary.

4.2 Conceptual Framework and Hypotheses

4.2.1 Global Conceptual Framework and Hypotheses

The conceptual model is illustrated in Boxes A to F, representing six aspects of the variables, in Figure 4-1. This conceptual framework has been influenced by many different authors, including Schwartz who proposed the dynamic relationships among ten types of values (Schwartz, 1992), Ajzen and Fishbein who developed the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) and the Theory of Planned Behaviour (TPB) (Ajzen, 1985; 1991), then improved them by adding a wide range of background factors into their model framework (Ajzen and Fishbein, 2005), and Ouellette and Wood who suggested that past behaviour can directly inform intentions for future responses (Ouellette and Wood, 1998). This conceptual framework has also gained from other comprehensive thoughts (e.g., Ahnström et al., 2009; Edwards-Jones, 2006).

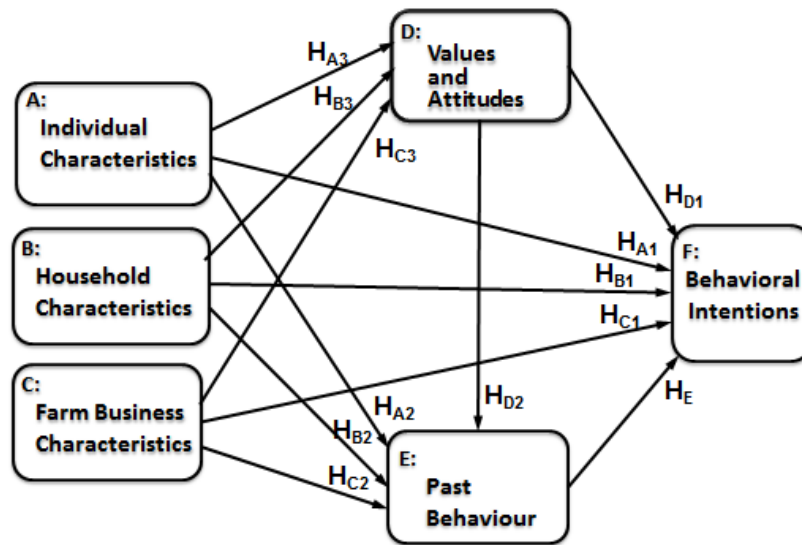


Figure 4- 1 Proposed Conceptual Model with Hypotheses Numbers

There are six boxes in the model. Boxes A, B, and C represent farmers' individual, household, and farm business characteristics, respectively. As discussed in Chapter Three, individuals' gender, age, education, and off-farm income and/or employment of farmers are often used to detect the influences on behaviour and behavioural intentions and are therefore included in box A. Considering the complexity of farmers' behaviour, farmers household and farm business characteristics also are believed to affect farming practices and farm decisions. The previous chapter detailed the variables that have been used as household and farm business characteristics to examine the influence on farmers' behaviour. There is no clear boundary between variables for household and farm business characteristics. Some variables clearly overlap to some extent. For example, active farm development seems more likely to occur early in both the family life cycle and enterprise cycle (Smithers and Johnson, 2004). In the present study, size of household, average age of family members, and off-farm work status of farm operator's spouse are considered as

components of Box B. The farm's size, trajectories of farm business development, successor plans, and the number of generations the family has owned the farm are considered as components of Box C. All the information required of farmers' individual, household, and farm business characteristics can be quantified and collected directly from the farmers through a farm survey.

Box D represents farmers' values and attitudes. Unlike, the data on farmers' individual, household, and farm business characteristics, these cannot be measured directly. The previous chapter noted that values are often assessed by asking people to rank or rate the importance of their values and attitudes, that is, by asking people to directly self-assess an attitude object by checking a numeric response on single or multiple indicators. Based on the aims of this study, some twenty value indicators and nine attitude indicators were selected and designed to collect information that represent farmers' values and attitudes. The detail on the indicators of values and attitudes and their relationships are discussed in the following section.

Box E represents farmers' past behaviour. Since the present study focuses on irrigators' responses to water policy reform, farmers' past behaviour in the model focuses only on the farming practices related to irrigation, that is, the irrigation equipment farmers currently use and whether farmers improved their irrigation equipment in the past five years. These two aspects of farmers' past behaviour are components of Box E.

Box F represents the behavioural intentions in the model. The present study aims to gain a better and more complete understanding of irrigators' behavioural intentions towards water policy changes. Considering the reality of Alberta' water policy reform, which was

discussed in Chapter Two, four behavioural intentions were chosen: (1) intention to agree that “water pricing should be based on actual and recorded volume of water used” (BI_1), (2) intention to “be willing to transfer some water that, historically, you have not used” (BI_2), (3) intention to “make any changes to your irrigation equipment in the next five years” (BI_3), and (4) intention to agree that “increasing the price of water will not reduce the use of water for irrigation” (BI_4). BI_1, BI_2, and BI_4 were measured by asking respondents to self-report a numeric response. BI_3 was measured simply by a yes or no.

In Figure 4.1, one-way arrows indicate the direction of dependence between two variables. Five sets of variables (individual, household, and farm business characteristics, values and attitudes, and past behaviour) are expected to have direct effects on behavioural intentions. Four sets of variables (individual, household, and farm business characteristics, values and attitudes) also are expected to have direct effects on past behaviour; and three sets of characteristics (individual, household, and farm business) are expected to have direct effects on values and attitudes. Some characteristics might also have indirect effects on behavioural intentions. For example, all personal, household, and farm characteristics might have effects on behavioural intentions through values and attitudes, as well as through past behaviour. The hypotheses for the relationships in the model are presented in Table 4-1.

4.2.2 Nested Models of Values and Attitudes

Conceptual Model of Values and Attitudes

Both values and attitudes are psychological concepts but they are not the same. Values are potential determinants not only of behaviour but also of attitudes. Therefore, inside Box D, values are expected to influence attitudes.

Table 4- 1 List of the Hypotheses

Name	Statement	Path
H_{A1}	Farmers' response intentions to possible water policy changes are associated with individual characteristics	A → F
H_{B1}	Farmers' response intentions to possible water policy changes are associated with household characteristics	B → F
H_{C1}	Farmers' response intentions to possible water policy changes are associated with farm business characteristics	C → F
H_{D1}	Farmers' response intentions to possible water policy changes are associated with their values and attitudes	D → F
H_{E1}	Farmers' response intentions to possible water policy changes are associated with past behaviour	E → F
H_{A2}	Farmers' past behaviour is associated with individual characteristics	A → E
H_{B2}	Farmers' past behaviour is associated with household characteristics	B → E
H_{C2}	Farmers' past behaviour is associated with farm business characteristics	C → E
H_{D2}	Farmers' past behaviour is associated with values and attitudes	D → E
H_{A3}	Values and attitudes are associated with individual characteristics	A → D
H_{B3}	Values and attitudes are associated with household characteristics	B → D
H_{C3}	Values and attitudes are associated with farm business characteristics	C → D

In this study, three sets of farmers' general attitudes are expected to influence farmers' response intentions to possible water policy changes (Attitudes to Land Attachment (ALA), Community Cohesion (ACC), and Farming Business (AFB)). Considering that attitudes cannot be measured directly, nine questions, three for each attitude, were

chosen: (1) for ALA the following questions were used: “Having land to pass down to future generations is more important than selling it for the highest price” (ALA_1); “You feel a responsibility to keep your land in the family” (ALA_2); and “Land is the most important heritage of the family” (ALA_3); (2) for ACC the following questions were used: “Rural communities are a great place to live and raise a family (ACC_1)”, “The lifestyle that comes with living in a rural area is very important to your family (ACC_2)”, and “You are active and willing to undertake activities in the community” (ACC_3); and (3) for measuring individual’s attitude to farming business, AFB the following questions were used: “A maximum annual net financial return from your farm is an important goal for your family” (AFB_1), “Increasing the asset value or net worth of your farming operation is very important to your family” (AFB_2), “You view your farming operation as first and foremost a business investment” (AFB_3).

Inside Box D, values are expected to have direct effects on Attitudes to Land Attachment (ALA), Community Cohesion (ACC), and Farming Business (AFB). The nested conceptual model of values and attitudes is illustrated in Figure 4-2.

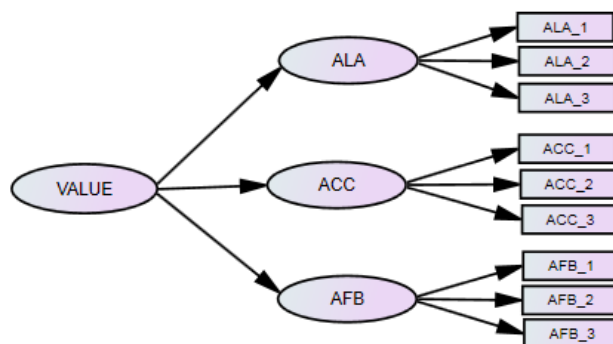


Figure 4- 2 Proposed Conceptual Model of Values and Attitudes

Measurement of Values

Based on the discussion in the previous chapter, compared to attitudes, values are more abstract and less specific; therefore, they are more difficult to measure. Schwartz's Value Survey (SVS) was used as the basis to measure farmers' values. In order to decrease respondents' workload, twenty value indicators were derived from Schwartz's list of values (Schwartz and Bilsky 1987, 1990; Schwartz 1992, 1994) and are shown in Table 4-2. These value indicators are from five types of values (Universalism, Benevolence, Self-direction, Power and Achievement), which are expected to be important for farmer and environmental studies.

Although twenty value indicators can be classified into five types by following Schwartz's Value Theory (Schwartz and Bilsky 1987, 1990; Schwartz 1992, 1994), the safer approach is using exploratory factor analysis (EFA) to find unobserved variables (also called latent variables, constructs, or factors) that influence observed variables (also called indicators, or items). As noted by Bolen (2002: 615) "In exploratory factor analysis, the factors are extracted from the data without specifying the number and pattern of loadings between the observed variables and the latent factor variables". There are three reasons that encourage the use of EFA instead of directly employing Schwartz's value types: (1) values are too abstract and too specific to be judged by subjective deduction; (2) twenty value indicators are only part of Schwartz's Value List; and (3) EFA is beneficial to determine the optimal choice of indicators, for example, the weakest indicator can be found and excluded.

Table 4- 2 Twenty Value Indicators Used in the Study

Name*	Value Indicator	Type
VI_16	Curious (interested in everything, exploring)	Self-direction
VI_18	Freedom (freedom of action and thought)	
VI_4	Choosing own goals (selecting own purposes)	
VI_19	Independent (self-reliant, self-sufficient)	
VI_15	Self-respect (belief in one's own worth)	
VI_1	Protecting the environment (preserving nature)	Universalism
VI_3	Unity with nature (fitting into nature)	
VI_17	A world of beauty (beauty of nature and the arts)	
VI_6	Broad-minded (tolerant of different ideas and beliefs)	
VI_14	Social justice (correcting injustice, care for the weak)	
VI_8	Equality (equal opportunity for all)	
VI_7	Inner harmony (at peace with myself)	
VI_12	Responsible (dependable, reliable)	Benevolence
VI_9	A spiritual life (emphasis on spiritual not material matters)	
VI_2	True friendship (close, supportive friends)	
VI_20	Meaning in life (a purpose in life)	
VI_5	Wealth (material possessions, money)	Power and Achievement**
VI_10	Authority (the right to lead or command)	
VI_13	Social recognition (respect, approval by others)	
VI_11	Successful (achieving goals)	

Source: Selected from Schwartz (1992).

Note: * The names of value indicators are based on the random order used in the questionnaire.

** Power and Achievement are two separate types of value, but they can be united into desire for social superiority and esteem (Schwartz, 1992).

The confirmed latent variables of values and attitudes subsequently were used in further analysis along with all other observed variables in the structural model, which is described in detail in Chapter Seven.

4.3 Statistical Methods and Structural Equation Modelling (SEM)

4.3.1 Hypothesized Model and SEM

Based on the above description, the hypothesized model used in this study has two main features. First, there are four outcome variables in the model. The reform of water policy

is a complicated systematic work that involves many actions. There is no way to fully understand farmers' responses by exploring only one response intention. Four response intentions can provide a better understanding although even that many might not resolve all the issues. Second, there are observed and unobserved variables simultaneously in the model. This study examines the influence of values and attitudes on behavioural intentions. They need to be measured indirectly by several observable indicator variables (value and attitude indicators).

Structural equation modelling (SEM) is a second generation data analysis technique, which can be regarded as a generalization, integration, and extension of familiar techniques such as analysis of variance (ANOVA), multiple regression analysis, and factor analysis (Hoyle, 2012a). SEM enables researchers to answer a set of interrelated research questions in a single, systematic, and comprehensive analysis by modelling the relationships among multiple independent and dependent constructs simultaneously (Gefen et al., 2000). It allows researchers to simultaneously estimate the relationships between observed and unobserved variables and the relationships among unobserved variables. It also allows researchers to simultaneously include both continuous and categorical observed and latent variables (Hoyle, 2012a). Considering the main features of the conceptual model, SEM has been chosen as the main statistical method to test the hypothetical model.

4.3.2 Basic Concepts of SEM

Within Structural Equation Modelling (SEM), unobserved variables are termed latent variables, factors, or constructs. A latent variable or factor is measured indirectly through one or more observable indicator variables that reflect or form the factor.

A general SEM model often includes two kinds of sub-models, *measurement model* and *structural model*. The *measurement model* defines relations between a latent variable and observed indicator variables. When an SEM model includes only one kind, a measurement model, it is a confirmatory factor analysis model. The *structural model* defines relations among the latent variables and observed variables that are not the indicators of latent variables (Hoyle, 1995). When an SEM model includes only a structural model, it is a path analysis model. Both confirmatory factor analysis and path analysis can be considered as special SEM cases.

As in path analysis, independent and dependent variables are termed exogenous and endogenous variables in SEM. Exogenous variables represent the variables that exert an influence on other variables and are not influenced by other variables in the model; endogenous variables represent the variables that are affected by exogenous and other endogenous variables in the model. Exogenous and endogenous variables can be observed or latent variables.

In general, SEM analysis includes five steps: model specification, data preparation, model estimation, evaluation, and (possibly) model modification. The practical considerations of each step are discussed in the following sub-sections.

4.3.3 Model Specification

The use of SEM always begins with model specification, the process by which the researcher creates a hypothesized model to explain the relationships among multiple variables and converts the model to multiple equation path diagrams. This process is theory driven and the model is built based on findings in the literature, knowledge in the field, or one's educated guesses (Lei and Wu, 2007). From the selection of variables to the designation of relationships between them and the specification of the parameters' association with those relations, a series of thoughtful decisions need to be made for the specification of a model (Hoyle, 2012). Several key issues need to be considered in this process, including: what to include in the model, how to measure the hypothetical construct, directionality, model complexity, and parameter status (Kline, 2011).

The fundamental concern in specification is model identification. Each parameter in a specified model must be identified and produce a unique set of parameter estimates (that are just identified). The researcher also needs to indicate which parameters will be estimated from the data, which parameters will be set to a specific numerical value, usually 0 or 1, and which parameters will be estimated from the data, but must hold a specified mathematical relation to one or more other parameters in the model.

One important issue in the requirements for identification concerns the number of indicators per factor. Because too few indicators per factor may produce unstable solutions and lead to failures of programs to converge, some researchers advocate using at least three indicators per factor (Bagozzi and Yi, 2012; Kline, 2013). However, adding more indicators may not be feasible in practice, and some latent variables may have only a limited number of measures or even a single indicator available by design or other constraints (Anderson and Gerbing, 1988; Bagozzi and Yi, 2012). As a result, a factor

with a single indicator fails to take into account measurement error in tests of hypotheses. Even so, it is still able to achieve advantages over first-generation procedures by SEM (Bagozzi and Yi, 2012). After all, as Bagozzi and Yi (2012, p16) noted, “researchers using multiple regression, ANOVA, and other first-generation statistical methods were forced to use single indicators per variable”.

Ideally, prior to estimation, researchers verify that all parameters are identified (Hoyle, 2012a; 2012b). If a model cannot be identified, either some model parameters cannot be estimated (under-identified) or numerous sets of parameter values can be produced (over-identified), model re-specification is needed. Most statistics textbooks provide common guidelines for researchers to handle these types of issues (e.g., Kline, 2011; Hoyle, 2012; Tabachnick, and Fidell, 2007).

4.3.4 Data Preparation

Once the model is specified, data must be prepared for the analysis. Based on the assumptions of SEM, three main issues about the data (sample size, missing data and multivariate normality) need to be addressed.

Sample Size

SEM is a large sample technique. Bigger is always better. If the sample size is not large, some statistical estimates in SEM, such as standard errors, may not be accurate, and the probability of technical problems in the analysis is greater (Kline, 2011). Plenty of studies focus on sample size and try to find an appropriate minimum sample size (e.g., Bentler and Yuan, 1999; Hoyle, 1999; Jackson, 2001; 2003; MacCallum et al., 1996;

Tanaka, 1987). However, there is no number that can be phrased as ‘large enough’ (Jackson, 2003).

Generally, a good rule of thumb is that the minimum sample size should be no less than 200. Some authors even suggest that SEM analyses based upon samples of less than 200 should not be accepted for publication (Barrett, 2007). However, Iacobucci (2010) argued that 200 is surely simplistic. She assumed that if the measurement is with good reliabilities, each factor has 3 or 4 indicators, and the structural path model is not overly complex, then samples of size 50 or 100 can be plenty.

Other recommendations suggest that determining sample size should depend on the number of variables used in an analysis (e.g., Bentler and Chou, 1987) or desired level of power (MacCallum et al., 2006). Models with more parameters to be estimated require larger samples. The ratio of cases per parameter is the most common method to determine sample size in SEM (Kline, 2011). Bentler and Chou (1987) suggested that cases per parameter estimate can be as low as 5 but 10 is more appropriate. Jackson (2003) suggested that cases per parameter estimate of 20 to be ideal. However, Bagozzi and Yi (2012) argued this was conservative advice. They found that satisfactory models have been obtained with ratios near 3:1, even close to 2:1 on occasion (Bagozzi and Yi, 2012).

MacCallum et al. (1996) presented tables for minimum sample size requirements with selected levels of model degrees of freedom. They indicated that if the model has high degrees of freedom, adequately powerful tests of fit can be carried out with moderate sample size. For example, a minimum sample size of 132 can achieve power of 0.80 for

the test of close fit when the degrees of freedom is 100, but the minimum sample size needs to be 214 when the degrees of freedom is 50.

Although there is still no consensus about minimum sample size in SEM applications, SEM models can perform well even with small samples, especially when the measurements have good reliabilities and the model has large degrees of freedom. As Bagozzi and Yi (2012, p29) pointed out, “The distributional properties of measures are important, not sample size or ratios of sample size to free parameters, per se.”

Normality

Most techniques used in SEM assume multivariate normality to obtain robust results. Violating this assumption can be problematic. Lei and Lomax (2005) found that the degree of non-normality plays a more important role than sample size and estimation method for parameter estimates. The effect of non-normality on SEM depends on its extent and source: the greater the extent of non-normality, the greater the magnitude of the problem (West et al., 1995).

Identifying whether or not the assumptions for multivariate normality are met is a big concern in the application of SEM. However, it is often impractical to examine multivariate normality (Kline, 2011; Weston and Gore, 2006). One common solution is to examine univariate distributions for each observed variable instead of trying to detect multivariate non-normality. Kline (2011) pointed out that many instances of multivariate non-normality can be detected by screening for univariate normality. Skewness and kurtosis are often used to examine univariate normality. Although the multivariate normality requirement appears to never be achieved exactly with raw empirical data (Gao

et al., 2008), it seems that SEM estimations with maximum likelihood (ML) are quite robust against the violation of normality (Chou et al., 1991; Fan and Wang, 1998; Hu et al., 1992). Moderate non-normality has quite negligible effects on parameter estimates by ML (e.g., Finch et al., 1997). Accordingly, testing skewness and kurtosis of every variable in the study is a common way to detect whether or not the assumptions for multivariate normality are met.

A rule-of-thumb suggests that if skewness is larger than 2 or kurtosis is larger than 7, the variable suffers from severe non-normality (Fabrigar et al., 1999; West et al., 1995).

Kline (2011) recommended using more precise measures of skewness index (SI) and kurtosis index (KI) to detect severe non-normality. It has been suggested that “Variables with absolute values of $SI > 3.0$ are described as ‘extremely’ skewed”; and “absolute values of $KI > 10.0$ suggest a problem, and absolute values of $KI > 20.0$ indicate a more serious one” (Kline, 2011: 63).

If non-normality is severe, remedies should be employed to normalize the distributions by using measures such as non-linear transformations (Kline, 2011; West et al. 1995). Some studies (e.g., West et al. 1995) and textbooks (e.g., Kline, 2011) provide detailed guidance for transforming data in order to increase normality. Most common transformations include square root, logarithm, and inverse functions. Generally, when data are in moderately positive skewed distributions, taking square root transformations will help achieve approximate normality; when data are more than moderately positive skewed, taking logarithmic transformations will be helpful; and when data are severely positive skewed, taking inverse transformations might be the way to increase the level of

normality (Kline, 2011). Suggestions for the transformations of other types of non-normality data are also provided by Kline (2011) and West et al. (1995) in detail.

Although transformations of some variables can help non-normal distributions to approximate normality, they make the model more difficult to interpret and might still fail to result in normality (Gao et al., 2008). As Gao et al. (2008) reminded, researchers must find the best balance between the level of non-normality and transformations of some variables.

Missing Data

Conventional statistical methods and software presume that all variables in a specified model are measured for all cases. Missing data can create problems for the estimation of models. Both methods for handling missing data and effects of missing data have received a lot of research attention.

First, the selection of methods for handling missing data is very important. The use of inappropriate methods for handling missing data can lead to bias in parameter estimates, standard errors and test statistics, and inefficient use of the data (Kline, 2011). Following Vriens and Melton (2002), Kline (2011) divides methods of dealing with missing data into four categories: available case methods, single-imputation methods, model-based imputation, and special form of maximum likelihood (ML) estimation for incomplete data.

Available case methods and single imputation are termed “classical” (Kline, 2011) or “conventional” (Allison, 2003) techniques. Available case methods, including listwise and pairwise deletions, are the simplest techniques. Listwise deletion simply deletes all

cases with missing data so it leads to a loss of sample size. Pairwise deletion excludes missing cases only when their corresponding variables are involved in a particular analysis, so it leads the numbers of cases to be different for different variables and causes out-of-bounds covariance or correlations (Kline, 2011). Both listwise and pairwise deletions may produce biased estimates and thus “leave much to be desired” (Allison, 2003, p555). Single-imputation methods include mean substitution and regression-based substitution that replace each missing score with a single calculated score. The simplest method is unconditional mean imputation; a more sophisticated single-imputation technique is regression-based imputation. All single-imputation methods tend to underestimate error variance (Vriens and Melton, 2002; Kline, 2011) so are not recommended as a method for imputing missing data in SEM.

Model-based imputation methods and special forms of ML estimation for incomplete data are more complicated. Model-based imputation methods can generate more than one estimated score for each missing observation, so it is also known as multiple imputations (Kline, 2011). Although the technical advantages of multiple imputations are unarguable, it is also the most complex, computer-intensive method and it is difficult to combine data sets for analysis after the multiple data sets have been generated (Schlomer et al., 2010). Direct maximum likelihood (ML) estimation, which is Kline’s (2011) fourth category of methods, is known as “raw” ML or “full information” ML method (Allison, 2003). Both MI and Direct ML can provide acceptable estimates of regression coefficients and standard errors (Schlomer et al., 2010). However, the chief disadvantage of MI is that it does not produce a determinate result (Allison, 2003). Direct ML, on the other hand, produces a determinate result (Allison, 2003). Not only that, it is available in several

SEM computer tools that are easy to use (Allison, 2003; Kline, 2011). For example, the computer software of AMOS can automatically recognize missing data and use ML estimation for incomplete data (Byrne, 2010). Also obviously, Direct ML yields less biased estimates than do the other classical techniques when the data has non-random missing values (Kline, 2011). Therefore, Direct ML appears to be the best method for handling missing data for most SEM applications (Allison, 2003; Duncan et al., 1998). Second, missing data can lead to a biased conclusion and its skewness depends on both the amount and pattern of missing values. Therefore, the pattern and amount of missing data always need to be addressed.

The patterns of missingness have been divided into missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR)². These have been discussed in detail by most literature related to missing data (e.g., Allison, 2003; Byrne, 2010; Kline, 2011; Schlomer et al., 2010). Schlomer et al. (2010) also presented a guide to distinguish each of them. Compared with the assumption of MCAR for conventional methods, a weaker assumption of MAR is required for Direct ML (Allison, 2003). Direct ML has been shown to yield acceptable estimates of regression coefficients and standard errors for randomly missing data (both MCAR and MAR) (Schlomer et al., 2010).

² Many conventional methods require that data with missing values are missing completely at random (MCAR) (Allison, 2003; Little and Rubin, 1989). According to Allison's (2002, 2009) definitions, if missingness of the missing values does not depend on the values of any other variables in the data set, or on the potentially missing values themselves, the missing data are MCAR; if missingness of the missing values does not depend on the potentially missing values themselves, the missing data are MAR. MAR allows missingness to depend on things (variables) that are observed. A special case of MAR is MCAR. On the other hand, if the MAR assumption is violated, the data are called to be not missing at random (NMAR) (Allison, 2002; 2009).

Generally, a few missing values, such as less than 5% of a single variable, is of little concern, especially for data missing at random (Kline, 2011). Schlomer et al. (2010) illustrated that Direct ML can produce acceptable results with up to 20% missing data. Furthermore, Byrne (2010) compared output results for complete and incomplete data using AMOS. She found that both the parameter estimates and the goodness-of-fit statistics are similar from samples of complete data and 25% missing data.

In short, missing data is an important issue in the application of structural equation modelling (SEM). Direct maximum likelihood (ML) is a well recommended method to handle missing data in SEM. Structural equation modellers have a particular advantage in using ML for handling missing data (Allison, 2003) as some computer tools, such as AMOS, automatically deal with missing data. Direct ML can yield acceptable results for most data (both MAR and MCAR) even for samples with relatively high percentage of data that are missing.

4.3.5 Model Estimation

Following model specification and preparation of the data for analysis, the SEM must be estimated. “The goal of estimation is to find values for the free parameters that minimize the discrepancy between the observed covariance matrix and the estimated, or implied, covariance matrix given the model and the data (Hoyle, 2012a: 9)”. SEM software programs provide all estimates automatically. However, several decisions need to be made by the researchers in the estimation stage. The main ones include which estimation method should be used and how many steps should be used (one, two or four steps) in the estimation.

Several methods can be used for estimation, including maximum likelihood (ML), unweighted least squares, generalized least squares (GLS), weighted least squares (WLS), and asymptotic distribution free (ADF) (Hoyle, 2012a; Weston and Gore, 2006). Studies have compared the performance of different methods; for example, Sugawara and MacCallum (1993) compared ML, GLS, ADF, and ordinary least squares (OLS); Ding et al. (1995) and Fan et al. (1999) compared ML and GLS; Hu and Bentler (1998) compared ML, GLS, and ADF; Olsson et al. (2000) compared ML, GLS, and WLS. Among all the methods, ML estimation is currently the most commonly used method (Anderson and Gerbing, 1988; Hoyle, 2012a) and the default in most SEM computer programs (Byrne, 2010; Hoyle, 2012a; Kline, 2011; Ullman, 2006). Ullman (2006) claimed ML is a good choice even with non-normality or suspected dependence among factors and errors, but only if the sample size is larger than 120.

Considering those obvious advantages, maximum likelihood (ML) was chosen as the method for the model estimations for this study.

SEM has an advantage in that both measurement and structural models can be estimated at the same time; in other words, the process of estimation can be implemented in one-step. However, if researchers are not confident that the measures represent the constructs of interest, there is little reason to use them to examine the structural relationships (Hair et al., 2011). A valid measurement model is needed before it makes sense to evaluate the structural part of the model (Kline, 2011). Accordingly, it might be useful to separate measures of fit into parts corresponding at least to these two major components (McDonald and Ringo Ho, 2002).

One well-known method is the Anderson and Gerbing (1988) two-step approach (Kline, 2011). Anderson and Gerbing (1988) suggested that confirmatory factor analysis should be used to test the measurement models before estimating the full structural model. Researchers can make re-specifications in the first step to achieve acceptable measurement models. After re-specification of measurement models (if necessary), researchers turn to the second step to test the full structural model by estimating expected directional associations among latent variables (Anderson and Gerbing, 1988). Another method, the Mulaik and Millsap (2000) four-step procedure, also has been recommended (Kline, 2011; Weston and Gore, 2006). However, the two-step procedure is simpler, does not require more than four indicators per factor (Kline, 2011), and is more widely recommended and used in the process of SEM estimation (Anderson and Gerbing, 1988; Kline, 2011, Hair et al., 2011; McDonald and Ringo Ho, 2002; Weston and Gore, 2006). Following the Anderson and Gerbing (1988) two-step approach, this study used confirmatory factor analysis for values and attitudes (discussed in Chapter Six) before the estimation of the full structural model (discussed in Chapter Seven).

4.3.6 Model Evaluation and Modification

Once model parameters have been estimated, the implementation proceeds to evaluation, one of the most important steps in structural equation modelling. The objective of evaluation is to determine whether the specified model offers an acceptable account of the data or should be rejected or re-specified.

Goodness of Fit of the Model

Because of the critical importance of the decision to accept or reject a specified model, an abundance of indices has been developed as measures to describe how well the statistical model fits the observed data (e.g., Bentler, 1990; Browne and Cudeck, 1993). Fit indices are distinguished mainly as “absolute fit” and “incremental fit” by SEM scholars.

Absolute fit indices provide the most fundamental indication of how well the proposed theory fits the data (Hopper et al., 2008). Incremental fit indices are also known as comparative or relative fit indices, which capture the relative goodness-of-fit, or the fit of one's hypothesized model as an empirical increment above a simpler model (in particular, one in which no paths are estimated) (Iacobucci, 2010).

