THE IMPACT OF THE FINANCIAL CRISIS ON AGRICULTURE AND IN PARTICULAR ON THE CONSUMPTION AND DEMAND FOR BANANAS AND FRESH FRUIT IN EUROPE[1]

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Introduction

Thank you for the invitation to be with you. It is both an honour and a privilege. I have spent my career in the agriculture and horticulture industries covering the public, charitable and commercial sectors. I have operated commercial businesses and guess I can offer some experience to discussions – the white hair is proof of this. What I would say is that I am not an expert on bananas and the perspective of this paper is very much looking at bringing a European dimension to the discussions of this conference. I am equally always wary of terming myself an expert. I think the definition is 'Someone who knows more and more about less and less until he knows everything about nothing!

The old Chinese proverb reads 'We live in interesting times'. I guess that to most Europeans in recent times, that would be an understatement. It is easy to forget, given the pace of change, that not many months ago, it started with spiralling oil prices, bringing with it increased costs and concerns about inflation. It was followed quickly by the realisation at last that, despite the very important discussions and actions on issues such as climate change and the environment, food security was a major issue both globally in determining how we would feed our rapidly increasing population, with significant changes in dietary needs, and also food security at individual country level. Such changes have brought with them the need for review of policies and the emergence of national campaigns such as the one in the UK of inspiring and educating people to grow or certainly know more about their food. All of this, of course, has now been overshadowed by a financial crisis of unbelievable proportions as we embark on very unchartered waters with many not quite sure where will be our destination.

Against this backdrop, our food producers and retailers must seek to chart their course. In the early phase, with spiralling energy costs, there is clear evidence that many consumers sought to trade down their standard weekly shop. Cost became even more critical and our retailers responded accordingly. Now, with our financial crisis, growing unemployment and decreased security, there are signs that alongside seeking cost reductions where possible, whilst cutting back on luxuries, consumers are in Europe trading up on some specific food purchases. Restaurants report lower bookings and people are eating and drinking more at home.

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[1] This paper was first presented by Professor John Moverley OBE at the International Forum for Banana and Fresh Fruit Sector in Ecuador in April 2009. It was jointly authored with Carl Atkin of Bidwells Agribusiness.

As said, we live in interesting times. The trading figures, whilst reflecting many of the challenges, are holding up for food purchases. Again there is some evidence that people are becoming more interested in food. Undoubtedly running a food related business has never been easy but the ability to adapt quickly and respond has always been paramount and never more so than now.

This paper addresses key issues starting with general background on the credit crisis, some related demand and supply considerations in terms of food production and demand and the extent to which agriculture is recession proof and the resulting opportunities.

Against this background we look specifically at the trends in consumption and demand for bananas and related foods and then update these for recent times. We look at statistics for a major supermarket retailer in the UK for the last 12 months to give hard evidence of what might be happening.

In concluding, we will seek to make some judgements and conclusions on demand and consumption which might set a context for future planning by suppliers of bananas and related produce.

The credit crisis

The current credit crisis impacting in Europe is a direct outgrowth of the fall in housing prices that began in 2006. The emergence of subprime lending in the USA brought things to a head and exposed failings in the banking system globally. This was particularly interesting given that up to a year before the major USA collapse, economic analysts thought that the European economy was relatively immune to what was happening in the USA. How wrong they were! Using the USA as an example, as a rough approximation, for every ten dollars issued by a US bank in loans, it must have one dollar in capital assets. With the introduction of financial derivatives, financial entities widely used mortgage backed securities as part of the capital backing their operations. As housing prices declined, the value of mortgage backed securities declined. As bank's assets fall in value, they must issue fewer loans. A downward spiral begins and the consequences are immense. Businesses cannot get credit even for relatively strong positions. Unemployment follows, consumer confidence falls, less money is available to spend on goods and produce and even where income level allows, anxiety creeps in and consumers spend less or importantly, in terms of food, trade down in terms of quality particularly for staple goods.

Tighter credit narrows the market for housing and prices have slumped tremendously, especially important in the UK where home ownership, rather than renting is the norm. Houses become less valuable than the loan creating negative equity. The continued decline in house values further lowers the value of mortgage backed financial derivatives and credit conditions further tighten. Unfortunately the crisis in Europe spiralled outwards from these sectors. As credit conditions tightened, loans for consumers for business operating expenses, and for corporate expansion further tightened. This has driven down sales of many items and more firms have failed. The current crisis has been compared with that of the Great Depression but in the latter there were more contributing factors. Different approaches have been adopted by countries. There can be no certainty as to when the recession might end.

Interestingly enough in 1867, Karl Marx wrote “Owners of capital will stimulate working class to buy more and more of expensive goods. The unpaid debt will lead to bankruptcy of banks…”

Impact on agriculture

In such circumstances what has been the impact on agriculture generally? In essence, the sector has shown itself to be relatively recession proof. Whilst the credit crisis in Europe has reduced demand for goods, people still need to eat and whilst demand for food continues to increase, supply is under pressure. The trend is towards real price increases in the longer term whatever the short term fluctuations. Of course, the picture varies and certainly in Europe, there is evidence of consumers trading down in their purchasing of staple food items. However, the opportunity for fruit is that the consumer may see its purchase as an added value or luxury item when times are hard. Campaigns are ongoing throughout Europe seeking to encourage greater intake of fruit and vegetables to improve health and attack obesity. In the UK, the target is eating at least five portions per person per day of fruit and vegetables. Whilst we still fall short especially in lower income groups, it is a factor helping to mitigate the impact of the credit crisis, certainly in terms of fruit purchases.

Undoubtedly the world is facing real pressures in competition for land, certainly in Europe. Creating a world where we optimise the economic, social and environmental value of our land requires a review of our systems of planning, land use and agriculture. Certainly in the UK, there is a move towards recognising the value of food for healthy living and real enjoyment. At the same time, there is growing public awareness of the challenges of climate change and the need to conserve resources. However, price remains the major driver for consumers in relation to food at retail. The difference between what people say about their buying and what they do in the supermarket can be very different. Increasing understanding of the whole food chain will contribute to maintaining a viable agricultural industry where the industry recognises that more of the same will not do.

There are key issues currently facing us all in terms of use of land. Please forgive me if my examples today are largely UK based but hopefully these can be translated to other country situations. I identify five issues. Our response to them will certainly shape the industry.

Population: The world’s population is growing and in need of food. Over 800 million people in the world are malnourished and a third lack food security. A 40% increase in world food production is required by 2020 to meet these needs. From a national perspective, the UK population will rise by 17% to 71m within 25 years according to the Office of National Statistics. Consequently, the policies we adopt for rural land use cannot and must not ignore food production.

World Trade*:* The impact of global choice and competition is now substantial. Food has become less valued in developed countries and choice and availability taken for granted. Yet in many parts of our world that is far from true. Imports and exports are increasing and distances decreasing through improved transport infrastructure leading to a greater need for farming to utilise comparative advantage. Appropriate procurement and consumption is vital to maintaining a sustainable balance between global trade and domestic production. Then we have significant dietary changes with major shifts in eating patterns across the world.

The Food versus Fuel Debate*.* Achieving both energy and food security where land area is limited is both a challenge and an opportunity. Agriculture must strike a balance between contributing to efforts to reduce the effects of climate change and achieving sustainability. Energy crops, viewed as a key way of reducing carbon emissions, compete for land used for food and producing food from fewer acres will require intensification and re-emphasis upon science and the transfer of technology. The EU target for bio-fuel is 5.75% of its fuel needs by 2010 and is testing. In the UK today, bio-fuel accounts for just 0.5% of fuel usage. As was demonstrated by the large increase in biofuel production from crops in 2007 in the USA, demand for bio-fuel can have a major impact on the supply of food such as wheat.

Climate Change**:** Although there are differences in scientific interpretation, the impact of climate change is critical; 10 years delay will be too late. Whilst the majority of our land will remain farmland, the pressures to alter the environmental footprint will be immense. Increasing demands on farming methods to reduce water pollution and soil erosion will be coupled with the need to accommodate significant increases in production. In addition to this, climate change may bring about shifting weather and temperature patterns resulting in reduced crop yields.

Land: They don't make it any more and there are real production challenges

Fresh Water Supply*:* Will water be the new oil? Globally, great changes are taking place in the supply and availability of clean water and the intensification of farming will put more strain on this. Many water distribution infrastructures are in need of major improvement to ensure supply meets demand and sadly in many areas people die because of insufficient water. Industry will be required to use water more efficiently and water storage must become common-place. There are real dangers that we run out of water. One expert has said that if we measure all the water flow in our world rivers, we have some 140 litres per head per day. A typical adult in the developed world can consume up to 200 litres in terms of what is needed to produce their food, clothes and consumer goods. The challenge is clear – water footprints rank alongside carbon ones in importance.

These factors are raised not to give a comprehensive picture but to illustrate that, whilst the current crisis might well impact on demand and certainly the currency weakening has impacted on prices, the long term position is somewhat more optimistic. Food producers will need to be quick on their feet and adapt to probably greater fluctuations in demand and price than before but, for sound businesses, there is real opportunity. According to Barclays Capital in January 2009, global wheat production was set to rise to 684 million tonnes in 2008-09 compared with a lean 596 million in 2006-07. On the face of it, this is good news but this only represents 11.7 weeks world consumption. All this impacts on all producers of food certainly including fruit. The factors of demand pull such as population, dietary shift, policy changes and bioenergy combined to supply constraints such as land and water will impact and provide opportunity in the longer term.

What will be key is technological advance and a realisation of the need to fully support science and technical advance.

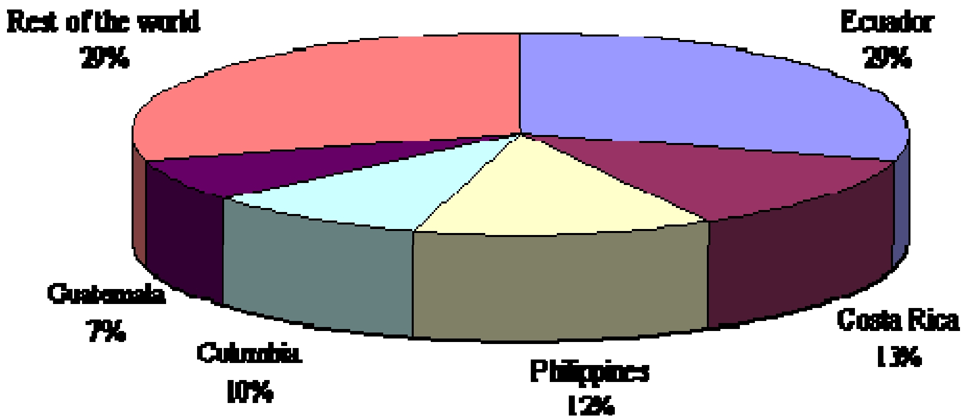
What all the statistics tell us is that agriculture is relatively recession proof and indeed food security is set to be a far more important issue than the credit crisis – more of that later.

Consumption and demand for bananas and fresh fruit

We can turn now to the core of this presentation – the consumption and demand for bananas. Whilst I am aware that much of this may be known by this audience and indeed that there are greater experts in the room than I who may have much more updated information, it is I believe useful to set the scene for what has been happening to consumption and supply of bananas running up to 2006.

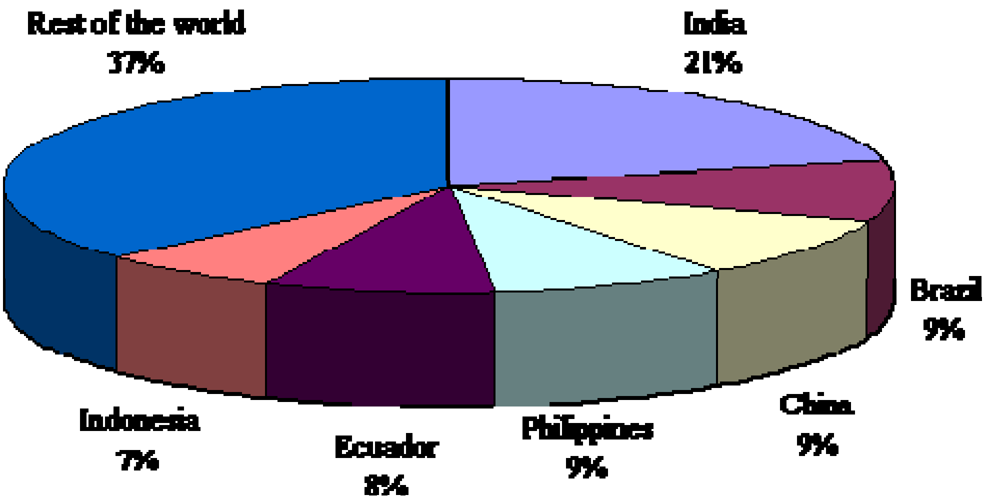
Bananas are the main fruit in international trade and the most popular one in the world. In terms of export volume they are first and second after citrus in terms of value. According to the Food and Agriculture Organization of the United Nations (FAO) Statistics estimations, world exports of banana were 16,8 million tonnes in 2006. Some of the main banana producing countries are hardly involved in international trade. In fact, only about one fifth of total banana production is internationally traded. Nevertheless, the proportion of the banana crop internationally traded increased slightly in the last decades (from around 18% in the sixties and seventies to over 22% in the 1990s and 2000s). The international banana market shows a highly regional character.

Distribution of the world Banana exports
Average over the 2002-2006 years



Source: UNCTAD Secretariat from FAO statistics

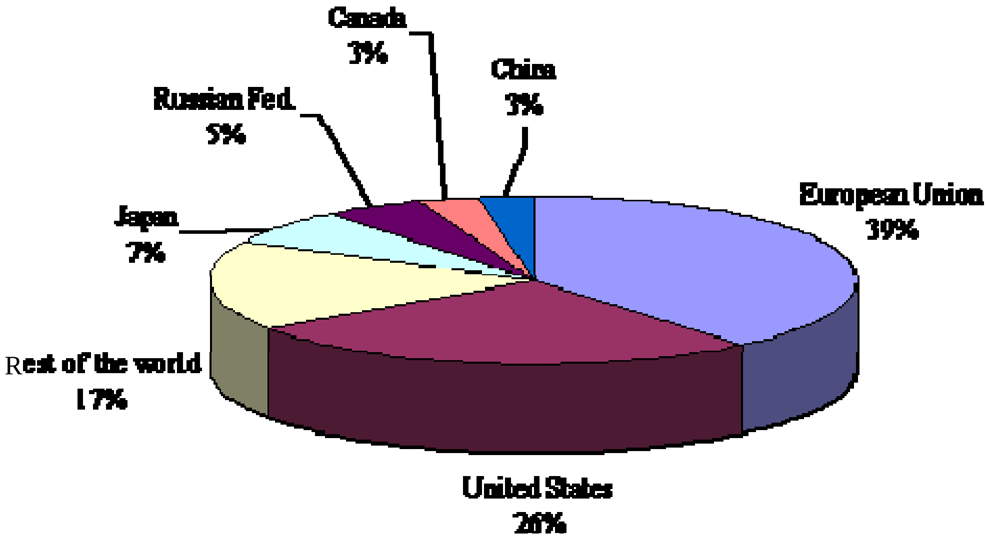
Distribution of the world banana production by countries
Average over the 2003-2007 years



Source: UNCTAD Secretariat from FAO statistics

From an historical perspective, banana imports are relatively concentrated. The main importing areas are the European Union, the United States of America and Japan, which together accounted for more than 70% of world total imports in 2006, while the first ten banana importing countries represented more than 80% of total imports (considering the EU as a whole).

Distribution of the world Banana imports
Average over the 2002 - 2006 years

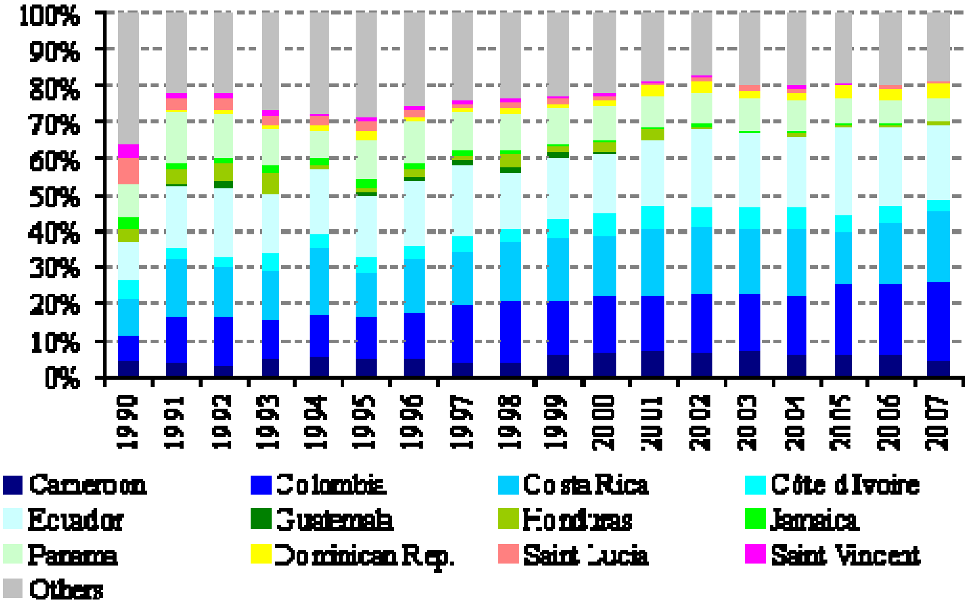


Source: UNCTAD Secretariat from FAO statistics

Concerning the direction of trade in bananas, it is important to emphasise that, due to the different banana import regimes in consuming countries, the world banana trade has a clear regional character. There has been both preferential markets and open markets for bananas, although this picture has been modified in the nineties with changes in quotas and related regimes especially in Europe. Transportation costs and time in banana distribution also play a role in the regional fragmentation of the market. North American banana imports come mainly from Central and South America on an open market basis, that is, with no tariff or quantitative restrictions.

Traditionally, banana imports to the EU have originated from three sources: first, national production from Spain (Canary Islands), France (Guadeloupe and Martinique), Greece and Portugal; secondly, ACP (African, Caribbean and Pacific) countries, which have been granted preferential access to the European market under the Lomé Convention and later the Cotonou Agreement; and Central American and South American bananas given mainly free (or open) entry to countries such as Germany. However, during the nineties the EU pattern of trade in bananas has suffered from the uncertainties arising from the introduction of the EU Banana Regime and the modifications that resulted from the banana dispute that came before the World Trade Organisation (WTO).

Geographical distribution of bananas imported in the European Union, 1990-2007



Source: UNCTAD Secretariat from COMTRADE statistics

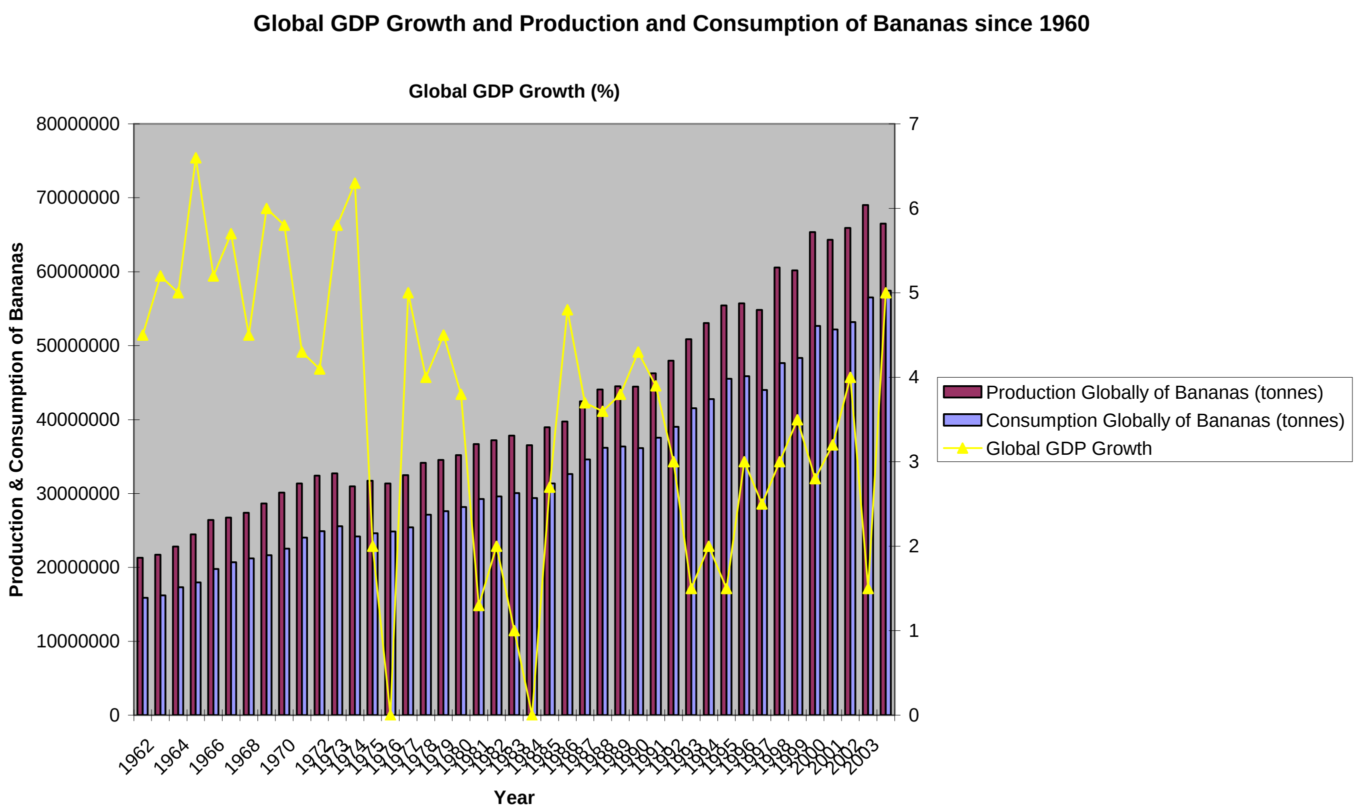
In the late nineties there was an oversupply of bananas, mainly due to higher exports from Ecuador and some other exporting countries. However, the main cause arose from expectations generated by the liberalization of the European Union market following the establishment of the EU Banana Regime market. In the late eighties and beginning of the nineties, banana marketing companies expanded their capacities to maximize their market shares in the profitable EU market. During the nineties the international banana market was greatly influenced by developments in the EU Banana Regime and the subsequent dispute and agreement at the WTO, which filled the market with uncertainties and limited the actions of the banana market operators. In addition, the emerging markets of Asia, particularly China, and the Russian Federation, and Eastern Europe were also considered to have great potential for bananas, but the economic situation in the Russian Federation, as well as the financial crisis in Asia meant that this was not achieved. All these circumstances, together with the sluggish growth of demand in saturated developed markets in USA and the EU resulted in the expected levels of banana consumption not being realised. This situation resulted in lower banana prices and increasing competitiveness between banana distribution companies as they restructured their businesses and sought to reduce costs.