Among the absolute indices, the χ^2 and Root-Mean-Square Error of Approximation (RMSEA) are the two most commonly reported measures (Jackson et al., 2009). The χ^2 was originally developed to serve as a criterion for model evaluation (Hu and Bentler, 1998). It is the most direct and obvious test of model fit and the only statistical test for SEM models at the moment (Bagozzi and Yi 2012; Barrett, 2007). A smaller χ^2 , relative to its degrees of freedom, suggests that the model fit the data better. An insignificant χ^2 suggests the model fits the data well. However, a χ^2 may not be a reliable guide to model adequacy (Hu and Bentler, 1998) because it is almost always significant (indicating a poor fit) (Iacobucci, 2010). This is why many alternative measures of fit were developed and recommended as plausible additional measures of model validity (Hu and Bentler, 1998). RMSEA is the one absolute fit index that is highly recommended, especially by MacCallum and Austin (2000). RMSEA represents the degree to which lack of fit is due to misspecification of the model versus being due to sampling error. It is sensitive to model misspecification (Hu and Bentler, 1998) and can build confidence intervals to

assess the precision of RMSEA estimates. Standardized Root Mean Square Residual (SRMR) also is an important absolute index and is highly recommended (e.g., Hu and Bentler, 1998, 1999). The SRMR index is based on covariance residuals, and indicates how much difference exists between the observed data and the model (Weston and Gore, 2006). SRMR is relatively less sensitive to violations of distributional assumptions (Iacobucci, 2010).

Unlike absolute indices, other types of fit indices concern the issue of comparing a target model with a restrictive baseline model, e.g., an independent model. Normed Fit Index (NFI) is the first incremental fit index introduced by Bentler and Bonnet (1980). NFI assesses the model by comparing the χ^2 value of the model to the χ^2 of the null model that is the worst case scenario as it specifies that all measured variables are uncorrelated (Hooper et al., 2008). NFI is influenced by sample size and has shown a tendency to underestimate fit for samples less than 200 (Bentler, 1990; Hooper et al., 2008; Mulaik et al., 1989). Revising the NFI to take sample size into account, Bentler (1990) proposed an improvement in measurement of fit in the Comparative Fit Index (CFI). Comparing the NFI and CFI, the CFI should be the index of choice (Bentler, 1990). Other indices, for example TLI and RNI, also are incremental fit indices; more detail and discussion on these can be found in Hu and Bentler's (1998) work. Among them, Comparative Fit Index (CFI) is the most commonly reported (Hopper et al., 2008; Jackson et al., 2009; McDonald and Ringo Ho, 2002).

Many scholars have discussed the issue of fit indices (e.g., Bagozzi and Yi, 1988; Barrett, 2007; Bentler, 1990; Bentler and Bonett, 1980; Bollen and Liang, 1988; Chen et al., 2008; Fan et al., 1999; Hooper et al., 2008; Hu and Bentler, 1998, 1999; Iacobucci, 2010;

Kenny and McCoach, 2003; Marsh et al., 1988; Rigdon, 1996; Schermelleh-Engel et al., 2003). Although χ^2 may not be a reliable guide to model adequacy (Hu and Bentler, 1998), it is the most fundamental in some ways (Bagozzi and Yi 2012). Kline (2011, p 291) emphasizes to “Always report the model chi-square and its p value for all models tested.” Besides, RMSEA, NNFI, CFI and SRMR are the generally recognized and recommended practical fit indexes (Bagozzi and Yi, 2012).

There are no golden rules for assessment of model fit (Hooper et al., 2008) and no single ‘magic’ value for the fit indices that can separate good from poor models (Hair et al., 2010). For assessing a model, it is widely suggested that multiple criteria, including both aforementioned types, should be taken into consideration to evaluate model fit simultaneously (e.g., Bollen and Long, 1993; Byrne, 2010; Hu and Bentler, 1998, 1999; Jackson et al., 2009; Kline, 2011; Schermelleh-Engel et al., 2003). With ML and GLS methods, Hu and Bentler (1998) recommend “a two-index presentation strategy”, and use SRMR, with one of other indices, such as, TLI, RNI, CFI, or RMSEA.

Based on existing findings, χ^2 and the associated degrees of freedom, SRMR, RMSEA, and CFI were chosen as a set of evaluation measures in this study. Some general rules for acceptable fit give guidance on making decisions. The selected fit indices and their acceptable thresholds recommendations are demonstrated in Table 4-3.

Reliability and Validity of Measurement Models

Following a two-step process, the measurement model should be assessed before testing for a significant relationship in the full structural model, (e.g., Fornell and Larcker, 1981; Hair et al., 2011). As discussed in the previous section, a confirmatory factor analysis

model (CFA) model can be regarded as a special SEM model. The above guidelines also apply to the assessment of measurement models.

Table 4- 3 Selected Fit Indices and General Rules for Acceptable Fit

Fit Index	Shorthand	General Rule for Acceptable Fit
Chi-Square	χ^2	p-values: ≥ 0.05 (Bagozzi and Yi, 2012) p-values: significance expected (Hair et al., 2010)* p-values: 0.05~ 1.00 for Good Fit; 0.01 ~ 0.05 for acceptable fit (Schermelleh-Engel et al., 2003)
Relative Chi-Square	χ^2 / df	≤ 2 or 3 (Schreiber et al., 2006) 0 ~ 2 for Good Fit; 2 ~ 3 for acceptable fit (Schermelleh-Engel et al., 2003)
Standardized Root Mean Square Residual	SRMR	≤ 0.07 (Bagozzi and Yi, 2012) < 0.09 with CFI > 0.92 (Hair et al., 2010)* ≤ 0.08 (Hu and Bentler, 1999; Schreiber et al., 2006) 0 ~ 0.05 for good fit; 0.05 ~ 0.10 for acceptable fit (Schermelleh-Engel et al., 2003)
Root Mean Square Error of Approximation	RMSEA	≤ 0.07 with SRMR ≤ 0.07 (Bagozzi and Yi, 2012) < 0.08 with CFI > 0.92 (Hair et al., 2010)* ≤ 0.06 (Hu and Bentler, 1999); < 0.06 ~ 0.08 with confidence interval (Schreiber et al., 2006) 0 ~ 0.05 for good fit; 0.05 ~ 0.08 for acceptable fit (Schermelleh-Engel et al., 2003)
Comparative Fit Index	CFI	≥ 0.93 with SRMR ≤ 0.07 (Bagozzi and Yi, 2012) > 0.92 (Hair et al., 2010)* ≥ 0.95 (Hu and Bentler, 1999; Schreiber et al., 2006) 0.97 ~ 1.00 for Good Fit; 0.95 ~ 0.97 for Acceptable Fit (Schermelleh-Engel et al., 2003)

* Hair et al. (2010: 654) originally provided guidelines for using fit indices in six different situations based on sample size (two categories: $N < 250$ and $N > 250$) and number of observed variables (three categories: $m \leq 12$, $12 < m < 30$, and $m \geq 30$). Here is the guideline in one of the situations when the sample size is less than 250 and the number of observed variables is greater than or equal to 30.

However, the global goodness-of-fits indicate that a satisfactory model does not always mean certain parameters corresponding to hypothesized relations are significant and/ or all measurement models are good in reliability (Bagozzi and Yi, 1988). Factor loading (or,

individual-variable reliability), composite reliability (CR), and the average variance extracted (AVE) from a set of measures of a latent variable are often recommended to be examined (e.g., Bagozzi and Yi, 1988; Fornell and Larcker, 1981; Hair et al., 2011).

The size of the factor loading is one of the most fundamental assessments (Hair et al., 2011). Factor loadings are the weights and correlations between each variable and the factor. High factor loadings confirm that the indicators are strongly related to their associated factor (Hair et al., 2011). All factor loadings are required to be statistically significant (Hair et al., 2011). Individual variable reliabilities are referred to as squared multiple correlations in SEM (Bagozzi and Yi, 2012; Hair et al., 2011). Factor loadings are regarded as alternative assessments to individual-variable reliabilities because squared multiple correlations are a function of the factor loadings in the process of reliability estimation (Hair et al., 2011). Squared multiple correlation represents the extent to which an observed variable's variance is explained by a latent factor and how well an observed variable measures a latent factor. A rule of thumb suggests that factor loadings should be at least 0.5 or higher, and ideally 0.7 or higher (Hair et al., 2010). In a larger model, individual-variable reliabilities also can be relatively low at times even when the measurement models perform satisfactorily (Bagozzi and Yi, 2012). Bagozzi and Yi (2012) suggest focusing more on composite reliability.

Composite Reliability (CR) is a widely recommended estimation of reliability in SEM (e.g., Bagozzi, 1991; Fornell and Larcker, 1981; Hair et al., 2011). Because construct reliability assessment often focuses on composite reliability (Hair et al., 2011), some scholars also directly term composite reliability (CR) as construct reliability and use the

same acronym CR (e.g., Hair et al., 2010). CR can be computed using the factor loadings. Fornell and Larcker (1981) suggest that CR should be greater than 0.7 to be considered adequate, while Bagozzi (1991) believe that CR with a value greater than 0.6 is desirable. Values of CR below 0.6 indicate a lack of reliability (Hair et al., 2011). However, as individual-variable reliabilities can be relatively low at times in a larger model with satisfactory performance, cut-off values “might be taken with some leeway in mind. ... and indeed focus should be placed more on the hypotheses under tests in, and goodness-of-fit of, any SEM” (Bagozzi and Yi, 2012, p17).

It should be noted that Cronbach’s alpha has been shown to be “neither accurate nor a useful decision aid in the structural equation context” (Bacon et al., 1995, p403). Bagozzi and Yi (2012) suggest Cronbach’s alpha should not be used in SEM.

Average Variance Extracted (AVE) (Fornell and Larcker, 1981) is widely recognized (e.g., Bagozzi, 1991, Hair et al., 2011) as a criterion to examine a measurement model. “AVE is the average amount of variance in observed variables that a latent construct is able to explain” (Farrell, 2010, p325). It is commonly suggested that all latent factors should have an AVE of at least 0.5; AVE less than 0.5 is considered questionable (Fornell and Larcker, 1981). An AVE less than 0.5 indicates that, on average, less than 50% variance of observed variables can be explained by the latent factor or more than 50% error remains in the observed variables. In other words, if AVE is less than 0.5, then on average, more error remains in the observed variables than variance explained by the latent factor structure imposed on the measure (Hair et al., 2010).

Fornell and Larcker (1981) present a method for assessing the discriminant validity of two or more factors, that is, distinctiveness between factors (Hair et al., 2010). To fully satisfy the requirements for discriminant validity, two rules should be followed: (1) the AVE of each factor should be greater than its highest squared correlation with any other factors, and (2) a factor loading should be higher than all of its cross loadings (Fornell and Larcker, 1981; Hair et al., 2011).

As discussed in above section, using multiple criteria to assess a model is highly recommended. For assessing a measurement model, Bagozzi and Yi (2012) suggest that researchers should focus more on the hypotheses under tests in, and goodness-of-fit of, any SEM.

Model Modification

Following evaluation, re-specification of the model might be needed. Two types of information can be helpful in detecting model misspecification: standardized residuals and modification indices (Byrne, 2010).

Residuals represent the discrepancies between the restricted covariance implied by the hypothesized model and observed sample covariance (Byrne, 2010). The smaller the residuals, the better the fit. The standardized residuals are analogous to Z-scores. They represent estimates of standard deviations that the observed residuals are from the zero residuals (i.e., the residuals if model fit were perfect) (Byrne, 2010). A good model-data fit should have a large proportion of standardized residuals close to zero (Schermele-Engel et al., 2003). A large value of a standardized residual indicates that significant amounts of variance remain and suggests that a specification error might exist (Bagozzi

and Yi, 1988). Generally, absolute values larger than 2.58 (Jöreskog and Sörbom, 1993; Byrne, 2010), or 1.96 (or 2) (Bagozzi and Yi, 1988; Kenny, 2012) are considered to be large. Nevertheless, Kenny (2012) also pointed out that 1.96 tends to be conservative (i.e., too small).

Model modification indices (MI) are another type of information that can be helpful in detecting model misspecification. MI can be conceptualized as a χ^2 statistic with one degree of freedom (Byrne, 2010; Jöreskog and Sörbom, 1993). All freely estimated parameters have MI values equal to zero (Byrne, 2010). A large MI suggests that a large improvement can be expected. By freeing the parameter with the largest modification index the χ^2 will drop at least as far as the value of MI (Bagozzi and Yi, 1988). An MI greater than 3.84 ($p < 0.05$) or 6.63 ($p < 0.01$) suggests model modification might need to be considered (Bagozzi and Yi, 1988; Schermelleh-Engel et al., 2003). Byrne (2010) has shown in detail how to use this information to conduct model modifications in AMOS.

However, many scholars argue that model modification is controversial (e.g., Bagozzi and Yi, 1988; Field, 2000; Hair et al., 2010; Schermelleh-Engel et al. 2003). Model modification based on purely empirical grounds are ill advised (Field, 2000) and discouraged (Hair et al., 2010). Bagozzi and Yi (1988) suggest that models should not be modified unless there are some theoretical and/ or methodological reasons.

4.4 AMOS as an SEM Program

4.4.1 Brief Introduction to AMOS

A steady increase in the development and revision of alternative SEM computer software has occurred since the development of the first SEM program, LISREL in 1974 (Byrne,

2012). Eight computer programs are specifically constructed for SEM and these appear to be the main options. These are AMOS (*Analysis of Moment Structures*), CALIS (*Covariance Analysis and Linear Structural equations*), EQS (*Equations*), LISREL (*Linear Structural Relationships*), Mplus, Mx (*Matrix*), RAMONA (*Reticular Action Model or Near Approximation*), and SEPATH (*Structural Equation Modeling and Path Analysis*) (Byrne, 2012; Kline, 2011). In addition to the core analytic features, each program has its own special features. Kline (2011) provided a descriptive review of these eight SEM computer programs. Tabachnick and Fidell (2007) compared EQS, LISREL, AMOS, and CALIS in detail and listed all their features. Byrne (2012) made a comparative review of AMOS, EQS, LISREL, and Mplus, four of the most widely-used SEM computer programs. IBM SPSS AMOS is a program with an easy-to-use graphical interface for visual SEM (Arbuckle, 2011). It provides a clear representation of models and publication-quality path diagrams. It has become the first choice for those who prefer working graphically. In this study, AMOS 20.0 was chosen to estimate and evaluate the hypothesized models.







AMOS is a Microsoft Windows program and can be used either as a stand-alone application or an optional part of SPSS (Kline, 2011). It has undergone almost yearly revisions since Version 5 in 2003 (Byrne, 2012). At the time of writing this chapter, the latest version is AMOS 22 (Arbuckle, 2013). With AMOS, researchers can quickly specify, view, and modify their model graphically, assess the model's fit, make modifications, and obtain a publication-quality graphic of the final model (Arbuckle, 2011). Several notable features of AMOS include: (1) it has a special maximum likelihood (ML) method for automatically dealing with missing data; (2) it can analyse

mixture models with latent categorical factors; (3) it has the ability to produce bootstrapped standard error estimates and confidence intervals for parameter estimates; and (4) it has extensive capabilities for Bayesian estimation of model parameters.

4.4.2 Graphical Notation

AMOS has two main components: AMOS Graphics and AMOS Basic. AMOS Graphics permits the specification of models by diagram whereas AMOS Basic allows the model specification from equations. However, with an easy-to-use graphical interface (Arbuckle, 2011), most AMOS users work within the framework of AMOS Graphics (Byrne, 2012). In this study, only the graphical approach was used and that is the focus of the following discussion.

In structural equation models (SEMs), four geometric symbols schematically portray variables and relationships. They are:

- 1) Squares or rectangles represent observed variables (e.g.,  , 
- 2) Circles or ellipses represent unobserved latent variables (e.g.,  , 
- 3) Single-headed arrows represent the impact of one variable on another (); and
- 4) Double-headed arrows represent covariance or correlations between pairs of variables ().

Unlike most other SEM programs, in AMOS path diagrams, both error and residual variables are also represented by circles since they are also unobserved (Byrne, 2010).

Figure 4-3 illustrates an example of a general SEM in AMOS. SD_1 to SD_4, BE_1 to BE_3, and AFB_1 to AFB_3 are ten observed variables and they are represented by

rectangles. Self-Direction (SD), Benevolence (BE) and Attitude to Farming Business (AFB) are three unobserved latent variables and they are represented by ellipses. SD_1 to SD_4 are indicator variables of SD, BE_1 to BE_3 are indicator variables of BE, and AFB_1 to AFB_3 are indicator variables of AFB. Ten error terms (err1 to err10) are associated with ten observed variables, respectively, and they are represented by circles. A residual term, named resid1 in Figure 4-3, also is represented by a circle.

The single-headed arrows that point from a latent variable to observed variables, such as $SD \rightarrow SD_1$ in Figure 4-3, represent the presumed causal effect of the latent variables on the observed variables. The single-headed arrows that point from the enclosed error variables, such as $err1 \rightarrow SD_1$, indicate the impact of measurement error term (random and unique) on the observed variables, and the single-headed arrow that points from the residual term (resid1) to AFB represents the impact of the error term in the prediction of AFB. The curved double-headed arrow represents a correlation between SD and BE. The single-headed arrows that point from a latent variable to another latent variable, $SD \rightarrow AFB$ and $BE \rightarrow AFB$, represent the corresponding direct effects.

Figure 4-3 includes two diagrams. Following Arbuckle (2011), the top one can be called “input”, which is the specified model that is created based on theoretical hypotheses. In order to make the model identified, the unit of measurement of each unobserved variable must be fixed by suitable constraints on the parameters (Arbuckle, 2011). One single-headed arrow path has been constrained to a value of 1 for each set of observed variables. Likewise, the error and residual terms also have been assigned a value of 1. Indeed, the AMOS program can automatically provide these assignments.

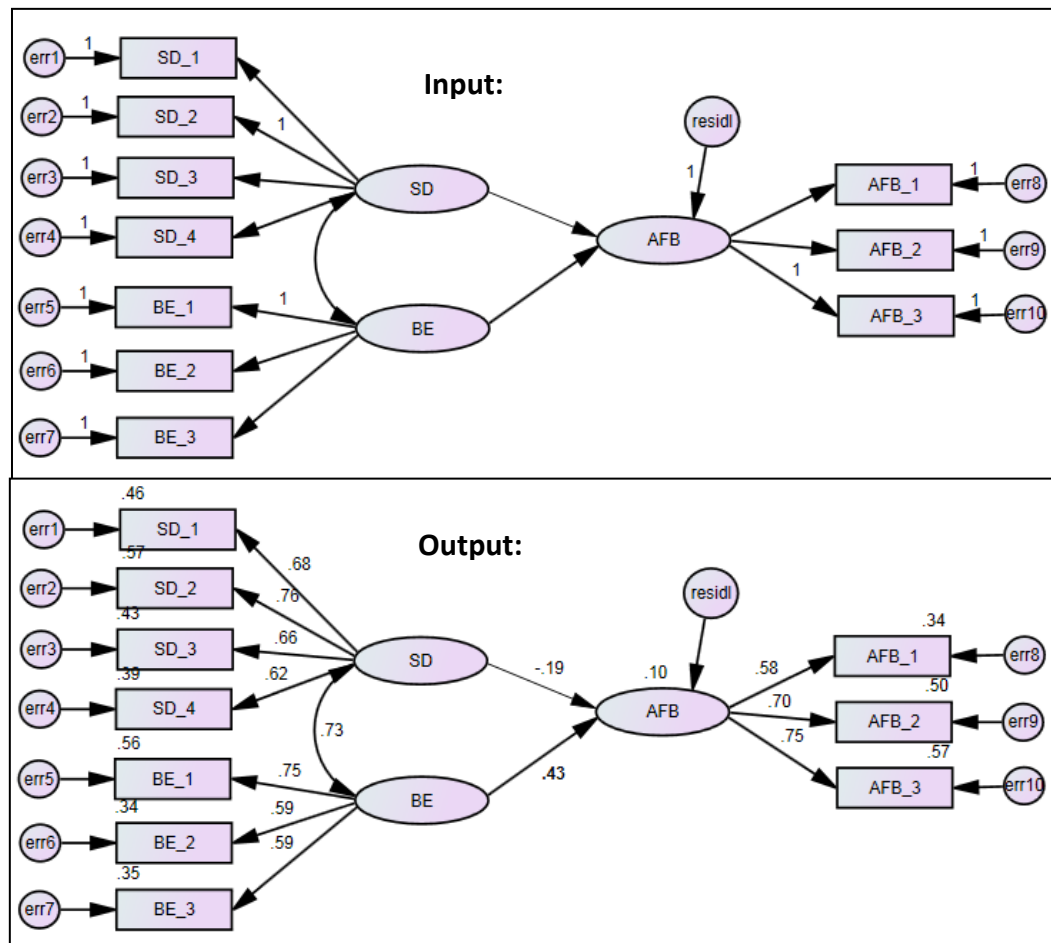


Figure 4- 3 An Example of A General SEMs in Amos

The bottom part of Figure 4-3 shows the standardized output, that is, the path diagram with standardized estimates. When AMOS has completed the calculations, it provides two options for viewing the output: text and graphics. The text output provides parameter estimates and model assessment results in detail. However, the graphics output demonstrates parameter estimates in an easy and intuitive way. AMOS can produce two graphics outputs of standardized or unstandardized estimates. For easier understanding, the graphics output with standardized estimates is more common and was chosen to show

results from the testing of our hypothesized model in Chapters Six and Seven in this study.

As described in the previous section, a general SEM model includes two kinds of sub-models: measurement model and structural model. The structural model defines the relations among the latent variables, which are the direct effects of $SD \rightarrow AFB$ and $BE \rightarrow AFB$ in Figure 4-3. The statistical estimates of direct effects are path coefficients, which are the same as the beta weights or regression coefficients in a multiple regression. Their standardized coefficients are illustrated by the numbers of -0.19 and 0.43 over the paths of $SD \rightarrow AFB$ and $BE \rightarrow AFB$, respectively, in the output diagram of Figure 4-3. The measurement model defines relations between a latent variable and observed indicator variables. Each latent variable is represented by a measurement model that specifies the pattern of direct effect on the observed variables. The statistical estimates of these direct effects are called factor loadings or pattern coefficients. The standardized factor loadings are illustrated next to single-headed arrows from the latent variables to one of their observed indicator variables (e.g., $SD \rightarrow SD_1$) in the output diagram of Figure 4-3.

AMOS provides a squared multiple correlation (SMC) for each endogenous variable in the model. In the output diagram of Figure 4-3, all estimates of standardized SMCs are illustrated as numbers beside the variables as they are requested. For example, the SMC for AFB is illustrated over its ellipse with the number 0.10, which indicates that 10% of the variance associated with Attitude to Farming Business (AFB) is accounted for by its two predictors—Self-Direction (SD) and Benevolence (BE). Likewise, the SMC for SD_1 is illustrated over its rectangle with the number of 0.46, which indicates that the

latent variable of Self-Direction (SD) explains 46% of the variance associated with its first observed indicator variable (SD_1).

4.5 Summary

Based on theoretical and practical needs, this study aims to explore the factors that influence farmers' responses to water policy reform in Southern Alberta. Based on previous studies, the conceptual model and hypotheses of this study are proposed and presented in this chapter.

Considering the complexity of the model, Structural Equation Modelling (SEM) techniques are used to estimate and assess the proposed model in this study. Although SEM has full generality and flexibility (Hoyle, 2012a) and is easy to use (Bagozzi and Yi, 2012), it has a complex set of procedures that must be guided by reason (Kline, 2011). In this chapter, several main considerations of using SEM, including assumptions about sample size, missing data and multivariate normality, were reviewed and some practical considerations, for example, choice of estimation method and fit indices were presented.

The SEM software of AMOS is used to estimate and assess the proposed models in this study. AMOS has a clever graphic feature. AMOS has two components: AMOS Graphics and AMOS Basic. As is common among most users of AMOS, only the AMOS Graphics approach is used in this study. Brief graphical notation and input and output diagrams were demonstrated in this chapter based on a hypothetical example.

In short, this study aims to gain a better and more complete understanding of farmers' behavioural intentions towards water policy changes. A general conceptual model that synthesizes previous research findings is proposed. AMOS 20.0 was chosen to estimate

and assess the model. The data to be used in the analysis were collected in Alberta, Canada. The next chapter discusses the study region and the process of data collection.

Chapter Five Survey Design and Data Collection

5.1 Introduction

The previous chapter proposed and described the conceptual model and hypotheses of this study. As it is clear that Alberta faces increasing water policy issues and irrigation farmers will need to be integrally involved in the search for solutions, the present study attempts to synthetically understand farmers' behaviour with regard to some of these policy issues. Thus, Alberta irrigators were surveyed to determine their responses to possible changes in water policies and to estimate the relationships between farmers' behaviour and their influential factors.

A structured questionnaire survey of irrigators in Southern Alberta was conducted in the summer of 2012. This chapter presents details on the survey design and data collection. First, a brief introduction of the survey region, target population and potential respondents is presented. This shows where the survey was conducted and who was interviewed. Second, this chapter describes the questionnaire structure, method of data collection and survey development. It introduces the data that were collected in the survey, which method was used to collect data, and the procedures used to collect the data. Third, this chapter presents a brief description of the respondents. It shows who actually accepted the interviews and where their farms are located. Finally, a short summary concludes this chapter.

5.2 The Alberta Context, Target Population and Potential Respondents

5.2.1 The Alberta Context

Alberta is located in western Canada. It is a landlocked prairie province, which has only 2.2 per cent of Canada's freshwater (Alberta Environment, 2002; 2010). As illustrated in the Figure 5-1, Alberta is bounded by the provinces of British Columbia in the west and Saskatchewan in the east. It is adjacent to the Northwest Territories in the north and to the state of Montana in the south.

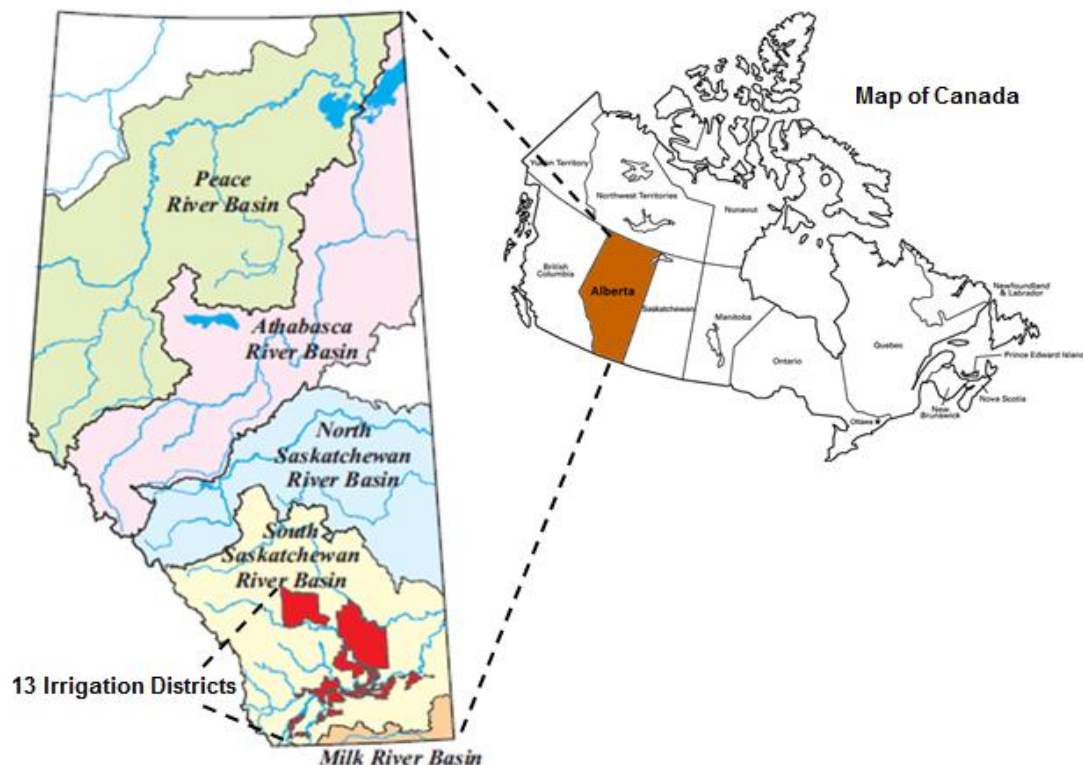


Figure 5- 1 Map of Alberta with the River Basins and the Irrigation Districts

Note: The map of Canada was adapted from http://pm.gc.ca/grfx/colouring_book/map_e.html; and the map of Alberta with the River Basins was adapted from AARD (2013b).

As discussed in Chapter Two, surface water is the main water source for the majority of Alberta's population and industries. There is evidence that water shortages will become a major issue for Albertans, especially for those who live and work in southern Alberta. In Alberta, water supplies are not all located where the demand exists: 80 per cent of its

population live in the southern part of the province while 80% of the water resources are located in the northern part (Alberta Environment, 2002; 2010). On the other hand, about two-thirds of land that receives water for irrigation across Canada is in southern Alberta (Statistics Canada, 2012). More than 96% of Alberta's irrigated agriculture is located within the South Saskatchewan River Basin (SSRB) (AARD, 2013b). The majority of Alberta's irrigators obtain their water from one or more of the thirteen organized irrigation districts. All thirteen irrigation districts are located within the SSRB (Figure 5-1). Accordingly, the South Saskatchewan River Basin in Alberta, the home of the biggest irrigation area of agriculture in Canada, was chosen as the location of the survey.

5.2.2 Target Population

As discussed in the previous chapters, the present study focuses on farmers' responses to possible water policy changes. The target population is Alberta irrigators. According to the 2011 Census of Agriculture, 3,027 farms had irrigated land, 410 acres on average for each irrigated farm in Alberta in 2010. As with most other types of farms in Canada, the number of irrigated farms has been decreasing while the area of irrigated land on each farm has been increasing. Between 2006 and 2011, the number of irrigated farms decreased by about 20% from 3,817 farms in 2005 and the area of irrigated land for each farm had increased by about 18% from 334 acres in 2005 (Statistics Canada, 2012).

Field and forage crops occupy most of the irrigated land in southern Alberta. Although some irrigated farms grew some specialty crops such as vegetables and fruits, the total area used for these crops was tiny. Only about 1% of irrigated land was used to support growth of vegetables, fruits and other unlisted crops in 2005 and 2010 (Statistics Canada,

2012). The top four crops grown in the 13 irrigation districts in recent years are hard spring wheat, canola, barley and tame pasture (AARD, 2010b; 2011; 2012; 2013b).