Before moving to the final element of my paper, I mention a few selected matters. In recent years, throughout Europe, there have been policy drivers encouraging the consumption of more fruit and vegetables for health reasons. It is interesting that, despite such initiatives, consumption remains below WHO/FAO minimum levels. This must present opportunities linked to appropriate promotion.

It is also interesting to look at the statistics for fruit in the EU. Statistics vary but undoubtedly the market in total remains fairly stable with traditional fruit sales declining and much more interest in exotic fruits, linked to increased customer choice and its 'luxury' appeal in given circumstances.

Finally, a reference to economic theory. In his book, The International Banana Trade, Julian Roche has measured elasticity for bananas finding very low figures showing consumption and demand relatively unaffected by price and income change. However, evidence is mixed, in the 80s and 90s the UK and Italy enjoyed high economic growth with increased banana consumption, whereas in the USA and Japan consumption growth was more limited.

Finally in this series it is interesting to plot the consumption and supply of bananas in the period since 1960 against change in global GDP. The statistic is marked. Consumption and demand have continued upwards oblivious to fluctuations in global GDP indicating clearly that bananas are a relatively inelastic commodity.



Source – Carl Atkin Bidwells Agribusiness

If we now turn the clock to 2007, just prior to the great changes especially in terms of credit, we can summarise the banana situation. In May 2007, the global banana market was undoubtedly booming. Euromonitor International data showed volume sales rising by an impressive 33 per cent, from 43 million tonnes in 1998 to 57 million tonnes between 1998 and 2006. Regional market growth was concentrated in Eastern Europe and Asia Pacific, increasing by 48 and 38 per cent, respectively. India had the largest market in terms of volume sales. In 2006, 17 million tonnes of bananas were sold in India, 30 per cent of the total world sales of 57million tonnes. Other large markets include Brazil and China. Brazil had the highest per capita consumption of bananas, at more than 28 kg in 2006 primarily due to the abundant availability and low price of the fruit. Interestingly, Ukraine witnessed the highest growth in banana consumption from 1998 to 2006, from 0.4 kg to 1.4 kg, an increase of 241 per cent. The availability of bananas increased dramatically in Ukraine as the market has opened up over the past ten years, aided particularly by a trade agreement with Ecuador, who supplied 80 per cent of the Ukraine's bananas at that time!

More interesting was to view the forecasts for bananas again by the same organisation, Euromonitor International. They expected growth would continue, with global volume sales increasing by a further four per cent. Growth in Eastern Europe, however, was expected to slow rapidly, overtaken by Western Europe at 10.7 per cent, as western Europeans continue to increase their fruit intake in light of the trend for healthy eating and concerns over obesity.

Bananas

Market sizes - total volume - '000 tonnes	2006
Banana	
India	17,161.8
China	6,349.3
Brazil	5,173.5
Indonesia	3,807.7
Philippines	2,337.7
Market sizes - kg per capita	**2006**
Banana	
Brazil	28.2
Philippines	27.3
Thailand	22.7
Indonesia	16.8
India	15.5
Latin America	15.0
Venezuela	14.7
Kg per capita - period growth	**1998-06 %**
Banana	
Ukraine	241.4
Netherlands	134.6
South Korea	129.2
France	82.2
Colombia	77.0
Russia	72.3
Russia	67.9
China	65.4

Source – Euromonitor International

In the UK, in 2007, the consumption of fruit in the UK was slightly over four million tonnes, with star performances from dried fruit snacks, fresh-cut fruit and fresh cranberries and blueberries. Retail value of fresh fruit was around $7.4 billion with 90 per cent of fruit being imported. There have been increased sales of soft citrus, berries, exotic fruit and pears. The average UK multiple supermarket now offers much more range, for example:

- More varieties of avocado & citrus fruit
- Fairtrade bananas

Latest findings show a strong shift in consumption from fresh whole fruits to fresh-cut fruits, with the latter registering total volume sales of 62,400 tonnes in 2007, representing growth of 14.7 per cent on the previous year. In contrast, total volume sales of fresh whole fruit registered only two per cent increase for the same period. *(Source: Euromonitor).*

If we now move this forward to current times using live and unique data for a large and leading supermarket in the UK and measuring actual sales values and consumption, we can see some interesting trends. The sub group looked at first in this analysis includes both conventional and organic bananas and apples with some standard vegetable products. The period shown is the 12 months to 22 March 2009 with comparison against the previous year. Against the column value for sales value and volume are indices which effectively measure change from the previous 12 months. Anything above 100 represents a real increase and less a decrease. The data shows increases in sales of bananas and indeed all fruits except for a slight fall in citrus. It is clear that, despite the pressures on incomes and the downward trend in goods purchased, the factors already described are keeping the position strong for fruit. In essence this data, a sample only, but repeatable across other retail outlets, demonstrates that the credit crisis, certainly as yet, has not really impacted on the consumption or demand for bananas. As can be seen sales values outstrip volumes because of price increases especially in terms of currency values. This is not set to change. Certainly in Britain the price of bananas without intervention could increase further as the impact of the weak pound sterling hits home. The cost of Britain's favourite fruit increased by more than a third in 2008 and further price rises look likely, according to trade magazine The Grocer (January 2009). Their report confirmed that bananas are particularly vulnerable to currency movements. A kilo of bananas has rocketed from an average 70 pence a year ago to 94 pence in January 2009.

However, in the UK, there has recently been substantial intervention with two supermarkets engaged in a banana war cut pricing the fruit as a loss leader. The current price is under 70 pence per kilo represents a 37% price decrease in real terms in the last 3 years and 50% since 2002. Sales of bananas, as said, have been rising for more than a decade, almost 100000 pieces per year, but the effect of this most recent price war is dramatic. A box of bananas wholesale in the week commencing 30th March 2009 was £20 but selling at an equivalent price of £11.20. Currently the supermarkets involved are insisting that it will not impact on suppliers. This price war is recognition that banana demand stays strong and the supermarkets are using the fruit as part of a package of price reductions to maintain customer footfall.

Selected Subgroup(s): Conventional Apples, Bananas, Carrots and other fruits and vegetables
Previous Period: 52 weeks from 26-Mar-07 to 23-Mar-08
Most Recent Period: 52 weeks from 24-Mar-08 to 22-Mar-09

	Sales Value	Index	Sales Volume	Index
Conventional Apples	£158,726,626	105	130,506,550	99
Conventional Bananas	£116,489,974	105	168,879,830	101
Conventional Citrus Fruit	£144,235,673	107	175,109,730	99
Conventional Grapes	£150,674,920	107	86,119,900	104
Conventional Pears	£47,683,324	120	40,793,330	102
Conventional Soft Fruit	£168,905,563	106	85,121,920	104
Conventional Stonefruit	£67,459,055	99	62,775,450	108
Conventional Carrots	£50,524,921	113	98,653,770	104
Conventional Cauliflower And Broccoli	£64,703,283	98	79,205,710	93
Conventional Onions	£53,766,116	108	95,138,780	103
Conventional Potatoes	£251,551,547	109	194,715,570	100
Fair Trade Citrus Fruit	£1,685,470	102	1,291,400	107
Fairtrade Bananas	£7,068,007	129	7,072,100	138
Fairtrade Grapes	£13	0	20	0
Fairtrade Pears	£15	100	10	100
All Products	**£1,283,474,506**	**107**	**1,225,384,070**	**101**

Using the same live retail data, it is interesting to review other retail characteristics, again using indices and making comparisons with the previous 12 months. These show that 66.7% of customers bought bananas on their shopping trips although compared to other products bananas were purchased more frequently.

Interestingly all these figures are stronger than when last measured in January 2009. Demand in Europe was generally slow to recover after Christmas, in particular because of the very cold weather throughout Europe that adversely affected both consumption and transport. However, moderate supply had an impact.

Selected Subgroup(s): Conventional Apples, Bananas, Carrots and other fruits and vegetables
Previous Period: 52 weeks from 26-Mar-07 to 23-Mar-08
Most Recent Period: 52 weeks from 24-Mar-08 to 22-Mar-09

	Customer Penetration	**Index**	**Purchase Frequency**	**Index**	**Average Price Per Unit**	**Index**
Conventional Apples	62.29%	98	9.28	96	£1.22	106
Conventional Bananas	66.72%	99	11.75	98	£0.69	104
Conventional Citrus Fruit	63.22%	101	8.10	100	£0.82	108
Conventional Grapes	55.61%	102	7.65	97	£1.75	103
Conventional Pears	35.84%	100	5.75	99	£1.17	117
Conventional Soft Fruit	50.16%	99	6.27	98	£1.98	102
Conventional Stonefruit	43.12%	102	4.74	102	£1.07	92
Conventional Carrots	59.17%	100	8.33	100	£0.51	109
Conventional Cauliflower And Broccoli	48.03%	96	7.49	96	£0.82	105
Conventional Onions	61.94%	100	7.37	100	£0.57	105
Fair Trade Citrus Fruit	3.69%	93	1.45	95	£1.31	95
Fairtrade Bananas	14.66%	128	2.37	96	£1.00	93
Fairtrade Grapes	0.00%	100	1.00	95	£0.64	35
Fairtrade Pears	0.00%	100	1.00	100	£1.49	100
All Products	**87.48%**	**100**	**23.25**	**101**	**£1.05**	**105**

Finally in this series of live supermarket data, it is useful to examine trends in conventional, organic and fair trade purchases. Organic figures are given overleaf for comparison with the data above. Organic is clearly on a down ward spiral as consumers react to the premium prices for these products. However, this does not apply to fair-trade where in fact the highest increase in consumption has occurred in the last year. Consumers do care about sustainability and social issues but their worries about non organic production methods matter far less certainly in times of economic recession.

Selected Subgroup(s): Organic Apples, Bananas, Carrots and other fruits and vegetables
Previous Period: 52 weeks from 26-Mar-07 to 23-Mar-08
Most Recent Period: 52 weeks from 24-Mar-08 to 22-Mar-09

	Sales Value	Index	Sales Volume	Index
Organic Apples	£8,215,791	82	4,438,540	80
Organic Bananas	£15,107,228	92	12,931,580	87
Organic Citrus Fruit	£2,350,309	76	2,062,810	68
Organic Grapes	£1,595,774	90	848,390	90
Organic Soft Fruit	£5,610,289	101	2,451,220	93
Organic Stonefruit	£1,918,150	89	1,014,140	81
Organic Pears	£2,550,181	88	1,448,050	83
Organic Carrots	£7,758,708	91	7,751,750	73
Organic Cauliflower And Broccoli	£3,542,430	85	3,046,460	81
Organic Potatoes	£11,305,677	86	8,709,470	89
Organic Onions	£1,981,001	92	1,897,220	80
All Organic Vegetables	**£43,568,463**	**88**	**38,566,870**	**83**
All Organic Fruit	**£40,046,472**	**88**	**27,282,400**	**83**

	Penetration	Index	Purchase Frequency	Index	Average Price Per Unit	Index
Organic Apples	7.94%	81	2.55	95	£1.85	102
Organic Bananas	18.91%	88	3.41	95	£1.17	106
Organic Citrus Fruit	5.15%	72	1.78	92	£1.14	111
Organic Grapes	2.77%	91	1.51	95	£1.88	100
Organic Soft Fruit	6.07%	89	1.78	100	£2.29	109
Organic Stonefruit	3.54%	80	1.41	97	£1.89	110
Organic Pears	3.54%	75	2.01	106	£1.76	106
Organic Carrots	10.29%	67	3.71	106	£1.00	125
Organic Cauliflower And Broccoli	6.87%	79	2.23	99	£1.16	104
Organic Potatoes	16.75%	96	2.38	88	£1.30	96
Organic Onions	4.68%	84	2.00	91	£1.04	115
All Organic Vegetables	**37.32%**	**91**	**3.91**	**88**	**£1.13**	**106**
All Organic Fruit	**31.06%**	**88**	**3.67**	**92**	**£1.47**	**107**

Interestingly these statistics show that despite there being a decline in demand for organic products because of price differentials, this does not appear to apply to fair-trade bananas where in the supermarket analysis here, demand has gone up significantly.

Our analysis in this paper has not referred to the EU Banana regime. This is not because it is not important and indeed it has influenced the market as previously discussed. However, it is felt that it is not really within the brief of this paper and time is limited. I personally feel that the regime has offered some solutions, albeit far from perfect, and it is serving the long run interests of the producer countries both in Latin America and the Caribbean but that could prompt even more debate.

Conclusions and projections

How can we summarise? Well certainly the economic situation in the European Union remains volatile. As businesses continue to fail or not be able to achieve growth forecasts, consumer confidence remains low. Prospects for improvement depend not only upon individual government stimulus plans but also on a global recovery. Government actions to date have varied. The UK banking system has moved towards greater nationalisation, increased government spending and adjustments to the money supply, but in France substantial infrastructure spending has been approved and Germany in January 2009 announced a 50 billion euro stimulus package. There are concerns that countries may retrench and introduce protectionist measures, thus working against free competition and distorting global markets. At this stage there seems no hope of coming out of the recession until 2010 although there is some consensus of an economic upturn in 2011 bringing with it rising consumer confidence, but it will be a hard road ahead. The European Commission in January 2009 provided projections on GDP growth. Ireland was expected to suffer the most in 2009 with the bursting of the construction and housing bubble. Other countries were very much on a par except for Greece with even 2009 being positive due to unusual factors. Some figures are given below rounded to the nearest 0.5%:

	2008	2009
Greece	+3.0	+1.5
France	-2.0	+1.0
Netherlands	-2.0	+2.0
Ireland	-5.0	-2.0
UK	-3.0	+1.0

Without going into the detailed projections for each European country (because they vary in the impacts and their responses to the credit crisis), perhaps some general conclusions are possible. The health warning is of course the generalisation and differences between European countries are very significant. However these comments are set in the context of the projections referred to above. We are especially grateful to J M Ferry from the Chamber of Commerce in Avignon, France on which our conclusions are heavily drawn. Firstly, undoubtedly the greater range of fresh fruit available and longer storage times mean more consumer choice. This emphasises the need for quality in primary produce, its conditioning, presentation in transit and at point of sale. There are clear signs that the demanding nature of consumer as regards choice of variety and quality will eliminate all but higher quality products from the market. Whilst price trends are upwards, all indications are that volumes will continue to increase but equally there are signs that growth may be diminishing and not be as buoyant as might have been forecast in 2006. Despite calls for healthy eating and the like, there may well be some movement to processed fruit products certainly whilst the current difficult conditions continue in Europe.

There will continue to be a growing need for information about fresh fruit products, the available varieties and their sources. Combined with growing consumer protection rights, this will impact on suppliers who must ensure these needs are met. Our research has shown that the market for bananas and fresh fruit along with most agricultural products is relatively recession proof. Issues impacting on supply and the challenge of supplying enough food to meet the needs of a growing population are acting as a counter balance to economic pressures. We all need to eat. Whilst there is undoubtedly a trading down in food purchasing patterns, this is not really reflected in the demand for bananas and related fruit. Campaigns such as five a day in the UK linked to strong messages on health reasons for fruit and vegetable consumption are a real factor here. Indeed, in times of financial austerity, buying and consuming fruit can often be seen, certainly in the UK, as a luxury that can be afforded.

Whilst we are all pre-occupied quite rightly with the credit crisis, we must not lose focus on that other threat to global stability which is that of hunger and food supply. Only just this month, a meeting of the G8 group of Ministers warned that the world faces the prospect of a permanent food crisis endangering international stability if countries do not take action now. It adds that such a crisis will not just impact further on business but equally on social and international relations. UN figures show that 850 million people were chronically hungry before the food crisis of 2007. FAO estimate 1 billion people are the current number of chronically hungry. The economic recession impacts on purchasing power and food costs remain high – the consequences on food supply are clear and there is still much potential for increased in fruit consumption in Europe.

This paper has sought to address the impact of the credit crisis on consumption and demand for bananas and fresh fruit in Europe. It is clear that, whilst important, certainly short term, the real issues are around food security. Indeed with agriculture commodity stocks at multiyear lows, an unexpected spate of bad weather could push prices up and trigger a further crisis upon the economic one. As the Chinese proverb says ‘We live in very interesting times’

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FARM MANAGEMENT RESEARCH: A DISCUSSION OF SOME OF THE IMPORTANT ISSUES.

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Abstract

The discipline of Farm management has often been criticized for not delivering the benefits to practitioners that are expected of it. This paper explores two issues that have limited the development of the discipline over the years. First, the research focus and methodologies adopted by the discipline have hindered the development of a robust and useful body of theory. Second, the divergence of farm management theory into three different views (management process, decision making process and problem solving process) of management practice has limited the development of theory.

The adoption of economics as the underlying theoretical framework for the discipline has limited the development of useful theory about the management practices of farmers. This has focused research on the criteria by which a choice is made rather than the process of making the choice. The discipline would be better served by drawing on theory from management science, where the focus is on the management process. Similarly, the discipline's focus on mathematical modeling has tended to ignore the effect of the farmer in farm management. Empirical research into farm management has tended to use survey-based cross-sectional studies that have focused on the statistical analysis of easily measured socio-economic variables to define the characteristics of successful farmers. There have been a limited number of longitudinal case studies that are more appropriate for investigating the complex management processes used by farmers.

The other factor that has limited the development of useful farm management theory has been the divergence of farm management theory into three different views (management, decision making and problem solving processes) of management practice. Analysis of the literature shows that these three views of management practice developed from common roots and are essentially the same process. However, this proliferation of theory has created confusion in the literature and has often been developed in a somewhat ad-hoc manner. For example, researchers have often failed to: build on preceding theory, cite sources when modifying existing theory, provide definitions of key concepts, or adopt recognised definitions and terms. They have also altered the position of various sub-processes within functions without justifying such changes. These inconsistencies are often associated with relatively new disciplines that have had limited theoretical development. It may also reflect may also reflect a general lack of empirical research into the management process and the comparison of these models to actual farmer practice.

The paper highlights that the management, decision-making, and problem solving processes reported in the literature can be considered synonymous and that theory development in farm management has tended to be somewhat *ad-hoc*. It would be sensible to adopt the management process as the model under which farm management is researched because management rarely comprises a single decision. Rather, it is an ongoing cyclical process of planning, implementation and control, where *planning* decisions tend to be much less frequent than *implementation* and *control* decisions. Such decisions need to be considered by level (strategic, tactical and operational), field (production, finance, marketing and human resources) and by structuredness (structured, unstructured). Similarly, the discipline needs

to adopt a more systematic and rigorous approach to theory development if it is to make greater progress.

It is the authors' belief that the discipline does not have to remain "*underexposed*". Rather, through a shift in research focus to the study of farmers' management practices, the integration of relevant theory from management science, the greater use of longitudinal case study-based methods (in conjunction with well thought out modeling and survey-based studies), the adoption of a management process view of farmer practice and a more systematic and rigorous theory development process, the farm management discipline can begin to generate theory that is highly relevant to practitioners.

Introduction

Farm management as a discipline has often been criticized for not delivering the benefits to practitioners that are expected of it (Rougoor *et al*., 1998). This paper explores two issues that may have limited the development of the discipline over the years. The first of these is the research focus and methodologies adopted by the discipline which has limited the development of a robust and useful body of theory. The second is the divergence of farm management theory into three different views of management practice, as a management process, as a decision making process and as a problem solving process. These issues are discussed in the following sections

Research focus and methodology

Over the history of farm management there have been a number of reviews of the discipline (Johnson, 1957, 1963; Jensen, 1977; Nix, 1979; Giles and Renborg, 1990; Malcolm, 1990; Rougoor *et al*., 1998) and often the conclusion from such reviews is similar to that made by Rougoor *et al.* (1998, p. 270) that the area was "*underexposed*". In particular, the discipline has struggled to develop useful theory that describes the management practices of farmers. Two inter-related factors stand out as possible reasons for the lack of theoretical development on the management processes used by farmers. First, the adoption of economics as the underlying theoretical framework for the discipline and second, the emphasis placed on quantitative research methods. At the famous Black Duck workshop in 1949, the role of economic theory in farm management research was debated and the proponents of economic theory set the methodological foundations that would dominate farm management research during the 1950's and 1960's (Jensen, 1977; Malcolm, 1990). The primary focus through this period was production economics and mathematical programming (Jensen, 1977; Malcolm, 1990), but little work was undertaken in relation to the critical success factors for exceptional farm performance (Howard and MacMillan, 1991). Ulf Renborg echoed this view when he stated: "*in the short space of twenty or thirty years, from the sixties to the eighties, farm management as an academic discipline has seemed to stray from the needs of farm management as a practice*" (Giles and Renborg, 1990). This was despite the criticism of researchers' preoccupation with an economic framework for studying management (Johnson, 1957, 1963; Gasson, 1973; Andison, 1989; Giles and Renborg, 1990). In economics, emphasis is placed on the criteria by which a choice is made or the way in which a choice is made (Gasson, 1973), rather than the "*process of making the choice*" (Andison, 1989) or "*why*" it was made (Gasson, 1973). Further, an economics paradigm leads to the presumption of homogeneity in production technology, management and behaviour (Driver and Onwona, 1986).

After reviewing the contributions that various disciplines might make to farm management research, Johnson (1957) concluded that economics provides a necessary, but not sufficient framework for the study of management in farming. Other authors (Williams, 1957; Wright, 1985; Andison, 1989; Giles and Renborg, 1990; Harling and Quail, 1990) reached the same conclusion. Several authors (Wright, 1985; Renborg, 1988; Andison, 1989; Harling and

Quail, 1990; Martin *et al.*, 1990) also made a case for the integration of management science with farm management, particularly because of its focus on the management process (Andison, 1989). The call for further research into the decision-making processes used by farmers has been reiterated through the history of farm management research (see Johnson, 1957, 1963; Plaxico and Wiegman, 1957; Williams, 1957; Burns, 1973; Jackson, 1975; Andison, 1989; Howard and MacMillan, 1990; Rougoor *et al*., 1998; Nuthall, 1999). Andison (1989) discussed the need for farm management researchers to identify the factors that make managers successful, and the separation of these into those that can and cannot be taught. The former can then be passed onto the farming community and strategies can be developed to minimise the impact of the latter.

The second factor that has limited research into farmers' management processes is the emphasis placed on quantitative research. These methods can be usefully separated into modeling and survey-based approaches. The development of prescriptive models (linear programming and simulation modeling) dominated the farm management literature through the 1960's and 1970's (Malcolm, 1990). This prescriptive approach in effect ignored the effect of the farmer in farm management.

Where empirical research into farmers' management processes has been undertaken, these studies have been dominated by survey-based cross-sectional research approaches (Howard and MacMillan, 1991; Rougoor *et al.*, 1998). Howard and MacMillan (1991) were critical of the studies on farm performance undertaken in the 1980's because they were based on easily measured "*historical phenomena*" but failed to investigate "*how*" farmers achieved high levels of performance. The criticisms identified by Howard and MacMillan (1990) also applied to many of the studies on farm performance undertaken in the 1990's which investigated the relationship between farm, farmer characteristics and farm performance (Rosenberg and Cowen, 1990; Tarabla and Dodd, 1990; Cruise and Lyson, 1991; Wadsworth and Bravo-Ureta, 1992; Jordan and Fourdraine, 1993; Jose and Crumly, 1993; Boland and Patrick, 1994; McGregor *et al.*, 1995). Interestingly, the distinction between the characteristics of successful managers and what they do was made as early as 1955 in the business literature (Katz, 1974). Katz (1974) argued that to study what managers do (i.e. the kinds of skills they exhibit when carrying out their job effectively), rather than their innate traits and characteristics would provide more useful research results in relation to the selection and development of managers.

Howard and MacMillan (1991) advocated a shift in emphasis away from quantitative surveys to qualitative case studies so that the management processes that farmers use to achieve various levels of performance could be identified. Rougour *et al*. (1998) after reviewing 28 management process studies also concluded that longitudinal rather than cross-sectional survey-based research methods were more suitable for the study of management because of its continuous and on-going nature. Over the last thirty years, several management-related disciplines have shifted towards this type of research in order to reduce the gap between theory and practice. These include operations management (Miller *et al*., 1981; Meredith *et al*., 1989; Flynn *et al*., 1990), accountancy (Christenson, 1983; Morgan, 1983a; Tompkins and Groves, 1983; Kaplan, 1984; Chua, 1986) and organisational sciences (Mintzberg, 1973, 1975, 1979; Burrell and Morgan, 1979; Van Maanen, 1979; Morgan and Smircich, 1980; Morgan, 1983b; Yin, 1984, 1993; Lincoln, 1985; Archer, 1988; Eisenhardt, 1989, 1991; Easterby-Smith *et al*., 1991; Guba and Lincoln, 1994).

The argument for using case study methods in management research is based on the belief that they provide a better understanding of the complex processes used by managers than traditional quantitative research approaches (Mintzberg, 1975, 1979; Morgan and Smircich, 1980; Yin, 1984). In contrast, the "quantitative-qualitative" debate has not featured strongly in the mainstream farm management literature. However, there has been an increasing number of case studies published since the early 1990's lead by work in France (e.g.

Attonaty and Soler, 1991; Cerf *et al*., 1993; Fleury *et al.*, 1996; Dore *et al.*, 1997; Aubry *et al*., 1998), Sweden (Ohlmer *et al*., 1996; Ohlmer, 1998; Ohlmer *et al* 1997; Ohlmer *et al.* 1998) and New Zealand (Crawford *et al*., 1995; Catley *et al*., 2000; Gray *et al*., 2002, 2003a, 2003b, 2004, 2006, 2008). The use of case studies has been also been advocated by several authors (e.g. Maxwell, 1986; Doorman, 1990; Howard and MacMillan, 1991) Bill Malcolm, a leading farm management researcher also advocated the use of case studies in both farm (Malcolm, 2000) and natural resource management (Crosthwaite *et al*., 1997). However, these have been in the minority, suggesting that these methods have yet to gain widespread acceptance amongst farm management researchers.

In summary, the adoption of economics as the underlying theoretical framework for the discipline has limited the development of useful theory about the management practices of farmers. Similarly, although numerous farm management studies have investigated the factors associated with farm performance, most have used surveys and focused on the statistical analysis of easily measured socio-economic variables to define the characteristics of successful farmers. There have been a limited number of in-depth studies that have investigated how farmers manage their farms and how their management practices impact on farm performance. This has restricted the development of a robust and useful body of theory on farm management. Until these limitations are addressed, farm management as a discipline will remain “under-exposed”.

The divergence of farm management theory into different views of management practice

Anthony (1965) argued that when studying a field of interest, a framework is required to organise the information collected. In farm management, a framework for investigating the management practices requires the researcher to distinguish between, and integrate three separate but interrelated processes: management, decision-making, and problem-solving (Scoullar, 1975). The terms "*management process*", "*decision-making process*", and "*problem-solving process*" are used interchangeably in the literature (Scoullar, 1975; Cary, 1980) and all three have been used to describe the management practices of farmers.

Numerous authors (Johnson, 1954; Koontz, 1962; Anthony, 1965) have suggested "usefulness" is an important criterion for evaluating the quality of theory. Given the above problem, fundamental questions can be asked such as what is the usefulness to management research of distinguishing between the processes of management, decision-making and problem-solving, and how might the literature on these three processes be best organised in the context of a management study? A framework is developed in the following section on important theoretical concepts relevant to the study of the management processes used by farmers.

Management process

The literature on the management process has developed from the seminal work of Bradford and Johnson (1953), Johnson and Haver (1953), Johnson (1954), Johnson *et al.* (1961), Lee and Chastain (1960), and Nielson (1961) (Table 1). A six-function model (Johnson *et al*., 1961) of the management process emerged from this research that has dominated farm management theory for the last forty years, although the model was simplified during this time from six (*problem recognition/definition, observation, analysis, decision, action, responsibility bearing*) to three functions (Table 2): planning, implementation and control (Boehlje and Eidman, 1984; Kay and Edwards, 1994). A major advance occurred during the early 1970's when Barnard and Nix (1973) introduced these functions into the farm management literature. However, the evolution of the management process model has not been straightforward (Table 2). Researchers have failed to: build on preceding theory, cite sources when modifying existing theory, provide definitions of key concepts, or adopt recognised definitions and terms. They have also altered the position of various sub-processes within functions without justifying such changes. These inconsistencies are often associated with relatively new disciplines that have had limited theoretical development (Kuhn, 1962) and may also reflect a general lack of empirical research into the management process. With the exception of the 1961 study by Johnson *et al*. (1961), few of the models proposed for farm management have been empirically tested.

Table 1. Components of models within management process theory as proposed by different authors in the 1950's - 1960's.

Model 1	Model 2	Model 3	Model 4
Bradford & Johnson (1953) Johnson & Haver (1953) Johnson (1954)	Lee & Chastain (1960)	Johnson *et al.* (1961)	Nielson (1961) Suter (1963)
			Goal formulation
	Problem recognition	Problem definition	Problem and opportunity recognition and definition
Observation	Information gathering	Observation	Observation and information gathering
Analysis	Recognition of alternative solutions and opportunities Analysis of alternative solutions	Analysis	Specification of alternative solutions and opportunities Analysis of alternative solutions
Decision	Decision	Decision	Decision-making
Action	Action or inaction	Action	Action-taking or implementation
Responsibility bearing	Responsibility bearing	Responsibility bearing	Responsibility bearing
			Evaluating the outcome

A comparison of the models of management process in Tables 1 and 2 highlight several inconsistencies. First, several authors (Nielson, 1961; Suter, 1963; Calkin and Di Pietre, 1983; Renborg in Giles and Renborg, 1990) believed that goal formulation was a function of the management process while others (Barnard and Nix, 1973; Scoullar, 1975; Kay, 1981; Dalton, 1982; Boehje and Eidman, 1984; Buckett, 1988; Giles in Giles and Renborg, 1990; Kay and Edwards, 1994) thought it was a separate and higher level process. Despite its importance and unlike the other management functions, little has been written on goal formulation or its sub-processes. For the purposes of this paper, it is assumed that goal formulation is separate to and outside the management process, but that its products, goals and objectives are key drivers of the process.

Table 2. Development of management process theory as proposed by different authors in the 1970's - mid-1990.

Barnard & Nix (1973)	Kay (1981)	Dalton (1982)	Calkin & Di Pietre (1983)	Boehlje & Eidman (1984)
			Goal formulation	
Compilation Planning	Planning	Forecasting Planning	Compilation Planning	Planning
Implementation	Implementation	Implementation	Implementation	Implementation
Control	Control	Recording Control	Evaluation	Control

Buckett (1988)	Giles in Giles and Renborg (1990)	Renborg in Giles and Renborg (1990)	Kay and Edwards (1994)
		Setting objectives	
Forecasting			
Planning	Planning	Information collection Analysis Planning	Planning
Implementation	Decision-making	Implementation	Implementation
Recording Analysis and appraisal of results Control	Control	Control Correction	Control

It is generally accepted that management comprises three functions: planning, implementation and control (Boehlje and Eidman, 1984; Kay and Edwards, 1994) and these appear to have been derived from the six functions proposed by Johnson *et al*. (1961). However, there are discrepancies in terms of what constitutes the management process (Table 2). For example, some authors (Barnard and Nix, 1979; Dalton, 1982; Calkin and Di Pietre, 1983; Buckett, 1988; Renborg in Giles and Renborg, 1990) separate out functions while others (Kay, 1981; Boehlje and Eidman, 1984; Kay and Edwards, 1994) subsume these under the major functions of planning (forecasting, compilation, information collection, analysis), implementation and control (recording, analysis and appraisal, correction) (Table 2).

Some aspects of the earlier models of management are omitted in later models. For example, evaluation, identified as critical for learning by Nielson (1961) is implied, rather than included in most models of the control process. Few authors (e.g. Mauldon, 1973) explicitly mention evaluation in relation to control. Similarly, recent management process models omit the function "*responsibility bearing*" (Table 2). This may be because it is assumed or because it is not a process: managers either accept or do not accept responsibility for their actions. Different views are also held on what the function *implementation* comprises. The majority of authors view implementation as the process of putting a plan into action (Dalton, 1982; Calkin and Di Pietre, 1983; Kay and Edwards, 1994). However, Barnard and Nix (1973) considered that it also included the process of selecting the best plan to implement.

The above examples show that although the management process has evolved from common roots over the last fifty odd years, this has not always been consistent. Inconsistencies included the carryover of additional functions from earlier models of management (Table 1) and the naming and definition of functions.

Most of the management process models prescribe the functions a farm manager must undertake. Scoullar (1975) took a different view and considered management from the point of view of the knowledge and skills a farmer might need to run a farm business. This allowed Scoullar (1975) to cleave the management process into two distinct types on the basis of the manager's knowledge level. The first, termed the "*goal achievement process*", is applied when managing situations where s/he has a full knowledge of the situation and the management actions required. Here the manager can draw on routine management procedures that they have used in the past. This model is similar to others of the management process.

The second, the "*problem solving process*", was developed by Scoullar (1975) to describe how managers operate when faced with novel situations and therefore have no prior knowledge upon which to draw. Here the manager needs to use quite different knowledge and skills. This view is similar to Simon's (1960) cleavage of "*programmed*" and "*non-programmed*" decisions, and Gorry and Morton's (1971) "*structured*" and "*unstructured*" decisions. Unstructured decisions do not have ready-made solutions (Simon, 1960) and because the decision-maker has no experience with such decisions, no pre-defined procedures exist for their execution (Gorry and Morton, 1971). Unstructured decisions also require more steps, with feedback between steps and may involve delays or interruptions (Gorry and Morton, 1971; Mintzberg *et al.,* 1976). Mintzberg *et al.* (1976) also reported that unstructured decisions required more rigorous diagnosis, search, design, screen and choice sub-processes than structured decisions. “Structured” and “unstructured” decisions identify two points on a continuum, and therefore, Gorry and Morton (1971) proposed a third category, “semi-structured” decisions. This distinction is useful for researchers when investigating different management situations, or for considering the skills and knowledge required by a manager to cope with distinct management situations. For example, tactical decisions, and decisions made by experienced managers, could be expected to fall predominantly in the "*programmed*" or "*structured*" decision category. In contrast, decisions made by inexperienced managers, or strategic decisions, by their very nature, could be expected to fall into the "*non-programmed*" or "*unstructured*" category. This taxonomy provides guidelines to researchers studying the management processes used by farmers. What then is the difference between the management and decision-making processes in farm management?

Decision-making process

The confusion surrounding the difference between the management and decision-making processes is not surprising when the literature is analysed (Hardaker *et al.*, 1970; Castle *et al.*, 1972; Osburn and Schneeberger, 1978). As Table 3 illustrates, the concepts evolved from common roots, namely the work on management functions undertaken by Bradford and Johnson (1953), Johnson and Haver (1953), Johnson (1954), Johnson *et al.* (1961), Lee and Chastain (1960) and Nielson (1961). Because many of these models formed the basis for the management process model, similar issues can be therefore expected to arise in the decision-making literature such as whether *goal formulation* is part of decision-making (See Tables 3 & 4). Castle *et al*. (1972) and Osburn and Schneeberger (1978) viewed *goal formulation* as part of decision-making, but later authors (Kay, 1981; Boehlje and Eidman, 1984; Makeham and Malcolm, 1993; Kay and Edwards, 1994) viewed it as separate from, but important to, decision-making.

Table 3. The roots and component elements of decision-making process theory.

Lee & Chastain (1960) Johnson *et al.* (1961)[1]	**Nielson (1961)**	**Brannen (1961)**	**Thornton (1962)**
	Goal formulation		
Problem definition	Problem recognition and definition Opportunity recognition	Defining the problem Goal orientation	Problem recognition
Observation	Observation and information gathering	Recognising alternatives Recognising and collecting information	Preparation
Analysis Recognition of opportunities	Specification of alternative solutions and opportunities Analysis of alternative solutions	Evaluating alternatives	
Decision	Decision-making	Selecting an alternative Making a decision in terms of a plan of action	
Action	Action-taking or implementation		Action
Responsibility bearing	Responsibility bearing		
	Evaluating the outcome		

Debate also exists in the literature about what constitutes a decision, i.e. is it the process of making a decision or does it extend further than this and include implementation, evaluation and responsibility bearing. Authors such as Brannen (1961), Nielson (1961), Thornton (1962), Scoullar (1975), and Dryden (1997) have argued that decision-making should be viewed solely as the act of making a decision. Brannen (1961) stated that a decision was final when expressed in action and thus the outcome of the decision-making process was a plan of action. Cary (1980) adopted the perspective of cleaving "*reflection*" from "*action*" and accordingly, he viewed decision-making as primarily a mental process that formed the link between thinking and doing. He argued therefore that researchers could not fully comprehend the behaviour of a decision maker until they understood their mental models and perception of reality at the time the decision was made. Consequently his view of decision-making incorporates all steps except *action*. This may be a more useful view because it explicitly incorporates evaluation and failure to undertake this function limits learning.

As mentioned previously, responsibility bearing, unlike the other decision-making steps, is not a process, but rather an attitude that is assumed to be held (or not held) by the decision maker. The existence of this attitude however is important. Without it, managers would most likely forego *evaluation* in the belief that poor outcomes from decisions were due to chance rather than their own actions. As a result, limited learning would occur. In contrast, *action* or *implementation*, although it is seen to be critical for effective decision-making, has not traditionally been the focus of management research. Management researchers' bias has been towards the cognitive aspects of decision-making, the actions managers take and the outcomes that result from those actions, rather than the action-taking process itself.

[1] Also based on Bradford and Johnston (1953), Johnson and Haver (1953) and Johnson (1954).

Table 4. Alternative models and elements of the decision-making process proposed in the farm management literature.

Hardaker *et al.* (1970)	Castle *et al.* (1972)	Osburn & Schneeberger (1978)	Kay (1981)	Boehlje & Eidman (1984)	Makeham & Malcolm 1993	Kay & Edwards (1994)
	Setting goals	Formulating goals and objectives				
Recognising a problem or situation where a decision should be made	Recognising the problem	Recognition and definition of problems	Identify and define the problem	Define the problem or opportunity	Recognising the problem and the need for action	Identify and define the problem
Collect relevant facts and opinions	Obtaining information	Gathering and organisation of facts	Collect information		Making observations, collecting facts, getting ideas	Collect data and information
Specify and analyse possible alternatives or courses of action	Considering the alternatives	Analysis of alternative courses of action	Identify and analyse alternative solutions	Identify alternative courses of action Gather information Analyse the alternatives	Analysing observations and testing alternative solutions to problems	Identify and analyse alternatives
Decide on the most appropriate solution or courses of action	Making the decision	Decision-making based on sound criteria	Make the decision	Make the decision and take action	Making the decision	Make the decision
Implementing the decision	Taking action	Implementation	Implement the decision		Implement the decision	Implement the decision
Observing and evaluating the consequen-ces of the action taken Bearing responsibility for the consequen-ces	Accepting responsibility Evaluating the decision	Acceptance of responsibility Evaluation of the outcome of the decision	Observe the results and bear responsi-bility for the outcome	Accept the consequen-ces and evaluate the outcome	Controlling the implementation Taking responsibility for the decision Reviewing the outcome and adapting the intended and expected to the actual Doing it better next time, i.e. learning from one's mistakes	Monitor and evaluate the results Accept responsi-bility for the decision

The final issue raised in the decision-making literature, and the most relevant to this paper, is whether decision-making and management processes differ and if so whether this distinction is useful. The fact that the two processes emerged from common roots, as illustrated earlier (Table 3), indicates that there may be grounds for considering them as versions of the same process. Dryden (1997) viewed decision-making to be isomorphic with the management process. He considered that the steps *problem recognition* or *definition*, *observation*, *analysis* and *decision* were equivalent to *planning*. *Action* was synonymous with *implementation*, while the *acceptance of responsibility* and *evaluation* were equivalent to *control*. In contrast, Thornton (1962) believed that the steps *observation*, *analysis* and *decision* were synonymous with planning. He (therefore) differed from Dryden (1997) in that he viewed *problem recognition/definition* as being distinct from *planning*. This view may be more logical because *problem recognition/definition* is similar to the *control* process except that the steps by which the choice of corrective action is chosen are missing.

A useful distinction made by Thornton (1962) was that managers made two types of decisions: detailed and infrequent decisions and simpler routine decisions. This may be useful for differentiating between less frequent "*planning*" decisions that involve a detailed planning process and more frequent "*control*" decisions where a deviation is identified, diagnosed and a suitable control response selected to minimise the impact of the deviation. This view is similar to that held by Boehlje and Eidman (1984) who believe that decision-making occurs across the three functions of management. As such, both decisions (planning and control) would incorporate a “control” aspect because a planning decision is normally triggered by the identification of a “problem” or the need to develop a plan.

The decision-making models have been criticised by Cary (1980) because of their simplistic nature and the lack of detail at the sub-process level. He argued that to understand how farmers manage and make decisions, researchers must understand how farmers perceive the world in which they operate and the mental models they use to do this. The majority of decision-making models provide limited insight into the cognitive processes used by farmers. A taxonomy of the sub-processes (or decisions) used by farm managers has been developed to varying degrees by several authors (Lee and Chastain, 1960; Scoullar, 1975; Boehlje and Eidman, 1984).

Some progress has been made in identifying the sub-processes used in decision making through the recent work of Ohlmer *et al*. (1998). They developed a matrix model of the decision-making process from a case study of the strategic decisions made by Swedish farmers. The matrix model (Figure 1), although similar to most models of decision-making (Johnson *et al.*, 1961; Hardaker *et al.*, 1970; Kay, 1981; Boehlje and Eidman, 1984; Makeham and Malcolm, 1993; Kay and Edwards, 1994), has some important differences and is influenced by decision-making research outside the discipline of farm management (e.g. Newell and Simon, 1972; Mintzberg *et al*., 1976; Hogarth, 1981; Beach, 1993; Klein *et al*., 1993; Lipshitz, 1993).

	Sub-process			
Phase	Searching & paying attention	Planning	Evaluating & choosing	Bearing responsibility
Problem detection	Information scanning Paying attention		Consequence evaluation Problem?	Checking the choice
Problem definition	Information search Finding options		Consequence evaluation Choose options to study	Checking the choice
Analysis & choice	Information search	Planning	Consequence evaluation Choice of option	Checking the choice
Implementation	Information search Clues to outcomes		Consequence evaluation Choice of corrective action(s)	Bearing responsibility for the final outcome Feed Forward information

Figure 1. Conceptual model of the decision-making process (Source: Ohlmer *et al*., 1998).

Ohlmer *et al*. (1998) separated the step problem recognition and definition (Tables 3 & 4) into two phases, problem recognition and problem definition. Identification and analysis of alternatives and decision are combined into one phase, called analysis and choice. The steps information collection, evaluation and bearing responsibility have been redefined as sub-processes that occur across the four phases. Observation has been renamed as searching and paying attention and evaluation as evaluating and choosing. A new sub-process, planning, has been introduced within the analysis and choice phase. They also argued that decision makers collect information at each phase of the decision-making process rather than just at the information collection step. The sub-process, searching and paying attention, may be different from the information collection step in the decision-making process, because it includes both the external search for information and the internal search for information stored in the memory of the decision maker. Further, Ohlmer *et al*. (1998), on the basis of their work and that of Lipshitz (1993), argued that option generation should occur within the problem definition phase rather than during analysis as had been the case historically. The naturalistic decision-making models of the problem-solving processes used by experts reviewed by Lipshitz (1993) suggested that option generation was strongly linked to problem definition.

Although it could be argued that the changes Ohlmer *et al.* (1998) made to the decision-making model could have been deduced logically from the existing literature, the model attempts to make more explicit, the sub-processes that comprise the decision-making process of farmers. Empirical information on the nature of these sub-processes remains scant.