According to national agricultural water surveys, irrigation intensity (the volume of water used for irrigation per unit area) varied widely by years. The main reason for this is the variation in growing season precipitation (AARD, 2013b). The average volume of water used on Alberta's irrigated crops in 2012 was 1231 cubic metres per acre, which was more than double what was used in 2010 (Statistics Canada, 2013a, b). As described in Chapter Two, low pressure centre pivot sprinkler systems now are the dominant on-farm irrigation system in Alberta. National agricultural water surveys indicate that about one-fifth of farms still use flood irrigation (Statistics Canada, 2012). Recent empirical research indicates that many farmers improved water use technology in the past, but relatively few had plans for further improvement because they already use the best water management practices, or the physical field conditions make improved technology unviable, or investment in improved technology is not cost effective (Bjornlund et al., 2013a; Nicol et al., 2008; Nicol et al., 2010a, b).

In theory, license holders in Alberta can buy, sell, or lease their licensed allocations since water trading was introduced with the *Water Act* in 1999. However, district irrigators have a limited capacity to participate because a transfer of water outside a district needs approval by a majority of irrigators within the district (Bjornlund et al., 2013a). Private irrigators have a greater ability to trade as they control their own licenses, but they were found generally less likely to engage in water trading activities (Hall et al., 2012). In general, recent research shows that irrigators in Alberta have limited water trading experience (Nicol and Klein, 2006; Hall et al., 2012).

Data on characteristics of irrigators (as distinct from other types of farmers) are not available. As described in Chapter Two, the average age of farm operators in Alberta was 54.5 in 2011. The majority of farm operators were male, with female farm operators accounting for only 29%.

5.2.3 Potential Respondents

As discussed in Chapter Four, Structural Equation Modelling (SEM) is a large sample technique. Bigger is always better. The minimum sample size generally should be no less than 200. Considering the costs of the survey and the desire for a large sample, a survey of approximately 300 irrigation farms was planned.

For privacy reasons it was impossible to obtain a list of irrigators with names, addresses and phone numbers. One previous irrigator survey in 2011 purchased a list of people with names, addresses and phone numbers who live in the postal codes where irrigation is practiced (Hall et al., 2012). By deleting names that were clearly not related to irrigation, such as business names, from the list, a list of 9,648 potential irrigators was generated. A professional data collection company, Advanis³, was hired to call people from this list to identify irrigators. 1,230 irrigators were identified.

In order to obtain a sample of approximately 300 irrigation farms, Advanis was asked to randomly recruit 350 irrigators, which were 50 irrigators more and about 17% larger than the target sample size, from the list of identified irrigators. In March of 2012, the company randomly called numbers from the list until 350 irrigators were recruited and

³Founded in 1990, Advanis is a research-based consulting firm that provides full-service market and public sector research. Its website is at <http://www.advanis.ca/>.

agreed to participate in the survey. The list of 350 irrigators with names, addresses and phone numbers was used as the original sample pool for our survey.

5.3 Data Collection

5.3.1 Questionnaire Design

A structured questionnaire⁴ was designed and used to collect data that could be used to estimate and assess the proposed model in this study. As indicated in Chapter Four, the present study aims to explore five aspects of factors that influence farmers' possible intentions to respond to proposed changes in water policies. The questionnaires also included other questions related to other aspects of the farms' agricultural production and water management practices. The questionnaires had four main sections.

The first section collected data on the major characteristics of farms, including land type (irrigated or dryland) and size (acres), farm and operation history, business cycle position, and succession plan. In this section, respondents were asked the numbers of acres of irrigated land and dryland separately that they manage or operate; the numbers of generations that their family had operated the current farms. Respondents were asked to select one set of words that can best describe their farms, from "expanding/growing", "stable", and "downsizing". In this section, respondents were asked to provide an answer of "yes" or "no" for if they have a succession plan in place. Data collected in this section was used in Box C (Farm Business Characteristics, as illustrated in Figure 4-1) of the conceptual model.

⁴ Full questionnaire is presented in Appendix A.

The second section collected data on agricultural production and irrigation, including data on irrigated crops grown, and irrigation and water management practices. In this section, respondents were asked to provide data on each crop that was under irrigation, including acres cropped and the type of irrigation system (flood, wheel move, high pressure sprinkler, low pressure sprinkler). These data were used in Box E (Past Behaviour, as illustrated in Figure 4-1) in the conceptual model. In this section, respondents also were asked if they made any changes to their irrigation equipment in the last five years and if they intend to make any changes to their irrigation equipment in the next five years. The answers for both questions were “yes” or “no”. The former was used in Box E (Past Behaviour); the latter is one indicator of behavioural intention (BI_3, as presented in Chapter Four) was used in Box F (Behavioural Intention, as illustrated in Figure 4-1).

The third section collected data on values, attitudes, and behavioural intentions, including 20 value indicators, 9 general attitude indicators and 3 behavioural intention indicators that were described in Chapter Four. This section divided two parts of values and attitudes and behavioural intentions. Following the procedure of Schwartz’s Values Survey (Schwartz and Bilsky, 1987, 1990; Schwartz 1992, 1994), in the values part, the respondents were asked to rate the importance on a nine-point scale of each value item as a guiding principle in their life. Seven indicated that the specified value is of supreme importance for the respondent in their life. The importance decreased with the rating. When someone rated one value item as 0, it meant this specified value is not important in his/her life. If any value item was contrary to someone’s values, then -1 was selected. An anchoring technique was introduced in the survey by asking respondents to choose and rate the most and least important value from the values list prior to rating the values. In

the attitudes and behavioural intentions part, a self-report Likert scale was used. The respondents were asked to evaluate statements by checking a numeric response on the indicators. In this study, a 7-point Likert scale anchored by “strongly disagree” (1), “neutral” (4), and “strongly agree” (7) was used. The data collected in this section were used in Boxes D and F (Values and Attitudes and Behavioural Intentions, as illustrated in Figure 4-1) of the conceptual framework.

The last section collected data on each person in the household, including gender, age, education, off-farm work, and relationship with respondent. In this section, respondents were asked to provide the information for all persons in the household. The respondents were asked to provide their actual age and the highest level of education achieved from a list of five levels (not finished high school, secondary diploma or equivalent certificate, college or other non-university certificate diploma, university Bachelor's degree, and university Master's or Doctorate degree). Respondents were asked about their off-farm involvement (no off-farm work, part-time off-farm work, and full-time off-farm work). These data were used in Box A (Individual Characteristics, as illustrated in Figure 4-1) of the conceptual framework.

The last section asked how many people lived in the household, which was used to represent one aspect of household characteristics. Besides household size, household average age was computed, and husband's and wife's off-farm work status was coded as follows: neither the husband nor the wife had any off-farm work, one or both of husband and wife had part-time off-farm work but neither had full-time off-farm work, or one or both of the husband and wife had full-time off-farm work. These data were included in

Box B (Household Characteristics, as illustrated in Figure 4-1) of the conceptual framework.

5.3.2 Method of data collection

Following approval by the University of Lethbridge Human Subject Research Committee, and pre-testing of the questionnaire, the method of data collection was considered. The most common way of self-completion questionnaires is collecting data through mail-out or internet. These methods have many advantages, such as low cost and no interviewer bias. However, response rates can be low and rates of missing data can be high. Face-to-face and telephone interviews are two popular methods of conducting interviews.

Interviews by telephone are travel-free for the researchers so they are cost-effective and time-efficient. However, without the help of visual signs, such as smiles and eye contact, it might not be possible to obtain complete information from complicated surveys. Face-to-face interviews are costly but might yield more reliable results. In particular, face-to-face interviews are believed to be an excellent way of exploring complex feelings and attitudes (Sommer and Sommer, 1997).

Since the present study involves exploring several psychological elements, such as values, attitudes and intentions, and it was important to get a high response rate, face-to-face interviews were chosen for the survey. The interviewers were two well-trained undergraduate students who had a farming background. Prior to conducting the survey, the two interviewers were given training to make sure they consistently understood all questions. Then they divided the sample irrigators into two groups and conducted the survey separately.

5.3.3 Survey Development

Data collection was conducted in the summer of 2012 from May to August. Summer is a relatively busy season for irrigation farmers and some might be too busy to participate in the survey. However, summer also is a season when farmers are at home taking care of their crops and, thus, are more available for the survey.

As Sommer and Sommer (1997) suggested, an advance letter or phone call is useful for increasing the rate of acceptance. Prior to visiting the farmers, the interviewers phoned and made appointments with the potential respondents on the list who promised to participate in the survey a couple months earlier. This was the most difficult part of the survey. When the interviewers phoned the potential respondents, some never answered the phone and never called back when the interviewers left messages on the answering machines. Some potential respondents were willing to accept the interview, but never found available time to do so, even though several arrangements were made. After making arrangements, the interviewers went to the appointed place (usually the farmer's home or working place, sometimes to a coffee shop) where the questionnaire was completed. Farmers were told that their participation in this study was voluntary and anonymous and all information submitted would be kept confidential. They were told that if they felt uncomfortable at any time, they could skip certain questions or terminate the interview altogether. They were told that if they felt emotional discomfort and would like to discuss specific issues with one of the researchers or a member of the University of Lethbridge Ethics Committee, they could call at phone numbers that were provided. Also, the research assistants who conducted the survey had signed confidentiality agreements to not reveal any information gathered, to destroy the contact information after the

interview was completed and not to note any identifying information on the survey form. The time of interviews was very flexible. Many took place in the evenings even after 11:00 pm by availing long daylight hours in summer.

At the end, out of 350 potential respondents on the original list, 96 never answered the phone, 55 were unavailable to find a mutually convenient time, and 12 refused to participate because they either had forgotten their commitment or changed their mind. As a result, only 187 irrigators from the potential respondent's list completed the survey.

In order to satisfy the need for the minimum sample size, the respondents were asked to invite their neighbour to complete the survey. An additional 20 irrigators accepted to be interviewed. In total, 207 questionnaires were completed.

5.4 Respondents

Of the 207 respondents who completed the questionnaire, four had a large amount of missing data because the respondents refused to answer all the personal information about them and their families. Therefore, these 4 respondents were excluded from the analyses.

Of the 203 valid questionnaires, 179 respondents were male and 24 were female. The proportion of female respondents was lower than the female farm operator ratio from the census (Statistics Canada, 2012), and lower than the previous irrigator survey in the SSRB, in which female respondents accounted for 20% of the total (Hall et al., 2012). The average age of the respondents was 55.57, which was fairly close to the average age of Alberta farm operators (54.5 years) in the 2011 census (Statistics Canada, 2012). The

most common household size was 2 persons. More individual and household characteristics of the respondents are described in the following chapter, Chapter Six.

The 203 respondent's farms were located in 12 of the 13 irrigation district in Alberta; only the smallest (Ross Creek) irrigation district was not represented. More than one quarter of the participant farms are located in the Eastern Irrigation District, which is the biggest irrigation district in the province. About two-thirds of the participant farms are located in one of four main irrigation districts: Eastern, Bow River, St. Mary and Lethbridge Northern. About one-tenth of the farms in the survey are not located in organized irrigation districts but rather have their own private water licenses. One farm had a private water license as well as having some land in an irrigation district. Six farms had land in two or more irrigation districts (Table 5-1).

The average area of irrigated land was 523 acres (excluding the six farms that had rented out their irrigated land or did not report any irrigated area). This number is somewhat larger than the 410 acres of irrigated land for each farm reported by the 2011 Census of Agriculture.

Reflecting the overall statistics for the 13 irrigation districts, the top four crops that the respondents grew in 2011 were wheat (all wheat), canola, barley, and alfalfa hay. Each of these four kinds of crops was grown by more than one third of the respondents. These four kinds of crops occupied about two-thirds of total irrigated land. Of the total irrigated area in the sample, 22% was planted to wheat, 18% canola, 15% barley, 13% alfalfa hay, and 33 % was in all other crops.

More details about the respondents' farm business characteristics, irrigation practices, and their values, attitudes, and behavioural intentions are provided in Chapter Six.

Table 5- 1 The Location Distribution of the 203 Farms

	Frequency	Percent	Average Irrigated Acres*
Aetna	3	1.5	143
Bow River	43	21.2	663
Eastern	56	27.6	397
Leavitt	2	1.0	-
Lethbridge Northern	20	9.9	462
Magrath	1	0.5	170
Mountain View	2	1.0	320
Raymond	13	6.4	872
Ross Creek	0	0.0	-
St. Mary River	17	8.4	700
Taber	3	1.5	190
United	1	0.5	20
Western	14	6.9	286
Two or more districts	6	3.0	797
Private and district	1	0.5	1000
Private	21	10.1	494
Total	203	100.0	523

Note: * Six farms were not included in calculating the average irrigated area: five had rented out all their irrigated land and one did not report their irrigated area.

5.5 Summary

Irrigated agriculture is an important part of the economy of southern Alberta. Irrigators in this region were chosen as subjects for the study of farmers' responses to water policy reform, and determinants of irrigators' responses to water policy reform.

A list of 350 irrigators was chosen by the private firm, Advanis. A structured questionnaire with face-to-face interviews was used to collect data. The survey was conducted from May to August, 2012. A total of 207 irrigators accepted the interviews and 203 valid questionnaires were obtained. The 203 participant farms are located in all

but the smallest irrigation district. About 10% of the sample resides outside organized irrigation districts and have their own private water licenses. Analysis of the subjects' individual, household, and farm business characteristics are undertaken in the next chapter.

A structured questionnaire was used to conduct the survey. The questionnaire had four main sections that were designed to collect data corresponding to the boxes in the proposed model (illustrated in Figure 4-1). The first section collected data on the major characteristics of farms corresponding to Box C. The second section collected data on agricultural production and irrigation practice corresponding to Box E (Past Behaviour) and one behavioural intention indicator, that is, part of Box F. The third section collected data on values, attitudes, and behavioural intentions corresponding to Box D and three behavioural intention indicators that are part of Box F. And the last section collected data on each person in the household corresponding to Boxes A and B. Discussion of estimation and assessment of the proposed model are undertaken in Chapter Seven.

Chapter Six Questionnaire Findings and Measurement Models

6.1 Introduction

As described in the previous chapter, 203 valid questionnaires were obtained from the survey. This chapter focuses on data preparation for the Structural Equation Modelling (SEM).

First, corresponding to Boxes A to E in the proposed theoretical model (Figure 4-1), the descriptive results of the respondent's personal, household and farm business characteristics, their values and attitudes, and past behaviour are presented in section 6.2. In order to satisfy the requirement of normality, skewness and kurtosis are tested for all variables and some necessary transformations are described.

Second, this chapter presents and discusses the major findings for respondents' policy response intentions in section 6.3. As discussed in the previous chapters, the primary focus is on four behavioural intentions related to irrigators' responses to water policy reform.

Third, this chapter defines and assesses the measurement models for values and attitudes that are used in the SEM model. Factor analysis provides a means by which these latent (unobserved) variables can be specified. The results and processes are described in section 6.4.

The last section presents a summary of the findings and results in this chapter.

6.2 Descriptive Statistics of Influential Factors

6.2.1 Socio-economic and Demographic Characteristics (Box A to Box C)

The first part of Table 6-1 corresponds to Box A in the model and depicts variables related to the respondent's Individual Characteristics (IC). Respondents' gender, age, educational level, and their off-farm work status represent their personal characteristics. The youngest respondent in the survey was 24 and the oldest was 88. The educational level of the respondents ranged from "not finished high school" to "university Master or Doctor Degree". Nearly 40% of respondents had a college or non-university certificate/diploma, followed by those with a secondary or equivalent certificate/diploma, and those with a bachelor, master or doctorate degree. Slightly more than three in five respondents (63.7%) did not have any off-farm employment. Of those respondents who had off-farm work, 30% had full-time off-farm jobs.

The second part of Table 6-1 shows the variables related to Household Characteristics (HC), which corresponds to Box B in the model. Household size, household average age, and the farm couple's off-farm work status represent their household characteristics. The household size ranged from 1 to 9 with a mean of 2.96 persons, which is about the same as the national average family size of 2.9 persons in the 2011 census (Statistics Canada, online). The youngest average age of a household was 10.3 and the eldest was 84. The mean was 47.6 years. More than half the families had someone in the family with off-farm employment.

The third part of Table 6-1 corresponds to Box C in the model. Focused on water use, the area of irrigated land as a proxy for farm size is combined with the farm's position in its business cycle, the farm's succession plan and the number of generations that lived on the family farm to compose a set of variables of Farm Business Characteristics (FBC) in the study. The area of irrigated land in the sample varied greatly from 3 to 4,000 acres. The

majority (65.5%) of farms were described as in a stable mode while about a quarter were growing or investing and less than one in ten (8.9%) were downsizing. Nearly half of the respondent farms (43.5%) indicated that they did not have a succession plan in place, 31.9% said they did have a succession plan in place, and about a quarter of respondents were uncertain. On average, the respondents had owned their farm for over two generations (2.22) with the longest being seven generations.

The statistics indicate that size of irrigated land had a high level of skewness and kurtosis, meaning that this variable is not normally distributed. It has been suggested that if the absolute value of skewness⁵ is less than 1.0 then the variable is slightly non-normal, if it is between 1.0 and 2.3 it is moderately non-normal, and beyond 2.3 it is severely non-normal (Lei and Lomax, 2005). Another rule of thumb suggested to determine when a variable suffers from severe non-normality is if skewness is larger than 2 and kurtosis is larger than 7 (Fabrigar et al., 1999; West et al., 1995). Table 6-1 indicates that the distribution of the variable ILSIZE severely violates normality. Fabrigar et al. (1999) recommended that if non-normality is severe, remedies should be employed to normalize the distributions using measures such as some non-linear transformation. Following the suggestion by West et al. (1995), a square root transformation was conducted for the variable ILSIZE. After transformation, the values of skewness and kurtosis dramatically dropped and fell into the category of moderate non-normality. Besides ILSIZE, it is not surprising to see that the skewness for GEND is high. Considering that the gender composition of respondents from the survey is severely biased with only a small number

⁵ It also includes kurtosis in the original literature, but the values specified here are only about skewness. So it is assumed that the authors discussed only skewness and did not include kurtosis.

of female respondents, it is inappropriate to analyse the gender influence on behavioural intentions. Therefore, the variable GEND has been excluded from further analysis.

Table 6- 1 Definitions and Descriptive Statistics for Socio-economic and Demographic Variables

Variable	Definition	Valid N	Mean	Std. D	Skewness	Kurtosis
Individual Characteristics (IC)						
GEND	Gender (male=0, female=1)	203	0.11	0.32	2.46	4.08
AGE	Age (years)	200	55.57	12.47	-0.15	0.04
EDU	Education level (unfinished high school=1; with secondary diploma or equivalent certificate = 2; with college/non-university diploma= 3; with university Bachelor's Degree= 4; with university Master or Doctor Degree = 5)	203	2.86	0.95	0.12	-0.38
OFFM	Respondent's off-farm status (without off-farm work=0; with part-time off-farm work =1; with full-time off-farm work=2)	193	0.62	0.87	0.83	-1.15
Household Characteristics (HC)						
HSIZE	Household size (Number)	203	2.96	1.52	1.40	2.16
HAGE	Household average age (Years)	200	47.55	17.08	-0.17	-0.85
HOFFM	Respondent and spouse (if available) off-farm status (no one with off-farm work=0; one or both with part-time but no full- time off-farm work =1, one or both with full-time off-farm work=2)	193	0.88	0.86	0.23	-1.62
Farm Business Characteristics (FBC)						
ILSIZE	Size of irrigated land (Acres)	193	522.91	619.84	2.90	11.40
ILSZ_T	Square root transformation of ILSIZE	193	19.85	11.38	1.04	1.67
BCYCL	Farm's position in business cycle (growing=1, stable=0; downsizing=-1)	203	0.17	0.56	0.02	-0.10
SCSRP	Succession plan (have a plan =1, uncertain=0, do not have a plan =-1)	191	-0.12	0.86	0.23	-1.63
GEN	The number of generations that the farm has been in the family's ownership	203	2.22	1.09	0.68	0.84

Correlations for the 11 variables are shown in Table 6-2. The correlations of the variables within each aspect of socio-economic and demographic characteristics in this study are diverse, with the weakest relations among variables in the Individual Characteristics (IC) category and the strongest relations among variables in the Farm Business Characteristics (FBC) category. Within each aspect of these characteristics, the largest correlation coefficient was 0.75. Multicollinearity is not likely to be an issue within each aspect of characteristics, but could be between different aspects of characteristics. The correlation between respondent's age (AGE) and household average age (HAGE) was very high ($r=0.90$). Although AGE and HAGE might cause a problem of multicollinearity, no attempt was made to remove one of them since they are used to present different aspects of characteristics. Omitting either AGE or HAGE would be an omission of one important aspect of personal or household characteristics.

Table 6- 2 Correlation Matrix^a of Socio-economic and Demographic Variables

Variables	AGE	EDU	OFFM	HSIZE	HAGE	HOFFM	ILSZ_T	BCYCL	SCSRP
IC									
AGE									
EDU	-0.12								
OFFM	-0.05	0.17*							
HC									
HSIZE	-0.50**	0.01	0.04						
HAGE	0.90**	-0.11	-0.04	-0.75**					
HOFFM	-0.17*	0.16*	0.69**	0.10	-0.18*				
FBC									
ILSZ_T	-0.24**	0.17*	-0.44**	.017*	-0.22**	-0.31**			
BCYCL	-0.43**	-0.01	-0.25**	0.30**	-0.45**	-0.10	0.31**		
SCSRP	0.03	-0.00	-0.31**	0.09	-0.02	-0.25**	0.28**	0.15*	
GEN	-0.21**	0.11	-0.17*	0.09	-0.17*	-0.09	0.35**	0.16*	0.21**

Note: * Correlation in bold is significant at the 0.05 level (2-tailed).

** Correlation in bold is significant at the 0.01 level (2-tailed).

a. Listwise N=171. Correlations in bold are values above 0.30.

6.2.2 Values and Attitudes (Box D)

Corresponding to Box D in our model, values and attitudes are defined as important influential components of behavioural intentions. As described in Chapter Four, twenty value items and nine attitudes items were used on the questionnaires in the survey.

Ratings for the Value Items

Among the 203 respondents, 190 rated all the value items (93.6% of the sample). Two respondents (1%) gave up after they rated the first few items and 11 (5.4%) refused to participate (perhaps because they did not want to share their values or they did not like the types of questions).

Respondents rated most value items from zero (or not) important in their life to seven, supremely important in their life (Table 6-3). However, “Equality (VI_8)” and “A spiritual life (VI_9)” were rated as -1, meaning opposed to their values, by some respondents. The lowest mean rating (4.23) occurred for the value of “Wealth (VI_5)” and the highest mean rating (6.39) occurred for the value of “Freedom (VI_18)”. Seven value items had mean ratings above 6, eight value items had mean ratings between 6 and 5, and five value items had mean ratings between 5 and 4.

The top five mean ratings were the values of “Freedom (VI_18)” (6.39), “Responsible (VI_12)” (6.38), “True friendship (VI_2)” (6.21), “Meaning in life (VI_20)” (6.11), and “Choosing own goals (VI_14)” (6.11). These results are consistent with those found in previous studies. For example, Gasson (1973) showed that farmers in her survey placed high value on independence and intrinsic aspects of work.

Table 6- 3 Ratings* for the Values Items

Values Items**	N	Min	Max	Mean	Std. D	Skewness	Kurtosis
VI_1	192	1	7	5.56	1.31	-1.17	1.21
VI_2	192	0	7	6.21	1.15	-2.43	8.56
VI_3	191	0	7	4.90	1.75	-1.05	0.87
VI_4	191	0	7	6.11	1.12	-1.92	5.14
VI_5	191	0	7	4.23	1.50	-0.68	0.81
VI_6	191	0	7	5.37	1.37	-0.98	0.81
VI_7	191	0	7	5.42	1.59	-1.63	2.81
VI_8	190	-1	7	5.22	1.87	-1.35	1.34
VI_9	190	-1	7	5.11	1.83	-1.21	1.21
VI_10	190	0	7	4.68	1.59	-0.91	0.68
VI_11	190	0	7	5.68	1.21	-1.75	4.78
VI_12	190	0	7	6.38	0.81	-2.95	19.05
VI_13	190	0	7	4.31	1.91	-0.61	-0.29
VI_14	190	0	7	5.63	1.25	-1.20	1.97
VI_15	190	0	7	6.01	1.19	-1.88	4.47
VI_16	190	0	7	5.47	1.22	-1.17	2.08
VI_17	190	0	7	4.96	1.60	-0.91	0.63
VI_18	190	0	7	6.39	0.95	-2.83	12.95
VI_19	190	0	7	6.21	1.01	-2.41	9.44
VI_20	190	0	7	6.11	1.21	-2.69	9.89

Note: * Ratings for the values items were as: of supreme importance (7), very important (6), (unlabelled; 5, 4), important (3), (unlabelled; 2, 1), not important (0), opposed to my values (-1).

** VI_1 =Protecting the environment (preserving nature); VI_2= True friendship (close, supportive friends); VI_3= Unity with nature (fitting into nature); VI_4 = Choosing own goals (selecting own purposes); VI_5 = Wealth(material possessions, money); VI_6 = Broad-minded (tolerant of different ideas and beliefs); VI_7 = Inner harmony (at peace with myself); VI_8 = Equality (equal opportunity for all); VI_9 = A spiritual life (emphasis on spiritual not material matters); VI_10 = Authority (the right to lead or command); VI_11 = Successful (achieving goals); VI_12 = Responsible (dependable, reliable); VI_13 = Social recognition (respect, approval by others); VI_14 = Social justice (correcting injustice, care for the weak); VI_15 = Self-respect (belief in one's own worth); VI_16 = Curious (interested in everything, exploring); VI_17 = A world of beauty (beauty of nature and the arts); VI_18 = Freedom (freedom of action and thought); VI_19 = Independent (self-reliant, self-sufficient); VI_20 = Meaning in life (a purpose in life).

The bottom five mean ratings were the values of “Wealth (VI_5)” (4.23), “Social recognition (VI_13)” (4.31), “Authority (VI_10)” (4.68), “Unity with nature” (4.90), and “A world of beauty (VI_17)” (4.96). Although few other people are as close to nature as farmers, these results show that farmers do not necessarily value nature more highly. Past findings show that there is a general tendency among farmers to underestimate the environmental impacts of their farming activities or overrate their friendly activities (Carr and Tait, 1991). Our findings provide evidence that farmers might not always value nature as highly as often expected.

Skewness and kurtosis indicate that five value items might be categorized as having severe non-normality. That means it would be problematic to use some statistical methods that depend on the normality assumption. Although omitting outliers might improve the distributional characteristics, taking such action might not be appropriate. After all, any options are possible and reasonable for the respondents’ rating of value items. Also, deleting outlier cases would decrease the size of the sample, which we prefer to avoid. Following the suggestion by West et al. (1995), squared transformations were made for the variables VI_2, VI_12, VI_18, VI_19, and VI_20. After transformation, the values of skewness and kurtosis for those variables dropped dramatically. The skewness for these five variables then ranged from -1.01 to -1.44; and kurtosis ranged from 1.06 to 2.24. The transformed variables, VI_2T, VI_12T, VI_18T, VI_19T, and VI_20T were used in the following analyses instead of their original variables.

The correlations for the 20 value items are shown in Table 6-4. The correlations between most value items are significant. The largest correlation coefficient (0.63) is between the value items VI_16 and VI_17.

Table 6- 4 Correlation Matrix^a of Value Items

Items	VI_1	VI_2T	VI_3	VI_4	VI_5	VI_6	VI_7	VI_8	VI_9	VI_10	VI_11	VI_12 T	VI_13	VI_14	VI_15	VI_16	VI_17	VI_18 T	VI_19 T
VI_1																			
VI_2T	0.29**																		
VI_3	0.58**	0.24**																	
VI_4	0.28**	0.18*	0.26**																
VI_5	0.22**	0.18*	0.24**	0.28**															
VI_6	0.34**	0.05	0.27**	0.37**	0.20**														
VI_7	0.39**	0.24**	0.48**	0.41**	0.27**	0.46**													
VI_8	0.31**	0.26**	0.24**	0.22**	0.11	0.33**	0.42**												
VI_9	0.15*	0.30**	0.10	-0.01	0.19**	-0.06	0.20**	0.17*											
VI_10	0.34**	0.30**	0.24**	0.22**	0.27**	0.20**	0.31**	0.29**	0.33**										
VI_11	0.12	0.16*	0.25**	0.36**	0.43**	0.28**	0.29**	0.10	0.02	0.23**									
VI_12T	0.25**	0.35**	0.29**	0.21**	0.16*	0.15*	0.19**	0.19**	0.23**	0.19*	0.32**								
VI_13	0.23**	0.10	0.23**	0.16*	0.34**	0.23**	0.20**	0.17*	0.12	0.24**	0.35**	0.12							
VI_14	0.26**	0.21**	0.29**	0.25**	0.01	0.33**	0.25**	0.41**	0.13	0.28**	0.14	0.35**	0.24**						
VI_15	0.38**	0.27**	0.35**	0.44**	0.27**	0.42**	0.46**	0.34**	0.04	0.31**	0.45**	0.33**	0.31**	0.36**					
VI_16	0.33**	0.30**	0.40**	0.11	0.06	0.27**	0.30**	0.09	0.07	0.32**	0.17*	0.18*	0.20**	0.22**	0.22**				
VI_17	0.46**	0.22**	0.58**	0.20**	0.15*	0.33**	0.51**	0.24**	0.15*	0.36**	0.12	0.12	0.27**	0.32**	0.29**	0.63**			
VI_18T	0.18*	0.24**	0.23**	0.34**	0.11	0.28**	0.30**	0.18*	0.06	0.15*	0.25**	0.32**	0.14	0.17*	0.42**	0.31**	0.34**		
VI_19T	0.31**	0.23**	0.29**	0.47**	0.17*	0.37**	0.37**	0.25**	0.04	0.12	0.36**	0.35**	0.11	0.20**	0.46**	0.23**	0.24**	0.53**	
VI_20T	0.38**	0.42**	0.35**	0.36**	0.23**	0.15*	0.43**	0.33**	0.37**	0.34**	0.36**	0.41**	0.22**	0.26**	0.42**	0.20**	0.29**	0.34**	0.37**

Note: * Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

a. Listwise N=190, Correlation in bold are values above 0.30.