Over the last two decades, farm management researchers (Fairweather, 1992; Murray-Prior 1998; Murray-Prior and Wright, 1994, 2001; Jangu *et al*., 1995; Fairweather and Campbell, 1996; Darnhofer *et al*., 2005) have adopted Gladwin's (1976, 1979ab, 1980, 1983, 1989) hierarchical decision tree model to look at the decision making processes of farmers. Gladwin (1976, 1979ab, 1980) developed a six step process to describe the option evaluation and selection process used by farmers. During step one, all the aspects of the options are listed. Then heuristics are used to eliminate aspects that are not relevant to the decision. One aspect from this "reduced" set of aspects is chosen, normally the most important one, to order the options on. The alternatives are then ordered according to the chosen aspect. The minimum condition that must be met by the options is specified. Constraints are formulated from the remaining aspects and if the option that is ranked first on the ordering aspect passes all the constraints, it is accepted. If the first ranked option does not pass all the constraints, the second ranked option is tested, and so on until a suitable option is identified. If none of the options pass the test, another strategy is adopted to identify a suitable option.

The hierarchical decision tree model has been applied to a range of decisions (e.g. Fairweather, 1992; Murray-Prior, 1994, 1998; Murray-Prior and Wright, 1994, 2001; Jangu *et al*., 1995; Fairweather and Campbell, 1996; Darnhofer *et al*., 2005) and found to predict farmer behaviour to a high degree of accuracy. However, it has also drawn some criticism. For example, several authors (Franzel, 1984; Fairweather, 1992; Murray-Prior, 1998) claim it was less useful in determining what factors dictate the quantity of an option chosen by the farmer. Franzel (1984) believed that this problem could be overcome where farmers could convert continuous variables into discreet variables. Murray-Prior (1998) also criticised the model because it did not explain (i) how the decision-maker chose the aspects used in the decision-making process, (ii) why decision makers behave in the way predicted by the model, (iii) the motivation for such decisions, or (iv) how learning takes place. He proposed the incorporation of personal construct theory (Kelly, 1955) into the model as a way to overcome these problems.

Murray-Prior (1998) argued that the constructs a person uses in a particular decision are a function of their perception of the current situation, and their experience with similar situations. Therefore, both context and experience are important in decision-making. Similarly, changing environments require individuals to reassess their decision rules and time is necessary before they learn which rules are most appropriate for the new conditions. Learning may result in a change in the hierarchical position of constructs, or the addition of new constructs. Murray-Prior (1998) therefore believed that Gladwin's (1976) hierarchical decision tree models would lose their predictive capability during periods of change. The farm management research that has used the hierarchical decision tree modeling approach has provided some very useful insights into farmer decision making. However, this approach only provides a “partial” view of the decision making process because it focuses primarily on the option evaluation and selection sub-processes.

Management and decision-making processes, according to the literature, are essentially the same. Both incorporate, to varying degrees, steps that involve the generation, analysis and selection of alternatives, the development and implementation of plans, and the identification, diagnosis and evaluation of problems or deviations from the plan, and some form of correction, whether it is through the development of a new plan or the introduction of a contingency plan. Interestingly, one process starts with planning while the other starts with control or the identification of a problem. This has important implications for researchers reporting empirical work under the banner of "decision-making". For example, depending on the magnitude of the problem, the decision maker may undertake either a relatively simple corrective process or a more detailed planning procedure (Thornton, 1962). Researchers, when reporting on such decisions, could usefully classify them as either simple control, or more complex planning decisions.

If the management and decision-making processes can be considered synonymous, then it would be sensible to adopt the management process as the model under which management is researched. This is because management rarely comprises a single decision (Brannen, 1961; Thornton, 1962), rather it is an ongoing cyclical process of planning, implementation and control, where *planning* decisions tend to be much less frequent than *control* decisions (Thornton, 1962). This model was used by Gray *et al.* (2003b) to describe the tactical management process of expert dairy farmers he investigated over a three year period (Figure 2). He found that farmers made major planning decisions at the start of a planning period, and then over the planning horizon, the farmers made regular implementation and control decisions, where the ratio of implementation to control decisions was a function of the level of uncertainty faced by the farmer. At the end of the planning horizon, the farmers then undertook another major planning decision. A planning decision will comprise a sub-set of lower level decisions or sub-processes as suggested by Cary (1980), e.g. what information to obtain, how long to search for this, what options to investigate, and so on.

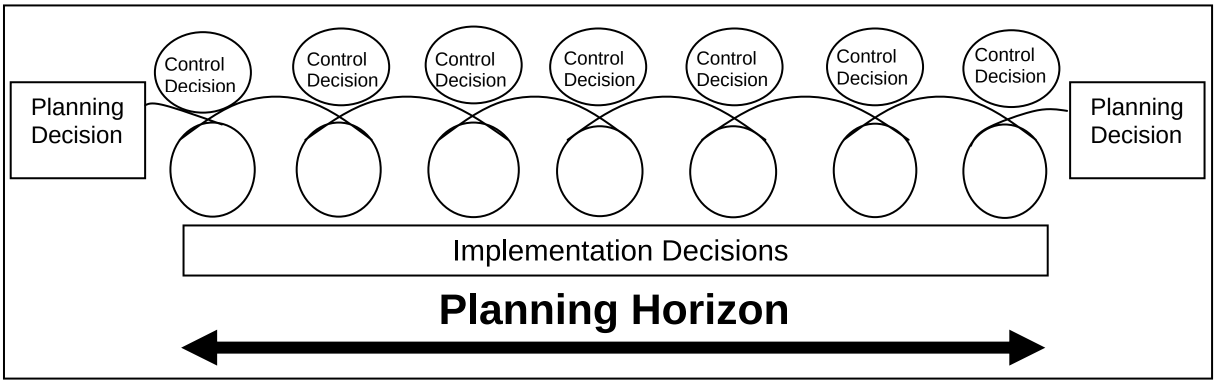

Figure 2. **Representation of the feed management process used by the farmers** (Source: Gray *et al*., 2003b).

In any decision making study, the classification of decisions is important. Castle *et al*. (1972) classified decisions on the basis of: importance, frequency, imminence, revocability and available alternatives. The usefulness of this classification schema is not clear since few, if any, researchers have reported using it when analysing farmers' decisions. There may also be some fundamental problems with such a schema. For example, *importance* and *imminence* may be time dependent and inter-related. In contrast to Castle *et al*. (1972), the schema originally proposed by Gorry and Morton (1971) and introduced to farm management by Dryden (1997) appears to provide a more useful way of classifying the decisions of farmers. Gorry and Morton (1971), drawing on the work of Simon (1960) and Anthony (1965), classified decisions by level (strategic, tactical and operational), and "*structuredness*" (structured, unstructured). By their nature, operational decisions tend to be structured and strategic decisions unstructured. Experienced (or more knowledgeable) farmers tend to make more structured decisions than inexperienced (or less knowledgeable) farmers. This latter distinction ties in with Scoullar's (1975) distinction between "*routine decision making*" (goal achievement), and "*problem solving*". Empirical research of decision-making could usefully be classified and reported using this matrix.

Problem-solving process

The final consideration in this paper is how problem-solving is related to the management and decision-making processes. The problem-solving process was derived from the same roots as decision-making process. Johnson (1976) developed a model of problem-solving (Table 5) from his model of the management process (Johnson *et al*., 1961). It is therefore not surprising that the terms management process, decision-making process, and problem-solving process are used interchangeably (Scoullar, 1975; Cary, 1980). Cary (1980) thought there was little point in distinguishing between decision-making and problem-solving because they appeared to be synonymous in the literature. It is not difficult to see how problem-solving fits into the management process. A problem is traditionally defined as a gap between actual and desired performance (Cary, 1980) and therefore problem-solving is the process used to minimise that gap in much the same way as the management process is used to progress a manager from his/her current state to some future desired state.

Table 5. Early research related to elements in the problem-solving and management functions.

Model of Managerial Adjustment Lee & Chastain (1960)	**Management Functions Johnson *et al.* (1961)**	**Problem-Solving Process Scoullar (1975)**	**Problem-Solving Process Johnson (1976)**
Problem recognition Difficulty is felt. Gather information. Recognise alternative problem definitions. Analyse alternative. Problem definitions. Define the problem. Accept responsibility for the definition.	Problem definition	Problem recognition Recognising the problem. Recognising a 'model' under which the problem will be studied Recognising all important variables within the 'model' Knowledge of methods needed to investigate the variables within the 'model' Knowledge of principles and generalisations. Comprehension of accumulated facts Recognising the interrelationships between variables Recognising the causes of the problem	Problem definition
Gather information about the	Observation		Observation

Model of Managerial Adjustment Lee & Chastain (1960)	Management Functions Johnson *et al.* (1961)	Problem-Solving Process Scoullar (1975)	Problem-Solving Process Johnson (1976)
problem			
Recognition of alternative solutions and opportunities Analysis of alternative solutions	Analysis	Recognition of the possible solutions to the problem	Analysis
Decision	Decision	Recognition of the most practical and economic solution Planning to carry out the solution	Decision
Action or inaction	Action		Action
Acceptance of responsibility	Responsibility bearing		Responsibility bearing

As previously mentioned, the process of problem recognition and definition is similar to the monitoring, comparison and diagnosis aspects of the control process. Problems as such, could be classified into a hierarchy comprising those that require the introduction of contingency plans due to an aberration in the environment (i.e. control problems), those that are significant enough to require the introduction of a new planning process (i.e. planning problems) or the reformulation of the manager's goals (goal formulation problems) due to long-term changes in the environment, and those that require the development of a new planning and/or control system due to fundamental problems with the planning model and/or the control system (i.e. management control problems). These planning and control problems are synonymous with planning and control decisions. They also reflect the various corrective actions open to a manager in relation to control (Barnard and Nix, 1973; Boehlje and Eidman, 1984). Problem-solving can therefore also be viewed as a broader form of control, in much the same way as Anthony (1965) viewed the management process.

From Scoullar's (1975) perspective (Table 1.5), problem-solving is synonymous with unstructured decision making and requires a quite different set of processes than those used for structured decision making. A problem, as defined by Scoullar (1975) is the result of a knowledge, not a performance, gap. As such, “problem-solving” in this context is synonymous with learning. This may provide a useful framework for considering unstructured decisions.

A framework for studying farmers’ management practices

Critical to any classification schema for management is the level of decision making (Anthony, 1965). Management decisions can be classified as strategic, tactical or operational. The degree of “*structuredness*” of decision-making, however, will be dependent on the farmer’s knowledge and the number of new situations s/he has encountered. The other aspects of management that must be considered are the functions (planning, implementation and control) and the fields of management (production, finance, human resources and marketing) (adapted from Boehlje and Eidman, 1984). From the above discussion, a classification schema based on the management “cube” (Boehlje and Eidman, 1984) can be derived as shown in Figure 3. Thus, farm management decisions could be classified by level, structuredness, primary function and field. Equally important, as discussed by Cary (1980), is the identification of the detailed sub-processes that comprise the decision-types within this taxonomy. This classification schema is almost identical to that developed by Boehlje and Eidman (1984) except that it distinguishes between structured and unstructured decisions, but does not classify decisions by placement on the farm family life cycle. The latter is not included here because it does not classify the decisions, but rather the decision-maker. The schema is also similar to that provided by Dryden (1997) except he did not include the fields of management.

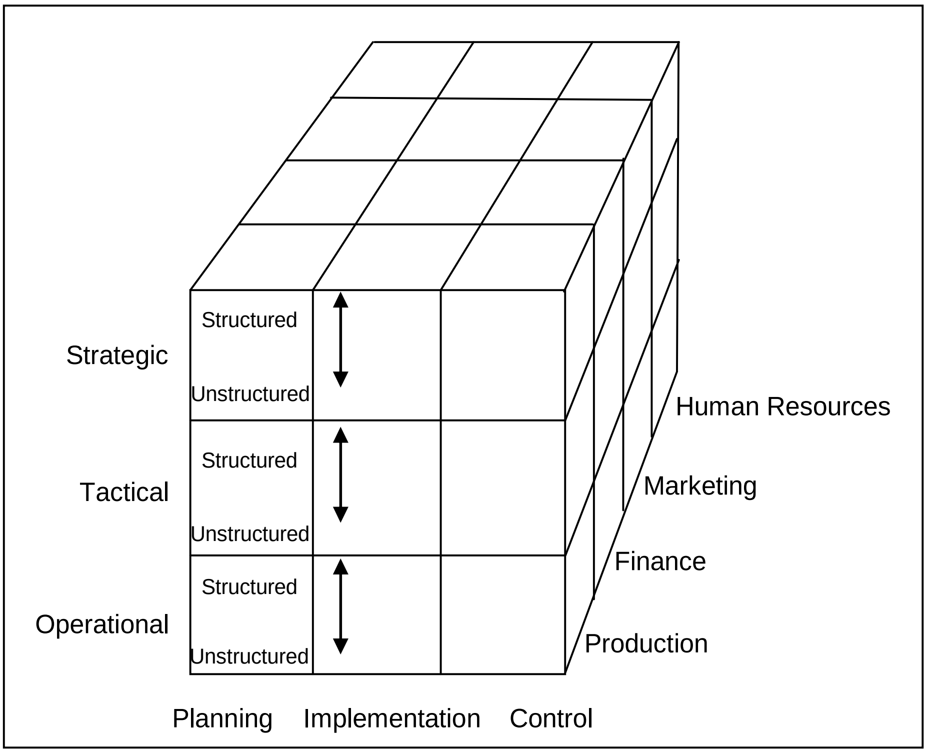

Figure 3. **A classification schema for decisions** (Derived from Boehlje and Eidman, 1984 and Dryden, 1997).

Conclusions

The farm management discipline has long been criticized for not developing theory that is relevant to practitioners. This paper has identified possible reasons for the paucity of relevant theory. These relate to the research focus and methods used by farm management researchers and also the divergence of farm management theory into three different views of management practice. Importantly, the adoption of economics as the underlying theoretical framework for the discipline has limited the development of useful theory about the management practices of farmers. Economics is a necessary, but not sufficient framework for the study of management practice. In the economics paradigm emphasis is placed on the criteria by which a choice is made or the way in which a choice is made rather than the process of making the choice. As such, the discipline would be better served by drawing on theory from management science, where the focus is the management process. Similarly, the disciplines focus on mathematical modeling tended to ignore the effect of the farmer in farm management. Thus, although this research was interesting, its contribution to the development of useful theory about the management processes used by farmers was limited.

Importantly, when farm management researchers have initiated empirical studies into the management processes of farmers, they have tended to use survey-based cross-sectional studies that have focused on the statistical analysis of easily measured socio-economic variables to define the characteristics of successful farmers. There have been a limited number of in-depth studies that have investigated how farmers manage their farms and how their management practices impact on farm performance. Longitudinal case studies rather than cross-sectional survey-based research methods are more suitable for the study of management because of its continuous and on-going nature. They provide a better understanding of the complex processes used by managers than traditional quantitative research approaches. The above factors have restricted the development of a robust and useful body of theory on farm management. Until these methodological limitations are addressed, farm management as a discipline will remain "under-exposed".

The other factor that has limited the development of useful farm management theory has been the divergence of farm management theory into three different views (management, decision making and problem solving processes) of management practice. Analysis of the literature shows that these three views of management practice developed from common roots and are essentially the same process. However, this proliferation of theory has created confusion in the literature and has often been developed in a somewhat ad-hoc manner. For example, researchers have often failed to: build on preceding theory, cite sources when modifying existing theory, provide definitions of key concepts, or adopt recognised definitions and terms. They have also altered the position of various sub-processes within functions without justifying such changes. These inconsistencies are often associated with relatively new disciplines that have had limited theoretical development. It may also reflect a general lack of empirical research into the management process and the comparison of these models to actual farmer practice.

If the management, decision-making, and problem solving processes can be considered synonymous, then it would be sensible to adopt the management process as the model under which farm management is researched. This is because management rarely comprises a single decision, rather it is an ongoing cyclical process of planning, implementation and control, where *planning* decisions tend to be much less frequent than *implementation* and *control* decisions. Such decisions need to be considered by level (strategic, tactical and operational), field (production, finance, marketing and human resources) and by structuredness (structured, unstructured).

It is the authors' belief that the discipline does not have to remain "*underexposed*". Rather, through a shift in research focus to the study of farmers' management practices, the greater use of longitudinal case study-based methods (in conjunction with well thought out modeling and survey-based studies), the adoption of a management process view of farmer practice, the integration of relevant theory from management science and a more systematic and rigorous theory development process, the farm management discipline can begin to generate theory that is highly relevant to practitioners. In the words of Lewin (1951, p. 169), "there is nothing so practical as good theory".

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ECONOMIC CONSEQUENCES OF MILK QUOTA PURCHASE AND RENTING OF MILK QUOTA ON FARM LEVEL

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Abstract

Dairy farmers with combined milk and beef production face complex decisions regarding optimum milk yield, slaughter age for bulls, calving age for heifers, disposal of farm land etc. The linear programming model TINE Optimal was developed to assist farmers in the decision making process. Application of the model on two case farms demonstrates that farmers with a moderate milk yield per cow can increase their profitability significantly by increasing milk delivery. Such farms have a high production potential which can be utilized when the quota program is abolished. However, this development will reduce inland beef production, requiring national initiatives to maintain self sufficiency. It is also demonstrated, the effect of increased milk delivery on profitability depends on farm conditions. Before increasing milk delivery, farmers should carefully identify possible bottlenecks in their production system, and the effects on heifer breeding and beef production should be taken into account. Comparing quota purchase and renting of quota demonstrates that renting of quota is more profitable at the current price level.

Key words: Dairy, profitability, linear programming, rent of milk quota

Introduction

In Norway there has been a debate regarding by how much the farm gross margin will increase when farm milk delivery is increased (Breines 2005, Flaten 2005). The two authors draw quite different conclusions. While Breines (2005) claims that gross margin will increase by 2.40 NOK per litre extra milk delivered, Flaten (2005) reports an increase of only 0.60 NOK per litre under identical conditions. Trading in milk quotas in Norway is regulated by the government. Quotas can be bought either in the private market or from the government. In the private market the price is agreed upon between buyer and seller, while the price for buying quota from the government is administratively fixed at 3.50 NOK per litre of milk. Usually there is a surplus demand in the market administered by the government, and the number of litres available for each buyer is thus limited. Prices farmers are willing to pay for quotas vary a lot between different counties. From 2009 on farmers are also allowed to rent milk quotas from other farmers for a minimum period of five years.

Norwegian dairy farming policy is determined in annual negotiations between the farmers unions and the government. Product prices are part of this negotiation. In order to reach several widely accepted political goals such as maintaining the cultural landscape and keeping up the establishment in rural areas, the government pays subsidies. Subsidies vary with farm size and geographical location, and are assigned per head of cows and young stock, per ha roughage grown and per unit of milk and beef produced. Although Norway is not member of the EU, the Norwegian dairy sector is affected by farming conditions in the EU. Most of Norway`s dairy imports come from the EU. A tariff is applied to all imported dairy products. At the time of writing the prices of some imported products are so low that they only equal Norwegian prices even after tariff is added. They thus represent an upper limit for the prices Norwegian dairy farmers can charge for their products. If quota abolition leads to decreased milk prices in the EU, this will constrain the prices Norwegian dairy farmers can charge for their products. Switzerland has already abolished milk quotas, and the EU will abolish them from 2015 (IFCN, 2008). Until then quotas will be increased by one percent per year. Even though Norway has its own agricultural policy, it is likely that these changes in the EU will affect Norwegian agricultural policy, at least in the long run.

For a dairy farmer increasing milk quota is an important strategic investment (Harrison, 1999), and profitability depends on how much the gross margin will increase. Possible consequences regarding the short run fixed costs also have to be addressed. In Norway most of the beef is produced from dairy herds. This joint production, together with a relatively complex system of subsidies, makes it a difficult task to determine the enterprise combination to maximize profit. Farmers frequently ask extension workers in TINE how much they can afford to pay for buying or renting additional milk quota. For TINE it was necessary to develop a tool for calculating the economic consequences of increased milk quota. The purpose of this paper is to increase understanding of the economic consequences of increased milk delivery at the farm level. Possible nationwide consequences are also addressed. A linear programming farm model is developed and applied to calculate the financial consequences of buying or renting milk quota. First theory regarding milk quotas is presented. Second the main activities in the empirical model are described. Finally the financial consequences of purchasing or renting milk quotas are calculated.

Quota programmes play an important role in agricultural policy and have generated an extensive literature. The standard theory of the effect of quota on asset values in agriculture is expressed by Dawson (1991), Colman (2000) and Alvarez, Arias & Orea (2006). A number of empirical studies have computed potential gains from removing restrictions on quota transferability or by changing the quota exchange (Ewasechko & Horbulyk 1995; Boots, Oude Lansink & Peerlings 1997; Bogetoft, Nielsen & Olesen 2003).

Here it is assumed that the dairy farmer maximizes short run profit. In the long run all costs must be covered, whereas in the short run a profit above variable costs only need be made, and some costs can be treated as overheads (Colman 2000). A milk quota adds a constraint to the optimizing behaviour of the producer, which can be written as

$$\max \pi = p_i y_i - c_i (y_i, w_i, x_i) \qquad [1]$$

$$\text{s.t. } y_i \leq Q_i$$

where π is the profit of producer i, y_i is the output, p_i is the output price, w_i is the input price vector, x_i is the vector of short run fixed inputs, $c\,(\cdot)$ is the variable cost function, and Q_i is the milk quota. A maximizing problem with constraints can be solved by forming the Langrangean function:

$$L = p_i y_i - c_i (y_i, w_i, x_i) + \lambda_i (Q_i - y_i) \qquad [2]$$

where λ_i is the Langrangean multiplier. The first- order conditions can be obtained by differentiating expression [2] with respect to output. Assuming that farmers produce near the quota constraint the relevant first order condition becomes

$$p_i - MC(y_i , w_i , x_i) - \lambda_i = 0$$

where $MC = \partial\, C(\cdot)/ \partial y$ denotes marginal cost. The optimal value of λ_i is the shadow price of the quota for producer i. The Lagrangean multiplier measures the change in the objective function (profit) when the quota changes by one unit. It can be described as the marginal profit and is expressed as

$$\lambda_i = p_i - MC\,(Q_i, w_i, x_i)\ .$$

Marginal cost is unobservable. A method to calculate it is to first estimate a cost function, and then obtain the marginal cost curve by taking the derivative of costs with respect to milk production.

In Norway most of the beef is produced in dairy herds, and cows are used for both milk and meat production. Beef is mainly produced from bull calves from dairy cows. In such combined dairy and beef herds, the decision variables are highly interrelated, and some of them are depicted in Table I.

Data and empirical model

In order to determine by how much the gross margin increases with higher milk production under different farm conditions, a farm model named TINE Optimal was developed. TINE Optimal is a single period linear programming model formulated by the author. In the model a short time horizon is assumed, such that the capacity of buildings and machinery is fixed. Current activities in the model are given in Table I.

Table I. Activities in TINE Optimal

Cows- milk yield per cow	**Heifers- calving age**	**Sheep**	**Roughage**
Cow 5000-10000 kg milk Beef- cows with bulls and heifers	Replacement heifers 24- 28 months Heifers sold live or purchased **Bulls- selling/ buying age** From baby calf 14 days old to bulls slaughtered at 19 months	Ewes fed during winter **Acreage use** Pasture Grass Cereal crops Other crops	Roughage, home-grown, sold or purchased

The model maximizes the gross margin included subsidies subject to the farming constraints, the most significant being land area, milk quota and cowshed capacity. Cows, bulls and heifers are modelled by linear approximation to the production function. Feeding regimes are calculated in accordance with the new Nordic feed evaluation system Norfôr Plan (Volden, 2006). Both cows and young stock are fed only concentrate and roughage. It is possible to choose between three different qualities of roughage; low, medium and high.

Heifers for replacement or sale are modelled with different calving ages, and are fed with roughage and concentrate. Models for beef cows and sheep are also included. Farm land can be used for roughage, grazing or other crops. In order to calculate the economic consequences as milk delivery increases, parametric programming is applied.

Labour is not included in the model. The reason is firstly that we wish to keep the model as simple as possible. Secondly, in practise the farmer assesses the working hours required for the different model solutions. The farmers` final decision as to which solution to choose is based both on model results and practical judgement of workload, possible investment and other features of each alternative. However in the case of buying or renting additional milk quota in this paper, additional workload necessary is included before calculating profitability.

Two case studies based on real farms are used to illustrate the economic consequences of increased milk delivery and the purchase or renting of quota. Farm A has a milk quota of 130.000 litres. Both farms have stanchion barns. For this reason the maximum milk yield per dairy cow on farm A is 8500 kilos, and on farm B 8000 kilos. The difference is due to lower roughage quality and less roughage quantity per cow on farm B. Farm B is situated in a more rural area, and has a milk quota of 119.000 litres. Increased milk yield per cow is planned at the beginning of the lactation.

Milk quota is a durable input. If milk quotas are abolished, as in the EU from 2015 on, dairy farmers are free to increase their production, and quota will have no value. It is difficult to predict how long the quota system in Norway will last. It is reasonable to expect that an abolition of milk quotas would be announced well ahead of the time it becomes operative. Due to the uncertainty regarding longevity of the quota system, profitability is calculated for a period up to eight years in this paper. In accordance with the EU directive yearly milk quota per farm is increased by one percent from 2010 until 2015.

Investment in milk quotas is not a deductible expense in Norway but increased milk income is taxable. In this paper the increased income is considered a marginal return, and the tax rate is 28 percent. This figure represents a reasonable marginal income tax rate for a dairy farmer, and it also equals the general tax rate on capital income.

Investment in milk quota increases the hours worked as the number of dairy cows increases, at least in the short run. In order to estimate the marginal work load due to increased milk production, figures from NILF (2002) are used. Quota purchase might also necessitate additional investments, such as refurbishment of the cowshed. If that is the case then their costs must be included. However, in the two examples reported in this paper, no such additional investments were required.

Calculating net present value requires a decision about the appropriate interest rate. In this paper the interest rate is three percent reduced by 28 % before calculating the net present value. In the case of rent of quota, the rent is subtracted from the additional gross margin and the residual is reduced by 28 percent.

Results

In Table II below the corresponding TINE Optimal solutions for farms A and B before and after the purchase or rent of quota are shown.

Table II. TINE Optimum solutions for farms A and B with both existing and new milk quotas

Production	Farm A existing quota	Farm A new maximum quota	Farm B existing quota	Farm B new maximum quota
Milk quota, litres	130.000	183.284	119.000	137.800
Gross margin incl. subsidies, NOK	735.758	872.881	608.937	635.770
No of dairy cows	21.6	24	16.4	19
Milk yield per cow, kilo	6.770	8.500	8.000	8.000
No of heifers raised	13	14.1	7.4	8.6
No of bulls 3 months old, sold	0	0	0	0
No of bulls 3 months old, purchased	0	0	9.4	1.3
No of bulls 13 months old sold	0	13.6	16.8	9.9
No of bulls 19 months old sold	13	0	0	0
Beef from bulls, kilo	4.081	3.861	4.534	2.668
No of sheep	0	0	30	30
Roughage, purchased FUm	18.561	25.363	20.938	25.108

On farm A, TINE Optimal suggests a solution with an average milk yield per cow of 6770 kilos from 21.6 cows. In the model replacement heifers older than 18 months use idle cow places on both farms. Initially all cow places on farm A are used for cows and heifers, and the model therefore suggests the increased milk production should be met by increasing the milk yield per cow. The milk yield per cow is increased before the maximum number of cows is reached, demonstrating that the argument in Knutson et al. (1997) that the solution should always be adjusted to practical farming conditions. As long as heifers are allowed to use idle cow places, all bulls should be slaughtered at the age of 19 months. This ensures high carcass weight and high beef production. The heifers calve when they are 24 months old. All farm land is used for roughage production, and the farmer has to buy some supplemental roughage due to high roughage intake.

On farm B the model suggests an average milk yield of 8000 kilos per cow, and 2.6 idle places for cows are occupied by replacement heifers. Due to lack of roughage and cowshed space, the model shows all home produced bulls and 9.4 purchased bull calves should be fed intensively and slaughtered at 13 months. The heifers calve at 24 months of age. In addition

30 sheep are included in the optimum solution, partly because they do not compete with cattle for cowshed space. All farm land is used for roughage production but some roughage is purchased each year.

TINE Optimal was then used to calculate the consequences of increased milk production on gross margin included subsidies. Figure 1 shows the increase in gross margin per litre milk with increased milk production on farms A and B.

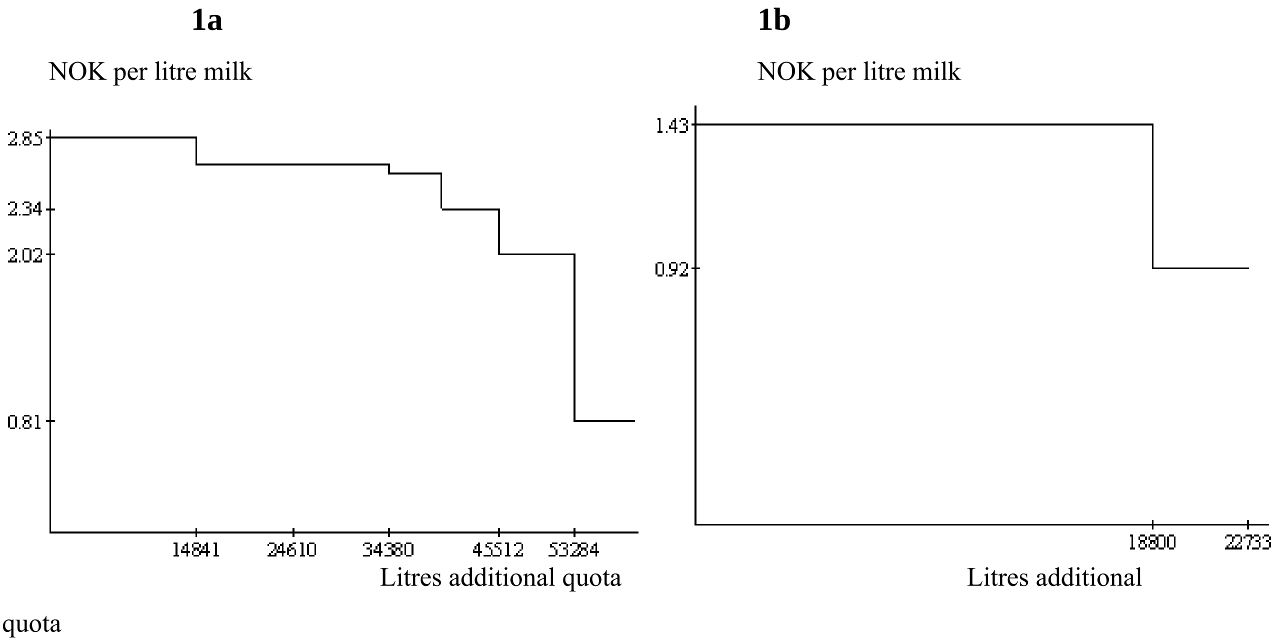

Figure 1. Increase in gross margin including subsidies per litre milk delivered on farm A (Figure 1 a) and farm B (Figure 1b) as the milk quota increases.

On farm A gross margin increases by 2.85 NOK per litre up to 14.841 litres additional milk quota (Figure 1a). At that point the milk yield per cow has increased to 7500 kilos on 21 cows. The most significant change in profitability takes place between 34.380 and 53.284 litres extra quota. At 34.380 litres additional quota, the milk yield per cow reaches its` maximum of 8.500 kilos per cow. From now on cow numbers have to be increased to produce more milk. Replacement heifers which earlier were placed on idle cow places, now start occupying space for bulls, and an increasing number of bulls are being slaughtered at 17 months of age. As milk production increases, the demand for cows increase, and thereby the number of replacement heifers. At 45.512 litres of extra quota the number of cows is increased to 23.1, increasing the need for heifers further reducing space and thereby lowering slaughter age for bulls to 15 months. As quota continues to increase, the slaughter age for bulls is gradually reduced to 13 months at 53.284 litres extra quota, where the cow number reaches its maximum of 24. From now on only one way to increase gross margin remains, namely by replacing milk from cows fed to calves by purchased milk powder. When all milk fed to calves is substituted by milk powder, the shadow price of quota drops to zero. The substitution of raw milk by purchased milk for calves is represented by the short line segment to the right in Figure 1a, from 53.284 litres on and to the right.

In contrast to farm A, on farm B the gross margin including subsidies increases by only 1.43 NOK per litre milk for the first 18.800 litres (Figure 1b). From then on the increase in gross margin falls to 0.92 NOK per litre milk up to a maximum of 22.733 litres extra quota. On farm B, increased milk production is met solely by increasing the number of cows. This requires more replacement heifers. Heifers displace bulls, and the number of purchased bulls for fattening therefore gradually falls, while keeping the slaughter age constant at 13 months. With 18.800 litres extra quota, dairy cows occupy almost all cow places, and displaced heifers reduce the number of purchased bulls to 1.68. At this point the quantity of beef from bulls is reduced to 1.796 kilos. Milk income has increased, but a substantial part of the increased income is offset by reduced income from beef. As can be seen from Table II beef production is significantly reduced as the milk production reaches its maximum. An increased quantity of concentrate due to more cows is outweighed by less concentrates for bulls. The cost for purchased roughage increases, lowering the gross margin. As milk production reaches its maximum, the model gradually switches from raw milk for baby calves to purchased skimmed milk powder. At 22.733 litres supplementary quota all cow places are occupied by dairy cows, and milk production can no longer be increased with existing cowshed capacity. The shadow price of quota is zero. The 30 sheep on farm B are present also in the new equilibrium solution (Table II).

There are several reasons why the increase in gross margin is lower on farm B than on farm A. First of all the cows milk yield potential is already fully realised on farm B, given the disposable quantity and quality of roughage. Secondly, space for bulls and heifers over six months of age is a more scarce resource on farm B than on farm A. In fact, gross margin on farm B can be increased just as much by increasing the number of places for heifers and bulls, as by increasing the number of cow places. This illustrates the complex interdependencies between the different animal groups in a cattle herd. A bottle neck in one part of the dairy operation can affect the overall profitability of the whole operation. Purchase or rent of additional milk quota is thus not a sufficient condition in order to increase profitability. Thirdly, cattle on farm B compete with sheep regarding roughage, reducing the profitability of keeping one extra cow or bull as compared to farm A.

In order to calculate the profitability in quota investment, both the government quota price, NOK 3.50 per litre, and the average buying price in the private market in Rogaland in April 2009, NOK 5.50 per litre, are applied. To be comparable it is assumed that both farm A and B buy the maximum additional quota that farm B can produce at the highest gross margin, 18.800 litres (see Figure 1b). Above this level the shadow price is reduced. The investment takes place in year 2009, and additional quota can be utilized from 2010 on. Farm B needs between two and three extra cows in order to fill the new quota. The farmer can buy heifers or cows, or reduce the number of culled cows. In the paper meat income from cows is reduced on farm B in year 0. Apart from the annual quota increase of one percent, the cash flow remains constant from year 1 to year 8. One might argue that the cash flow should increase. However, statistics for dairy farms from NILF over the years 1996 to 2007 show only minor changes in net farm income (NILF, 2008). Net present value is calculated by subtracting the annual after tax payments discounted to the year of investment, from the invested amount.

Profitability is calculated using the net present value method (NPV). The mathematical procedure for calculating NPV can be expressed by the formula: $NPV = FV / (1+ i)^n$, where FV stands for future sums of money under consideration; n equals the number of years over which discounting will take place; and i is the interest rate. In this paper FV represents the annual net increase in gross margin due to quota purchase. If NPV is positive, the investment yields a higher dividend than the required rate of return, and the investment is profitable. Correspondingly, an investment with a negative NPV is not profitable.

In Figure 2a and 2b net present values for farms A and B are calculated for the two quota prices and different depreciation periods.

2a. **2b.**

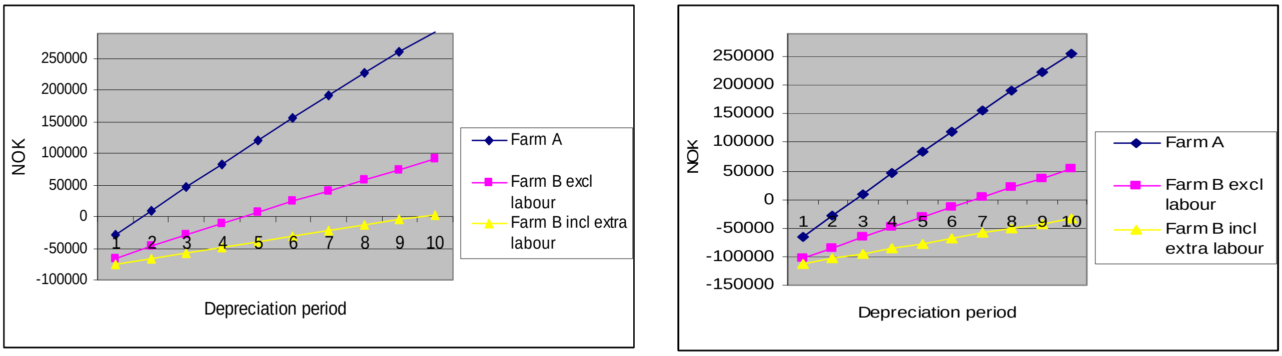

Figure 2. NPV for quota investment on farm A and farm B with different depreciation periods. Quota price is NOK 3.50 in Figure 2a, and NOK 5.50 in Figure 2b.

On farm A, for quota investment to be profitable at a price of NOK 3.50, the depreciation period must exceed two years (Figure 2a). For farm B, for the quota investment to be profitable at the same price, the depreciation period must exceed five years if extra labour costs are excluded, and 10 years if they are included (Figure 2a). In the case of a milk quota abolition in year 6 (year 2015), quota purchase remains profitable on farm A at both price levels. However, on farm B, quota investment yields a small positive net present value in year 6 only when additional labour is not included (Figure 2a). With the higher quota price, the depreciation period on farm A must exceed three years for the investment to be profitable (Figure 2b). On farm B however, a quota price of NOK 5.50 yields a negative NPV at least within a depreciation period of 7 years, even when additional labour costs are excluded (Figure 2b).

In order to compare quota investment and renting of quota on farms A and B, accumulated gross margin less rent and tax is given in Figure 3.

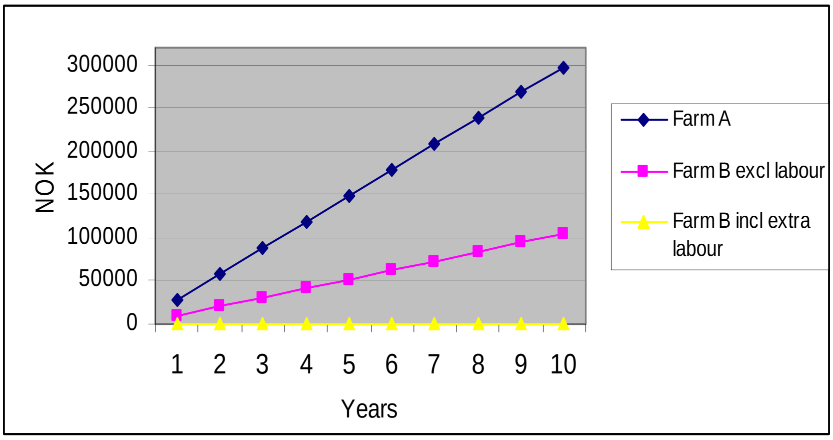

Figure 3. Yearly accumulated gross margin less rent and tax on farm A. Rent price 0.5 NOK per litre milk.

Comparing Figures 2 and 3 demonstrate that for farm A renting of quota is a highly competitive alternative to buying quota. Considering the period until 2015 renting of quota is a more profitable alternative than buying. In addition renting quota on a five year contract implies less financial risk and appears to be a more flexible option than buying quota. On farm B renting of quota is also more profitable alternative than buying, however when additional labour costs are included, renting is not profitable on farm B.

Discussion and conclusion

The results for farm A illustrate that farmers with idle production capacity have a strong incentive to increase milk production. Thus it is not surprising that the demand for milk quotas in Norway has been high. The results for farm A are in line with the example by Breines (2005). Initially farm A has idle milk yield capacity per cow and no competing livestock (sheep). In this situation, the model shows that it is profitable to have a relatively low milk yield per cow combined with a high slaughter age and slaughter weight for bulls. The results from this study are consistent with those obtained by Flaten (2001). With heifers occupying space not required by cows, increased milk quota is filled by increasing the milk yield per cow. This finding demonstrates that the results by Knutson et al. (1997), suggesting that the number of cows should be increased before the milk yield, do not always hold under practical farming conditions.

Factors like land scarcity, alternative use of land and the subsidy scheme influence optimal plans. Subsidies influence optimum milk yield per cow (Flaten, 2001). With limited space for cows, or if the cowshed needs replacement, high yielding milk production systems become profitable.

The results for farm A illustrate that some farms have a high potential for producing additional milk, which can be utilized once the quota program is abolished. But as is clearly demonstrated on both farms, the increased milk production comes at the cost of reduced beef production from bulls. In the long run, a substantial increase in milk yield per cow and number of cows per farm reduce national beef production. In order for Norway to be self-contained in beef, raising a herd of beef cows might be required.

The results for farm B however demonstrate that on farms with initially well utilized production and milk yield capacity, the economic effect of purchasing or renting additional milk quota is significantly smaller. Thus, the findings for farm B are more in line with the example used by Flaten (2005). Farm B starts in a position with roughage scarcity, no idle places for cows, and fully utilized milk yield capacity from dairy cows. Farm B also purchases bull calves at three months old and thus has a higher utilization of the cowshed.

Increased milk yield per cow requires high farming skills and a high cow yield potential, as well as high roughage quality. If, for example, the roughage quality on farm A had been bad, the milk yield would not have exceeded 7500 kilos per cow. Increased milk yield on farm A also requires that the total feed ration is balanced with respect to all nutrients, especially protein, otherwise the effect of increased quantity of concentrate per cow will be reduced. To obtain the desired milk yield increase, it is important to choose the right feeding strategy. This implies that feeding surplus energy must be avoided, and that the concentrate is carefully adapted to the milk yield and the roughage quality. Furthermore it is crucial to plan increased milk yield per cow well ahead of a new lactation. If farm A had tried to increase the milk yield per cow in mid lactation, it would have been much less effective.

Labour constitutes a considerable part of the costs in dairy farming. Inclusion of labour costs in TINE Optimal would have made it profitable to fill the quota on farm A with fewer cows, all other factors kept unchanged (Flaten 2001). The shadow price of the milk quota would have been reduced, and thus the profitability of milk quota investment or rent.

In this paper only short run consequences of quota purchase and increased milk production are considered. In the short run, returns only need cover variable costs. However, in the longer run, the cowshed will need refurbishment or enlargement and the fixed costs to be covered. Furthermore it is assumed that both farms have sufficient liquid assets at their disposal. If that is not so they might get stuck in a liquidity trap. It is also assumed in the paper that the farmers are able to fill the purchased milk quotas. However, Colman (2000) reports that a large number of dairy farmers achieve a poor match between available quota and production. Producing under quota will lengthen the payback time and thus reduce the profitability on both farm A and B.

In the introduction it was stated that there had been a debate as to how much the gross margin will increase with increased milk quota or milk delivery. The overall conclusion from the two examples is that this depends heavily on the current farm situation, a result which is in line with both Colman (2000) and Bogetoft et al. (2003). Before purchasing or renting quota, it is crucial that the farmer examines carefully how existing production will be affected by the additional quota. There exists no standard answer which fits all dairy farmers, and the consequences need to be calculated for each individual farm.