Ratings for the Attitudes

As described in Chapter Four, three sets of farmers' general attitudes, Attitudes to Land Attachment (ALA), Community Cohesion (ACC), and Farming Business (AFB), were explored in this study. Nine attitude items, three for each attitude, were chosen.

For most attitude items, respondents' ratings varied from strongly disagree (-3) to strongly agree (3). For four statements, no one strongly disagreed. All the mean ratings were positive and indicate that overall there were more respondents who "agreed" than "disagreed" with all of the attitude items (Table 6-5). The lowest mean rating (0.92) was for the attitude item of "Land is the most important heritage of the family." The highest mean rating (2.55) was for the attitude item "Rural communities are a great place to live and raise a family."

Generally, the distributions of attitude items were moderately non-normal. Two attitude items (ACC_1 and ACC_2) had high values of skewness and kurtosis. This makes those items problematic for further analysis that depends on the normality assumption. Squared transformations were made for the variables ACC_1 and ACC_2. After transformation, the values of skewness and kurtosis decreased dramatically. The skewness for ACC_1 and ACC_2 became -1.05 and -0.87, and kurtosis -0.34 to -0.73, respectively. The transformed variables, ACC_1T and ACC_2T, were used in the following analyses instead of their original variables.

Correlations for the 9 attitude items are shown in Table 6-6. The correlations among three items in Attitude to Land Attachment (ALA) were moderate, ranging from 0.48 to 0.66.

A similar pattern of correlations also occurred among three items in Attitudes to Farming

Business (AFB), where correlation coefficients ranged from 0.41 to 0.53. However, among the three items in Attitude to Community Cohesion (ACC), the correlation between ACC_1 and ACC_2 was moderate, but ACC_3's correlations to both ACC_1 and ACC_2 were quite weak (0.25 and 0.19, respectively). This suggests that ACC_3 might not be a good indicator for the Attitude to Community Cohesion. Although other correlations between attitude items exist, most associations were weak; however, the pattern was consistent with our design.

Table 6- 5 Ratings^{*} for the Attitudes Items

Attitude Items	N	Min	Max	Mean	Std. D	Skewness	Kurtosis
Land Attachment (ALA):							
ALA_1. Having land to pass down to future generations is more important than selling it for the highest price	203	-3	3	1.81	1.38	-1.44	1.90
ALA_2. You feel a responsibility to keep your land in the family.	203	-3	3	1.42	1.58	-1.05	0.20
ALA_3. Land is the most important heritage of the family.	203	-3	3	0.92	1.78	-0.58	-0.80
Community Cohesion (ACC):							
ACC_1. Rural communities are a great place to live and raise a family.	203	-2	3	2.55	0.80	-2.47	7.78
ACC_2. The lifestyle that comes with living in a rural area is very important to your family.	203	-2	3	2.47	0.86	-2.20	5.90
ACC_3. You are active and willing to undertake activities in the community	203	-2	3	2.04	0.94	-1.30	2.30
Farming Business (AFB):							
AFB_1. A maximum annual net financial return from your farm is an important goal for your family.	203	-3	3	1.93	1.28	-1.67	3.04
AFB_2. Increasing the asset value or net worth of your farming operation is very important to your family.	203	-2	3	1.73	1.14	-1.27	1.92
AFB_3. You view your farming operation as first and foremost a business investment.	203	-3	3	1.46	1.42	-0.97	0.34

Note: * Ratings for the attitudes items were “strongly disagree” (-3), “disagree” (-2), “somewhat disagree” (-1), “neutral” (0), “somewhat agree” (1), “agree” (2) and “strongly agree” (3).

Table 6- 6 Correlation Matrix^a of Attitude Items

Variables	ALA_1	ALA_2	ALA_3	ACC_1T	ACC_2T	ACC_3	AFB_1	AFB_2
ALA_2	0.64**							
ALA_3	0.48**	0.66**						
ACC_1T	0.15*	0.19**	0.12					
ACC_2T	0.09	0.18*	0.12	0.51**				
ACC_3	0.21**	0.11	0.01	0.25**	0.19**			
AFB_1	0.22**	0.25**	0.19**	0.13	-0.04	0.13		
AFB_2	0.25**	0.30**	0.21**	0.18*	0.07	0.13	0.41**	
AFB_3	0.13	0.17*	0.19**	0.08	-0.06	0.18*	0.44**	0.53**

Note: * Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

a. Listwise N=203, Correlation in bold are values above 0.30.

6.2.3 Past Behaviours (Box E)

Focusing on farmers' behaviour related to water use, the use of irrigation equipment was used to represent past behaviour. Two aspects of water use behaviour were investigated: the irrigation equipment farmers currently are using and whether they improved their irrigation equipment in the past five years.

One hundred and ninety-nine respondents provided data on their irrigation equipment. Among the four respondents (2%) who did not provide these data, one rented out the irrigated land, one just purchased the land and had not yet started working it, and one sold most of the irrigated land, retaining only three acres. One respondent did not provide an explanation why s/he did not provide the data.

Table 6-7 shows the irrigation equipment that farmers were using at the time of the survey. The majority (69%) of farmers used the same kind of irrigation equipment on all their land, about a quarter of farmers used two different kinds of equipment, and eight

used three kinds of equipment on their land. The majority (61%) of farms used low pressure pivots. Some of these farmers also used other kinds of equipment, even gravity/flood; only about two-thirds of these farmers used low pressure pivots exclusively on all their land. Among the respondent farms, about one out of seven farmers used only gravity irrigation.

Table 6- 7 Irrigation Equipment Farmers Currently Are Using

Category	Frequency	Percent	Valid Percent
Using one kind of irrigation equipment:			
Gravity/Flood	28	13.8	14.1
Wheel Move	20	9.9	10.0
High Pressure Pivot	14	6.9	7.0
Low Pressure pivot	78	38.4	39.2
Subtotal	140	69.0	70.4
Using two kinds of irrigation equipment:			
Gravity/Flood and Wheel Move	6	3.0	3.0
Gravity/Flood and High Pressure Pivot	1	0.5	0.5
Gravity/Flood and Low Pressure pivot	13	6.4	6.5
Wheel Move and High Pressure Pivot	6	3.0	3.0
Wheel Move and Low Pressure pivot	17	8.4	8.5
High and Low Pressure Pivot	8	3.9	4.0
Subtotal	31	15.3	15.6
Using three kinds of irrigation equipment:			
Gravity/Flood, Wheel Move and Low Pressure pivot	6	3.0	3.0
Wheel Move, High and Low Pressure pivot	2	1.0	1.0
Subtotal	8	3.9	4.0
Valid total	199	98.0	100.0
Missing	4	2.0	
Total	203	100.0	

Since the early 1960s, irrigation practices on Alberta farms have shifted largely from surface gravity irrigation (“flood”) systems, to wheel move side-roll sprinklers, to high pressure centre pivots and then to low pressure centre pivot systems (AECOM, 2009, p51). Although farmers’ skills in using the various systems are important, this shift in

irrigation application methods has generally led to improvements in on-farm water-use efficiency in Southern Alberta (AECOM, 2009). Based on this improvement, one new variable was created to represent the efficiency of the irrigation equipment used on the farm (PB_EQP). If a farm had two or more kinds of equipment, then PB_EQP took the value of the most efficient type of irrigation equipment used on the farm (as defined in Table 6-8). The mean of PB_5YS is 0.56; hence more than half the farms improved their irrigation equipment in the last five years. The definition and descriptive statistics for the two variables used for representing past behaviour are shown in Table 6-8.

Table 6- 8 Definitions and Descriptive Statistics for Past Behaviour Variables

Variables	Definition	Valid N	Mean	Std. D	Skewness	Kurtosis
PB_EQP	The most efficient irrigation equipment used on the farm (Gravity/Flood =1; Wheel Move = 2; High Pressure Pivot = 3; Low Pressure pivot = 4)	199	3.21	1.13	-1.02	-0.58
PB_5YS	If the farm improved irrigation equipment in past five years (No =0; Yes =1)	202	0.56	0.50	-0.24	-1.96

Skewness and kurtosis were far lower than the critical values (skewness >2, kurtosis >7), indicating no violation of the assumptions of normality. This suggests that these data can be used for analyses that are based on assumptions of multivariate normality, such as Maximum Likelihood.

The correlation between the two variables was significant. Farmers' current irrigation efficiency was related to whether or not the farm improved irrigation equipment in the past five years; the correlation coefficient was 0.41.

6.3 Main Results for Respondents' Policy Response Intentions

Corresponding to Box F in the model (Figure 4-1), results of the four behavioural intentions are depicted in Table 6-9. The average of respondents' intentions was around zero. BI_1 and BI_4 were above zero; this means over half of respondents agreed that "Water pricing should be based on actual and recorded volume of water used" and "Increasing the price of water will not reduce the use of water for irrigation". The mean of BI_2 was negative, indicating that slightly more respondents disagreed than agreed with the statement "You would be willing to transfer water that, historically, you have not used". This suggests that, in general, more respondents would not be willing to transfer unused water. For BI_3, the descriptive statistics indicate that more respondents intend to make no changes than those who intend to do so. Some respondents held neutral intentions; they might join groups that either agree or disagree in the future. For BI_1 and BI_2, the statements of "Water pricing should be based on actual and recorded volume of water used" and "You would be willing to transfer water that historically, you have not used", over one-tenth of respondents did not hold clear agree or disagree intentions.

Skewness and Kurtosis statistics for these variables are low. This suggests the distributions of variables of behavioural intentions are quite close to normal and the data can be used for ML analyses.

Correlation tests reveal that there is no correlation among the four behavioural intentions.

Table 6- 9 Definitions and Descriptive Statistics for Four Intention Variables

Variables		BI_1	BI_2	BI_3	BI_4
Definition		Water pricing should be based on actual and recorded volume of water used.	You would be willing to transfer water that, historically, you have not used.	You intend to make any changes to your irrigation equipment in the next five year.	Increasing the price of water will not reduce the use of water for irrigation.
Code and Frequency	Strongly Disagree (-3)	17	24	-	4
	Disagree (-2)	33	55	-	48
	Somewhat Disagree* (-1)	19	10	107	22
	Subtotal	69	89	107	74
	Neutral** (0)	28	29	6	13
	Somewhat Agree*** (1)	37	22	90	31
	Agree (2)	53	54	-	68
	Strongly Agree (3)	15	9	-	15
	Subtotal	105	85	90	114
	Valid total	202	203	203	201
Mean		0.26	-0.17	-0.08	0.41
Std. Deviation		1.83	1.94	0.98	1.81
Skewness		-0.33	-0.01	0.17	-0.30
Kurtosis		-1.15	-1.49	-1.96	-1.43

Note: * For BI_3, the answer was coded as -1, indicating “No”;

**For BI_3, the answer was coded as 0, indicating “No answer” or “Uncertain”;

***For BI_3, the answer was coded as 1, indicating “Yes” as 1.

Correlations between the four behavioural intentions and socio-economic and demographic characteristics and past behaviour are shown in Table 6-10. There were seven statistically significant correlations. Farmers’ intention to agree that “Water pricing should be based on actual and recorded volume of water used” (BI_1) was significantly correlated to only one of the Farm Business Characteristics (FBC) variables: the position

in farm business cycle (BCYCL). Farmers' intention to "make any changes to your irrigation equipment in the next five years" (BI_3) was significantly correlated to two Individual Characteristics (IC) variables (AGE and OFFM), two FBC variables (ILSZ_T and BCYCL), and whether farmers improved their irrigation equipment in past five years (PB_5YS), which is a variable of Past Behaviour (PB). Farmers' intention to agree that "increasing the price of water will not reduce the use of water for irrigation" (BI_4) was significantly correlated to only respondents' education (EDU), which is an IC variable. Farmers' intention to "be willing to transfer some water that, historically, you have not used" (BI_2) did not show any significant correlations with any variables. All three Household Characteristics (HC) variables had no statistically significant correlations to any of the four intention variables. Generally speaking, most correlations between the four behavioural intentions and socio-economic and demographic characteristics and past behaviour were weak or statistically insignificant.

6.4 Measurement Models of Values and Attitudes

Following the Anderson and Gerbing (1988) two-step approach, prior to estimation and assessment of Structural Equation Modelling (SEM), confirmatory factor analysis is used to define and assess the measurement models of values and attitudes.

6.4.1 Values

As discussed in Chapter Four, Exploratory Factor Analysis was used to identify the correspondence between possible latent variables and measured value items.

Exploratory Factor Analysis for Value Items

Table 6- 10 Correlations^a between Four Behavioural Intentions and Socio-economic and Demographic Characteristics and Past Behaviour

		BI_1	BI_2	BI_3	BI_4
Individual Characteristics (IC)	AGE	0.26	-0.17	-0.08	0.41
	EDU	0.03	-0.06	-0.19*	0.05
	OFFM	-0.08	-0.09	0.03	-0.20*
Household Characteristics (HC)	HSIZE	0.15	-0.07	-0.23**	-0.10
	HAGE	-0.04	0.13	0.01	0.15
	HOFFM	0.06	-0.10	-0.10	0.00
Farm Business Characteristics (FBC)	ILSZ_T	0.05	-0.05	-0.10	-0.07
	BCYCL	-0.02	0.07	0.28**	0.00
	SCSRP	-0.23**	-0.12	0.23**	0.09
	GEN	-0.02	0.07	0.08	0.08
Past Behaviour (PB)	PB_IRQP	0.08	0.01	0.10	0.00
	PB_5YS	-0.06	0.11	0.14	-0.11

Note: * Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

a. Listwise N=164

Exploratory factor analysis (EFA) is one of the most popular statistical methods for finding a small set of unobserved variables (also called latent variables, constructs, or factors) that influences (or are influenced by) observed variables (also called indicators, or items). As noted by Bolen (2002, p615) “In exploratory factor analysis, the factors are extracted from the data without specifying the number and pattern of loadings between the observed variables and the latent factor variables”. The result of EFA can provide a basis for specifying a confirmatory factor analysis (CFA) model in a subsequent study (Fabrigar et al., 1999).

Prior to conducting EFA, all variables were standardized. The Kaiser-Meyer-Olkin (KMO) and Baetlett’s test of sphericity were used to determine whether or not EFA is appropriate. The KMO varies between 0 and 1. Kaiser (1974) recommends that KMO values greater than 0.5 are acceptable but considers values between 0.5 and 0.7 as

mediocre, values between 0.7 and 0.8 as good, values between 0.8 and 0.9 as great, and values above 0.9 as superb. The result of testing 20 value items indicates that the KMO is 0.85, which fell into the range of being great, and indicates that factor analysis is appropriate.

Bartlett's test of sphericity is another test used to verify the appropriateness of using factor analysis. Bartlett's measure tests the null hypothesis that the original correlation matrix is an identity matrix. For conducting factor analysis, this test should be significant, i.e., having a significance value less than 0.05. Bartlett's test of sphericity is highly significant ($p = .000 < .05$), which also indicates that factor analysis is appropriate. Therefore, using EFA to identify latent factors underlying the data on values is appropriate.

The overall reliability test shows Cronbach's alpha is 0.878. Based on the rules of thumb suggested by George and Mallery (2003), the internal consistency among the value items falls in the category between good and excellent. This suggests that the latent factors are reliable.

Corrected Item-Total Correlation is a way to assess how well one item's score is internally consistent with composite scores from all other items that remain. If this correlation is weak, then that item should be removed and not used to form a composite score for the variable in question. There is no exact standard for the cut-off of Corrected Item-Total Correlation, but a rule-of-thumb is that they should be at least 0.40 (Gliem and Gliem, 2003; Lounsbury et al., 2006) or 0.30 (de Vaus, 2002). de Vaus (2002, p184-185) suggested that if any Item-Total Correlation is less than 0.30, the item should be deleted.

Except for VI_9, the Corrected Item-Total Correlations for all other 19 value items are above 0.3, with a range from 0.37 to 0.63. As it was already found that VI_9 did not correlate with many other value items, its Corrected Item-Total Correlation is low at 0.24 and, therefore, it was excluded from the EFA.

The result of testing the 19 remaining value items indicates that the KMO is 0.86, Bartlett's test of sphericity is highly significant ($p = 0.000 < 0.05$), and Cronbach's alpha is 0.88.

A recent article by Costello and Osborne (2005) suggests that Maximum Likelihood (ML) or Principal Axes Factor (PAF) generally give the best results in EFA. However, the ML method is based on the assumptions of a normal distribution. If the assumption of multivariate normality is "severely violated", PAF is recommended (Costello and Osborne, 2005; Fabrigar et al., 1999). Although after transformations the overall data distribution improved, the variables still were slightly or moderately non-normal. Thus, PAF was used instead of ML for EFA.

There is no reason to presume that those possible latent variables, extracted from 19 value items, are independent. Based on Schwartz's value theory (1987; 1992), among the 19 value items, 15 items come from three types of values, which are adjacent to each other in the human value structure; and the other four value items come from a type of value that is opposite to the first type. Oblique rotation would be the appropriate method in the EFA of value items since they allow the factors to correlate (Costello and Osborne, 2005; Fabrigar et al., 1999; Kline, 2013). As the most widely used method (Kline, 2013), promax rotation is employed with PAF in the EFA because all methods of oblique

rotation tend to produce similar results (Costello and Osborne, 2005; Fabrigar et al., 1999).

Although the eigenvalue > 1.0 rule has been widely used for determining the number of factors, it is believed to be a mistake when a reduced correlation or covariance matrix is analysed (Fabrigar et al., 1999; Kline, 2013). A scree test is used to determine the number of factors in the present EFA. A scree plot of the eigenvalues from the initial factors solution is presented in Figure 6-1. After the fourth factor, the line is almost flat. Notice that factor 5 has an eigenvalue greater than 1. Both 4-factor and 5-factor solutions were tested. The residual correlations (unreported) indicate that there are 42 (24%) non-redundant residuals with absolute values greater than 0.05 when four factors are extracted, whereas only half that number (21, 12%) non-redundant residuals with absolute values greater than 0.05 when five factors are extracted. That means the 5-factor solution improves the explanatory power of a factor solution. Therefore, the data should be analysed for 5 factors. Not only that, it is believed that “It is generally better in EFA to extract too many factors, or overfactoring, than to retain too few, or underfactoring” (Kline, 2013, p184).

Based on the above considerations, Principal Axis Factoring (PAF) analysis with promax rotation was performed, forcing all 19 value items to a 5-factor solution. The pattern matrix is shown in Table 6-11.

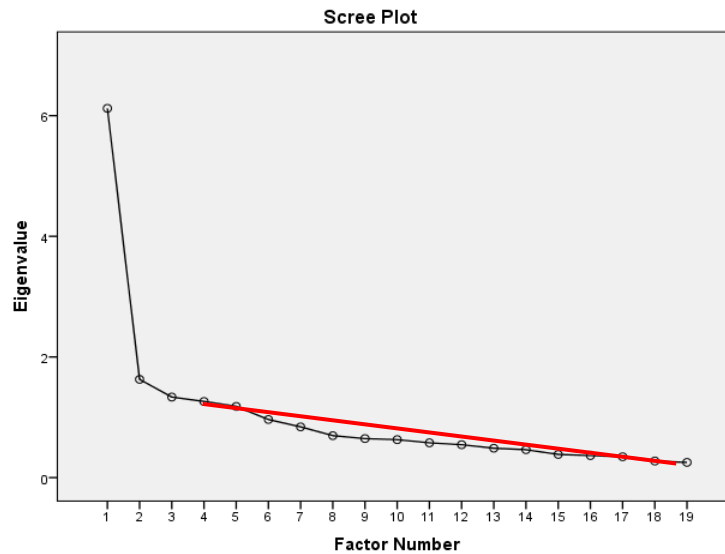


Figure 6- 1 Scree Test for A PAL Analysis of 19 Value Items

The first factor is defined by four value items: “A world of beauty (VI_17), “Curious (VI_16), “Unity with nature (VI_3)” and “Protecting the environment (VI_1)”. Except for VI_16, the other three items in factor 1 come from Schwartz’s value type of “Universalism”. According to the definition of Schwartz’s value types (Schwartz, 1992), the motivational goal of universalism is for the welfare of all people and for nature. The motivational goal of these three values is appreciation, understanding, and protection for nature (Schwartz, 1992). VI_16 comes from “Self-direction” in Schwartz’s value structure, but to a large extent is also close to nature, exploring nature. Therefore, Factor 1 was given the name of “Universalism_Nature” (UN_N).

The second factor has four value items: “Independent (VI_19)”, “Freedom (VI_18)”, “Choosing own goals (VI_4)”, and “Self-respect (VI_15)”. All value items in this factor are chosen from Schwartz’s “Self-Direction” type of value. Following Schwartz’s Value Types (Schwartz, 1992), Factor 2 was also named as “Self-Direction” (SD).

Table 6- 11 Five Factor Pattern Matrix^a, Eigenvalues and Internal Consistency Estimates for 19 Value Items

N=190

Variables	Pattern Matrix ^a					Communalities	Corrected Item-Total Correlation
	UN_N	SD	UN_H	PA	BE		
VI_17	0.96	0.00	0.00	-0.04	-0.09	0.84	0.56
VI_16	0.79	0.11	-0.25	-0.04	0.08	0.53	0.44
VI_3	0.50	0.01	0.11	0.12	0.09	0.46	0.57
VI_1	0.34	-0.05	0.31	0.05	0.13	0.42	0.56
VI_19T	-0.01	0.84	-0.01	-0.12	0.08	0.64	0.54
VI_18T	0.19	0.70	-0.16	-0.15	0.14	0.47	0.47
VI_4	-0.11	0.43	0.19	0.19	-0.03	0.40	0.50
VI_15	-0.06	0.34	0.29	0.23	0.07	0.53	0.65
VI_8	-0.18	-0.08	0.89	-0.18	0.13	0.50	0.44
VI_14	0.02	0.01	0.58	-0.15	0.14	0.33	0.45
VI_6	0.09	0.30	0.44	0.07	-0.35	0.50	0.49
VI_7	0.22	0.16	0.38	0.11	-0.05	0.49	0.62
VI_5	-0.02	-0.13	-0.15	0.81	0.00	0.44	0.36
VI_11	-0.10	0.26	-0.26	0.73	0.06	0.56	0.46
VI_13	0.12	-0.16	0.04	0.53	-0.04	0.28	0.38
VI_10	0.19	-0.23	0.23	0.26	0.21	0.33	0.46
VI_2T	0.11	0.00	0.08	-0.04	0.57	0.40	0.41
VI_20T	-0.01	0.12	0.18	0.13	0.49	0.51	0.58
VI_12T	-0.07	0.26	0.05	-0.01	0.47	0.38	0.44
Eigenvalues ^c	5.61	1.21	0.77	0.72	0.67		
% of Variance	28.54	6.37	4.07	3.79	3.52		
Cronbach's Alpha	0. 80	0.76	0. 70	0.64	0.66		

Note: Extraction Method: Principal Axis Factoring.

Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

b. Loadings in bold are values above 0.30.

c. Extraction Eigenvalues

The third factor is a combination of four value items: “Equality (VI_8)”, “Social justice (VI_14)”, “Broad-minded (VI_6)”, and “Inner harmony (IV_7)”. The four items in Factor 3 come from Schwartz’s value type of “Universalism”. The motivational goal of these

four values is understanding and tolerance for the welfare of all people (Schwartz, 1992). Therefore, Factor 3 was given the name of “Universalism_Human” (UN_H).

The fourth factor combines four value items: “Successful (VI_11)”, “Wealth (VI_5)”, “Social recognition (VI_13)”, and “Authority (VI_10)”. VI_11 was chosen from “Achievement” type of value, and the three other items (VI_5, VI_13, and VI_10) come from “Power” type of value. Factor 4 was named “Power-Achievement (PA)”.

The fifth and last factor is formed by three value items: “True friendship (VI_2)”, “Meaning in life (VI_20)”, and “Responsible (VI_12)”. In this factor, all three value items come from the “Benevolence” type. Following Schwartz’s Value Types (Schwartz, 1992) Factor 5 was named as “Benevolence (BE)”.

The forced 5-factor solution explained 47.3% of the total variance, and the eigenvalues for the five factors ranged from 5.61 to 0.67.

Communality is a statistic in a squared metric that indicates the amount of variance in a variable that is explained by a combination of the extracted factors. If a variable has a low communality, it indicates that the variance for the variable is not explained by the extracted factors. It is normally suggested that variables with low communalities be dropped in order to increase the explanation of total variance (De Vaus, 2002).

The final set of communality estimates in Table 6-11 came from converged iterative estimation. VI_13 has communalities lower than 0.30 (0.28), which is often suggested as being too low and should be removed from the model. However, its structural coefficient, or correlation between VI_13 and the fourth factor is 0.50 at an acceptable level

(structure matrix⁶ is shown in Table 6-12). We agree with the statement of “A communality of 0.25 seems low but may be meaningful if the item is contributing to a well-defined factor” (Jordaan and Grove, 2007, p557; Tam et al., 2007, p287), and, thus, keep it in the model. Although VI_10 has communality above 0.30, it does not have a distinguished factor loading in the pattern matrix. In the structure matrix, the structural coefficients from the first, third, and fourth factors are all above 0.40 and with similar levels (0.42, 0.45 and 0.43, respectively). This indicates that VI_10’s contributions cannot be clearly distinguished from those three factors and should be discarded.

Corrected Item-Total Correlations range from 0.36 to 0.65 and Cronbach's Alphas range from 0.64 to 0.80 among the five factors. This indicates acceptable reliabilities of the subscales.

The Factor Correlation Matrix is presented in Table 6-13. It provides supporting evidence that the five extracted factors are inter-correlated. Not surprisingly, the two Universalism factors have quite strong correlation (0.60). The factor of Universalism (for human) with both Self-direction and Power-Achievement, and the factor of Self-Direction with Power-Achievement also are quite highly correlated. Correlations exist among all five factors and the correlation coefficients range from 0.32 to 0.62.

Confirmatory factor analysis (CFA) of a revised 5 factor model was conducted by using AMOS 20.0, and the results are presented in the following section.

⁶ Unlike orthogonal rotations, oblique rotations allow the factors to be correlated. When the rotation is oblique, the loadings and correlations are distinct; both factor pattern and factor structure matrices are produced. The structure matrix shows correlations between the variables and the factors. The pattern matrix shows the loadings or standard weights to be used to reproduce the item scores from the factor scores. The structure matrix is regarded as suitable for the purpose of selecting items (Gorsuch, 1997).

Table 6- 12 Five Factor Structure Matrix^a for 19 Value Items

N=190

Variables	UN_N	SD	UN_H	PA	BE
VI_17	0.91	0.33	0.52	0.35	0.21
VI_16	0.70	0.29	0.30	0.25	0.27
VI_3	0.65	0.37	0.52	0.44	0.33
VI_1	0.57	0.34	0.56	0.41	0.35
VI_19T	0.30	0.79	0.43	0.39	0.31
VI_18T	0.36	0.65	0.32	0.29	0.32
VI_15	0.38	0.64	0.61	0.60	0.35
VI_4	0.25	0.59	0.48	0.49	0.21
VI_8	0.28	0.30	0.66	0.29	0.29
VI_7	0.54	0.51	0.65	0.51	0.24
VI_6	0.40	0.52	0.60	0.44	-0.03
VI_14	0.35	0.31	0.55	0.27	0.29
VI_10	0.42	0.20	0.45	0.43	0.37
VI_11	0.19	0.51	0.30	0.70	0.29
VI_5	0.20	0.25	0.27	0.64	0.20
VI_13	0.30	0.21	0.34	0.50	0.16
VI_20T	0.36	0.46	0.49	0.49	0.64
VI_12T	0.32	0.26	0.32	0.27	0.62
VI_2T	0.22	0.42	0.32	0.33	0.56

Note: Extraction Method: Principal Axis Factoring.

Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

b. Structural coefficients in bold are values above 0.50.

Table 6- 13 Correlation Matrix for Five Extracted Factors of Value

N=190

Factor	UN_N	SD	UN_H	PA	BE
UN_N	1.00				
SD	0.41	1.00			
UN_H	0.60	0.58	1.00		
PA	0.44	0.59	0.62	1.00	
BE	0.32	0.34	0.35	0.37	1.00

Extraction Method: Principal Axis Factoring.

Rotation Method: Promax with Kaiser Normalization.

Confirmatory factor analysis (CFA) for Value Measurement Models

Based on the results of Exploratory Factor Analysis (EFA), the model of 5 factors with 18 value items (VI_9, VI_10 are excluded) is shown on the left side of Figure 6-2 (I).

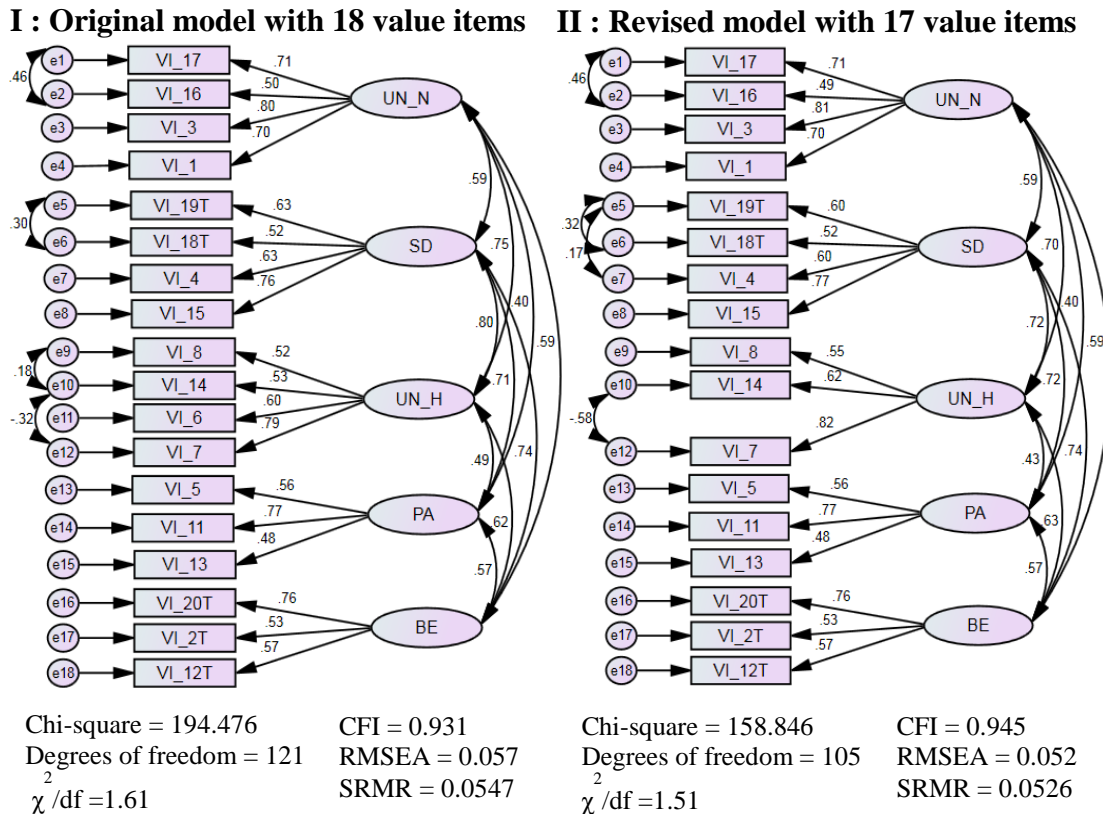


Figure 6- 2 Five Factor Model for Value Items with Standardized Estimates and Fit Indices

Note: All coefficients are significant at the 0.05 level.

Following Hu and Bentler's (1998, 1999) two index presentation strategy, Comparative Fit Index (CFI), Root-Mean-Square Error of Approximation (RMSEA), and Standardized Root-Mean-square Residual (SRMR) were used to test for the model fit. Hu and Bentler (1999) suggest that $CFI > 0.95$, $SRMR < 0.08$, and $RMSEA < 0.06$ indicate a relatively good fit between the hypothesized model and the observed data. As shown in Figure 6-2, $CFI > 0.90$ but quite close to 0.95, and both RMSEA and SRMR are lower than

recommended cut-offs, indicating that the model provides a satisfactory fit to the data.

Meanwhile, χ^2/df ratio < 2 also suggests that the model has a good fit with the data obtained from the valid sample of 190 respondents.

Noticing that VI_6 had unacceptable double loading, the measurement model was revised by discarding VI_6. As shown in the right side of Figure 6-2 (II), the revised model has 17 value items. The fit indexes for the revised model obviously improved. This indicates that the revised model provides a better fit to the data and will be adopted in the following analysis.

6.4.2 Attitudes

Prior to conducting CFA, all variables were standardized. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were conducted. After testing all nine attitude items, the KMO was 0.7, which is close to the range of being good, and indicates that factor analysis is appropriate. Bartlett's test of sphericity was highly significant ($p = 0.000 < 0.005$), also indicating that factor analysis is appropriate. Therefore, using factor analysis to confirm latent factors underlining the data of attitudes was deemed to be appropriate.

As illustrated in Figure 6-3, the measurement model of attitude has three factors and nine attitude items. A Confirmatory Factor Analysis (CFA) was used to test the validity of the measurement model by AMOS 20.0. With χ^2/df ratio < 2 , CFI > 0.95 , RMSEA < 0.06 and SRMR < 0.06 , the results indicate the model provides a very good fit to the data.

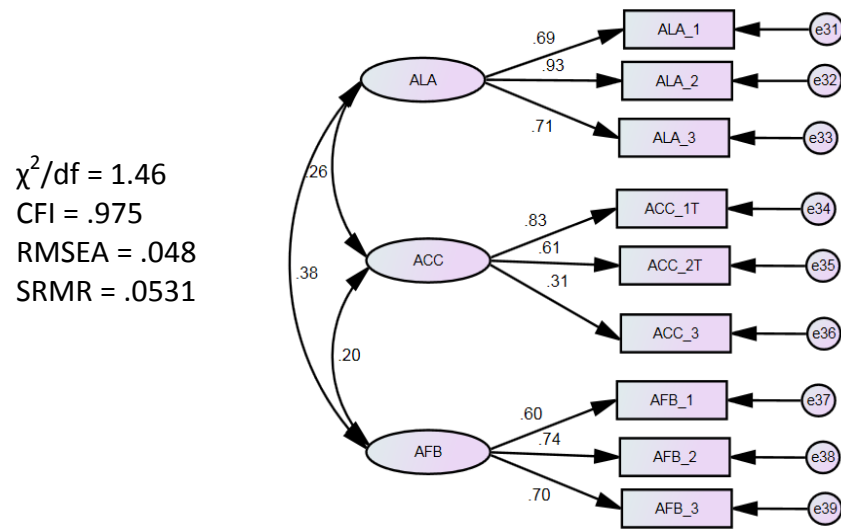


Figure 6- 3 Measurement Model for Attitude with Standardized Estimates and Fit Indices

Note: All coefficients are significant at the 0.05 level.

However, similar to the pattern that was seen in the correlation analysis, the loading of ACC_3 to ACC is too low to keep it in the model. Although choice of the cut-off for size of loading is a matter of researcher preference (Tabachnick and Fidell, 2007: p649), it is generally suggested that it should be more than 0.32 (10% overlapping variance) (e.g., Tabachnick and Fidell, 2007; Worthington and Whittaker, 2006). After ACC_3 was removed from the model, the revised model provided a better fit to the data. The result of the revised model is shown in Figure 6-4 and is used in the following analysis.

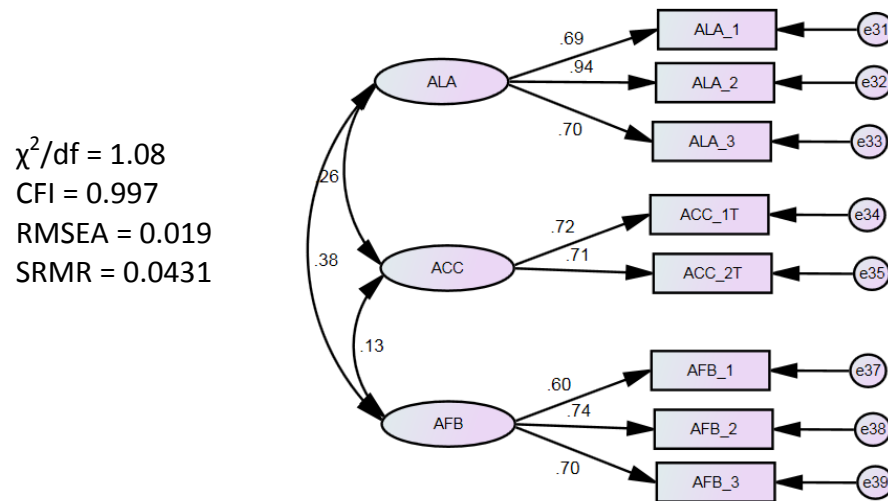


Figure 6- 4 Revised Measurement Model for Attitude with Standardized Estimates and Fit Indices

Note: All coefficients are significant at the 0.05 level.

6.4.3 Values and Attitudes

Values are viewed as potential determinants of preferences and attitudes (Olson and Zanna, 1993). Previous studies have shown that values can predict environmental attitudes (Schultz and Zelezny, 1999) and attitude formation towards new or emerging attitude objects, specifically emerging attitude objects within the environmental field (Thøgersen and Grunert-Beckmann, 1997).

A path analysis was used to test the relationship between the values and attitudes explored in this study. Although value items have about 6.4% missing data, AMOS automatically recognizes them and uses Maximum Likelihood (ML) estimation for the incomplete data (Byrne, 2010). Furthermore, Byrne (2010) proved that even with 25% data loss, both the parameter estimates and the goodness-of-fit statistics are similar for

complete or incomplete data. Therefore, AMOS was allowed to handle missing data in the analysis.

Results from the model of values and attitudes with all 5 value factors and proposed paths are shown in Figure 6-5. Seven paths are statistically significant in the direction predicted at the 0.1 probability level. Both Attitudes to Community Cohesion (ACC) and Attitude to Land Attachment (ALA) significantly related to their Universalism (both for to nature and human, UN_N and UN_H) and Self-direction (SD) types of value. However, Attitude to Farming Business (AFB) related to Benevolence (BE) and Universalism for human (UN_H) types of value. The model explains 29%, 54% and 29% of the variance in Attitude to Community Cohesion (ACC), Attitude to Land Attachment (ALA), and Attitude to Farming Business (AFB), respectively. The validity test indicated the model has a good fit with the data obtained from the sample of 203 respondents.

As demonstrated in Figure 6-5, Power and Achievement type of value (PA) does not have significant influence on any of the given attitudes. Theoretically, Power and Achievement type of value opposes Self-direction, Universalism and Benevolence values in the circular structure in Schwartz's Value Theory. As Schwartz (2006) points out, the closer any two values are in either direction around the circle, the more similar their underlying motivations; the more distant any two values are, the more antagonistic their underlying motivations. The motivational goal that is embedded in Power and Achievement type of value (PA) is distant from those of Self-direction (SD), Universalism (UN_N and UN_H), and Benevolence (BE). Therefore, the reduced model without Power and Achievement type of value (PA) has been tested with the results shown in Figure 6-6.

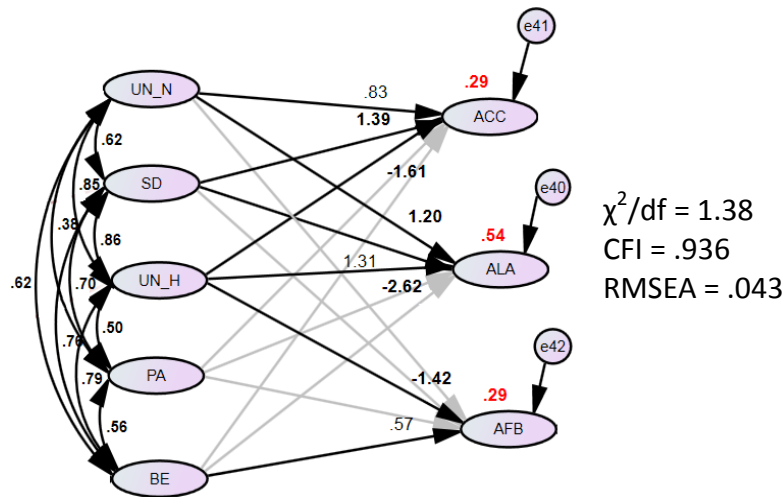


Figure 6- 5 Model of Values and Attitudes

- Note:
1. For the sake of simplicity, all the observed variables and the errors were concealed.
 2. The numbers beside the paths are the standardized path coefficients, which are the same as the beta weights in a multiple regression. Paths in light grey are not statistically significant at 0.1 probability level and their coefficients are omitted. Path coefficients in bold indicate that they are significant at 0.05 probability level.
 3. High correlations between UN_N and UN_H (.85) and between UN_H and SD (0.86) raise the possibility of multicollinearity in the data, and lead to some standardized coefficients greater than one. As Deegan (1978) suggests that standardized coefficients greater than one can legitimately occur and there is no compelling reason to modify models simply to reduce the presence of multicollinearity, no attempt was made to modify the model to eliminate the coefficients greater than one because it might cause biasing effects of model specification error.
 4. The numbers in red over the endogenous variables are the squared multiple correlations, which are the R^2 's in regression.
 5. With incomplete data, Amos does not provide Standardized RMR.

After eliminating the latent variable (factor) of Power and Achievement type of value (PA), the model fit index was greatly improved. Compared to the model in Figure 6-5, the reduced model was greatly simplified; the number of distinct parameters to be estimated decreased from 102 to 86. However, the explanatory power of the reduced model was reduced by only 4%, 0% and 3% for Attitude to Community Cohesion (ACC), Attitude to Land Attachment (ALA), and Attitude to Farming Business (AFB),

respectively. Therefore, the latent variable of Power and Achievement type of value (PA) and its observed variables are excluded from the following analysis.

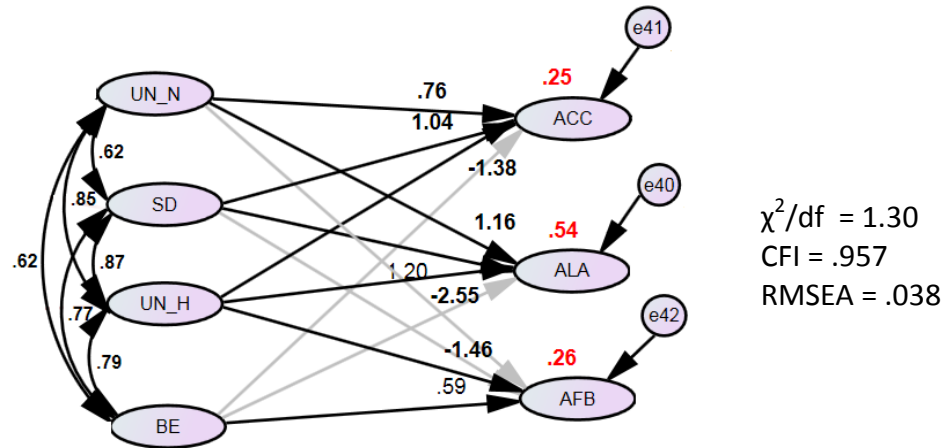


Figure 6- 6 Reduced Model of Values and Attitudes

- Note:
1. For the sake of simplicity, all the observed variables and the errors were concealed.
 2. The numbers beside the paths are the standardized path coefficients, which are the same as the beta weights in a multiple regression. Paths in light grey are not statistically significant at 0.1 probability level and their coefficients are omitted. Path coefficients in bold indicate that they are significant at 0.05 probability level.
 3. High correlations between UN_N and UN_H (.85) and between UN_H and SD (0.87) raise the possibility of multicollinearity in the data, and lead to some standardized coefficients greater than one. According to Deegan's (1978) suggestion, no attempt was made to modify the model to eliminate the coefficients greater than one.
 4. The numbers in red over the endogenous variables are the squared multiple correlations, which are the R^2 's in regression.
 5. With incomplete data, Amos does not provide Standardized RMR.

6.5 Summary

Among the 203 respondents, 179 were male and 24 were female. The average age of respondents was about 56 years; nearly two in five had a university degree, college or non-university certificate/diploma. The majority of respondents (63.7%) did not have any off-farm employment. The average household size in the survey was nearly 3 persons.

The average irrigated land on respondents' farms was about 523 acres. The majority (65.5%) of farms were described as in a stable mode, neither growing nor declining in size. Nearly one third reported that they had a succession plan in place. On average, the respondents had owned their farm for over two generations. More than half improved their irrigation equipment in the last five years, and the majority (61%) used low pressure pivots on their farms. Very few respondents believed their current irrigation efficiency was low or very low.

Descriptive statistics indicate that the majority of the respondents agreed with the statement that "Water pricing should be based on actual and recorded volume of water used"; but a majority of the respondents had no intention to "make any changes to your irrigation equipment in the next five years" and reduce irrigation water if the price of water increases. There were quite similar rates for respondents who either were or were not willing to transfer historically unused water.

Our proposed model suggested that five kinds of factors (referred to as Boxes A to E in Figure 4.1) influence farmers' behavioural intentions (referred to as Box F in Figure 4.1). In total, 47 variables were involved in the study.

In Box A (Individual Characteristics (IC)), four variables of respondents' Gender (GEND), Age (AGE), Education level (EDU), and Off-farm work status (OFFM) were selected. Although gender always attracts attention in the field of behavioural research, it had to be excluded from our analysis since female respondents were few in our survey. In the analysis, three variables of AGE, EDU and OFFM are used to explore the influence of personal characteristics on farmers' behavioural intentions.

In Box B (Household Characteristics (HC)), three variables of respondents' Household Size (HSIZE), Household average Age (HAGE), and the Household couple's Off-Farm work status (HOFFM) were used to explore the influence of Household Characteristics (HC) on behavioural intentions.

In Box C (Farm Business Characteristics (FBC)), four variables of the Size of Irrigated Land (ILSZ), the farm's position in Business Cycle (BCYCL), the farm's Succession Plan (SCSRP) and the number of Generations that lived on the family farm (GEN) were used in the analysis.

In Box D (Value and Attitude (VA)), twenty value items and nine attitude items were used to represent their psychological makeup. By means of factor analysis, five value factors, "Universalism_Nature" (UN_N), "Self-Direction" (SD), "Universalism_Human" (UN_H), "Power-Achievement (PA)", and "Benevolence (BE)" were extracted from 17 value items (three that were in the questionnaire were excluded due to lack of explanatory ability). These five value factors are consistent with the category of Schwartz's Value Types (Schwartz, 1992). Three attitude factors (Attitudes to Community Cohesion (ACC), Attitude to Land Attachment (ALA), and Attitude to Farm Business (AFB)) were confirmed from 8 attitude items (one was excluded). Since Power and Achievement type of value (PA) had no statistically significant influence on any of three attitude factors, PA and its three relative value items were excluded in order to simplify the model. That is, 14 value items and 8 attitudes items were used in the analysis.

In Box E (Past Behaviour (PB)), three variables were selected to represent three aspects of water use behaviour. They included the irrigation equipment farmers currently were

using (PB_EQP) and whether farmers improved their irrigation equipment in the past five years (PB_5YS).

Finally, Behavioural Intentions (BI) are in Box F. Four behavioural intentions were explored in this study: (1) intention to agree that “water pricing should be based on actual and recorded volume of water used” (BI_1), (2) intention to “be willing to transfer some water that, historically, you have not used” (BI_2), (3) intention to “make any changes to your irrigation equipment in the next five years” (BI_3), and (4) intention to agree that “increasing the price of water will not reduce the use of water for irrigation” (BI_4).

In sum, thirty-nine variables in total were kept for further study after the preliminary analysis presented in this chapter. The overall reliability test was acceptable (Cronbach’s alpha was 0.71) and indicated acceptable internal consistency among the 38 variables, which will be used in structural equation modelling (SEM) in Chapter Seven.

Chapter Seven Structural Equation Modelling and Results

7.1 Introduction

The proposed model (developed in Chapter Four) sought to identify the factors that influence farmers' behavioural intentions to water policy changes.

As discussed in Chapter Six, the measurement models were identified and 7 latent variables (factors) were extracted. Thirty-nine reliable and validated observed variables were identified for the model. Maximum Likelihood (ML) was used to estimate parameters in this study. The literature shows that ML is the most widely utilized method for estimating structural equation models and can be applied when sample size is quite small, even when it is just slightly larger than the number of variables (Bentler and Yuan, 1999). The ML estimator assumes that the variables in the model are multivariate normal. Several variables in this study, including one of the farm business characteristics (FBC) variable (ILSIZE), five value items (VI_2, VI_12, VI_18, VI_19, and VI_20), and two attitude items (ACC_1 and ACC_2), showed clear signs of non-normality.

Transformations of these variables were conducted prior to SEM estimation (as described in Chapter Six).

Using SEM, the proposed model is estimated, assessed, and described in the following section. The reliability, validity and goodness of fit of the models are presented. A detailed description of one modified model and one equivalent model also are provided in section 7.2. Following the estimation and assessment of the models, Section 7.3 presents and discusses the results of SEM. Also, in section 7.3, the hypotheses tests are discussed

and reported, with interpretation of the main model results. A summary is provided at the end of this chapter.

7.2 Model Assessment and Modification

7.2.1 Model Assessment

Reliability and Validity of Measurement Models

Based on the proposed model, Model I was specified and estimated. As Structural Equation Modelling (SEM) refers to a hybrid model, both for the measurement and the structural models, its assessment should be conducted using a two-step process that involves separate assessments of the measurement and the structural models. As discussed in Chapter Six, there are four value and three attitude measurement models in Model I. Also, two variables (the irrigation equipment currently used by the farmers and whether or not they improved their irrigation equipment in the past five years) were designed to represent past behaviour in this study. Before testing for a significant relationship in the structural model, the measurement models should be assessed with regard to their reliability and validity (e.g., Fornell and Larcker, 1981; Hair et al., 2011). As discussed in Chapter Four, examination of factor loading (or, individual-variable reliability), composite reliability (CR), and the average variance extracted (AVE) from a set of measures of a latent variable are often recommended (e.g., Bagozzi and Yi, 1988; Fornell and Larcker, 1981; Hair et al., 2011).

Table 7-1 shows the results for these indexes. All individual and composite reliability values fall within the acceptable range; (the former, all above 0.5; the latter, all above 0.6). However, the average variances extracted for some latent variables are quite low.

Table 7- 1 Reliability and Validity of Measurement Models

	Variable		Loading	CR	AVE
Value	UN_N	VI_3	0.720	0.79	0.49
		VI_16	0.817		
		VI_17	0.502		
		VI_1	0.709		
	UN_H	VI_7	0.758	0.63	0.37
		VI_14	0.526		
		VI_8	0.509		
	SD	VI_15	0.626	0.73	0.40
		VI_4	0.731		
		VI_18T	0.543		
	BE	VI_19T	0.620	0.67	0.40
		VI_12T	0.576		
		VI_2T	0.586		
Attitude	ALA	VI_20T	0.727	0.79	0.57
		ALA_1	0.732		
		ALA_2	0.870		
	AFB	ALA_3	0.635	0.72	0.47
		AFB_1	0.588		
		AFB_2	0.699		
	ACC	AFB_3	0.752	0.70	0.55
		ACC_1	0.608		
Past Behaviour	PB	ACC_2	0.850	0.62	0.46
		PB_EQP	0.808		
		PB_5YS	0.515		

Note: UN_N = values of “Universalism_Nature”, including four indicators: VI_3 (Unity with nature), VI_16 (Curious), VI_17 (A world of beauty), and VI_1 (Protecting the environment);

UN_H = values of “Universalism_Human”, including three indicators: VI_7 (Inner harmony), VI_14 (Social justice), and VI_8 (Equality);

SD = values of “Self-Direction”, including four indicators: VI_15 (Self-respect), VI_4 (Choosing own goals), VI_18 (Freedom), and VI_19 (Independent);

BE = values of “BEnevolence”, including three indicators: VI_12 (Responsible), VI_2 (True friendship), and VI_20 (Meaning in life);

ALA = Attitude to Land Attachment, including three indicators: ALA_1 (Having land to pass down to future generations is more important than selling it for the highest price), ALA_2 (You feel a responsibility to keep your land in the family), and ALA_3 (Land is the most important heritage of the family);

AFB = Attitude to Farming Business, including three indicators: AFB_1 (A maximum annual net financial return from your farm is an important goal for your family), AFB_2 (Increasing the asset value or net worth of your farming operation is very important to your family), and AFB_3 (You view your farming operation as first and foremost a business investment);

ACC = Attitude to Community Cohesion, including two indicators: ACC_1 (Rural communities are a great place to live and raise a family) and ACC_2 (The lifestyle that comes with living in a rural area is very important to your family);

PB = Past Behaviour, including two indicators: PB_EQP (The most efficient irrigation equipment used on the farm) and PB_5YS (If the farm improved irrigation equipment in past five years).

The average variance extracted for three latent attitude variables and one value of UN_N latent variable are above or close to the criterion of 0.5, and the average variance extracted for the other three value latent variables (UN_H, SD, and BE) are about 0.4. Although there is room to modify measurement models by deleting some weak indicator items, it can be concluded that the reliabilities and validities of these measurement models are generally acceptable.

Goodness of Fit of the Structural Model

The goodness of fit of a statistical model describes how well it fits the observed data. The fit statistics for Model I are depicted in Table 7-2. Based on existing findings, χ^2 and the associated degrees of freedom, SRMR, RMSEA, and CFI were chosen as a set of evaluation measures in this study.

Table 7- 2 Fit Statistics for Model I and the General Rule for Acceptable Fit

Fit Indices	Model I	General Rule for Acceptable Fit
χ^2 (df)	595.242 (467)	Ratio of χ^2 to df ≤ 2 or 3
χ^2 / df	1.27	2~3
SRMR	No report with missing value	$\leq 0.08 \sim 0.1$
RMSEA	0.037	$\leq 0.06 \sim 0.08$
LO90--HI90	0.027--0.045	
CFI	0.948	≥ 0.95

Note: SRMR = Standardized Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; LO90 = Lower boundary of a two-sided 90% confidence interval for the RMSEA; HI90 = Upper boundary of a two-sided 90% confidence interval for the RMSEA; CFI = Comparative Fit Index.

As shown in Table 7-2, all measures fall within, or are better than, recommended acceptable threshold levels. The confidence interval around the RMSEA provides more assistance in the evaluation of model fit. The upper boundary of the 90% interval of RMSEA for the Model I also is less than 0.05, which is a criterion for “close fit”

(Browne and Cudeck, 1993) or “good fit” (Schermelleh-Engel et al., 2003). Therefore, the model provides a satisfactory fit to the data.

7.2.2 Model Modification and an Equivalent Model

Model Modification

Although *post hoc* model modification is a controversial topic, statisticians and applied researchers alike emphasize the need to clearly state when there was *post hoc* modification (Weston and Gore, 2006). In this study, three value measurement models (UN_H, SD and BE) have an AVE of less than 0.4, which means the latent variables of UN_H, SD and BE explain less than 40% of their indicators’ variance. This could indicate the convergent validities are questionable (Fornell and Larcker, 1981), inadequate (Bagozzi et al., 1991), or insufficient (Hair et al., 2011). Therefore *post hoc* modifications of the measurement models for those latent variables were made. To more closely determine possible sources of the lack of fit, standardized residuals and modification indices are useful (Jöreskog and Sörbom, 1993). AMOS can provide these two types of indices when the data series has no missing values.

To obtain standardized residuals and modification indices, missing values therefore were imputed by means of a single regression imputation. Although multiple imputations have statistical advantages, they are also more complex, computer-intensive, and difficult to use (Schlomer et al., 2010). Compared to multiple imputations, single regression imputation is simple and easily handled. Not only that, regression imputation also represents the best “guess”, and produces unbiased means under MCAR or MAR (Schlomer et al., 2010). Although single imputation tends to underestimate the standard

errors and thus overestimate the level of precision (Acock, 2005), it would not be of much concern when the purpose simply is to find possible sources of the lack of fit.

Among the variables that were used in the model, 25 had missing values. Five are missing completely at random (MCAR), and twenty are missing at random (MAR)⁷.

Therefore, single regression imputation was chosen, and all missing values were imputed⁸.

Standardized residuals are analogous to Z-scores. They represent estimates of the number of standard deviations the observed residuals are from the zero residuals that would exist if the model fit were perfect (Byrne, 2010, p86). If the model is correctly specified, large values of standardized residuals indicate poorly fitted correlations (Kenny, 2012). Values larger than 2.58 (Jöreskog and Sörbom, 1993; Byrne, 2010), or 2 (Bagozzi and Yi, 1988; Kenny, 2012), are considered to be large.

Running the model with complete data where missing values were imputed by regression imputation, a standardized residual covariance matrix was created. In examining the

⁷ Following Schlomer et al. (2010)'s suggestion, 25 dummy variables with two values (missing and nonmissing) were created. The relation between these dummy variables and the other variables used in the model were tested. Five dummy variables for missing values in variables of respondent's age (AGE), household average age (H_AGE), succession plan (SCSRP), _R ZC8 ZC15R were not related to any other variables, which indicated that the data are either missing completely at random (MCAR) or not missing at random (NMAR). Twenty dummy variables for missing values in variables of respondent couple and self's off-farm status (HOFFM and OFFM), size of irrigated land (ILSIZE), the most efficient irrigation equipment used on the farm (PB_EQP), two behavioural intentions (BI_1 and BI_4), and all 14 value items were associated with some other variables, which means the data for those variables are either missing at random (MAR) or not missing at random (NMAR). Because the association between missingness and how the participant would have responded cannot be evaluated, NMAR has to be evaluated conceptually (Schlomer et al., 2010). There was no evidence that participants who were likely high (or low, or any particular value) on those 25 variables with missing values were more likely to have missing data. Therefore, the former 5 variables are MACR, the latter 20 variables are MAR, and none of them are NMAR.

⁸ Based on Arbuckle (2011, p461), the procedure of regression imputation has three steps. First, the model is fitted using maximum likelihood; second, model parameters are set equal to their maximum likelihood estimates, and linear regression is used to predict the unobserved values for each case as a linear combination of the observed values for that same case; third, predicted values are then plugged in for the missing values.

standardized residual values, only two values exceeded the cut-off point of 2.58 and both represented the covariance related to ALA_3. Nine were larger than 1.96, and the two largest ones also were associated with ALA_3 (demonstrated in Table 7-3). Therefore, ALA_3 was the main variable that caused statistically significant discrepancies.

Table 7- 3 Selected Standardized Residual Covariances for Model I*

Variables	AFB_2	ALA_3	VI_4	VI_14	VI_18T	VI_19T	PB_5YS
AGE		2.91				2.03	
OFFM							
H_AGE		2.46					
ILSZ_T				-2.31			
PB_EQP			2.11		-1.97		
ACC_1T	2.33						
VI_3		2.37					2.02
VI_16		2.64			2.07		

Note: * Only the values that are greater than 1.96 in absolute value are shown here.

Modification indices (MIs) is another type of information related to misspecification that reflects the extent to which the hypothesized model is appropriately described (Byrne, 2010, p89). Associated with each MI, AMOS reports “Par Change”, which is an expected parameter change (EPC) value (Saris, Satorra, & Sörbom, 1987), that is, how much the parameter is expected to change if it is set free (Jöreskog & Sörbom, 1993). In reviewing the MIs related to the covariance (the results table is not shown), one value of 10.64 was substantially larger than the rest of the estimates, which relates to covariation between the error term of e10 and observed variable ILSZ_T. The error term of e10 is associated with value items VI_14. Because error terms with observed or latent variables cannot covary, or with other error terms that are not part of the same factor, no more covariance could be added to remedy the discrepancies between the proposed and estimated model based on the modification indices.

The MIs and EPCs for possible regression weights are shown in Table 7-4. The suggested regression paths between two observed variables (e.g., PB_5YS <--- HSIZE, VI_1 <--- GEN) make no substantive sense. However, seven regression weights that are highlighted with underlines in Table 7-4 need to be noted; they are PB_5YS <--- UN_N, VI_4 <--- PB, ACC_1T <--- AFB, AFB_2 <--- ACC, ALA_3 <--- SD, ALA_3 <--- UN_H, and ALA_3 <--- UN_N. These parameters represent cross-loadings. However, most cross-loadings, e.g., PB_5YS <--- UN_N, VI_4 <--- PB, ALA_3 <--- SD, ALA_3 <--- UN_H, and ALA_3 <--- UN_N, have no substantial significance. Besides, there were two MI values above 10 which are substantially larger than the rest of the estimates; both are associated with ALA_3.