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THE FARMLAND INVESTMENT MARKET IN CANADA

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Abstract

Farming in Canada has changed significantly over the past 50 years. The biggest changes have resulted from the adoption of new technologies that have made farming very capital intensive, increased land productivity, significantly reduced the required labour and management effort per hectare, and has increased average farm size many fold. Farmers have had to constantly improve their management and entrepreneurial skills to compete and most importantly, they had to grow their farm operations to survive economically. Throughout these changes, farmers have become real estate investors as well as farm commodity producers. This paper assesses and discusses the 'separation' of the farmland investment decision from farm operating decisions, maximum farmland debt ratios and the implications for financing farmland in Canada. The results in this study indicate a significant difference between reported net farm income in Canada and the actual Canadian returns to farm operations and land investment. The differences are so large that reported net farm income will lead to wrong conclusions about farm and farmland financial performance. The Canadian farm sector is financially healthy, producing investment returns that are competitive with, but slightly lower than average international stock market returns. As the Canadian farm sector continues to change, farmers must realize that they are real estate investors just as much as farm commodity producers. Production is still a large part of land value but other factors are becoming more and more important.

Introduction

Farming in Canada has changed significantly over the past 50 years. The biggest changes have resulted from the adoption of new technologies that have made farming very capital intensive, increased land productivity, significantly reduced the required labour and management effort per hectare, and has increased average farm size many fold. Throughout these changes, farmers have had to constantly improve their management and entrepreneurial skills to compete and most importantly, they had to grow their farm operations to survive economically. Along with the agribusinesses changes that farmers have adapted to, they have also had to adapt to the growing non-farm demand for farmland. As farmland normally represents the largest asset on a farm balance sheet, farmers have come to realize that they are not just food producers but real estate managers as well. As non-farm demand for farmland grows, more and more of farmland value is being determined by factors unrelated to food production (Painter 2008). As Oltmans indicated, "Managers need to view the land ownership decision more as an investor **in** the land and less as producer **on** the land." (Oltmans 2007). Oltmans applied his "New" Analysis of farmland returns which separated the land investment from the farm operations and provided significantly improved information about financial performance. One of his conclusions is that farmland will not cash flow itself (Oltmans 1995 and 2007), and as the non-farm demand for farmland increases, the portion of farmland value that can be cash flowed becomes even smaller. Farmland investors, who most often are farmers, need to treat farmland like any other growth asset, which has implications for financing, such as maximum sustainable debt ratios. This paper assesses and discusses the 'separation' of the farmland investment decision from farm operating decisions, maximum farmland debt ratios and the implications for financing farmland in Canada.

Background and Objectives

The average total return on investment (ROI or yield) for US stock markets for the period 1969 – 2008 has been approximately 8% annually (Morgan Stanley 2008), of which 2.4% has been cash dividend yield (cash flow to the investor) and 5.7% has been capital gain yield (non-cash growth in stock values). A simple example of an average US stock portfolio (almost any stock market in the world will provide a similar result) illustrates why growth assets (like farmland) may not cash flow themselves. For simplicity, assume a US stock worth $1,000 is purchased with an expected dividend yield of 3% and an expected capital gain yield of 5%. Suppose the investor borrows the $1,000 at an interest rate of 6% to purchase the stock. The annual cash flow required to pay the interest on the loan (exclude the principal payment for simplicity) is $60. The total annual return on the stock is $80 ($1,000 x 8%) but only 3%, or $30 of dividends, is the actual cash flow return. The other 5%, or $50, is accrued capital gain due to growth in the stock price and is only a cash flow if the investor sells the stock. Therefore, if the intent is to hold the stock for long term growth, the investor would need to supplement the cash flow from the dividends with another source in order to make the debt payment. The growth stock will not cash flow itself. This is usually true of any growth asset, farmland included. Suppose an investor purchases Canadian farmland for $100,000 and the expected cash operating return (farm net income) is 3% per year while the farmland value is expected to grow by an average 6% per year, which is a non-cash capital gain return. The overall expected annual return of 9% (operating + capital gain) is satisfactory to the investor, given the perceived farmland investment risk level. If the investor decides to finance the purchase with a $100,000 bank loan at an interest rate of 6% repaid over 25 years, the annual payment would be $7,820 (interest plus principal reduction). Since the initial annual cash operating return is only $3,000, the land cannot cash flow itself and the investor would need another source of cash to make up the shortfall. To the extent that the cash operating portion of the return on farmland is less than the debt rate (or required return), a growth asset like farmland will not cash flow itself, even though the overall expected return on investment is satisfactory to the investor.

The maximum amount of debt that could be taken to finance a growth asset is:

$$MD = \frac{I \times DY}{DR} \tag{1}$$

Where:

MD = maximum debt;

I = total investment;

DY = dividend or cash operating yield;

DR = debt interest rate.

In the stock example the maximum serviceable debt for the $1,000 investment is the cash dividend return of $30 divided by the debt interest rate of 6%, which is $500, or a 50%

debt ratio. The maximum debt ratio is simply the cash operating yield of 3% divided by the debt interest rate of 6%, or 50% maximum debt ratio. In the farmland example, the maximum debt ratio is approximately 38% when the debt payment, including the principal payment, is used in the calculation ($3,000 operating cash divided by $7,820 loan payment). If the dividend or cash operating yield is equal to or greater than the debt payment, the asset will cash flow itself. If not, either other sources of cash flow are needed (farmers have off-farm employment, for example) or equity financing is used for that portion of the investment that cannot be cash flowed. Equity financing is 'patient' in that equity investors are willing to wait for their cash returns, eventually selling the asset at a higher value and realizing a cash capital gain.

Separating the land investment decision from the farm operations gives a better picture of financing requirements and provides much better information for farm business and land investment analysis. Farmers, like any other business managers, need good information in order to make sound decisions. The standard 'net farm income' approach used by government reporting agencies in Canada does a very poor job of providing farm financial information for business decision making and indeed, mixes and confuses returns to operations and farmland investment, and often leads to incorrect conclusions about farm business performance (as Oltmans very clearly showed). For example, near the end of 2008, the president of the Canadian National Farmers Union (NFU) said; "Grain prices may have soared earlier this year, but the 20-year average income of the Canadian family farmer remains at zero." In an address made at the NFU convention, she said farmers have generated two-thirds of a trillion dollars in gross income during the past 20 years and have kept none of it, implying zero net income[1]. This illustrates the problem associated with how farm income is calculated and reported. The NFU president is either misinformed or unable to calculate farm incomes and returns, because when calculated correctly, they have been far from zero over the past 20 years. Relying on poor information such as this will lead to poor farm business and investment decisions. This paper will discuss how to improve the 'net farm income' source of information.

[1] Paulson, Joanne (2008). "Free trade hurts farmers, claims NFU president". Saskatoon Star Phoenix, Friday, November 21, 2008

The main objectives of this paper are to analyze the reported net income and investment yields for Canadian farmland in five major agricultural producing provinces for the period 1972 – 2007 to assess the following:

a) The separation of Canadian 'net farm income' into farm operating income and farmland investment income;
b) Farmland ownership investment yields over the study period, broken down into cash and growth components, and how they have compared to similar risk growth assets;
c) The portion of Canadian farmland that can be cash flowed (maximum debt ratios) and how this has varied by province over the study period;
d) The implications for financing Canadian farmland in light of the growing non-farm demand.

Previous Research

The recognition that farmland is a growth asset has been reported in many studies. Melichar (1979) pointed out the importance of properly estimating and including expected earnings growth in farmland valuation (to explain the capital gains portion of the return) and properly accounting for technological change so that a true estimate of earnings could be obtained. Alston (1986) concluded that growth in earnings, as opposed to other factors such as inflation, could explain capital gains on farmland, which supports the standard theory of valuation. Castle and Hoch (1982) indicated that valuation analysis must include expected growth in earnings and the discount rate used must not be the average debt rate but rather a risk-adjusted opportunity cost for farmland investors. These studies all showed that a significant portion of farmland returns are attributed to growth, which implies a non-cash component of the return. Oltmans (1995) demonstrated very clearly that farmland is a non-depreciable asset with growing cash flows, which produces an expected capital gain to farmland investors. Since part of the value of farmland is from the expected growth component, which is future cash flows as opposed to current, it will not cash flow itself today. Painter (2000 and 2002) showed that Canadian farmland has a significant growth component in its historical return on investment, implying that

Oltmans' conclusion is valid. Painter (2006) showed that because of the high growth component in farmland returns, Canadian farmers will need more sources of external equity financing if they are to keep growing at the rate necessary to remain competitive. Painter (2008) assessed the impact of non-farm demand on farmland values in Canada and concluded that Alberta and Ontario exhibited significant non-farm value premiums, which further reduces the cash portion of the overall farmland return on investment.

Methodology and Data

The Canadian farm financial data were derived from provincial departments of agriculture; Alberta Agriculture, Food and Rural Development, Saskatchewan Agriculture and Food, Manitoba Agriculture and Food, Ontario Agriculture and Food, and Ministere de l'Agriculture in Quebec[2]. The main part of the methodology is in disaggregating net farm income into two components; land investment income and farm operating income.

Land Investment Income and Return on Farmland Investment (ROI)

The total land investment income is made up of two parts: lease income and capital gain income. The capital gain income (or loss) is simply the change in the value per hectare from one year to the next. The lease income for farmland in Canada is calculated using an average net lease value that could be obtained by a farmland owner for leasing out the land. The method used in this study is based on a standard crop share approach, where the land owner receives a percentage of the gross revenues produced (in this study, 17.5% of total revenue is used to calculate the gross lease revenue to the farmland owner[3]). The farmland owner is then responsible for paying property taxes and building depreciation, which are deducted to arrive at a net lease income to farmland ownership.

The income return to land ownership is measured by the Net Lease Income/hectare (NLI) in each province, calculated as follows:

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[2] Other data sources that were used included Agriculture and Agri-Food Canada, Canada Grains Council, Canadian Wheat Board, Canadian Grain Commission, Canadian Transport Agency, Farm Credit Canada, and Statistics Canada.

[3] 15% - 20% of gross revenues is a common crop share arrangement in North America, which compares closely with cash rents that are usually in the 5% - 7% of land values range.

$$NLI_t = CS_t - PT_t - BD_t \qquad (2)$$

where,

NLI_t = Net Lease Income/hectare in year t;

CS_t = average gross lessor crop share/hectare in year t (17.5% of gross cash receipts);

PT_t = average property tax/hectare in year t; and

BD_t = average building depreciation/hectare in year t.

Then, the return on farmland investment, or yield, is calculated as:

$$ROI_t = \frac{NLI_t}{V_{t-1}} + \frac{V_t - V_{t-1}}{V_{t-1}} \qquad (3)$$

where,

ROI_t = average investment yield on farmland and buildings investment in year t;

V_t, V_{t-1} = average value of farmland and buildings/hectare in years t and t-1;

$\frac{NLI_t}{V_{t-1}}$ = farmland owner's lease income yield on farmland investment in year t;

and

$\frac{V_t - V_{t-1}}{V_{t-1}}$ = farmland owner's capital gain yield in year t.

Farm Operating Income

With this approach, the farmer's operating income is the residual left after all other expenses and returns to land investment have been paid. In Canada, close to 50% of all farmland is leased. The farmer lessee must pay the lease payment just like any other expense, leaving the residual as the operating income. In the case where the farmer owns the land, the farmer's opportunity cost is the lease revenue that could otherwise be obtained by leasing out the land, leaving the residual as the operating income.

The farm operating income is the residual after paying all cash *operating* expenses and deducting the crop share paid to the lessor. The normal accounting for net farm income does not provide an indication of this residual or the land investment income.

Adjustments need to be made to the stated net farm income to arrive at the total net income that can be divided into the farm operating income and the land investment income. The expenses that need to be adjusted in the calculation (added back to arrive at adjusted net farm income) are; 1) land rent, building depreciation and interest expenses[4], as they are paid out of the land investment income, and 2) paid hired and family labour expenses (often paid to family members for tax purposes) as they are part of the overall farm operating income[5]. The annual adjusted net farm income can then be divided into land investment income and farm operating income, as follows:

Net Farm Income + property taxes + interest + building depreciation + farm wages + rents =

Adjusted Net Farm Income

Land Investment Income	**Farm Operating Income**
= Lessor Crop Share (out of which is paid property taxes, interest and building depreciation)	= Adjusted Net Farm Income – Lessor Crop Share (this return can be used to pay farm wages to family members, hired help, or farmer owners, as they choose)

Therefore, the calculation of farm operating income excludes all paid hired and family workers and any imputed value for unpaid family work and represents labour and

[4] Only interest on farmland and building debt is added back, not operating interest as it is considered an operating expense. Building depreciation and interest is added back because buildings are included in farmland values (value of farmland and buildings).

[5] Farm operating income is not net of a labour and management expense but rather an amount available to pay labour and management inputs. All paid hired and family labour must be added back in order to determine the total amount *available* to be paid to labour and management efforts. How the farm owners choose to pay out this portion is their choice, as they can pay themselves a wage, or a wage to other family members, or they can hire workers if the farm owners decide to engage in off-farm employment. Regardless of who it is paid to, it represents the return available to the labour and management effort.

management income available to the farm family[6]. The net farm operating income per hectare (FOI) is calculated for each year in the study period and for each province, as follows.

$$FOI_t = ANFI_t - CS_t \quad (4)$$

where,

$ANFI_t$ = adjusted net farm income/hectare in year t; and

CS_t = gross lessor crop share/hectare in year t.

Analysis of Results

Table 1 illustrates the disaggregation of reported 'net farm income' into farm operating income and land investment income. The difference between net farm income and the total of farm operating income and land investment income is significant, which would lead to very different conclusions about the profitability of farming and investing in farmland. The main problem with reported net farm income is that it mixes and confuses farm operating income with land investment income. Reported net farm income includes costs associated with farmland investment that are not operating expenses, such as farmland and building debt interest, rents, property taxes and building depreciation, even though it does not take into account the non-cash farmland investment income associated with appreciation or depreciation of the farmland assets. As well, some wages are included but not all, and nothing for management wages, which makes it very inaccurate[7]. The farm operating income (FOI) represents the return to farm labour and management while the land investment income represents the return to the land ownership investment; this represents the information farmers and farmland investors need to make management and investment decisions.

[6] It should be recognized that some of the wages may have been paid to non-family members.

[7] Farm operating income and land investment income add up to significantly more than 'net farm income'. It is important to remember that some significant expenses such as paid wages and land debt interest are included in 'net farm income' but are excluded after the adjustment because farm operating income is the amount *available* to the farmer for labour and management and the land investment income is the amount *available* to pay the source(s) of land financing, whether that is debt or equity or some combination.

Table 1 illustrates that the average level of farm operating income (per average farm) is between $20,000 and $30,000 (all in Canadian $) and between $17,000 and $30,000 for land investment income, over the study period. The total farm income is between $46,000 and $57,000, compared with average total family incomes ranging from $58,000 to $78,000. It appears that farm income is lagging average total family income; however, it should be noted that average farm incomes are based on average farm size, as indicated in Table 1, which does not represent full employment for a family[8]. Over 80% of Canadian farm families have at least one source of off-farm employment income. According to Agriculture and Agri-Food Canada,[9] average Canadian non-farm income per farm family in 2007 was $53,338. When this is added to the farm incomes in Table 1, farm families are significantly better off than non-farm families. This also explains why average Canadian farm family net worth is significantly greater than average family net worth. The latest survey of Canadian family net worth was in 2005, which indicated average Canadian family net worth to be $148,350[10] while in the same year, the average net worth of all Canadian farm families was $1,035,944[11]. The calculated incomes provided in Table 1 combined with the statistics for average net worth in Canada indicate how misleading average net farm income can be. Canadian farm families are doing very well, both on an annual income basis and on an accumulated wealth basis (net worth) but if you look only at reported 'net farm income' alone, your conclusion about the financial performance of Canadian farm families might be as wrong as that of the National Farmers' Union president, who said, "the 20-year average income of the Canadian family farmer remains at zero." The importance of good financial information for making farm operating and investment decisions cannot be over-emphasized.

[8] This is a problem with many farms in countries where agriculture is subsidized – they are not large enough to be viable economic units on their own and therefore suffer income and cash flow problems.
[9] Agriculture and Agri-Food Canada is the Government of Canada Ministry of Agriculture. (www.agr.gc.ca)
[10] The average is for economic families only. Source: The Wealth of Canadians: An Overview of the Results of the 2005 Survey of Financial Security. Statistics Canada.
[11] Source: Farm Financial Survey 2006, Statistics Canada. There was significant variance in average farm family net worth by province: Quebec $987,472; Ontario $1,145,619; Manitoba $856,700; Saskatchewan $689,366; and Alberta $1,254,741.

Table 1: Disaggregated Net Farm Income by Province (1972 – 2007)

	Alberta	Sask	Man	Ontario	Quebec
	Real 2007 CDN$ per hectare				
Reported Net Farm Income	$ 45.99	$ 60.95	$ 74.18	$ 175.40	$ 282.69
Add back:					
Property Taxes	5.73	8.78	9.99	34.73	29.52
Land & Building Interest	21.45	14.03	22.75	84.94	97.54
Building depreciation	9.34	3.54	5.40	64.27	42.95
Rents	15.44	14.98	20.16	48.89	15.67
Farm Wages	21.61	11.11	24.68	185.12	145.63
Total Adjustments	73.57	52.45	82.98	417.95	331.31
Adjusted Net Farm Income	119.55	113.40	157.16	583.35	614.00
Gross Crop Share Expense	63.03	47.51	79.80	282.54	277.57
Farm Operating Income (eq 4)	**56.53**	**65.89**	**77.36**	**310.81**	**336.43**
Net Lease Income (equation 2)	47.96	35.19	64.41	183.54	205.11
Capital Gain Income	36.95	3.21	13.73	127.16	97.31
Land Investment Income	**84.91**	**38.40**	**78.15**	**310.70**	**302.41**
	Alberta	**Sask**	**Man**	**Ontario**	**Quebec**
	Real 2007 CDN$ per average farm				
Average Farm Size (hectares)	361	448	301	80	90
Reported Net Income	$16,621	$27,301	$22,330	$14,018	$25,348
Farm Operating Income	**20,431**	**29,514**	**23,287**	**24,840**	**30,166**
Net Lease Income	17,333	15,761	19,390	14,669	18,391
Capital Gain Income	13,354	1,439	4,134	10,163	8,725
Land Investment Income	**30,687**	**17,200**	**23,524**	**24,831**	**27,117**
Farm Op & Investment Income	**51,118**	**46,714**	**46,811**	**49,672**	**57,283**
Average Family Income[12]	**78,400**	**60,500**	**58,700**	**66,600**	**59,000**

Table 2 compares the average annual investment yields for Canadian farmland, bonds and international stock markets for the period 1972 – 2007. It is interesting to note that farmland investment yields are very similar to average stock market yields. Farmland average income/dividend yields are normally higher than for stock markets, while the average capital gain yields are lower for farmland. Farmland investment also appears to

[12] This is average total family income by province, from the 2006 Canadian Census. Source: Statistics Canada, CANSIM 111-0009

be lower risk, as indicated by the lower coefficient of variation.[13] Farmland investment yields and risk are most similar to high dividend yielding blue-chip stocks.[14] It is clear that farmland is a growth asset where, on average, 36.5% of the total investment yield is from income (cash return) while the reminder, 63.5% is from growth (non-cash return). This has important implications for financing farmland; specifically the amount of debt financing that can be sustained.

Table 2: Average Annual Investment Yields for Canadian Farmland, Bonds and International Stock Markets (1972 - 2007)

	Income/Div Yield		Cap Gain Yield		Total Yield		Coefficient
	Avg Yield	Std Dev	Avg Yield	Std Dev	Avg Yield	Std Dev	of Variation
T-bills					7.3%	0.0%	n/a
Long Bonds					8.5%	2.8%	0.33
Canadian Farmland:							
Alberta	2.8%	0.7%	7.1%	12.5%	9.8%	12.8%	1.30
Saskatchewan	3.3%	0.9%	5.3%	11.8%	8.6%	12.3%	1.43
Manitoba	4.7%	0.9%	6.0%	9.5%	10.7%	9.7%	0.90
Ontario	2.6%	0.7%	6.9%	10.5%	9.5%	10.8%	1.14
Quebec	6.5%	1.6%	8.1%	7.7%	14.6%	8.6%	0.59
Stock Markets:							
Australia	3.2%	0.9%	7.4%	23.3%	10.6%	24.0%	2.26
Canada	2.6%	1.0%	7.9%	19.7%	10.5%	19.9%	1.90
France	2.7%	1.6%	9.4%	27.5%	12.2%	27.9%	2.29
Germany	2.2%	0.9%	9.8%	29.2%	12.0%	29.6%	2.47
Hong Kong	4.4%	1.7%	11.2%	45.7%	15.4%	46.9%	3.05
Italy	2.2%	0.9%	6.5%	35.7%	8.6%	36.2%	4.21
Japan	1.2%	0.9%	9.3%	33.8%	10.4%	34.3%	3.30
World	2.4%	0.9%	7.7%	16.6%	10.1%	17.0%	1.68
United King	3.8%	1.2%	7.2%	26.1%	10.9%	27.1%	2.49
United States	2.5%	1.1%	7.3%	16.8%	9.7%	17.2%	1.77

[13] Coefficient of Variation = standard deviation (risk) divided by the total yield, representing risk per unit of return.

[14] However, it should be noted that these average farmland investment yields and risk are based on a provincially diversified farmland portfolio so the risks for an individual farmer would be somewhat higher.

Table 3 illustrates the maximum and actual average debt ratios for Canadian farmland investment over the study period. Equation 1 is used to estimate maximum debt in year t, which is then divided by the farmland value in year t-1 to get the maximum debt ratio. The average actual debt ratio is significantly lower than the average maximum, which implies that farmers have been somewhat conservative with debt financing and that there is a significant amount of equity in the farmland market. It is likely that farmers use some of the net lease income to cover costs other than debt, pay themselves incomes and so on, leaving less cash flow available to finance debt. Figure 1 shows the comparison of actual and maximum debt ratio for Alberta farmers,[15] over the period 1972 – 2007. During the 1980's the maximum debt ratio fell very quickly due to very high interest rates and the actual debt ratio rose due to farmers using more debt to finance purchases at increasing prices. This left many farmers in financial difficulty and is probably another reason why farmers keep a large cushion between their maximum and actual debt ratio.

Table 3: Average Maximum and Actual Debt Ratios for Canadian Farmland Investment by province (1972-2007)

	Alberta	Sask	Manitoba	Ontario	Quebec
Maximum Debt Ratio	26.2%	31.7%	44.7%	24.5%	59.2%
Actual Debt Ratio	16.1%	16.9%	22.4%	15.1%	32.9%

[15] Because of space constraints, only Alberta is shown here but the pattern is identical in each of the other provinces.