Taking full account of standardized residuals and modification indices, ALA_3 and VI_14 tend to be problematic. Removal of these two variables from the revised model, Model II, was considered. The validity test indicates that Model II provides a better fit than Model I as all fit statistics for Model II improved (see Table 7-5). As shown in Table 7-5, after removing two indicator variables, the explanatory power for four behavioural intentions remained about the same. Composite Reliability (CR) and Average Variance Extracted (AVE) were assessed for each measurement in Model II. Compared to the results from Model I, except for two measurement models, ALA and UN_H, which removed one indicator variable respectively, CRs and AVEs for all other measurement models remain about the same. For both ALA and UN_H, CRs increased and AVEs decreased. After removing VI_14, AVE for UN_H went up to 0.43 from 0.37; meanwhile, CR was still at a desirable level of 0.59; without ALA_3 in the measurement model of ALA, AVE increased to 0.65, while CR did not change; therefore, both parameters are

considered adequate. Furthermore, as shown in Table 7-4, the explanatory powers of Model II are slightly different from those of Model I. Both increased and decreased ranges are small and similar. Therefore, it can be concluded that the revised model, Model II, is a better fit to the data.

Table 7- 4 Modification Indices and Parameter Change Statistics of Regression Weights for Model I

Suggested Regression Path	M.I.	Par Change	Suggested Regression Path	M.I.	Par Change
PB_5YS <--- BI_3	4.62	0.13	<u>ACC_1T <--- AFB</u>	6.81	0.23
PB_5YS <--- HSIZE	4.07	-0.13	ACC_1T <--- AFB_1	6.20	0.15
<u>PB_5YS <--- UN_N</u>	5.14	0.19	ACC_1T <--- AFB_2	4.71	0.13
PB_5YS <--- VI_17	5.59	0.15	ACC_1T <--- VI_18T	4.28	0.13
PB_5YS <--- VI_3	5.59	0.15	AFB_1 <--- OFFM	7.11	-0.17
VI_1 <--- GEN	4.33	-0.11	<u>AFB_2 <--- ACC</u>	4.60	0.16
VI_1 <--- ALA_3	5.23	-0.12	AFB_2 <--- AGE	5.33	-0.13
VI_3 <--- ALA_3	4.58	0.10	AFB_2 <--- HAGE	7.25	-0.16
VI_16 <--- ALA_3	5.52	0.12	AFB_2 <--- HSIZE	6.19	0.14
VI_16 <--- VI_2T	5.81	0.13	AFB_2 <--- PB_5YS	4.76	-0.12
VI_17 <--- BI_2	5.95	-0.11	AFB_3 <--- BI_4	4.61	-0.12
VI_17 <--- VI_12T	6.33	-0.12	ALA_1 <--- VI_4	4.03	-0.11
VI_4 <--- BI_3	4.04	0.11	ALA_3 <--- AGE	13.23	0.19
<u>VI_4 <--- PB</u>	8.53	0.22	ALA_3 <--- BCYCL	5.42	-0.12
VI_4 <--- PB_EQP	9.71	0.17	ALA_3 <--- EDU	4.54	-0.11
VI_18T <--- BCYCL	4.48	-0.12	ALA_3 <--- HAGE	11.06	0.18
VI_18T <--- VI_16	5.36	0.13	<u>ALA_3 <--- SD</u>	4.15	0.16
VI_19T <--- AGE	6.88	0.14	<u>ALA_3 <--- UN_H</u>	6.04	0.19
VI_19T <--- ALA_3	4.44	0.11	<u>ALA_3 <--- UN_N</u>	4.82	0.16
VI_8 <--- VI_16	4.19	-0.12	ALA_3 <--- VI_16	4.74	0.12
VI_14 <--- ALA_1	4.38	0.12	ALA_3 <--- VI_19T	7.99	0.15
VI_14 <--- ALA_2	4.03	0.12	ALA_3 <--- VI_3	8.85	0.16
VI_14 <--- ILSZ_T	7.85	-0.16	ALA_3 <--- VI_7	5.98	0.13
VI_14 <--- VI_12T	4.73	0.13			

Note: 1. Parameters representing cross-loadings are highlighted in bold and with underlines.
2. Modification indices greater than 10 are highlighted in bold and italic.

Table 7- 5 Comparison between two models

Category	Model I	Model II
Fit Indices		
χ^2 (df)	595.24 (467)	493.79 (400)
χ^2 / df	1.27	1.23
RMSEA	0.037	0.034
LO90--HI90	0.027--0.045	0.023--0.044
CFI	0.948	0.959
Squared Multiple Correlations		
BI_1	0.21	0.20
BI_2	0.22	0.24
BI_3	0.26	0.27
BI_4	0.22	0.20

Note: 1. RMSEA = Root Mean Square Error of Approximation; LO90 = Lower boundary of a two-sided 90% confidence interval for the RMSEA; HI90 = Upper boundary of a two-sided 90% confidence interval for the RMSEA; CFI = Comparative Fit Index.

2. BI_1: Water pricing should be based on actual and recorded volume of water used;
 BI_2: You would be willing to transfer water that, historically, you have not used;
 BI_3: You intend to make any changes to your irrigation equipment in the next five year;
 BI_4: Increasing the price of water will not reduce the use of water for irrigation.

An Equivalent Model

Recently, the use of one type of variable – composite - in structural equation modelling has raised concerns (Bollen and Bauldry, 2011). Several pieces of literature have provided a detailed explanation and demonstration of both theoretical and practical issues associated with composites (e.g., Grace, 2006; 2008; Grace and Bollen, 2008). A “statistical composite is akin to a multiple regression predictor, some weighted combination of causal influences that maximizes variance explanation in one or more response variables” (Grace, 2006, p146). Composite variables “can be specified in SEMs and they represent potentially heterogeneous collections of causes” (Grace and Bollen, 2008, p194).

Corresponding to the proposed theoretical model (shown in Figure 4.1), this study introduced (statistical) composite variables into Model II and formed an equivalent model, Model III (demonstrated in Figure 7-1). Using composites in SEM not only could summarize groups of effects that match the proposed model; more importantly, it could lead to a dramatic reduction of the pathways in the structural model that help to illustrate the model. As an equivalent model of Model II, Model III has similar results to Model II. Model chi-square is 493.791 with 400 degrees of freedom ($p = 0.001$). CFI is 0.959, and RMSEA is 0.034 with 90% confidence interval of 0.023-0.044. In Model III, the composite of individual characteristics (IC) is defined as a linear sum of the variables age (AGE), educational level (EDU), and off-farm work status (OFFM); the composite of household characteristics (HC) is defined as a linear sum of the variables household size (HSIZE), household average age (HAGE), and household off-farm work status (HOFFM); and the composite of farm business characteristics (FBC) is defined as a linear sum of the variables size of irrigated land (ILSZ_T), farm's position in the business cycle (BCYCL), farm's succession plan (SCSRP) and number of farm generations (GEN).

7.3 Results and Hypotheses Testing

The final step in the data analysis process is to examine the different relationships in the model to determine whether the constructs are significantly and directionally related as predicted by theoretical hypotheses. Following Cheung and Lau's (2008) suggestion, instead of total effects, regression weights were used to interpret the effect of independent variables on the dependent variable.

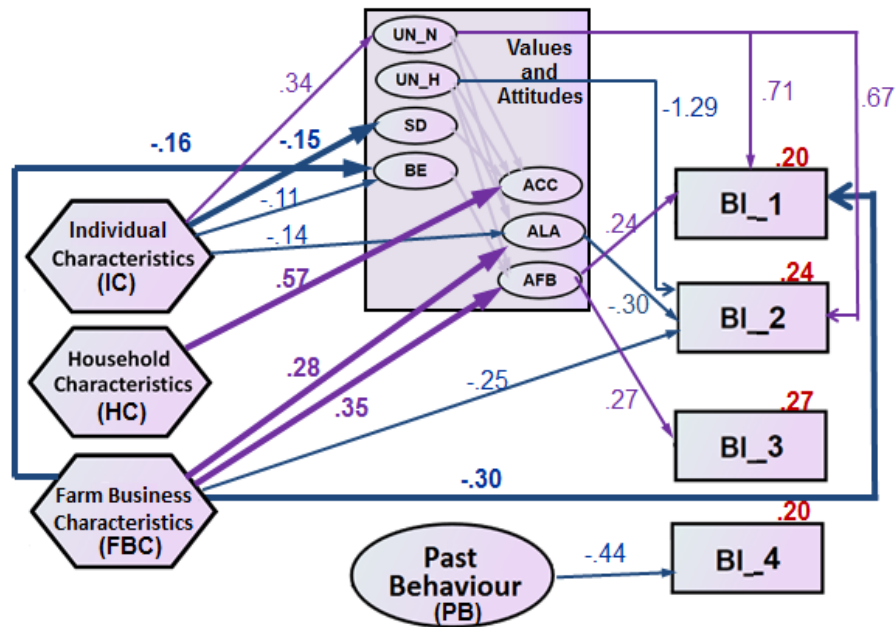


Figure 7- 2 Result of Model III

- Note: 1. For the sake of simplicity, all the observed variables except four variables of behavioural intentions, all errors, and all paths with insignificant path coefficients were concealed. The paths between latent variables of values and attitudes are simplified and their path coefficients are omitted.
2. The numbers beside the paths are the standardized path coefficients. Paths in thin purple are statistically significant at 0.1 probability level with positive coefficients; paths in bold purple are statistically significant at 0.05 probability level with positive coefficients; paths in thin blue are statistically significant at 0.1 probability level with negative coefficients; and paths in bold blue are statistically significant at 0.05 probability level with negative coefficients.
3. The numbers in red over four variables of behavioural intentions are the squared multiple correlations, which are the R^2 's in regression.
4. Composite variables of personal, household, and farm business characteristics are presented in hexagon.

Figure 7- 1 Result of Model III

As discussed in the previous section, Model III, as an abbreviated version of Model II, had fewer paths when using composite variables. In this section, the relationships are analysed using the results from both the revised model (Model II) and its equivalent, Model III.

7.3.1 Results for the Hypotheses Related to Behavioural Intentions

As illustrated in Figure 7-1, the influential factors have quite different patterns of effects on the four behavioural intentions. For respondents' response intentions to volumetric pricing (BI_1), the effects of farm business characteristics (FBC), and the Universalism value related to nature (UN_N), and attitude to farm business (AFB) are statistically significant. For respondents' willingness to transfer historically unused water (BI_2), the effects of FBC, and Universalism values both for nature and human (UN_N and UN_H), and attitude to land attachment (ALA) are statistically significant. For respondents' intentions to improve irrigation equipment (BI_3), the effect of attitude to farm business (AFB) is statistically significant, and for respondents' intentions to not reduce irrigation water if the price of water increases (BI_4), the only statistically significant effect is from past behaviour (PB). Table 7-6 shows coefficient estimates for all paths directly to four behavioural intentions from Model III. Those paths correspond to the hypotheses of H_{A1} , H_{B1} , H_{C1} , H_{D1} , and H_E . The overall conclusions for the hypotheses related to behavioural intentions are summarised in Table 7-7.

As shown in Table 7-7, individual and household characteristics (IC and HC) had no statistically significant effects on all four behavioural intentions, which indicates that H_{A1} and H_{B1} are not supported. H_{C1} is partly supported because the composite variable of farm business characteristics (FBC) has statistically significant effects on both BI_1 and BI_2, but not on BI_3 and BI_4.

Table 7- 6 Estimates for the Paths to Behavioural Intentions from Model III

Paths	Unstandardized Regression Weights	S.E.	C.R.	P	Standardized Regression Weights
BI_1 <--- IC	-0.08	0.22	-0.35	0.73	-0.30
BI_1 <--- HC	0.34	0.40	0.86	0.39	0.24
BI_1 <--- FBC	-0.25	0.12	-2.12	0.03	-0.30
BI_1 <--- UN_N	0.85	0.47	1.82	0.07	0.71
BI_1 <--- UN_H	-1.12	0.89	-1.25	0.21	-0.87
BI_1 <--- SD	0.98	0.96	1.03	0.30	0.74
BI_1 <--- BE	-0.73	0.66	-1.10	0.27	-0.55
BI_1 <--- ACC	-0.18	0.24	-0.73	0.47	-0.15
BI_1 <--- ALA	-0.12	0.19	-0.61	0.54	-0.10
BI_1 <--- AFB	0.31	0.19	1.69	0.09	0.24
BI_1 <--- PB	-0.18	0.41	-0.43	0.67	-0.12
BI_2 <--- IC	-0.17	0.12	-1.46	0.14	-0.21
BI_2 <--- HC	0.30	0.31	0.98	0.33	0.20
BI_2 <--- FBC	-0.22	0.13	-1.78	0.08	-0.25
BI_2 <--- UN_N	0.82	0.49	1.67	0.10	0.67
BI_2 <--- UN_H	-1.69	0.95	-1.77	0.08	-1.29
BI_2 <--- SD	0.65	0.99	0.65	0.51	0.48
BI_2 <--- BE	0.41	0.69	0.60	0.55	0.30
BI_2 <--- ACC	-0.13	0.26	-0.51	0.61	-0.11
BI_2 <--- ALA	-0.35	0.19	-1.82	0.07	-0.30
BI_2 <--- AFB	-0.21	0.19	-1.15	0.25	-0.16
BI_2 <--- PB	0.26	0.44	0.58	0.56	0.18
BI_3 <--- IC	-0.31	0.32	-1.00	0.32	-0.33
BI_3 <--- HC	-0.25	0.12	0.91	0.36	-0.37
BI_3 <--- FBC	0.11	0.30	-0.83	0.41	0.20
BI_3 <--- UN_N	-0.29	0.48	-0.60	0.55	-0.23
BI_3 <--- UN_H	1.33	0.93	1.43	0.15	1.00
BI_3 <--- SD	-1.34	1.01	-1.33	0.18	-0.98
BI_3 <--- BE	0.35	0.69	0.51	0.61	0.25
BI_3 <--- ACC	0.21	0.25	0.84	0.40	0.17
BI_3 <--- ALA	0.22	0.19	1.13	0.26	0.19
BI_3 <--- AFB	0.37	0.19	1.97	0.05	0.27
BI_3 <--- PB	0.57	0.45	1.26	0.21	0.38
BI_4 <--- IC	-0.23	0.19	-1.18	0.24	-0.25
BI_4 <--- HC	0.38	0.27	1.39	0.16	0.30
BI_4 <--- FBC	-0.17	0.15	-1.11	0.27	-0.25
BI_4 <--- UN_N	-0.01	0.43	-0.01	0.99	0.00
BI_4 <--- UN_H	-0.44	0.85	-0.52	0.60	-0.35
BI_4 <--- SD	1.03	0.90	1.14	0.26	0.78
BI_4 <--- BE	-0.40	0.59	-0.68	0.50	-0.30
BI_4 <--- ACC	-0.05	0.25	-0.19	0.85	-0.04
BI_4 <--- ALA	0.11	0.19	0.56	0.58	0.09
BI_4 <--- AFB	-0.04	0.18	-0.24	0.81	-0.03
BI_4 <--- PB	-0.64	0.38	-1.69	0.09	-0.44

Note: 1. Boldface type indicates significance at $p < 0.05$; boldface italic type at $p < 0.1$. 2. BI_1: Water pricing should be based on actual and recorded volume of water used; BI_2: You would be willing to transfer water that, historically, you have not used; BI_3: You intend to make changes to your irrigation equipment in the next five year; BI_4: Increasing the price of water will not reduce the use of water for irrigation.

Table 7- 7 Testing Results for the Hypotheses Related to Behavioural Intentions

Hypotheses	Associated Variable	BI_1	BI_2	BI_3	BI_4	Testing Result
H_{A1} : Response intentions to possible water policy changes are associated with family characteristics.	Individual Characteristics (IC) (Box A in Figure 4-1)	×	×	×	×	Not supported
H_{B1} : Response intentions to possible water policy changes are associated with family characteristics.	Household Characteristics (HC) (Box B in Figure 4-1)	×	×	×	×	Not supported
H_{C1} : Response intentions to possible water policy changes are associated with farm business characteristics.	Farm Business Characteristics (FBC) (Box C in Figure 4-1)	√	√	×	×	Partly supported
H_{D1} : Respondents' intentions to possible water policy change are associated with values and attitudes.	Values and Attitudes (Box D in Figure 4-1)	√	√	√	×	Partly supported
H_E : Response intentions to possible water policy changes are associated with past behaviour.	Past Behaviour (PB) (Box E in Figure 4-1)	×	×	×	√	Partly supported

Note: 1.The results are based on Model III;

2. √ indicates the association is statistically significant; × indicates the association is not statistically significant.

3. BI_1: Water pricing should be based on actual and recorded volume of water used;

BI_2: You would be willing to transfer water that, historically, you have not used;

BI_3: You intend to make changes to your irrigation equipment in the next five years;

BI_4: Increasing the price of water will not reduce the use of water for irrigation.

Based on Table 7-6, some values and attitudes have statistically significant effects on behavioural intentions (BI_1 to BI_3) except BI_4. H_{D1} is partly supported (shown in Table 7-7). Theoretically, value is always a core concept in the field of behaviour and decision study. The literature shows that farmers' values often have been used to identify and distinguish farmers' behaviour.

The intention to agree that water pricing should be based on actual and recorded volume of water used (BI_1) was significantly influenced by values of Universalism for nature

(UN_N) and Attitude to Farming Business (AFB). Farmers who place more importance on “Protecting the environment” (VI_1), “United with nature” (VI_3), “Curious” (VI_16), and “A world of beauty” (VI_17), were more likely to agree that water pricing should be based on actual and recorded volume of water used. Farmers who had a more positive Attitude to Farming Business (AFB), which means they are more likely to agree with the statement “A maximum annual net financial return from your farm is an important goal for your family” (AFB_1), “Increasing the asset value or net worth of your farming operation is very important to your family” (AFB_2), and “You view your farming operation as first and foremost a business investment” (AFB_3), also were more likely to agree that water pricing should be based on actual and recorded volume of water used.

The intention to transfer historically unused water (BI_2) was influenced by values of Universalism for human (UN_H) and Attitude to Land Attachment (ALA). Farmers who more highly value “Inner harmony” (VI_7) and “Equality” (VI_8), and who have a more positive Attitude to Land Attachment (ALA), that is they were more likely to agree with the statements of “Having land to pass down to future generations is more important than selling it for the highest price (ALA_1)”, and “You feel a responsibility to keep your land in the family” (ALA_2), were less willing to transfer their historically unused water. The intention to improve irrigation equipment in the next five years (BI_3) was influenced by Attitude to Farming Business (AFB). That is, farmers who had a more positive Attitude to Farming Business (AFB), which means they were more likely to agree with the statement “A maximum annual net financial return from your farm is an important goal for your family” (AFB_1), “Increasing the asset value or net worth of your farming operation is very important to your family” (AFB_2), and “You view your farming

operation as first and foremost a business investment” (AFB_3), also were more likely to improve irrigation equipment in the next five years. The intention to reduce irrigation water if the price of water increases (BI_4) has no statistically significant relationship with any of the values and attitudes.

Based on Table 7-6, past behaviour had quite a strong statistically significant relationship with intention to reduce irrigation water if the price of water increases (BI_4). The effects of PB on BI_1 to BI_3 were statistically insignificant. Farmers who made changes to their irrigation equipment in the past five years (PB_5YS), and who had newer irrigation equipment, which usually is more efficient (PB_EQP), were less likely to intend to reduce irrigation water if the price of water increases (BI_4).

Using composites, Model III allows us to demonstrate the results of the model graphically and to emphasise some general theory. For example, focusing on the behavioural intentions to respond to the water policy change, farm business characteristics play a more important role than do individual and household characteristics. However, some results of Model III are general and unspecific. For example, Model III shows that farm business characteristics have significantly negative influence on farmers’ willingness to transfer historically unused water. Unlike Model III, without composites, Model II provides more specific and detailed results. Table 7-8 shows estimates of standardized regression weights for paths from individual, household, and farm business characteristics to four behavioural intentions.

Although previous research suggests that farmers’ behaviour is related to their individual characteristics, in the current study, farmers’ age, education level and off-farm status did

not show statistically significant influences on all four behavioural intentions. Similarly, farmers' decisions concerning the farm's development usually are treated as family decisions, but the evidence in this study did not show statistical significance between farmers' household characteristics and their intentions to possible water policy changes.

Table 7- 8 Estimates for the Paths from Individual, Household and Farm Business Characteristics to Behavioural Intentions

Associated Variable	BI_1: Respondents' response intentions to volumetric pricing is associated with	BI_2: Respondents' willingness to transfer historically unused water is associated with	BI_3: Respondents' intention to improve irrigation equipment is associated with	BI_4: Respondents' intention to not reduce irrigation water if the price of water increases is associated with
Respondent's age (AGE)	-0.29	-0.14	-0.30	0.02
Respondent's education level (EDU)	-0.06	-0.17	0.08	-0.04
Respondent's off-farm status (OFFM)	-0.08	0.00	-0.04	-0.23
Household size (HSIZE)	0.25	0.30	-0.25	0.38
Household average age (HAGE)	0.34	0.23	0.15	0.13
Respondent and spouse off-farm status (HOFFM)	-0.02	0.04	0.07	0.00
Size of irrigated land (ILSZ_T)	-0.04	0.15	-0.20	0.25
Farm's position in business cycle (BCYCL)	-0.25	-0.22	0.11	0.00
Succession plan (SCSRP)	0.06	0.11	-0.06	-0.03
Generations owned the farm (GEN)	-0.10	0.01	0.06	-0.17

Note: 1. The results are based on Model II.

2. The numbers in the table are standardized regression weights. Boldface type indicates significance at $p < 0.05$; boldface italic type at $p < 0.1$.

Farm business characteristics, especially the farms' position in the business cycle show statistically significant influences on some of their behavioural intentions. A farm's position in the business cycle (BCYCL) is statistically significant on BI_1 and BI_2, but not on BI_3 and BI_4. Not surprisingly, farms that tend to be downsizing were more likely to agree that water pricing should be based on actual and recorded volume of water used (BI_1), and were more willing to transfer historically unused water (BI_2).

7.3.2 Results for the Hypotheses Related to Past Behaviour

The proposed model suggests that farmers' socio-demographic characteristics influence their past behaviour (Hypotheses H_{A2} , H_{B2} , and H_{C2}), and through past behaviour also influence their behavioural intentions. The results from Model II indicate that neither individual nor household characteristics had statistically significant influence on past behaviour. The only statistically significant determinant was the variable size of irrigated land (ILSZ_T). The size of irrigated land had a significant influence on past behaviour. The larger the irrigated area, the more likely it was that changes had been made to their irrigation equipment in the past five years (PB_5YS) and the more likely it was that they had low pressure centre pivots (PB_EQP). However, the past behaviour did not show statistically significant relationships with the farm's position in the business cycle (BCYCL), whether or not they had a succession plan (SCSRP), and the number of generations that the farm had been in the family's ownership (GEN).

As values and attitudes are expected to predict behavioural intentions or future behaviour, the outcomes of previous behavioural intentions also are expected to be associated with values and attitudes, or at least with values since values are presumed to be stable.

Although attitudes are not as stable as values, their stability also has been shown in some situations. However, none of the values and attitudes had statistically significant associations with past behaviour.

As shown in Table 7-9, data from this study indicate that for the hypotheses related to past behaviour, only H_{C2} was partly supported whereas H_{A2} , H_{B2} , and H_{D2} were not supported.

Table 7- 9 Testing Results for the Hypotheses Related to Past Behaviour

Hypotheses	Associated Variable	Estimate	Testing Result
H_{A2} : Farmers' past behaviour is related to individual characteristics.	Respondent's age (AGE)	-0.02	Not supported
	Respondent's education level (EDU)	0.01	
	Respondent's off-farm status (OFFM)	-0.27	
H_{B2} : Farmers' past behaviour is related to household characteristics.	Household size (HSIZE)	0.26	Not supported
	Household average age (HAGE)	-0.08	
	Respondent couple's off-farm status (HOFFM)	-0.03	
H_{C2} : Farmers' past behaviour is related to farm business characteristics.	Size of irrigated land (ILSZ_T)	0.54	Partly supported
	Farm's position in business cycle (BCYCL)	-0.02	
	Succession plan (SCSRP)	0.01	
	Generations owned the farm (GEN)	-0.23	
H_{D2} : Farmers' past behaviour is associated with values and attitudes.	Universalism for nature type of (UN_N)	0.42	Not supported
	Universalism for human type of value (UN_H)	-0.76	
	Self-Direction type of value (SD)	1.05	
	Benevolence type of values (BE)	-0.67	
	Attitudes to community cohesion (ACC)	-0.27	
	Attitudes to land attachment (ALA)	-0.14	
	Attitudes to farm business (AFB)	0.06	

Note: 1. The results are based on Model II.

2. The numbers in the table are standardized regression weights. Boldface type indicates significance at $p < 0.05$.

3. UN_N = values of "Universalism_Nature", including four indicators: VI_3 (Unity with nature), VI_16 (Curious), VI_17 (A world of beauty), and VI_1 (Protecting the environment); UN_H = values of "Universalism_Human", including two indicators: VI_7 (Inner harmony) and VI_8 (Equality);

SD = values of "Self-Direction", including four indicators: VI_15 (Self-respect), VI_4 (Choosing own goals), VI_18 (Freedom), and VI_19 (Independent);

BE = values of "Benevolence", including three indicators: VI_12 (Responsible), VI_2 (True friendship), and VI_20 (Meaning in life);

ACC = Attitude to Community Cohesion, including two indicators: ACC_1 (Rural communities are a great place to live and raise a family) and ACC_2 (The lifestyle that comes with living in a rural area is very important to your family);

ALA = Attitude to Land Attachment, including two indicators: ALA_1 (Having land to pass down to future generations is more important than selling it for the highest price) and ALA_2 (You feel a responsibility to keep your land in the family);

AFB = Attitude to Farming Business, including three indicators: AFB_1 (A maximum annual net financial return from your farm is an important goal for your family), AFB_2 (Increasing the asset value or net worth of your farming operation is very important to your family), and AFB_3 (You view your farming operation as first and foremost a business investment).

7.3.3 Results for the Hypotheses Related to Values and Attitudes

Table 7-10 shows the testing results for the hypotheses related to values and attitudes. As

Individual Characteristics (IC), Age (AGE) has a statistically significant influence on

values of Universalism for nature (UN_N), Education level (EDU) has a statistically significant influence on Self-Direction (SD) and Benevolence values (BE). The respondent's Off-Farm status (OFFM) has a statistically significant influence on Self-Direction values (SD). The older farmers are, the higher they valued Universalism for nature. That is, farmers align more closely with the values of "Protecting the environment" (VI_1), "United with nature" (VI_3), "Curious" (VI_16), and "A world of beauty" (VI_17) as they get older. Education level (EDU) had significant negative influences on values of Self-Direction and Benevolence. Farmers with less education aligned more closely with the values of Self-Direction, such as "Choosing own goals" (VI_4), "Freedom" (VI_18), "Self-respect" (VI_15), and "Independent" (VI_19) as well as values of Benevolence, such as "True friendship" (VI_2), "Responsible" (VI_12), and "Meaning in life" (VI_20). Farmers who were more involved in off-farm activities aligned more closely with values of Self-Direction, giving higher scores in "Choosing own goals" (VI_4), "Self-respect" (VI_15), "Freedom" (VI_18), and "Independent" (VI_19). Table 7-10 shows that education level (EDU) had a significant negative influence on attitude towards land attachment (ALA). Farmers with less education had a stronger attitude towards land attachment (ALA), that is they were more likely to agree with the statements of "Having land to pass down to future generations is more important than selling it for the highest price (ALA_1)", and "You feel a responsibility to keep your land in the family" (ALA_2).

Unlike individual characteristics (IC), the household characteristics (HC) had no statistically significant influence on four types of values. Only the household size (HSIZE) had a statistically significant relationship with Attitudes to Community Cohesion (ACC).

Based on the model, farmers with larger households were more likely to agree with the statement that “Rural communities are a great place to live and raise a family” (ACC_1), and “The lifestyle that comes with living in a rural area is very important to your family” (ACC_2).

The size of the irrigated area had statistically significant inverse influences on Benevolence values (BE) and Attitudes toward the Farming Business (AFB). Farmers with more irrigated land placed less importance on Benevolence values (BE), such as “True friendship” (VI_2), “Responsible” (VI_12), and “Meaning in life” (VI_20), and they were more likely to agree with the statements of “A maximum annual net financial return from your farm is an important goal for your family” (AFB_1), “Increasing the asset value or net worth of your farming operation is very important to your family” (AFB_2), and “You view your farming operation as first and foremost a business investment” (AFB_3). Farmers who had a succession plan in place had a stronger land attachment attitude (ALA); that is they were more likely to agree with the statements of “Having land to pass down to future generations is more important than selling it for the highest price (ALA_1)”, and “You feel a responsibility to keep your land in the family” (ALA_2). Farmers whose land had been in the family for more generations unexpectedly were less likely to agree with the statement that “Rural communities are a great place to live and raise a family” (ACC_1), and “The lifestyle that comes with living in a rural area is very important to your family” (ACC_2). Although farmers whose farms were in different positions in their business cycle had different response intentions to water policy changes (e.g., BI_1 and BI_2), their farm’s position in the business cycle did not significantly influence their values and attitudes.

Table 7- 10 Testing Results for the Hypotheses Related to Values and Attitudes

Hypotheses	Associated Variable	UN_N	UN_H	SD	BE	ACC	ALA	AFB	Testing Result
H_{A3} : Respondents' values and attitudes are associated with their personal characteristics	AGE	0.42	0.08	-0.07	-0.09	-0.35	-0.20	-0.24	Partly supported
	EDU	-0.12	-0.12	-0.20	-0.15	0.00	-0.16	-0.13	
	OFFM	0.13	0.19	0.24	-0.08	-0.18	-0.14	0.13	
H_{B3} : Respondents' values and attitudes are associated with their household characteristics.	HSIZE	-0.15	0.00	-0.15	0.08	0.68	0.30	0.24	Partly supported
	HAGE	-0.22	0.25	0.23	0.19	0.60	0.32	0.35	
	HOFFM	-0.03	-0.03	-0.01	-0.04	0.16	0.08	-0.12	
H_{C3} : Respondents' values and attitudes are associated with their farm status.	ILSZ_T	0.02	0.09	-0.03	-0.22	-0.22	0.03	0.47	Partly supported
	BCYCL	0.00	-0.03	-0.01	-0.08	-0.06	0.07	0.02	
	SCSRP	0.02	-0.04	0.09	0.14	0.11	0.32	-0.03	
	GEN	0.07	0.02	0.11	-0.05	-0.29	0.14	0.00	

Note: 1. The results are based on Model II.