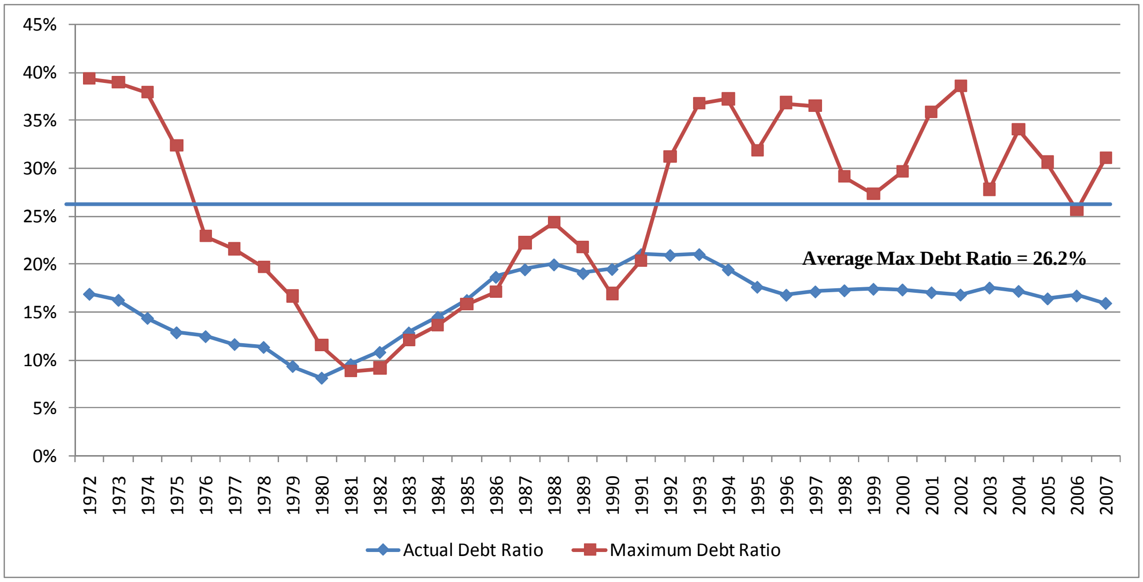

Figure 1: Alberta Farmland Debt Ratios (1972 – 2007)

The lower maximum debt ratios in Alberta and Ontario are a function of the non-farm demand for farmland and the resulting impact on farmland prices. Painter (2008) showed that “there appears to be a significant non-farm price premium in Ontario and Alberta due to non-farm demand for farmland”. This implies that in Ontario and Alberta, farmland prices have been bid up to a level higher than would normally be paid by farmers, based on the income and growth potential of the farmland. This does not imply that the farmland in those provinces is overpriced but that the farmland investor will likely have to rely proportionately more on the growth potential of the farmland (from farm and non-farm sources) than on its farm income producing ability. This is further illustrated in Table 2, where the income/dividend yield for Ontario and Alberta farmland is lower than for the other provinces. This suggests that in those two provinces, farmers will have to be aware that part of their investment return could come from non-farm demand (potentially higher future selling price) which is not an annual cash flow. This indicates a lower maximum debt ratio and a greater requirement for equity financing.

Summary and Conclusions

The results in this study indicate a significant difference between reported net farm income in Canada and the actual Canadian returns to farm operations and land investment. What are the implications of this result? The differences are so large that reported net farm income will lead to wrong conclusions about farm and farmland financial performance. As Oltmans suggested, farmers and farmland investors should not use net farm income for making operational and investment decisions but rather separate the income to get a clear picture of the real returns. Governments in Canada must also have the correct information when setting agricultural policy. Farm lobby groups should be careful when picking and choosing their financial information for public announcement; reported net farm income might convince the public that farm subsidies are needed but how do you reconcile farm subsidies with average farm family net worth?

The results show that the Canadian farm sector is financially healthy, producing investment returns that are competitive with, but slightly lower than average international stock market returns. But, the risk levels of provincially diversified farmland portfolios in Canada are lower than average stock market portfolios, making the risk-return tradeoff comparable and Canadian farmland an attractive investment.

The average growth component in Canadian farmland investments is 60% - 65% of the total return, which combined with average income yields relative to farmland debt interest rates, implies a significant amount of equity financing required. Maximum debt rates for the five provinces range from 24.5% in Ontario, which has the lowest average income yield at 2.6%, to 59.2% in Quebec, which has the highest average income yield at 6.5%. The higher is the income portion of the yield, the higher the sustainable debt ratio. Currently, the three most common sources of equity financing for Canadian farmers are a) farm profits, b) off-farm employment income, and c) farmland leases. However, a growing source of new equity is from farmland corporations[16], wealthy individuals purchasing large farms, and individuals, businesses or governments purchasing farmland for both farm and non-farm purposes (acreages, hobby farms, urban expansion, commercial development, and any other demands for farmland that are not for agricultural production). As growth in farmland prices increases due to farm plus non-

[16] An example is the Agriculture Development Corporation in Western Canada, which manages over 32,000 hectares for its farmland investors. (www.farmlandinvestor.ca)

farm demand for farmland (which is currently the case in Alberta and Ontario: Painter 2008), the maximum affordable debt ratio declines while the minimum required equity financing increases, putting even more pressure on finding new equity sources of financing in the agriculture industry. Canadian farmers must realize that they are real estate investors just as much as farm commodity producers. The conclusion is that farmers in Canada need to heed Oltman's advice: The land ownership decision needs to be viewed as 'investor in the land' as much as 'producer on the land'. Production is still a large part of land value but other factors are becoming more and more important.

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An analysis of the horticultural industry in Bulgaria during the transition period - a study in the Plovdiv region

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Abstract

Agriculture is an important sector of the Bulgarian economy and horticulture is a significant part of agriculture. This paper reviews the structural changes in Bulgarian agriculture since 1945 and analyses the situation and dynamic of horticultural farms in the Plovdiv region. During the transition period (1990s), Bulgarian agriculture underwent dramatic reforms including land restitution and privatization. The restructuring of the agricultural sector in Bulgaria took place mainly in the pre-accession period (1999-2007) in order to fulfill the criteria for entry into the EU. EU accession in 2007 has presented new challenges and opportunities for the future development of agriculture in Bulgaria. This research demonstrates that despite the difficult economic environment, horticultural farms have a significant potential due to favorable natural conditions coupled with the traditions of growing horticultural crops.

Keywords: Bulgarian agriculture, Bulgaria, horticulture, horticultural farms, farm marketing

1. Introduction

Agriculture has traditionally been an important sector in the economy of Bulgaria and horticulture is a significant part of agriculture. The total territory of Bulgaria is 11.1 million ha, of which 48.0% is utilised agricultural area (UAA). During the last two decades, the contribution of agriculture and forestry to Gross Domestic Product (GDP) fluctuated substantially, ranging from 17% in 1990 to 26% in 1997. It has been decreasing since then to about 11% in the last few years, reflecting large changes in the activities of other sectors of the economy over this period. In 1990, the workforce employed in agriculture was 19.2% which gradually increased to 26.2% in 2000 and then slightly decreased to 24.9% in 2004 (OECD, 2000; MAF, 2007).

In the last two decades, the agricultural industry has undergone dramatic economic changes as Bulgaria moved from a centrally planned to a free market economy, the European Union (EU) accession process and joining the EU. In the early 1990s, the agricultural sector underwent significant reform including land restitution and privatization which was characterised by inefficient governmental agricultural policies, poor legislation, lack of investment capital and the de-population of rural areas. The EU accession process began in 1999 with the introduction of the Special Accession Programme for Agriculture and Rural Development (SAPARD) which led to membership of the EU in 2007 and the introduction of the Common Agricultural Policy (CAP) in Bulgaria (OECD, 2000; Kostov and Lingard, 2002; MAF, 2002; Doichinova, 2003; Bachev, 2005; Bencheva, 2005, Yanakieva, 2007).

During the period of Communism (1945-1989), agriculture was characterised by large state-controlled and over-specialised Agricultural Industrial Complexes (AICs), centrally determined prices, guaranteed markets and no recognition of market forces. Over that time, the main goals of agricultural policies in Bulgaria were to provide an adequate supply of basic food products, at low prices, to the domestic market (OECD, 2000; Mergos et al., 2001). The over-specialisation of these AICs resulted in decreased gross agricultural output in the middle of the 1980s and the necessity for radical reform that was not introduced prior to 1989 (EC, 1998; OECD, 2000).

In 1989 the transition towards a 'free market' economy began in Bulgaria. The reform of the agricultural sector started with the introduction of new regulations and laws that were developed to re-introduce private farming after 45 years of a communist regime. The agricultural reform was characterised by the liquidation of the AICs, development of a private sector, land restitution, privatization and price liberalization. Subsequently agriculture and especially horticulture experienced a deep crisis due to the accumulated problems inherited from the period under communism, the slow pace of reforms, inconsistent agricultural policies, loss of the main export markets and tight fiscal conditions (EC, 1998; MAF, 2000; Georgieva, 2003). The total value of agricultural production declined reaching a low in the mid 1990s, when it dropped to about 60% of the 1990 level (Ivanova et al, 2007). The farming structure that emerged after the liquidation of the AICs was characterized by a large number of small private farms, private co-operatives (average size of about 600 ha) and other legal entities (e.g. limited companies, sole traders and partnerships). The majority of the private farms and co-operatives needed significant improvement and consolidation (FAO, 1999; Georgieva, 2003; MAF, 2007).

In 1998, the agricultural reform in Bulgaria was officially completed. Agricultural policies became more consistent with the long-term goals of developing an efficient, competitive and export-orientated agricultural sector, improving the incomes of those working in agriculture and preparing the country for EU accession. There were still many problems remaining that obstructed the development of agriculture including the lack of official ownership records of the land (granted title deeds), an inefficient land market, low profitability in this sector and difficulties in obtaining credit for purchasing land.

At the end of the 1990s, the Special Accession Programme for Agriculture and Rural Development (SAPARD) was introduced to prepare Bulgaria for EU accession with the two big challenges being an inefficient land market and fragmented land ownership (FAO, 1999; Evtimov, 2006; MAF, 2007). During the pre-accession period (1999-2007), the land market was underdeveloped but improving and there were a large number of small farms that needed to consolidate and a very small number of big commercial farms that would benefit from the introduction of CAP payments. The total value of agricultural production increased in the late 1990s but it was low compared to the 1990 level (about 60%) (Evtimov, 2006; Popov, 2006; Ivanova et al, 2007). The main instruments for supporting farmers were direct subsidy schemes, input subsidies, subsidies for short and long term credit, export subsidies and financial support under the SAPARD programme (Ivanova et al, 2007).

Bulgaria joined the EU in 2007 when the CAP was introduced together with the single area payment system. While agriculture in Bulgaria in the pre-accession period has been studied by various national and international researchers and organizations, the impact of the CAP on Bulgarian agriculture has not yet been evaluated, analysed and discussed (EC, 2000; MAF, 2000; Georgieva, 2003; MAF, 2007). Ivanova et al. (2007) have argued that the economic environment for Bulgarian agriculture would change significantly given the experience of EU accession by the other CEE countries. They also forecasted in their econometric models that the EU accession would have a very positive effect on the crop sector and a negative effect on the livestock sector. Furthermore, the de-coupled payments would positively affect the recent production levels.

This paper discusses the situation and challenges facing horticultural farms of different sizes in the Plovdiv region of Bulgaria during the transition period and is the first comprehensive study of the horticultural sector in Bulgaria. The paper is divided into five sections. The next section reviews the horticultural sector in Bulgaria, the methodology is described in section three while the analysis and discussion of the data is reported in section four. The final section reports the conclusions from the study.

2. Review of Horticulture in Bulgaria

Bulgaria enjoys good natural conditions for horticulture including fertile soils and a mild continental climate. About 4% of the agricultural land in 2004 was used for perennials and less than 3% for vegetables (MAF, 2007). The main horticultural products are wine grapes, potatoes, plums, tomatoes and apples (OECD, 2000; Bencheva, 2005; MAF 2005). Over 14% of the value of total agricultural output in Bulgaria was vegetables in 2004 (MAF, 2007). The Plovdiv region is a major horticultural region of Bulgaria and is situated in the central-south part of the country where the majority of the vegetables are grown.

Before World War II, Bulgaria was one of the main vegetable producers in Europe (SENTER, 2000). During the period under communism, Bulgaria produced a range of horticultural products, most notably wine, vegetables, fruits, arable crops and tobacco and became one of the leading exporters of agri-food products from Central and Eastern Europe (CEE) (OECD, 2000).

Since the economic reform began in Bulgaria at the end of 1989, changes in the horticultural sector have been dynamic. This sector was badly affected by the political, economic and agricultural reforms in Bulgaria over the subsequent two decades. Overall, the area and production of fruit and grapes decreased dramatically due to the changeable weather conditions, the volatile economic and political situation, unfavourable age structure of the trees and vineyards, high production costs, usage of old technologies and machinery and lack of investment capital (FAO, 1999; OECD, 2000; MAF, 2005; MAF 2007). By 2004, fruit output had declined by more than 60% compared to 1990. In 2004, the grape production had more than halved compared to 1990 (SENTER, 2000; MAF, 2005). Vegetables have traditionally been grown in Bulgaria and their production was fairly stable over the last two decades (MAF, 2007).

Subsistence and semi-subsistence farms mainly specialising in labour intensive crops (vegetables, fruits and vineyards) accounted for almost 90% of agricultural employment. The lack of investment in machinery resulted in increased use of manual labour and in consequence low labour productivity (MAF, 2007).

In 1997, agricultural products accounted for 14% of total exports compared to 8.8% of total imports. The principal exported commodities were tobacco, wine, processed fruit and vegetables and animal products (mainly dairy products). In 2004, agricultural products accounted for 10% of total exports of which wine, processed and fresh fruits were the key horticultural products. Prior to the transition, more than half of the agricultural trade was with CMEA (Council for Mutual Economic Assistance – ex-Communist) countries. Trade with the EU countries has developed significantly during the transition period. Agricultural exports to the EU increased from 6% of total exports in 1989 to 23% in 1997. In 2004, the key horticultural markets for Bulgaria were EU-25, the Balkan countries and Russia. Bulgaria mainly imports processed agri-food products with high added value, while exporting largely raw materials and by-products (MAF, 2000; MAF, 2007).

3. Methodology

In this research based on a survey of horticultural farms in the Plovdir region, horticulture includes fruits, vegetables (including melon and watermelon) and wine grapes. Some of the farms in the survey were not solely horticultural as they also cultivated agricultural crops such as cereals, herbs, tobacco, etc. Primary data collection was undertaken during 2001/02. The research method used was structured face-to-face interviews as this took account of the farmers' lack of experience with research interviews and the innovative nature of this study. Purposive sampling was employed due to the lack of an accurate and up-to-date list of the horticultural farms in the Plovdiv region in 2001/02. The main advantage of this sampling technique is that it can provide critical, extensive and vital information for achieving the research targets, while the principal weakness is that the sample might not be representative and the results can not directly be generalized. A total of 108 farmers were interviewed in their work places.

A literature review suggested that farm size is a very important factor as it has a strong influence on farm business performance and strategic development (FAO, 1999; OECD, 2000; Kostov and Lingard, 2002; Georgieva, 2003; Popov, 2006). In this study, the farms in the survey were divided into the following groups: 'small' farms – less than 2 ha (mainly subsistence farms); 'medium size' farms – between 2 and 10 ha; and 'big' farms – more than 10 ha[1]. Over half of the sample (54%) were 'medium size" farms and 23% equally were farms under 2 ha and farms over 10 ha.

The questionnaire included both closed and open questions (based on free elicitation) and a range of quantitative and qualitative data was collected. It was not appropriate to undertake statistical testing because of the small sample size.

4. Main Results

4.1 Product structure of the farms

More than half of the interviewees (53%) were cultivating **fruit** (Table 1), the most common being apples, plums and cherries. The Plovdiv region is the major apple producer and second biggest producer of plums in Bulgaria (SENTER, 2000). The respondents cultivated fruit because they acquired their orchard(s) as part of the land restitution process. They also stated that fruit growing was profitable during the transition period and had been traditionally grown in the Plovdiv region. The results (Table 1) also revealed that the majority of the 'big' farms (76%) had fruit, whereas 60% of the 'small' farms did not cultivate any fruit due to high start up costs and delayed returns.

Grapes (table and wine) were cultivated by 45% of the respondents (Table 1). According to the interviewees, the rationale for cultivating grapes was very similar to those for fruits, which

1 There is no certain way of grouping the farms in Bulgaria in terms of size, however, research undertaken by the EU, FAO, MAF, OECD, and various researchers provided guidelines for the division of farms by size (EC, 1998; FAO, 1999; Mishev et al. 1999; MAF, 2000; OECD, 2000; Kostov and Lingard, 2002).

were: the vineyards were inherited after the land restitution, profitability and increased demand from the increased number of private wineries. Grape production was largely stable in the Plovdiv region, which is the second biggest in terms of area of vineyards after the Bourgas region (near the Black Sea) (MAF, 2002). One of the traditional varieties of wine grapes in Bulgaria 'Mavrud' is specific to the Plovdiv region and is a very popular crop for cultivation. The data indicates there was no difference between the grape orientation of farms with different size (Table 1).

Table 1. Crop cultivation on farms of different sizes

	SIZE OF FARMS						Total	
	Small		Medium		Big			
Fruits	Count	%	Count	%	Count	%	Count	%
Yes	10	40	28	48	**19**	**76**	**57**	**53**
No	**15**	**60**	**30**	**52**	6	24	51	47
Total	25	100	58	100	25	100	108	100
Grapes								
Yes	**13**	**52**	25	43	11	44	49	45
No	12	48	**33**	**57**	**14**	**56**	**59**	**55**
Total	25	100	58	100	25	100	108	100
Vegetables								
Yes	**20**	**80**	**44**	**76**	**18**	**72**	**82**	**76**
No	5	20	14	24	7	28	26	24
Total	25	100	58	100	25	100	108	100
Other crops								
Yes	**15**	**60**	**46**	**79**	**22**	**88**	**83**	**77**
No	10	40	12	21	3	12	25	23
Total	25	100	58	100	25	100	108	100

The favourable natural conditions in the Plovdiv region, on the Thracian plain around the river Maritsa, has historically provided a sound basis for the development of the horticulture and for growing vegetables in particular (MAF, 2002). This was confirmed by the respondents as the majority of them (76%) cultivated **vegetables** (Table 1). The reasons, according to the respondents, were that vegetables are annual crops that do not need big or long-term investments, they have traditionally been grown in the Plovdiv region and they were profitable and they had maintained relatively high prices during the economic transition and the years leading to EU accession. The most frequently grown vegetables by the surveyed farmers were tomatoes, peppers and potatoes. Farm size did not appear to be a factor in terms of the vegetable orientation of the enterprises investigated (Table 1).

A range of other agricultural crops, were grown by some farmers in the sample, including arable crops, herbs, tobacco, etc. The majority of the farmers who participated in this study (77%) cultivated, together with their horticultural crops, some of these ‘other’ crops. The main reasons for combining horticultural products with ‘other’ crops were: better use of resources such as land, machinery and labour, profitability and the necessity for crop rotation. The results indicated that there was no reliable evidence that farms of different size differed in relation to the frequency of ‘other’ crops grown (Table 1).

The cropping programmes, especially possible growth in perennial products, might change significantly with the introduction of the CAP and the single area payment system in Bulgaria, which could be a subject for further studies.

4.2 Market structure

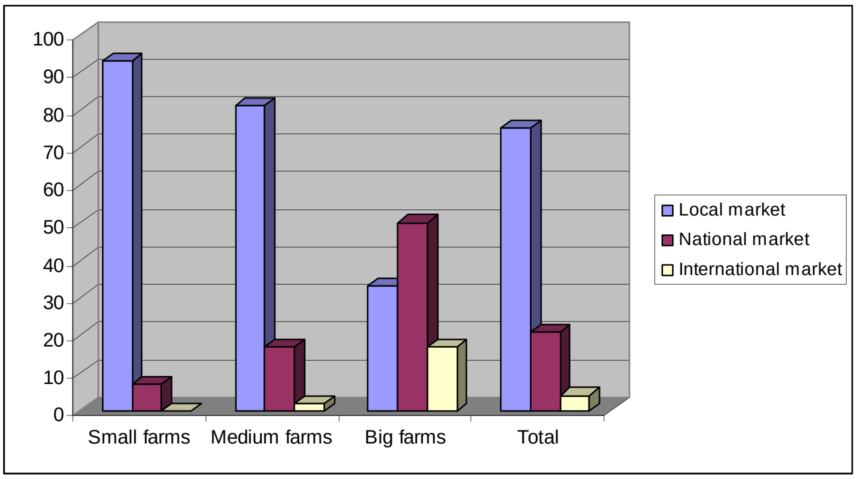
Prior to 1989, Bulgaria was a major exporter of agri-food products to the former USSR and other communist countries. Since then the country has had difficulties finding new markets due to low competitive power, poor quality of products and increased competition from the EU and other countries (OECD, 2000; MAF, 2002, Bachev, 2005). Furthermore, the agricultural market structure in Bulgaria, including horticulture was poor due to reduced domestic purchasing power, the slow process of privatization of the agri-food processing industry, lack of marketing skills among farmers and limited marketing support by the Government (SENTER, 2000; EC, 2002; Bachev, 2005).

Since 1989 the distribution channels in Bulgaria have been under continuous development but are still not well developed. The large state monopolies in marketing and distribution in Bulgaria were dismantled at the end of the communist period, the wholesale and retail channels were privatized and that process resulted in the emergence of a large numbers of new private agents (suppliers, processors, intermediaries) (FAO, 1999; SENTER, 2000).

Both before and after 1989, the farmers in the Plovdiv region had an advantage in terms of ‘selling’ their products because one of the three established wholesale markets in Bulgaria is located in the Plovdiv region. This advantage was present before 1989 and has continued since. However, according to FAO (1999) and Bachev (2005), the existing wholesale markets have functioned ineffectively and need significant improvement and modernisation.