2. The numbers in the table are the standardized regression weights, which are statistically significant. Boldface type indicates significance at $p < 0.05$; boldface italic type at $p < 0.1$.

3. UN_N = values of “Universalism_Nature”, including four indicators: VI_3 (Unity with nature), VI_16 (Curious), VI_17 (A world of beauty), and VI_1 (Protecting the environment);

UN_H = values of “Universalism_Human”, including two indicators: VI_7 (Inner harmony) and VI_8 (Equality);

SD = values of “Self-Direction”, including four indicators: VI_15 (Self-respect), VI_4 (Choosing own goals), VI_18 (Freedom), and VI_19 (Independent);

BE = values of “BENEvolence”, including three indicators: VI_12 (Responsible), VI_2 (True friendship), and VI_20 (Meaning in life);

ACC = Attitude to Community Cohesion, including two indicators: ACC_1 (Rural communities are a great place to live and raise a family) and ACC_2 (The lifestyle that comes with living in a rural area is very important to your family);

ALA = Attitude to Land Attachment, including two indicators: ALA_1 (Having land to pass down to future generations is more important than selling it for the highest price) and ALA_2 (You feel a responsibility to keep your land in the family);

AFB = Attitude to Farming Business, including three indicators: AFB_1 (A maximum annual net financial return from your farm is an important goal for your family), AFB_2 (Increasing the asset value or net worth of your farming operation is very important to your family), and AFB_3 (You view your farming operation as first and foremost a business investment).

As shown in Table 7-10, data from this study indicated that all the hypotheses related to values and attitudes, H_{A3} , H_{B3} , and H_{C3} , were partly supported.

7.3.4 Issues Related to Direct, Indirect and Total Effects

One of the attractive advantages of the SEM approach is that it allows a model with more than one mediator and dependent variable to be considered simultaneously (Hoyle and Smith, 1994).

In a model with one or more intervening variables, an independent variable is postulated to exert an effect on an outcome variable through one or more potential intervening variables, called mediators (Hayes, 2009). For example, in the current study, the total effect of age (AGE in model II), or Individual characteristics (IC in Model III), on behavioural intentions (BIs) might come through a variety of paths both directly (IC directly to BIs) and indirectly (IC indirectly through potential intervening variables such as values (e.g., UN_N), attitudes (e.g., ACC), and past behaviour). The former is called the direct effect and the latter is called the indirect effect. The total effect of an independent variable on a dependent variable is the sum of its direct and its total indirect effects.

The estimates of the direct and indirect effects from Model II are shown in Table 7-11. Some coefficients of indirect effects were relatively conspicuous, but it cannot be determined whether or not they are statistically significant.

For testing statistical significance, the bootstrap method was employed. Bootstrapping provides the most powerful and reasonable method of obtaining confidence limits for specific indirect effects under most conditions (Preacher and Haye, 2008) and has received increasing attention in recent years (Cheung and Lau, 2008). Bootstrapping is a computationally intensive method that involves repeatedly sampling from the data set and estimating the indirect effect in each

resampled data set. Then an empirical approximation of the sampling distribution is built to construct confidence intervals for the indirect effect by repeating this process thousands of times (Preacher and Haye, 2008).

Table 7- 11 Estimates of Standardized Direct and Indirect Effects on Behavioural Intentions in Model II

Variable		BI_1		BI_2		BI_3		BI_4	
		Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
IC									
	AGE	-0.29	0.18	-0.14	0.25	-0.30	-0.07	0.02	-0.11
	EDU	-0.06	-0.05	-0.17	0.05	0.08	-0.06	-0.04	-0.07
	OFFM	-0.08	0.18	0.00	-0.03	-0.04	-0.12	-0.23	0.15
HC									
	HSIZE	0.25	-0.26	0.30	-0.28	-0.25	0.30	0.38	-0.10
	HAGE	0.34	-0.26	0.23	-0.48	0.15	0.15	0.13	0.17
	HOFFM	-0.02	-0.04	0.04	-0.04	0.07	-0.04	0.00	0.05
FBC									
	ILSZ_T	-0.04	0.06	0.15	-0.04	-0.20	0.33	0.25	-0.31
	BCYCL	-0.25	0.05	-0.22	-0.01	0.11	-0.01	0.00	0.02
	SCSRP	0.06	-0.01	0.11	-0.04	-0.06	0.04	-0.03	0.10
	GEN	-0.10	0.14	0.01	-0.01	0.06	-0.12	-0.17	0.15
VA *									
	UN_N	0.71	-0.15	0.67	-0.23	-0.23	0.33	0.00	-0.06
	UN_H	-0.87	0.17	-1.29	0.55	1.00	-0.76	-0.35	0.11
	SD	0.74	-0.27	0.48	-0.27	-0.98	0.68	0.78	-0.29
	BE	-0.55	0.26	0.30	-0.18	0.25	-0.11	-0.30	0.25
	ACC	-0.15	0.03	-0.11	-0.05	0.17	-0.10	-0.04	0.12
	ALA	-0.10	0.02	-0.30	-0.02	0.19	-0.05	0.09	0.06
	AFB	0.24	-0.01	-0.16	0.01	0.27	0.02	-0.03	-0.03
PB									
	PB	-0.12	-	0.18	-	0.38	-	-0.44	-

Note: * VA = values and attitudes.

Cheung and Lau (2008) suggest k should be at least 500 to 1,000 for bootstrap sampling.

Following their suggestion, bootstrap was used (k = 1000) with bias-corrected 95% confidence intervals to test the significance of the indirect effects of each variable in the model. Prior to bootstrapping, missing data also were imputed by single regression. The confidence intervals were used to test the null hypothesis that the indirect effect is zero. The effect is considered to be significant if zero is not within the confidence interval. The results of all indirect effects on behavioural intentions (BIs) in Model II are shown in Table 7-12. Unexpectedly, the indirect

effects of all variables on four behavioural intentions are statistically insignificant with quite high p values. All lower bounds of bias-corrected 95% confidence intervals are less than zero, and in contrast, all upper bounds are more than zero. This means that zero is within the confidence interval (CI) for all variables, and the null hypothesis that they had zero indirect effects on variables of behavioural intentions cannot be rejected.

Table 7- 12 Estimates of Indirect Effects on Behavioural Intentions in Model II by Bias-corrected Bootstrap method

	BI_1			BI_2			BI_3			BI_4		
	95% C.I.		Two Tailed p value	95% C.I.		Two Tailed p value	95% C.I.		Two Tailed p value	95% C.I.		Two Tailed p value
	L	U		L	U		L	U		L	U	
AGE	-1.91	5.24	0.60	-1.80	2.61	0.58	-5.99	0.93	0.74	-1.15	7.51	0.95
EDU	-2.39	0.56	0.66	-1.43	0.80	0.77	-0.62	1.49	0.75	-1.33	0.72	0.67
OFFM	-0.98	6.37	0.58	-1.79	5.48	0.99	-6.10	0.82	0.71	-0.83	6.97	0.57
HSIZE	-5.17	1.40	0.57	-3.27	1.53	0.53	-0.58	6.35	0.47	-10.82	0.87	0.71
HAGE	-7.08	1.74	0.57	-3.89	1.51	0.39	-1.05	14.16	0.58	-17.27	1.53	0.98
HOFFM	-3.34	0.72	0.72	-1.33	0.92	0.76	-0.83	2.24	0.95	-2.39	0.82	0.89
ILSZ_T	-2.59	3.86	0.87	-4.48	1.43	0.84	-2.13	3.84	0.40	-2.32	4.84	0.53
BCYCL	-1.17	1.51	0.81	-1.26	0.96	0.88	-1.34	0.83	0.97	-0.81	2.06	0.91
SCSRP	-1.13	1.49	1.00	-0.95	1.51	0.94	-1.28	1.47	0.89	-1.92	0.88	0.68
GEN	-0.61	4.62	0.48	-1.00	2.96	1.00	-5.88	0.37	0.53	-0.44	7.37	0.47
UN_N	-4.42	5.25	0.90	-4.11	3.74	0.67	-0.73	14.98	0.33	-23.66	1.39	0.68
UN_H	-6.46	8.92	0.93	-18.83	5.85	0.65	-17.46	1.88	0.33	-3.82	29.16	0.80
SD	-15.93	6.98	0.80	-14.76	7.28	0.75	-2.32	30.92	0.40	-36.54	4.26	0.70
BE	-5.97	12.56	0.74	-5.70	18.23	0.82	-25.77	2.82	0.80	-4.41	18.41	0.69
ACC	-0.61	3.76	0.64	-7.95	0.27	0.33	-9.28	0.17	0.31	-0.21	13.27	0.31
ALA	-0.85	1.80	0.74	-4.01	0.29	0.45	-3.22	0.32	0.46	-0.29	6.17	0.39
AFB	-2.39	1.02	0.82	-1.34	1.18	0.87	-0.57	3.37	0.56	-2.59	0.62	0.67

Note: 95% C.I. means 95% confidence interval, L means lower bound, and U means upper bound.

However, it is noticed that, in the current study, the behaviour of indirect effects is complex because there are multiple-level mediators in the models. Taking an independent variable of AGE as an example, besides its direct effect on behavioural intentions (BIs), AGE might have indirect effects through four value variables of UN_N, UN_H, SD, and BE, three attitude

variables of ACC, ALA, and AFB, and the variable of past behaviour at first layer. AGE also possibly had second layer indirect effects on BIs: through UN_N, UN_H, SD, and BE, and further from each of them to ACC, ALA, AFB, and PB, and then to BIs; likewise, through ACC, ALA, and AFB, and further from each of them to PB, and then to BIs. In the current study, AGE might even have third layer indirect effects on BIs through UN_N, UN_H, SD, and BE, and further, from each of them to ACC, ALA, AFB, and then further from each of them on UN_N*ACC, UN_N*ALA, UN_N*AFB...BE*AFB to PB, and finally to BIs. When two or more indirect effects with opposite signs cancel each other, it might produce a total indirect effect or a total effect that is not detectably different from zero (Hayes, 2009), which is called a suppressor phenomenon (e.g., Maassen and Bakker, 2001). A suppressor is defined as a variable that increases the regression weight between the independent and dependent variables by its inclusion in a regression equation (Conger, 1974). It is possible for several mediators and suppressors to coexist in models that involve multiple intervening variables (Preacher and Hayes, 2008). Suppressor variables are well known in the context of multiple regressions (Maassen and Bakker, 2001). Suppressor effects should be detected before concluding that no indirect effects exist based upon Table 7-12.

Tables 7-13 and 7-14 show estimates of standardized direct and indirect effects on potential mediator or suppressor variables in Model II. Taking a close look at AGE as an example, the standardized direct effect of AGE on UN_N is 0.42 (shown in Table 7-13), standardized direct effect of UN_N on BI_3 is -0.23 (shown in Table 7-11). Therefore, the standardized indirect effect of AGE on BI_3 through UN_N is the product of $0.42 \times -0.23 = -0.097 < 0$; the standardized direct effect of AGE on ACC is -0.35 (shown in Table 7-13). The standardized direct effect of ACC on BI_3 is 0.17 (shown in Table 7-11) and the standardized indirect effect of AGE on BI_3

through ACC is the product of $-0.35 \times 0.17 = -0.060 < 0$. Under such circumstances, suppression is concluded (Cheung and Lau, 2008). Both UN_N and ACC served as suppressors for the indirect effects of AGE on BI_3. Similarly, as shown in Table 7-14, the standardized direct effect of UN_N on ACC is 0.8, the standardized direct effect of ACC on PB was -0.27, then the standardized indirect effect of UN_N on PB through ACC is the product of $-0.35 \times 0.8 = -0.28 < 0$. ACC also is a suppressor between UN_N and PB.

Table 7- 13 Estimates of Standardized Direct and Indirect Effects of Socio-demographic Characteristics on Values, Attitudes and Past Behaviour

	Effect	AGE	EDU	OFFM	HSIZE	HAGE	HOFFM	ILSZ_T	BCYCL	SCSRP	GEN
UN_N	Direct	0.42	-0.12	0.13	-0.15	-0.22	-0.03	0.02	0.00	0.02	0.07
UN_H	Direct	0.08	-0.12	0.19	0.00	0.25	-0.03	0.09	-0.03	-0.04	0.02
SD	Direct	-0.07	-0.20	0.24	-0.15	0.23	-0.01	-0.03	-0.01	0.09	0.11
BE	Direct	-0.09	-0.15	-0.08	0.08	0.19	-0.04	-0.22	-0.08	0.14	-0.05
ACC	Direct	-0.35	0.00	-0.18	0.68	0.60	0.16	-0.22	-0.06	0.11	-0.29
	Indirect	0.20	-0.12	0.25	-0.38	-0.31	0.03	-0.02	0.08	0.11	0.21
ALA	Direct	-0.20	-0.16	-0.14	0.30	0.32	0.08	0.03	0.07	0.32	0.14
	Indirect	0.06	-0.07	-0.03	-0.14	-0.21	0.01	-0.16	0.01	0.14	0.06
AFB	Direct	-0.24	-0.13	0.13	0.24	0.35	-0.12	0.47	0.02	-0.03	0.00
	Indirect	-0.06	-0.08	-0.08	-0.03	-0.05	-0.01	-0.20	-0.02	0.14	0.00
PB	Direct	-0.02	0.01	-0.27	0.26	-0.08	-0.03	0.54	-0.02	0.01	-0.23
	Indirect	0.16	-0.01	0.23	-0.36	-0.25	-0.04	0.15	0.05	-0.08	0.16

Table 7- 14 Estimates of Standardized Direct and Indirect Effects of Values and Attitudes on Attitudes and Past Behaviour

Variable	Effect	UN_N	UN_H	SD	BE	ACC	ALA	AFB
ACC	Direct	0.80	-1.35	1.43	-0.62			
ALA	Direct	0.47	-1.11	0.57	0.24			
AFA	Direct	0.17	-0.77	0.35	0.56			
PB	Direct	0.42	-0.76	1.05	-0.67	-0.27	-0.14	0.06
	Indirect	-0.27	0.46	-0.44	0.17			

When the suppressor phenomenon is present in the structural equations model, the interpretation becomes particularly problematic (Maassen and Bakker, 2001; Cheung and Lau, 2008). Cheung and Lau (2008) suggest that one should not interpret the total effect of the independent variable

on the dependent variable, but should interpret regression weights as the direct effect. If possible, an adjusted model should be made which fits the data more closely (Maassen and Bakker, 2001).

7.4 Summary

This chapter provides structural equation modelling and results. The proposed model was estimated and assessed. By dropping two weak indicators, the revised model, Model II provided a better fit of the data and was used to conduct hypotheses tests. Model II explained 20-27% of the variance in the four behavioural intentions.

Corresponding to the proposed model, composite variables were introduced into Model II, An equivalent model, Model III was developed. With fewer paths, based on Model III, the results of this study were graphically illustrated.

In summary, farm business characteristics, values and attitudes, and past behaviour all play roles to some extent in determining farmers' behavioural intentions towards water policy changes. However, their effects were quite different, depending on the specific intention. Some difference in intentions, e.g., BI_1 and BI_2, were explained significantly by farm business characteristics and the respondent's values and attitudes; BI_3 was explained significantly only by attitude to farming business; BI_4 was explained only by past behaviour. As discussed in previous sections, the model in the current study is complex and the mediator and compressor variables possibly co-exist in the model, hiding some effects that need to be further explored and discovered.

Chapter Eight Conclusions

8.1 Review of the context of this study

8.1.1 Need for this Research

At the beginning of this dissertation it was noted that water shortage is a severe issue for Albertans, especially for people who live in southern Alberta. The South Saskatchewan River Basin (SSRB) Water Management Plan was issued in August, 2006. It specified that no more applications would be accepted for new water licenses for the Bow, Oldman, and South Saskatchewan Rivers (AEDA, 2008). Based on prior allocation—or the first-in-time, first-in-right (FITFIR) principle- the earliest granted licensees (the “senior” rights holders) have historically and primarily been held by the agricultural and hydropower sectors. In this setting, satisfying new demands for water will require the resource to be transferred from farmers with historically secure rights (Kuehne and Bjornlund, 2008). Responding to requirements of the Water Act for establishing a framework for water management and planning, protecting the aquatic environment, and facing water shortage problems, the Government of Alberta (2003) released Water for Life: Alberta’s Strategy for Sustainability. After a few years’ working on the strategy, the Alberta Government published Water for Life: a renewal in 2008 and Water for Life: Action Plan in 2009. Two of the strategy’s main action plans were to “develop and implement an enhanced water rights transfer system that supports sustainable economic development” and “develop and implement conservation, efficiency, and productivity plans” that targets “a 30% improvement in overall efficiency and productivity of water use by 2015”.

Agriculture, especially irrigation, is the largest water consuming industry in Alberta. Various agronomic, technical, managerial and institutional options have been, or are being, developed to

improve water use efficiency in irrigation, and to further contribute to the sustainable use of water. Such improvements of water use efficiency in irrigation and exports of water out of rural areas largely relies on farmers' support and irrigators' participation. Understanding farmers' objectives and the motivations for their behaviours is likely to lead to better policy design and more successful policy implementation (Kuehne and Bjornlund, 2008). It is perilous for policy-makers to neglect farmers' willingness to adopt improved water management practices (Burton, 2004).

In the context of Alberta, understanding farmers' reactions to water policy reforms is of significant importance. This study explored irrigators' responses to possible water policy reforms and the factors that influence irrigators' responses to water policy reforms. It offers an empirical analysis of farmers' responses and their underlying reasons by using first-hand investigation. This study not only provides guidance for local policy design and implementation, it also contributes an example to other areas that face water shortages.

8.1.2 Theoretical Need

The review of existing literature revealed a general acceptance that the farming business cannot be disentangled from the farmer's family life. Gasson et al. (1988) provided a multidisciplinary review that integrated many of the contributions made by economics, social anthropology, history and rural sociology on the study of farm families and family businesses. They claimed that the farm family might be too complex to understand in any single perspective. Fairweather and Keating (1994, p184) believe that "business and way of life goals might co-exist in different ways among farmers in varying situations".

In recent decades, many scholars have suggested that behavioural research should be conducted from an interdisciplinary perspective, by bringing values back into sociological (e.g., Hitlin and Piliavin, 2004, Spates, 1983) and economics research (e.g., Bruni and Sugden, 2007) and adding background factors into psychological models (e.g., Ajzen and Fishbein, 2005). Incorporating psychological variables in models of farmer behaviour is believed to lead to better predictions (Edwards-Jones et al., 1998). Edwards-Jones (2006) suggests that farmers' decisions are influenced by six groups of factors: socio-demographics of the farmer, psychological make-up of the farmer, characteristics of the farm household, structure of the farm business, the wider social milieu, and characteristics of the innovation to be adopted.

However, comprehensive studies are rare. Scholars from different fields have used their own perspectives to find influential factors. Studies have focused on social psychological factors, such as farmers' values and attitudes (Beedell and Rehman, 1999; 2000; Cary and Wilkinson, 1997; Lynne et al., 1988; Vogel, 1996), socio-demographic characteristics (Perz, 2001; Potter and Lobley, 1992), or profit and utility motivations (Berbel and Gómez-Limón, 2000; Gómez-Limón and Riesgo, 2004; Marques et al., 2005; Schuck et al., 2005) to explain farmers' behaviour. It is still not clear what the main determinants of farmers' behaviour are and how various determinants co-influence farmers' behaviour.

This dissertation attempts to build a more complete model of farmer's behaviour and provides new empirical evidence to synthetically understand farmers' behaviour.

8.2 Method and Findings

8.2.1 Method

Structural equation modelling (SEM) techniques are regarded as second generation data analysis techniques, which enable researchers to answer a set of interrelated research questions in a single, systematic, and comprehensive analysis by modelling the relationships among multiple independent and dependent constructs simultaneously (Gefen et al., 2000). Farming is regarded as a family engagement and is interwoven with life and community. Farmers' behaviour and their decision making are often believed to be so complex that they must be understood under multiple perspectives. Structural equation modelling provides a powerful means to uncover the relationship between farmers' behavioural intentions to some water policy reforms and their complex determinants.

The software AMOS 20.0, which supports covariance-based SEM, was used to estimate and assess the structural equation model in this study.

8.2.2 Main Findings

A face-to-face survey of irrigation households in Southern Alberta using a structured questionnaire was conducted from May to August, 2012. A total of 207 irrigators accepted the interviews and 203 valid questionnaires were completed. Each respondent was asked to rate the likelihood of their intended response to four questions. Two questions related to their reaction to proposed water policy reforms: Do you agree that "Water pricing should be based on actual and recorded volume of water used" and do you agree that "Increasing the price of water will not reduce the use of water for irrigation"? Two questions related to intentions to trade water and adopt more efficient irrigation technology: Do you agree that "you would be willing to transfer some water that, historically, you have not used"; and "Do you intend to make any changes to your irrigation equipment in the next five years"?

Data on respondents' individual, household and farm business characteristics, and past behaviour were obtained in the survey. Respondents' age, education level, and off-farm work status were used to represent their individual characteristics. Household size, household average age, and the farm couple's off-farm work status were used to represent their household characteristics.

Focusing on water use, the area of irrigated land as a proxy for farm size, the farm's position in the business cycle, the farm's succession plan, and the number of generations that lived on the family farm were used to represent farm business characteristics. The irrigation equipment farmers currently are using and whether farmers improved their irrigation equipment in the past five years were used to represent past behaviour.

Since values and attitudes are not directly observable, data on twenty value items and nine attitude items were obtained. By means of factor analysis, four value factors, "Universalism_Nature", "Self-Direction", "Universalism_Human", and "Benevolence", and three attitude factors, attitudes to community cohesion, land attachment, and farm business were used to represent values and attitudes in the analysis. "Universalism_Nature" includes value indicators of "A world of beauty", "Curious", "Unity with nature" and "Protecting the environment", its motivational goal is mainly for nature; "Self-Direction" includes value indicators of "Independent", "Freedom", "Choosing own goals", and "Self-respect", its motivational goal is for independent thought and action; "Universalism_Human" includes value indicators of "Equality", "Social justice", "Broad-minded", and "Inner harmony", its motivational goal is for the welfare of all people; and "Benevolence" includes value indicators of "True friendship", "Meaning in life", and "Responsible", its motivational goal is mainly for the welfare of people with whom one is in frequent personal contact.

Slightly more than half of the respondents agreed, to varying degrees, with the statement that “Water pricing should be based on actual and recorded volume of water used”. However, also more than half of the respondents had no intention to “make any changes to your irrigation equipment in the next five years”. More than three in five respondents intended to not reduce the use of water for irrigation with an increase in the price of water. Developing and implementing an enhanced water rights transfer system is an important strategy for Alberta. A major result in this dissertation suggests there was no dominant tendency between those who were willing or not willing to transfer some water that, historically, was not used.

By dropping weak indicators, the final revised model of this study was built based on Structural Equation Modelling using AMOS. It provides a satisfactory fit to the data, and explains 20% to 27% of the variance in the four behavioural intentions. Furthermore, corresponding to the proposed model, composite variables were introduced into the final revised model, and an equivalent model with fewer paths was developed. Using composites, the equivalent model allows us to demonstrate the results of the model graphically and to emphasise some general results.

On the intention to agree that water pricing should be based on actual and recorded volume of water used, the model indicates that the farm’s position in the business cycle, farmers’ “Universalism_Nature”, and their attitudes to farming business had statistically significant influences. Those whose farm was growing more likely disagreed that water pricing should be based on actual and recorded volume of water used; conversely, those who were downsizing were more likely to agree that water pricing should be based on actual and recorded volume of water used. Farmers who placed more importance on “Protecting the environment”, “United with nature”, “Curious”, and “A world of beauty” were more likely to agree that water pricing should

be based on actual and recorded volume of water used. Farmers who were more likely to agree with the statements “A maximum annual net financial return from your farm is an important goal for your family”, “Increasing the asset value or net worth of your farming operation is very important to your family”, and “You view your farming operation as first and foremost a business investment” also were more likely to agree that water pricing should be based on actual and recorded volume of water used.

On the intention to transfer historically unused water, the model indicates that the farm’s position in the business cycle, farmers’ Universalism values (both related to nature and human), and their attitudes to land attachment had statistically significant influences. Similar to the influence on the behavioural intention mentioned above, those whose farm was growing were less likely to intend to transfer historically unused water; conversely, those who were downsizing were more likely to intend to transfer historically unused water. Farmers who placed more importance on “Protecting the environment”, “United with nature”, “Curious”, and “A world of beauty” were more likely to intend to transfer historically unused water. Farmers who placed more importance on “Inner harmony” and “Equality” were less likely to intend to transfer historically unused water. Farmers who were more likely to agree with the statements “Having land to pass down to future generations is more important than selling it for the highest price” and “You feel a responsibility to keep your land in the family” were less willing to transfer their historically unused water.

Regarding the intention to improve irrigation equipment in the next five years, the model indicates that farmers’ attitudes to the farming business had a statistically significant influence. That is, farmers who were more likely to agree with the statements “A maximum annual net financial return from your farm is an important goal for your family”, “Increasing the asset value or net worth of your farming operation is very important to your family”, and “You view your

farming operation as first and foremost a business investment” also were more likely to intend to improve irrigation equipment in the next five years.

Regarding the intention to reduce irrigation water if the price of water increases, the model indicates that farmers’ past behaviour had a statistically significant influence. Farmers who had made changes to their irrigation equipment in the past five years, and who had newer irrigation equipment, which usually is more efficient, were more likely to intend to reduce irrigation water if the price of water increases.

Overall, the model indicates that farmers’ values and attitudes play an important role in determining farmer’s behavioural intentions. Farmers’ farm business characteristics and their past behaviour also had statistically significant influences on some behavioural intentions. Farmers’ individual and household characteristics had no statistically significant direct influence on the four given behavioural intentions.

However, farmers’ individual and household characteristics had statistically significant direct influence on their values and/or attitudes, and farmers’ values and attitudes had influences on farmer’s behavioural intentions. Farmers’ individual and household characteristics exert influence on behavioural intentions through values and attitudes, rather than directly. Previous studies show similar evidence. For example, Lynne and Rola (1988) found that farmers with higher incomes had stronger conservation attitudes, but they also tended to rank a comfortable life higher, were willing to tolerate more soil erosion, and tended to have weaker attitudes towards conservation action. Ahnström et al. (2009) provided a possible reason why seemingly conflicting actions, such as more pesticides but also more conservation actions, were taken by the younger and more educated farmers. It might be because they tend to be more

environmentally concerned and also more business-minded. Farmers' behavioural intentions seem to be a result of balancing and judging values and attitudes, and farmers with different individual and household characteristics might have different values and attitudes. It is also a plausible reason why the literature shows clearly that farmers' behaviour are influenced by individual and household characteristics, but the effects are not conclusive.

8.2.3 Additional Findings Related to Values and Attitudes

This dissertation has also provided evidence to support some existing value and attitude theories.

The Influence of Individual, Household, and Farm Business Characteristics on Values

Five value factors, "Universalism_Nature", "Self-Direction", "Universalism_Human", "Power-Achievement", and "Benevolence", extracted from our study are consistent with the category of Schwartz's Value Types (Schwartz, 1992). "Power-Achievement" had no statistically significant influence on any of three attitude factors, thus it was excluded in the structural modelling analysis.

Based on the model analysis, individual characteristics have statistically significant influence on their values.

Respondents' age had statistically significant positive influence on their "Universalism_Nature" values. This corresponds to results from the European Social Survey conducted in 2002-3 (Schwartz, 2006b). It means that the older the farmers, the higher they value "A world of beauty", "Curious", "Unity with nature" and "Protecting the environment". In this study, influence of age on values of "Benevolence" and "Self-Direction" were not statistically significant while Schwartz's (2006b) study showed age had a statistically significant positive correlation with

“Benevolence” and a negative correlation with “Self-Direction”. The influence of respondents’ age on their “Universalism_Human” values was also not statistically significant in this study.

Different from Schwartz’s (2006b) study, our finding shows that respondents’ education level had statistically significant negative influences on their values of “Self-Direction” and “Benevolence”. Schwartz (2006b) shows years of formal education positively correlated with “Self-direction” and was insignificantly correlated with “Benevolence”. However, our study indicates that farmers with less education placed higher value on “Self-Direction”, such as “Choosing own goals”, “Freedom”, “Independent” and “Self-respect”, and also placed higher value on “Benevolence”, such as “Meaning in life”, “Responsible”, and “True friendship”.

Respondents’ off-farm work status had a statistically significant positive influence on their values of “Self-Direction”. Farmers who were more involved in off-farm activities also valued more highly “Self-Direction”, giving higher scores in “Choosing own goals”, “Freedom”, “Independent” and “Self-respect”.

In this study, household characteristics did not have any statistically significant influences on farmers’ values. However, the size (acres) of irrigated land had a statistically significant negative influence on their “Benevolence” values. This means that farmers with more acres of irrigated land placed a lower value on “Benevolence”, such as “Meaning in life”, “Responsible”, and “True friendship”.

The Influence of Values on Attitudes

This study supports the theory that “values are potential determinants of attitudes” (Olson and Zanna, 1993). Respondents’ rating of the “Universalism_Nature” value had a statistically significant influence on their attitude to community cohesion and attitude to land attachment.

Farmers who more highly valued “Protecting the environment”, “United with nature”, “A world of beauty”, and “Curious”, also were more likely to have a more positive attitude to community cohesion, which means they were more likely to agree with the statements “Rural communities are a great place to live and raise a family” and “The lifestyle that comes with living in a rural area is very important to your family”. They also were more likely to have a positive attitude to land attachment and attitude to farming business, which means they were more likely to agree with the statements “Having land to pass down to future generations is more important than selling it for the highest price” and “You feel a responsibility to keep your land in the family”.

Respondents’ value of “Universalism_Human” had a statistically significant influence on all three kinds of attitudes. In contrast to the influence of values of “Universalism_Nature”, farmers who more highly valued “Inner harmony” and “Equality”, had more negative attitudes to community cohesion, land attachment, and farming business. Consequently, the closer farmers aligned themselves with the “Inner harmony” value, the less likely they were to agree with all attitude statements.

Respondents’ “Self-Direction” value had a statistically significant influence on their attitude to community cohesion. The more closely farmers aligned themselves with “Choosing own goals”, “Freedom”, “Independent” and “Self-respect”, the more likely they were to have a positive attitude to community cohesion. Consequently, they were more likely to agree with the statements “Rural communities are a great place to live and raise a family” and “The lifestyle that comes with living in a rural area is very important to your family”.

Respondents’ “Benevolence” value had a statistically significant influence on their attitude to farming business. Farmers who aligned themselves more closely with the values “Meaning in

life”, “Responsible”, and “True friendship” were more likely to have a positive attitude to farming business. Consequently, they were more likely to agree with the statements “A maximum annual net financial return from your farm is an important goal for your family”, “Increasing the asset value or net worth of your farming operation is very important to your family”, and “You view your farming operation as first and foremost a business investment”.

The results of this study have found that, in addition to values, respondents’ attitudes also were directly influenced by other factors, but not directly by personal characteristics. It provides evidence to support the psychological theory that attitudes are specific for “a (given) object” (Rokeach, 1966; Fishbein and Ajzen, 1975), and “a particular entity” (Eagly and Chaiken, 1993).

Respondents’ attitudes to community cohesion were significantly influenced by household size. The more members in the farm household, the more likely it was that the farmers held a positive attitude to community cohesion. Consequently, the more likely they were to agree with the statements “Rural communities are a great place to live and raise a family” and “The lifestyle that comes with living in a rural area is very important to your family”. Respondents’ attitudes to farming business were significantly influenced by the size of their irrigated area. Farmers with more irrigated land were more likely to hold a positive attitude to the farming business.

Consequently, they were more likely to agree with the statements “A maximum annual net financial return from your farm is an important goal for your family”, “Increasing the asset value or net worth of your farming operation is very important to your family”, and “You view your farming operation as first and foremost a business investment”. Not surprisingly, respondents’ attitudes to land attachment were significantly influenced by whether or not they have the farm’s succession plan in place (SCSRP). Farmers with a succession plan were more likely to have a positive attitude to land attachment, which means they more likely agree with statements of

“Having land to pass down to future generations is more important than selling it for the highest price” and “You feel a responsibility to keep your land in the family”.

8.3 Strengths and limitations of this study

The strength of this study is that it has used Structural Equation Modelling (SEM) to provide a comprehensive understanding of the factors that influence irrigators’ responses to water policy reform. The SEM technique enables researchers to answer a set of interrelated research questions in a single, systematic, and comprehensive analysis by modelling the relationships among multiple independent and dependent constructs and relationships between multiple observed and latent variables simultaneously. Farming is regarded mainly as a family business and is therefore interwoven with family and community. Farmers’ behaviour and their decision making are often believed to be so complex that they must be understood under multiple perspectives. Structural equation modelling provides a powerful means to achieve a comprehensive understanding of an issue.

Another contribution of this study is that four behavioural intentions were analysed simultaneously. This provided greater insights when identifying the influence of particular factors, and therefore allowed the researcher to avoid producing one-sided and partial conclusions.

The most important limitations to this study were that some potential key influential factors, such as gender and income, were not included in the model. The gender composition of respondents from the survey was severely biased with only a small number of females in the sample.

Although the reality is that male farmers far outnumber female ones, the gender variable had to be excluded from the analysis due to the low number of females in the sample. Another

important variable, income, also should be, but was not, included in the analysis. In consideration of the ethics protocol of the University of Lethbridge, data on personal and household income were not collected. Overall, the main focus of this study was on how values and attitudes (mainly sociological and psychological concepts) affect behavioural intentions. Greater integration of economic variables could provide an even more comprehensive study of behavioural intentions of farmers who consider the impacts on their livelihoods of changes in water policies.

Another limitation to this study was the somewhat restricted sample size; the number of respondents in the survey was barely at an acceptable level. “Bigger is always better” when it comes to sample size for SEM. A general rule of thumb is that the minimum sample size should be no less than 200. Although the survey was designed to collect data from approximately 350 irrigation farms, due to time and budget limitations, only 203 valid questionnaires were collected. In consideration of the number of parameters to be estimated in the model, the sample size in this study was barely sufficient.

A lesson from this study is the need to develop more indicators to measure farmers’ general attitudes. Attitudes play an important role in determining farmer’s behavioural intentions. Nine indicators were designed for three attitude factors, but two were excluded from the analysis. As Kline (2013) pointed out, technical problems in the analysis are more likely to happen if some factors have just two indicators, especially for small samples. A general rule of thumb is that there should be at least three indicators for each anticipated factor. Not only that, fewer cases might be needed when each factor has at least three indicators (e.g., MacCallum et al., 1999). Because there might be some bad indicators that need to be removed in the process of confirmation, some extra indicators should be designed in the survey.

8.4 Contributions

8.4.1 Policy Implications

This study provides guidance to environmental practitioners and policy makers to help them understand how farmers would likely respond to some sensitive issues related to reforms of water policy. It is a good signal for advocates of volumetric pricing of irrigation water that more respondents agreed that “Water pricing should be based on actual and recorded volume of water used”. However, it should be noted that farmers with a growing business seem to be less likely to agree than those with a declining or stagnant business. Further, this study suggests that the effect of water pricing on water consumption is likely to be limited. The majority of respondents did not expect to reduce the use of water for irrigation if the price of water were to increase. If policy makers expect that volumetric charges play a role in price adjustment to encourage saving water, they need to be cautious and need to develop some supporting measures. In other words, simply using volumetric consumption as a means of charging for water is not likely to lead to large reductions in water used for irrigation. Increasing water prices and/or changing the way they are charged should be treated with caution and subject to further research.

This study draws attention to Alberta’s water conservation action plan. A majority of respondents had no intention to make any changes to their irrigation equipment in the next five years, thus making it difficult to realize one of the objectives of the Water for Life strategy that of achieving a “30% improvement in overall efficiency and productivity of water use by 2015”. It is rather worrying that this study also shows that younger farmers and those with higher education might be less willing to make changes to their irrigation equipment in the next five

years. Hence, programs and policies should be carefully designed to encourage farmers to improve their water application technologies and irrigation management practices.

Developing and implementing an enhanced water rights transfer system is another important strategy in the action plan for Alberta. This study did not identify a strong willingness to transfer all or part of their licensed water allocations, even if farmers do not currently use all the water to which they are entitled. Therefore, programs need to be designed to inform farmers about the advantages of water trading and policies are needed to expand the ability to trade water and to make the transfer process easier both for buyers and sellers.

Alberta's Water for Life strategy celebrated its 10th anniversary in 2013 but achieving its goals is likely to require improved operational policies and water management plans. This study informs policy makers and water managers designing such policies and plans in three ways.

First, this study identifies a pattern in how farmers' values and attitudes, as well as their personal, household and farm characteristics jointly influence their behavioural intentions in response to specific aspects of water policy reforms. It therefore helps policy makers to understand how and why farmers would react to water policy reforms, and thereby informs them of the likely impact of implementing more effective policies.

Second, this study demonstrates how farmers' values and attitudes play a role in determining their behavioural intentions in response to four different policies. It offers guidance to policy makers and executives to understand the factors that directly or indirectly, significantly or insignificantly, and positively or negatively influence farmers' behavioural intentions. For example, farmers' "Universalism_Nature" value had a positive influence on farmers' behavioural intentions and "Universalism_Human" value. Increasing importance of farmers'

“Universalism_Nature” value by, for example, raising awareness of “protecting the environment”, will likely benefit the implementation of policies of volumetric water charges and water rights transfers because farmers who more highly value “protecting the environment” were more likely to agree that water pricing should be based on actual and recorded volume of water used and were more willing to transfer their historically unused water. On the contrary, increasing importance of farmers’ “Universalism_Human” value by, for example, enhancing awareness of “Inner harmony”, will be unfavourable to the policy of “develop and implement an enhanced water rights transfer system that supports sustainable economic development” because farmers who more highly value “Inner harmony” were less willing to transfer their historically unused water. Based on these understandings, targeted measures should be taken to help achieve policy goals.

Third, based on this study, policy makers and executives need to pay attention to farmers who have a succession plan in place. While farmers with a succession plan did not have significantly different behavioural intentions in response to water policy reforms, those with a succession plan were more likely to have a positive attitude to land attachment and those with a positive attitude to land attachment were less willing to transfer their historically unused water. Therefore, farmers with a succession plan were more likely to keep, rather than transfer, their historically unused water. This suggests that farmers perceive water to be an integral part of their land. Developing and implementing a water rights transfer system might need to take this into consideration.

8.4.2 Academic Contribution

This study extends the existing literature in five ways. First, it demonstrates that values and attitudes clearly play an important role in determining farmer's behavioural intentions and advances our understanding of how this process takes place. It was shown that values influence attitudes, which in turn influence farmers' behavioural intentions in response to water policy reforms. Although values and attitudes are widely believed to be determinants of social behaviour, and value is a determinant of attitude as well as of behaviour (Rokeach, 1968), most existing behavioural studies are dominated by research into attitude-behaviour relations. For those few studies that have reported on value-attitude-behaviour relationships, most are in fields related to environmental issues (e.g., Milfont et al., 2010). Because an attitude focuses directly on specific objects and situations, the theories of attitude and behaviour, (e.g., the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB)), emphasizes that measures of attitude and behaviour must involve exactly the same action, target, context, and time elements (Ajzen, 2002; Ajzen and Fishbein, 2005). However, specificity in attitude measurement might not always be necessary or desirable (McQuarrie and Langmeyer, 1985). When the primary concern is to understand farmers' reactions to a policy reform, it cannot be expected that measures of attitudes are tied to specific actions. Value is believed to provide a channel to understand farmers' reactions to water policy reform as McQuarrie and Langmeyer (1985) demonstrated in understanding reaction towards discontinuous innovation. This study contributes new empirical evidence of value-attitude-behaviour relationships. It sheds light on a new research approach to understand farmers' behavioural intentions towards new policy.

Second, this study contributes to a better understanding of the incongruity between values and behaviour by identifying how values indirectly influence behavioural intentions. Values and attitudes are sometimes inconsistent with behaviour (e.g., Kennedy et al., 2009; LaPiere, 1934;

Wicker, 1969). This study provides evidence that value not only has a direct but also an indirect influence on behavioural intentions. Direct and indirect effects can be opposite in sign resulting in a small total effects. For example, on the one hand, the direct effect of “Universalism_Nature” value on the willingness to transfer historically unused water was positive: the higher the Universalism value related to nature, the more likely farmers were willing to transfer historically unused water. On the other hand, the direct effect of “Universalism_Nature” value on attitude to land attachment was positive: the higher the “Universalism_Nature” value, the more positive their attitude to land attachment. The direct effect of attitude to land attachment on the willingness to transfer historically unused water was negative: the more positive the attitude to land attachment, the less willing they were to transfer historically unused water. The indirect effect of “Universalism_Nature” value on the willingness to transfer historically unused water through attitude to land attachment was negative: the higher the farmers placed the “Universalism_Nature” value, the less willing they were to transfer historically unused water. Values are abstract and less specific; a number of attitudes can be associated with one value (Reich and Adcock, 1976). Maio and Olson (1994) claimed that attitude functions to moderate value-attitude-behaviour relations. When attitudes are inconsistent mediations (MacKinnon, Fairchild, and Fritz, 2007; Kenny, 2013), the incongruity between values and behavior unavoidably emerges to some extent.

Third, the results from this study expand our knowledge of the relationships of socio-demographic characteristics and farmers’ behaviour and behavioural intentions. Although it is never doubted that farmers’ behaviour has a relationship with their socio-demographic characteristics, there is no simple answer to how it is manifested. Existing studies provide scattered and contradictory evidence of how socio-demographic characteristics influence farmers’

adoption of conservation agriculture (Ahnström, 2009; Knowler and Bradshaw, 2007). Ahnström et al. (2009) explained that younger and more educated farmers often tend to be more business-minded, and, thus, they might take seemingly conflicting actions: use more pesticides but also take more conservation actions. Our research provides new empirical evidence suggesting that the influence of farmers' socio-demographic characteristics on their behavioural intentions takes place mainly through their values and attitudes. For example, individual characteristics had no significant influences on farmers' intentions to improve irrigation equipment in the next five years, but, in total effects, age and off-farm involvement did show a significant influence. The study indicates that the size of a farmer's irrigated land had a significantly positive influence on farmers' attitudes to farming business, which in turn had a significantly positive influence on their intentions to improve their equipment. The study also indicates that both farmers' age and their off-farm involvement had a significant negative correlation with the size of farmer's irrigated land. Following these paths, it is not hard to understand that farmers' age and their off-farm involvement had significantly negative influences on their intentions to improve their equipment. As a result, it is no surprise that there is no uniform effect or pattern that farmers' socio-demographic characteristics influence their behaviour and behavioural intentions.

Fourth, this study contributes to understanding the role of past behaviour in determining farmer's behavioural intentions. Although the influence of past behaviour on predicting intentions and future behaviour has attracted considerable attention, almost all the existing studies have focused on habitual or repeated behaviour on the predicted behaviour in a number of everyday life domains (e.g., Ouellette and Wood, 1998), especially health-related behaviour (e.g., Conner et al., 2000); pro-environmental behaviour (e.g., Dahlstrand and Biel, 1997; Knussen et al., 2004); exercise behaviour (e.g., Hagger et al., 2001; Norman et al., 2000; Rhodes and Courneya, 2003);

and travel mode behaviour (e.g., Bamberg et al., 2003; Verplanken et al., 1997). Farmers' past behaviour was found to have one of the largest impacts on their future behaviour (Wheeler et al., 2013). However, relative studies are still rare. Many farmers' behaviour has unlikely become habitual, but rather an antecedent for future behaviour. For example, the behaviour of using irrigation equipment is an antecedent or context for future behaviour related to this equipment, and also an outcome of their past purchase behaviour. The findings of this study advance our understanding of how past behaviour as antecedents influence behavioural intentions, and as outcomes of their previous behavioural intentions mediate the relationships between values and attitudes and behavioural intentions. As antecedents influence behavioural intentions, our study has shown that farmers who made changes in their irrigation equipment in the last five years were less likely to intend to reduce irrigation water use if the price of water increases. However, when the intentions are global or beyond specific farming practices, for example, the intentions to agree to volumetric pricing of water and willingness to transfer historically unused water, the influence of past behaviour on farmer's behavioural intentions becomes insignificant. The influence of past behaviour, i.e., farmers' current irrigation equipment and whether or not they made changes in their irrigation equipment in the last five years, did not have a statistically significant influence on farmers' intentions to improve irrigation equipment in next five years. As outcomes of their previous behavioural intentions, past behaviour also was not a statistically significant influence on farmers' values and attitudes in this study. Understanding the role of farmers' past behaviour in predicting future behaviour is a big research topic; the current study presents a primary attempt.

Fifth, this study contributes a comprehensive understanding of farmers' behaviour. The model incorporated all the major factors behind farmer's behaviour, which were influenced by many

different authors, including Ajzen and Fishbein who developed the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) and the Theory of Planned Behaviour (TPB) (Ajzen, 1985; 1991), then improved them by adding a wide range of background factors into their model framework (Ajzen and Fishbein, 2005), and Edwards-Jones (2006) who suggested that farmers' decisions are influenced by six groups of factors: socio-demographics of the farmer, psychological make-up of the farmer, characteristics of the farm household, structure of the farm business, the wider social milieu, and characteristics of the innovation to be adopted. Although some comprehensive conceptual models of farmer' behaviour have been proposed (e.g., Ahnström et al., 2009; Edwards-Jones, 2006), farmer-level empirical research based on those models is rare. This dissertation is the first attempt to put such a wide range of factors into one model simultaneously. The findings contribute to a more complete understanding of farmer's behaviour and provide new empirical evidence that fills the gap between model proposal and application.

8.5 Recommendations for Future Research

This study has shown that farmers' values and attitudes play an important role in determining farmer's behavioural intentions. However, not enough data were available to reliably study the participants' Power and Achievement values, which are opposite to Universalism in the value system and underlie conflicting motivations to Universalism type of values (Schwartz and Bilsky, 1987, 1990; Schwartz 1992, 1994). Future research should be undertaken to examine the relationship between farmers' Power and Achievement values and their attitudes, especially attitude to farming business, and how Power and Achievement values influence existing farmers' behaviour and behavioural intentions. As discussed in the section on limitations, this study has

not gathered enough data about farmers' attitudes. Future research should develop more indicators to measure farmers' general attitudes.

This study did not collect data related to farmers' personal and household income. Lynne and Rola (1988) believe that income has both direct and moderating effects on behaviour. Evidence has shown that farmers with higher income are more oriented towards monetary goals and economic success than are low income farmers (Pemberton and Craddock, 1979) and tend to have different attitudes towards conservation action (Lynne and Rola, 1988). Future research should not ignore the influence of income on farmers' behavioural intentions.

This study has shown that farmers' past behaviour plays an important role in determining their behavioural intentions. Farmers' current water consuming behaviour can be regarded as an antecedent for future behaviour. The behaviour of using irrigation equipment is an antecedent or context for future behaviour related to this equipment, and also an outcome of their past purchase behaviour. The current study has taken only two aspects of this into account. However, farm crop planting structure, especially in irrigated land, is one of the most fundamental determinants of irrigation water demand. Future research should give adequate consideration to its impact.

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Appendices

Appendix A: Questionnaire

Cover Page

- A1. Household No. _____ (from column A in Excel spreadsheet)
- A2. Did this respondent completed the last survey: yes: _____; no: _____
- A3. If yes, who entered the data from the first survey onto this form: _____
- A4. If, yes has the data on this form been checked against the spreadsheet: Yes: _____
- A5. Who checked it: _____
- A6. Farm Location: _____
- A7. Irrigation District No. _____
- | | |
|---|---|
| (1) Aetna Irrigation District | (8) Raymond Irrigation District |
| (2) Bow River Irrigation District | (9) Ross Creek Irrigation District |
| (3) Eastern Irrigation District | (10) St. Mary River Irrigation District |
| (4) Leavitt Irrigation District | (11) Taber Irrigation District |
| (5) Lethbridge Northern Irrigation District | (12) United Irrigation District |
| (6) Magrath Irrigation District | (13) Western Irrigation District |
| (7) Mountain View Irrigation District | (0) Private, which river: _____ |
- A8. Number of Persons in the Household: _____
- A9. Date of the interview: _____
- A10. Start Time: _____
- A11. Finish Time: _____
- A12. Interviewer: _____
- A13. Date of Data Input: _____; by whom: _____
- A14. Date of data validation spreadsheet against form: _____; by whom: _____

Part I: Farm

The first part is about you, your family and your farm.

- B1. How many acres of dryland do you manage or operate?
- | | |
|----------------------------|---|
| (1) _____ owned acres | (2) _____ Rented (crop share or cash) acres |
| (3) _____ Rented out acres | (4) Refused |
- B2. How many acres of irrigated land do you manage or operate?
- | | |
|----------------------------|---------------------------------------|
| (1) _____ owned acres | (2) _____ Rented (crop share or cash) |
| (3) _____ Rented out acres | (4) Refused |
- B3. How many years have you and your spouse participated in operating this farm?
_____ years.
- B4. How many generations has this farm been in your (or your wife/husband/partner) family's ownership? Please include your own generation. _____ generations.

B5. Did you (or your wife/husband/partner) participate in operating this farm before you took over the management of it?

- (1) I had, but my spouse/partner had not.
- (2) I had not, but my spouse/partner had.
- (3) Both my spouse/partner and I had.
- (4) Neither of us.

B6. How many irrigated acres were on this farm when you took over its management?
 _____ acres (2) Refused

B7. Which of the following three best describe your farm?

- (1) Expanding/growing
- (2) Stable
- (3) Down sizing

B8. Is a succession plan in place:

- (1) Yes
- (2) No
- (3) uncertain

B9. If no or uncertain why: _____

Part II: Agricultural Production and Irrigation

The next section relates to the production on your farm and any changes you have made or are planning to make to your irrigation technology and management practices.

C1—C7 Irrigated crops in 2011

Which crop did you grow on your farm during 2011? Interviewer, please fill in crop name in top row following the numbering provided below the table. For each crop ask the respondent C2 to C7. If the crop is not listed below, please write the name in the top row.

Crop Name							
C1. Crop No. (see below)*							
C2. Area cropped (acres)							
C3. Yield (bu/acre)							
C4. Nitrogen fertilizer (lb/acre)							
C5. Phosphorus fertilizer (lb/acre)							
Irrigation	C6. Irrigation Equipment**						
	C7. Total water applied (inches/acre)						

* Crop No: 1) Barley; 2) All Wheat; 3) Oats; 7) Alfalfa Hay; 8) Barley Silage; 9) Corn Silage; 10) Grass Hay; 11) Tame Pasture; 12) Timothy Hay; 13) Canola; 14) Beans; 15) Potatoes; 16) Sugar Beets; 17) Fallow

** Irrigation Equipment: (1) Gravity/Flood; (2) Wheel move; (3) High pressure pivot (30 psi or more); (4) Low pressure pivot (under 30 psi); (5) Others (please specify it) _____

If the respondent provide any other information re irrigation system please write it here: _____

C8. Have you made any changes to your irrigation equipment in the last five years?

(2) Yes (2) No

C9. Do you intend to make any changes to your irrigation equipment in the next five years?

(3) Yes (2) No

C10. If yes, what are you planning to change?

- (1) Convert from flood/gravity to wheel move
- (2) Convert from wheel move to pivot irrigation
- (3) Convert from flood/gravity to pivot irrigation
- (4) Convert from high pressure pivot system to low pressure pivot system
- (5) Purchase a computer panel for your pivot system

Please provide any additional details: _____

Part III: Values and Attitudes

D. Attitudes related to farming life

The statements listed here reflect the ways some people think about their farming lives, and attitudes related to water use and water policy. The statements related to water use and water policies do not represent the opinions of the researchers but reflect a variety of opinions that often are expressed by various people who are concerned with water use in Alberta. Please indicate the degree to which you agree or disagree with each statement.

D1. A maximum annual net financial return from your farm is an important goal for your family.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

D2. The lifestyle that comes with living in a rural area is very important to your family.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

D3. Increasing the asset value or net worth of your farming operation is very important to your family.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

D4. You view your farming operation as first and foremost a business investment.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

D5. Rural communities are a great place to live and raise a family.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

D6. Having land to pass down to future generations is more important than selling it for the highest price.

(1) Strongly Agree	(2) Agree	(3) Somewhat Agree	(4) Neutral	(5) Somewhat Disagree	(6) Disagree	(7) Strongly Disagree
D7. You feel a responsibility to keep your land in the family.						
(1) Strongly Agree	(2) Agree	(3) Somewhat Agree	(4) Neutral	(5) Somewhat Disagree	(6) Disagree	(7) Strongly Disagree
D8. Land is the most important heritage of the family.						
(1) Strongly Agree	(2) Agree	(3) Somewhat Agree	(4) Neutral	(5) Somewhat Disagree	(6) Disagree	(7) Strongly Disagree
D9. You would be willing to transfer water that, historically, you have not used.						
(1) Strongly Agree	(2) Agree	(3) Somewhat Agree	(4) Neutral	(5) Somewhat Disagree	(6) Disagree	(7) Strongly Disagree
D10. You are active and willing to undertake activities in the community.						
(1) Strongly Agree	(2) Agree	(3) Somewhat Agree	(4) Neutral	(5) Somewhat Disagree	(6) Disagree	(7) Strongly Disagree
D11. The current system for pricing irrigation water does not reflect the reality or potential of water shortages.						
(1) Strongly Agree	(2) Agree	(3) Somewhat Agree	(4) Neutral	(5) Somewhat Disagree	(6) Disagree	(7) Strongly Disagree
D12. Increasing the price of water will not reduce the use of water for irrigation.						

(1) Strongly Agree (2) Agree (3) Somewhat Agree (4) Neutral (5) Somewhat Disagree (6) Disagree (7) Strongly Disagree

E. Values

In the following sections we would like to explore the values you hold in more general terms.

Please use a nine-point scale to measure the importance of each value “as a guiding principle in my life”: of supreme importance (7), very important (6), (unlabeled; 5, 4), important (3), (unlabeled; 2, 1), not important (0), opposed to my values (- 1).

Would you please follow the following steps to fill the form?

1. Please read the following value list;
2. Please choose and rate the value most important to you (can be more than one value);
3. Please choose and rate the value of the least important to you (could be more than one value);
4. Rate all of the others.

Value List	Rate Respondent	Rate Spouse
Ea. Protecting the environment (preserving nature)		
Eb. True friendship (close, supportive friends)		
Ec. Unity with nature (fitting into nature)		
Ed. Choosing own goals (selecting own purposes)		
Ee. Wealth(material possessions, money)		
Ef. Broad-minded (tolerant of different ideas and beliefs)		
Eg. Inner harmony (at peace with myself)		
Eh. Equality (equal opportunity for all)		
Ei. A spiritual life (emphasis on spiritual not material matters)		
Ej. Authority (the right to lead or command)		
Ek. Successful (achieving goals)		
El. Responsible (dependable, reliable)		
Em. Social recognition (respect, approval by others)		
En. Social justice (correcting injustice, care for the weak)		
Eo. Self-respect (belief in one’s own worth)		
Ep. curious (interested in everything, exploring)		
Eq. A world of beauty (beauty of nature and the arts)		
Er. Freedom (freedom of action and thought)		
Es. Independent (self-reliant, self-sufficient)		
Et. Meaning in life (a purpose in life)		

If your spouse/partner is available, we would like him/her to rate the same questions.

If not, could I leave the statements with you for him/her to fill out and then call back later to get the answers over the phone?

To the interviewer: If yes, please hand a copy of the value list and instructions to the respondent as well as a consent form and say: ‘We would then also like your

spouse/partner to sign a consent form and either mail to us in this reply paid envelope or fax it to us at 403-xxxxxxx’.

Part IV: Demographic

The last section of questions is about you, your family and their relationship with the farm.

F1—F10. Information of Household Members (including all children)

F1. Member No.	1	2	3	4
F2. Age				
F3. Relationship with interviewee (1) Self (6) Parent-in-law (2) Spouse or partner (7) Son-in-law (3) Son or daughter (8) daughter-in-law (4) Step-son or step-daughter (9) Siblings (5) Parent (10) Others (99) Unclear or refused				
F4. Gender (1) Male (2) Female				
F5. Highest level of Education (1) Did not finish high school (2) Secondary (high school) diploma or equivalency certificate (3) College or other non-university certificate diploma (including apprenticeship or trade) (4) University Bachelor's Degree (5) University Master's or Doctorate degree (6) None of the above (9) Refused				
F6. Marital status (1) Single and never married (4) Separated (9) Refused to answer (2) Legally married (5) Divorced (3) Common-law (6) Widowed				
F7. Is the farm currently your permanent residence? (1) Yes (2) No				
F8. Relationship with the farm (1) Owner and full-time operator (2) Owner and part-time (3) Owner but not an operator (4) working fulltime on the farm (5) working part-time on the farm (6) None of above (including operator little child and students not living at home) (9) Refused to Answer				
F9. Off-farm working status (1) Full-time (2) Part-time (3) No off-farm work				
F10. If you work full time off-farm, what kind of occupation?				

Appendix B: Acronyms and Abbreviations

AARD - Alberta Agriculture and Rural Development
ACC - Attitude to Community Cohesion
ADF - Asymptotic distribution free
AEDA -Alberta Economic Development Authority
AFB - Attitude to Farming Business
AGE - Respondent's age
ALA - Attitudes to Land Attachment
AMOS - Analysis of MOment Structure
ANOVA - Analysis of variance
AVE - Average variance extracted
AWC -Alberta Water Council
BCYCL - Farm's position in business cycle
BI - Behavioural Intention
CFA - Confirmatory factor analysis
CFI - Comparative Fit Index
CR - Composite reliability
EAST - the Extrinsic Affective Simon Task
EDU - Respondent's education level
EFA - Exploratory Factor Analysis
FAO - Food and Agriculture Organization of the United Nations
FBC - Farm Business Characteristics
FIT-FIR - First in Time, First in Right
GEN - The number of generations that the farm has been in the family's ownership
GEND - Respondent's gender
GLS - Generalized least squares
GNAT - Go/No-go Association Task
GWP - Global Water Partnership
HAGE - Household average age
HC - Household Characteristics
HOFFM - Respondent and spouse (if available) off-farm status
HSIZE - Household size
IAT - the Implicit Association Test
IC - Individual Characteristics
ILSIZE - Size of irrigated land (Acres)
ILSZ_T - Square root transformation of ILSIZE
IWRM - Integrated Water Resources Management
KI - Kurtosis Index
KMO - Kaiser-Meyer-Olkin measure of sampling adequacy
MAR - Missing at random
MCAR - Missing completely at random
MI - Modification indices
ML - Maximum Likelihood
NFI - Normed Fit Index
NMAR - Not missing at random

NRTEE - National Roundtable on the Environment and the Economy
 OFFM - Respondent's off-farm status
 OLS - Ordinary least squares
 PAF - Principal Axes Factor
 PB - Past Behaviour
 PB_5YS - If the farm improved irrigation equipment in past five years
 PB_EQP - The most efficient irrigation equipment used on the farm
 RMSEA - Root-Mean-Square Error of Approximation
 RVS - Rokeach's Value Survey
 SCSRP - Succession plan
 SD - Self-Direction
 SEM - Structural equation modelling
 SI - Skewness Index
 SMC - Squared multiple correlation
 SRMR - Standardized Root Mean Square Residual
 SSRB - The South Saskatchewan River Basin
 SVS - Schwartz's Value Survey
 TACT - Target, Action, Context, and Time
 TPB - the Theory of Planned Behaviour
 TRA - the Theory of Reasoned Action
 UN - United Nations
 UN_H – Universalism for Human
 UN_N – Universalism for Nature
 UNCED - United Nations Conference on Environment & Development
 UNDESA - United Nations Department of Economic and Social Affairs
 UNEP - United Nations Environment Programme
 VI - Value Indicator
 WCED - The World Commission on Environment and Development
 WLS - Weighted least squares
 WWAP- World Water Assessment Programme