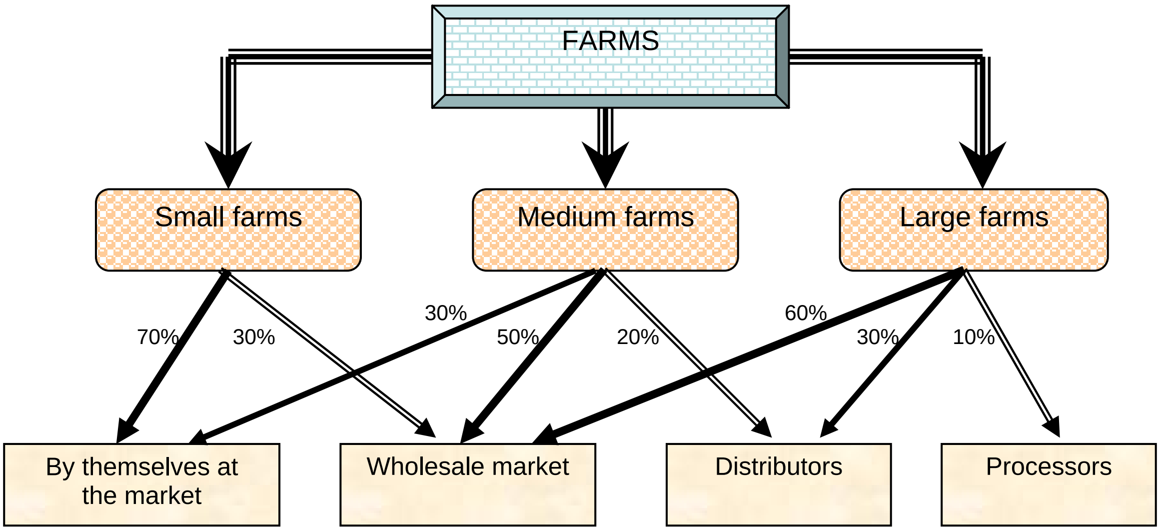
Given this troubled background, 75% of the farms in the survey sold their production locally during the pre-accession period. The national market was supplied by 21% of the farms and only 4% of them had international markets (Figure 1). Within these broad percentages, the results revealed that 50% of the farms of more than 10ha sold their production nationally. In comparison, the vast majority of the 'small' and 'medium size' farms (93% and 81%) were orientated towards their local market (Figure 1) due to their small production capacity.

Figure 1. Markets for farms of different sizes (volume)



In the years leading to EU accession, approximately half of the respondents used a wholesale market to sell their products. The farms of less than 2ha kept some of their production for self-consumption and sold the rest through the 'local' retail market. The 'medium' farms mainly sold their produce in the wholesale market (50%). The large farms, cultivating over 10ha, mostly used wholesale markets and due to their higher capacity also sold to distributors and processors (Figure 2).

Figure 2. The distribution channels for farms of different sizes



Both, the secondary sources and the primary data suggested that the practice of growing under contract did not appear to be widely used by the respondents. However, a few commercial farms marketed relatively large amount of products through contracts with national or international companies.

4.3 Land ownership patterns of the farms

More than half the farmers (56%) cultivated their own restituted land, about one third of them (34%) had a mixture of owned and leased land or leased land only and 10% of them were co-operatives (Table 2).

Table 2: Land ownership patterns for farms with different size

Land ownership	SIZE OF FARMS							
	Small		Medium		Big		Total	
	Count	%	Count	%	Count	%	Count	%
Own farms	**23**	**92**	**36**	**62**	1	4	**60**	**56**
Mixed/leased farms	2	8	22	38	**13**	**52**	37	34
Co-operatives	0	0	0	0	11	44	11	10
Total	25	100	58	100	25	100	108	100

The results show that 92% of the ‘small’ and 62% of the ‘medium size’ farms cultivated only their own land, whereas 52% of the big farms leased land and 44% of them were co-operatives (Table 2). The process of land restitution fragmented the agricultural land because many owners inherited a plot of land (FAO, 1999; OECD, 2000; MAF, 2002). Consequently, farm consolidation was possible only by leasing or buying neighbouring land. However, leasing land was perceived as a risky activity because the land legislation was poor and the land market was inactive in Bulgaria during the transition and in the years leading to EU accession (FAO, 1999; OECD, 2000). MAF (2006) believes that some land consolidation has taken place. However, after joining the EU land ownership remains fragmented and the land market is still inactive in Bulgaria.

4.4 Vision of the Farmers

The respondents were asked to describe their ideal vision for their farm business during the years leading to the EU accession. More than half of the interviewees (57%) stated that they wished to have a **modern farm** (Table 3). The main weaknesses of the farms were obsolete machinery and old technologies inherited from the large AICs that were not necessarily suitable for small-scale farming (OECD, 2000; SENTER, 2000; MAF, 2002; Bencheva, 2005). These aspects, combined with the lack of finance for buying new machinery, or to support research and development, help to explain the difficulties the respondents had in modernizing their farms.

Table 3. The visions of the farmers managing different sized farms

Visions*	**SIZE OF FARMS**						**Total**	
	Small		**Medium**		**Big**			
	Count	% of cases	Count	% of cases	Count	% of cases	Count	% of cases
Modern farm	10	40	**41**	**71**	**11**	**44**	**62**	**57**
Farm expansion	**14**	**56**	21	36	7	28	43	40
Having perennial crops	2	8	18	31	**11**	**44**	31	29
Effective marketing	2	8	3	5	**11**	**44**	16	15
Diversified activities	0	0	7	12	5	20	12	11
No dreams	5	20	5	9	2	8	12	11
Total of cases	25	100	58	100	25	100	108	100

Note: * This table includes only the top six answers given by the respondents. Percentages are based on multiple response answers. They are the percentages of cases rather than responses therefore they do not sum to 100%

The first steps towards achieving economic stability in Bulgaria after 1997, and the beginning of the EU accession process, influenced the farmers' vision and they began to consider the idea of becoming bigger and stronger in economic terms. Therefore, their second vision was

farm expansion (40%) (Table 3). At the same time, the official completion of land restitution, the improvement of land legislation, the establishment of long-term agricultural policies, the start of the SAPARD programme, and the EU accession process provided a basis for business growth. However, there were also some obstacles such as an inefficient land market, limited capital for investments and turbulent political, technological and economic changes (SENTER, 2000; MAF, 2007).

The results revealed that 29% of the farmers had a vision to **grow perennial crops** (fruits and grapes) (Table 3). MAF (2000), OECD (2000) and MAF (2006) have argued that fruits and grapes were the most profitable crops during the transition period and the years leading to EU accession due to strong market demand. This was confirmed by the respondents who identified perennial crops as providing capital for running the existing business as well as for business expansion. They also stated that the lack of finance for investments, limited governmental support, complicated loan procedures and the slow development of long-term leasing arrangements made the establishment of new orchards and vineyards very difficult.

Only 15% of the respondents sought an **effective market structure** (Table 3). They suggested that a market information database or establishing new wholesale markets (Western type auctions) would improve the marketing system in the country. Various national and international reports have argued that the market structure has been poor in Bulgaria during the transition period (FAO, 1999; OECD, 2000; MAF, 2002,) and several market support initiatives for farmers were introduced during the pre-accession period. However the marketing problems are still to be solved (MAF, 2007).

Only 11% of the interviewees had a vision related to **farm diversification** (agri-food processing units, plant nursery, agri-tourism, etc.) (Table 3). Again, lack of finance was the major obstacle for developing alternative economic activities. However, the respondents hoped that joining the EU would present better opportunities for farm diversification. Eleven percent of respondents did **not have a vision** regarding their farm business due either to their advanced age (over 60 years) or their difficult lives in a fast changing economic and business environment (Table 3).

There were some minor differences in the visions of the respondents with different sized farms. More than half of the interviewees with ‘small’ farms (56%) stated that their main vision was farm expansion. They believed this was essential if they wanted to stay in agriculture/horticulture, and be competitive, after Bulgaria joined the EU. The managers of the ‘big’ production units placed equal emphasis (44%) upon farm modernization, better marketing and cultivating perennial crops based on the potentially bigger profits that would enable them to invest in these activities. A relatively high percentage of farmers with ‘small’ enterprises declared that they did not have visions for their farms (Table 3). That could be because they were subsistence farms, and the farmers were over 60 years old.

4.5 Policy issues – critics and advice

The literature showed that the agricultural industry in Bulgaria has been in a critical situation over the last two decades. The OECD (2000) and SENTER (2000) stated that during the first 10 years of economic transition the agricultural and rural development policies have been unclear as some regulations contradicted each other or essential policy activities had been postponed. Therefore, the farmers in the sample who were the ‘main actors’ in agriculture/horticulture were asked to give advice about the economic development of this sector in the Plovdiv region of Bulgaria. This innovative ‘bottom up’ approach was novel for the respondents as prior to 1990 they were given no choice but to follow Government directions. For many of them being asked to give advice to the authorities was perceived as a ‘new’ positive experience.

In terms of advice they identified a range of activities that the Government needed to consider carefully and they were pleased to express their vision in regard to agriculture/horticulture. However, they did not believe that their advice would be followed by the government and the policy makers, consequently they considered this question as a ‘waste of time’.

The majority of the farmers who responded (73%) stated that they needed *financial support* in terms of grants and/or an improved credit system (Table 4). The agriculture/horticulture sector was regarded as having been primitive over the period (1989-2000) by SENTER (2000) and Mihailova (2000) and for the development of this sector there needed to be finance for buying new machinery, implementing modern technologies and research for introducing new crop varieties.

Table 4. Advice of the farmers to the Bulgarian Government

Advice*	SIZE OF FARMS						Total	
	Small		**Medium**		**Big**			
	Count	% of cases	Count	% of cases	Count	% of cases	Count	% of cases
Financial support	14	56	45	78	20	80	79	73
Marketing support	14	56	18	31	12	48	44	41
Better import/export regulations	10	40	22	38	11	44	43	40
Incentives to stay in the agriculture	8	32	19	33	3	12	30	28
Total of cases	25	100	58	100	25	100	108	100

Note: * This table includes only the top five answers. Percentages are based on multiple response answers. They are the percentages of cases rather than responses therefore they do not sum to 100%

During the transition period, the banks considered advancing loans for agricultural activities to be very risky. Therefore it was very difficult for farmers to borrow. Another obstacle to borrowing was that agricultural land was not accepted as a good security, which made the procedure very complicated and time consuming. An agricultural credit association was established in the Plovdiv region but its lending capacity was below the demand for loans (OECD, 2000). The farm business required low interest rates and long-term loans. The respondents claimed that offering grants to farmers for buying machinery would increase the efficiency and the competitiveness of horticultural enterprises.

Various national and international reports have identified that the market structure has been poor in Bulgaria since 1989 (FAO, 1999; MAF, 2000; OECD, 2000). Fortyone percent of the farmers confirmed this fact and suggested that the Government should improve the *marketing system* (Table 4). The farmers' proposals included: the establishment of Western type auctions; developing a market network for farmers and distributors; supporting the agri-food processing industry, which had used huge quantities of agricultural products as raw materials, prior to 1989.

It was also reported in the studies made by SENTER (2000) and EC (2001) that Bulgarian farmers were not prepared for the sudden change from a centrally planned economy to a free market and joining the EU, which demanded a commercial approach to farming.

Consequently, Bulgarian farmers did not have enough business and marketing skills and proposed that the Government should initiate more training courses to improve producers' skills in these areas (SENTER, 2000; EC, 2001).

It has to be acknowledged that the Government did take some actions towards improving the market system during the pre-accession period such as running a project for the establishment of wholesale markets (supported by the German Government), building an advisory and network information system and trying to find markets for agri-food products (MAF, 2000; SENTER, 2000; MAF, 2007).

According to 40% of the interviewees, *import/export regulations* were unfavourable to farmers (Table 4). On one side, with the collapse of the Communist regime in 1989, Bulgaria lost its main international markets (other CEE countries and the former USSR) which were not replaced. Therefore agricultural exports fell dramatically. On the other hand, Bulgarian farmers faced increased competition from Western European countries, which was new for them and they did not have the skills to deal with it. The competition was amplified because of the various agreements for low tariff barriers with CEFTA and EU (OECD, 2000; SENTER, 2000; Mihailova, 2000).

At the same time farmers were under pressure from illegal imports at low prices from neighbouring countries, for example Macedonia and Turkey. Respondents suggested changing the import/export regulations by implementing a stable and clear trade policy that would protect local producers and would support the export of Bulgarian agricultural produce. Farmers sought increased import taxes to protect domestic agricultural producers.

Twentyeight percent of the respondents sought *incentives to stay in agriculture/horticulture* (Table 4). Addressing the problems of the rural areas by improving the infrastructure and the social environment, reducing the level of bureaucracy, supporting small and medium businesses, as well as younger farmers, were the main suggestions that interviewees proposed.

During the pre-accession period, some EU programmes (*e.g.* SAPARD) introduced measures to tackle the problems of the rural areas. The measures aimed to support young farmers, provide adequate training programmes (*e.g.* diversified economic activities) and improve the infrastructure in the rural areas (OECD, 2000; EC, 2000). The national strategy plan for rural development (2007-2013) addresses the problems of rural areas and provides a plan for solving them (MAF, 2007).

5. Conclusions

Horticulture is an emerging field of research in Bulgaria. This research found that small-scale (often subsistence) farms (less than 2ha) were involved primarily in vegetable production, which farmers sold at the local market. The 'medium' farms (2-10ha) were transitional and were working under pressure for either survival or expansion under the EU conditions. They produced mainly annual crops (vegetables and other agricultural crops) for the local wholesale markets. The 'big' farms (over 10 ha) were commercial and focused on efficiency and profitability. They grew annual crops and some perennials (fruits and grapes) (Garnevska et al, 2008).

The economic reforms in 1989, the process of land restitution and the development of the private farming found farmers unprepared for running commercial farms, not having the skills to run businesses in a free market economy.

During the transition period, lack of capital for investment, lack of, or uncertain markets, illegal imports and loss of the main export markets were the key obstacles hindering horticultural producers identified in this research. The farmers in the Plovdiv region suggested that for the successful development of Bulgarian agriculture and horticulture there needed to be from government more financial support, marketing support and more favourable import/export regulations.

Considering the problems of the horticultural sector and the difficult financial situation in Bulgaria during the years leading to EU accession, the farmers' visions were for modern farms or larger farms to be more competitive. Perennial crops, like fruit and grapes, were widely acknowledged to be the most profitable products during the transition and pre-accession periods. Bulgaria joined the EU in 2007 and the visions of the farmers might now be very different but this requires further research.

This study demonstrated that despite the difficult economic and dynamic environment in Bulgaria, horticultural farms have significant potential due to favourable natural conditions coupled with the tradition of growing horticultural crops that has existed for centuries. During the transition period (1990s), Bulgarian agriculture underwent dramatic changes and reforms such as land restitution and privatization. In the pre-accession period (1999-2007) the agricultural sector in Bulgaria was restructured to fulfill the criteria for joining the CAP and entry into the EU. Equally, joining the EU in 2007 has presented new challenges and opportunities for farm businesses in Bulgaria.

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Successful implementation of new strategies in the farm business – Facilitators and inhibitions found at Swedish sugar beet farms

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Abstract

This paper aimed at relating the implementation success of new action programs in farm businesses to the nature of the program and to personal characteristics and situation of the farmer. Hypotheses about how the nature of the action program and personal characteristics and situation of the farmer influence implementation success, defined as the extent to which the program solved the problem it was intended to solve, were developed and tested in a generalized logits model. The study was based on the observed implementation success among Swedish sugar beet farmers, who implemented action programs in response to the recent sugar beet reform. Data were collected through a postal questionnaire sent to a random sample of Swedish sugar beet farmers. Results showed that successful implementation of action programs was related to action programs that do not allow for incremental implementation, i.e. a situation where a more thorough change is done directly. Furthermore, successful implementation was found to be related to internal locus of control, absence of other major problems, and to analytical approaches to interpreting information. The results provided a ground for discussing how farm advisory services can be improved to help farmers to successfully implement new action plans.

Keywords: Farms, Implementation of action programs, Strategy, Sugar beet, Sweden

1. Introduction

Many farmers face an increasingly unstable external environment. In several European countries, farms are involved in major structural changes, where small farms tend to exit farming or merge with other farms (see e.g. Hansson, 2008a). At the same time, farms are meeting new challenges and opportunities through increasingly unstable prices, new emerging markets, such as bio-energy and agricultural tourism, and increasing competition.

To survive and stay competitive in this environment, successful implementation of action programs in response to the problems that arise are essential and successful strategic decision-making, or in other words, strategic problem solving, must be viewed as a key success factor. Indeed, in a study by Harling in 1992 it was found that farmers who tend to think more in terms of strategic management were the more successful ones. Thus, careful strategic management can help farmers to handle the increasingly unstable environment. Despite this, strategic management among farmers is somewhat under-developed. For instance Hansson (2008b) found, while surveying dairy farmers in Sweden, that only 15% of 313 farmers reviewed their financial situation and made a new budget at the beginning of the year. Furthermore, Hansson (2008b) found that 35% of 327 farmers did not check the outcome of their major decisions after implementing them. Thereby, they missed the opportunity to use this information when making major decisions in the future.

Farmers' actual strategic decision making processes have been studied in some detail in the literature. However, most of the studies do not focus on the implementation of action programs. Successful implementation of action programs would be crucial for the farmers to adapt to new situations. Rather, previous literature has focused on the detection and definition of unique problems (eg. Öhlmér et al. 1997; Öhlmér 1998), on the choice of action alternatives (e.g. Lunneryd & Öhlmér 2009) or on the strategic decision-making process as such (e.g. Farmar-Bowers & Lane 2009; Sutherland 2010). However, Öhlmér et al. (1998) studied in detail the entire problem solving process (including implementation) of farmers and found that they prefer an incremental approach to implementation, where strategic matters are solved step-wise and ideas can be tested at a smaller scale before the main implementation. Furthermore, Lund & Christensen (2003) and Noell & Lund (2003) advocated the utility of the Balanced Scorecard to implement new strategies on farms. None of these studies evaluated the success of the problem solving process.

Outside agriculture, facilitators and inhibitors of successful implementation of strategic decisions are studied in empirical applications. For instance, Nutt (1999) found that the implementation tactic must be adapted to situational conditions, such as corporate culture and power. Hickson et al. (2003) concluded that a combination of an experience-based, i.e. planned approach, and a readiness-based approach provides the best implementation success. In a study by Miller (1997) successful implementation was found to depend on clear aims, planning and cultural receptivity, whereas experience, prioritizing implementation, and having abundant resources were found to matter less.

Although these studies contribute to the understanding of successful implementation of action programs, they are not readily applicable to farms. As farms are often small, one-man-businesses, the decision-maker and the person implementing the decision is often the same person and this is different to the above-cited studies, where decisions are implemented by someone else. On farms, successful implementation is more likely to depend on the nature of the action program and on personal characteristics and situation of the farmer. In particular, successful implementation is likely to depend on whether or not the action program can be implemented through an incremental strategy (Öhlmér et al. 1998), implying that the farmer can test the idea on a smaller scale, or have a realistic possibility to change the program once implementation has started. This can be contrasted to the case where the program cannot be tested on a smaller scale or be adjusted to any larger extent once implementation has started. Furthermore, the small size of farms, and that they are often run and managed by only one or a few people, means the personal characteristics and situation of the farmer will heavily influence the strategic decision making on the farm.

Successful implementation of new strategies can be defined either as having adopted a decision, a definition which does not consider the effectiveness of the decision and what was achieved with the decision, or as choosing and implementing an action plan that solves the problem it was intended to solve i.e. the appropriateness of the implemented strategy. The first definition of successful implementation is a pre-requisite to the second one; however, the second definition is not a pre-requisite to the first one. In the literature, both definitions are used, sometimes simultaneously, and sometimes only one of the definitions is used (Miller 1997; Nutt 1999).

The aim of this paper was to contribute to the farm management literature, by relating the implementation success of action programs in farm businesses to the nature of the program and to the personal characteristics and situation of the farmer. In so doing, the paper provides a foundation for improved farm advisory services for farmers implementing working action programs in response to the changing surrounding environment. Further, the paper contributes to the literature on implementation of strategic plans by considering the effect of incremental implementation. Successful implementation was defined as the extent to which the new strategy solved the problem it was intended to solve. This measure of successful implementation takes into consideration whether or not the implemented action program achieved what it was intended to achieve.

2. Literature and hypotheses

2.1 The nature of the action program

One way of analyzing the nature of the action program is whether it can be regarded as allowing for incremental implementation. In a situation where incremental implementation is possible, the farmer can try the action program on a small scale before full implementation (Öhlmér et al 1998). Incremental implementation enables learning through trial-and-error, to undertake necessary corrective actions during implementation and to reverse the process if the results are not according to plan. In this respect, the incremental implementation process can be contrasted to more rational implementation processes, where implementation is thoroughly planned before the process starts, and once the implementation process has started there are no, or only minor, possibilities to reverse the decision. Incremental implementation involves several interwoven decisions and streams of actions, which all constitute the new action program, and in this respect is similar to the concept of emergent strategy (Mintzberg & Quinn 1992).

It was hypothesized that whether or not the new action program allows for incremental implementation affects implementation success. As farmers prefer incremental implementation (Öhlmér et al 1998), it was assumed that a strategy allowing incremental implementation should lead to more successful implementation. This produced the following hypothesis:

H1: *Farmers who choose an action program that does not allow incremental implementation experience less successful implementation.*

2.2 Personal characteristics and situation of the farmer

Personal characteristics and situation of the farmer have been found repeatedly in the empirical literature to affect the economic outcome of farms (e.g. Wilson et al. 2001; Trip et al. 2002; Hansson, 2008b). The success of a strategic decision making process is likely to depend considerably on the human resources in the firm (e.g. Lee et al. 1999). The literature on the influence of the farmer's personal characteristics and situation on farm outcome covers a wide range of aspects, including the demographics such as the farmers' experience (Wilson et al. 1998; Sharma et al. 1999; Wilson et al. 2001), their goals and values (Gasson 1973; Wilson et al. 2001; Trip et al. 2002; Hansson 2008b), and psychological aspects such as locus of control. Locus of control, originally due to Rotter (1954), refers to the extent that individuals believe that they can affect their own situations themselves. Locus of control has been found by Öhlmér et al. (1997) and Öhlmér (1998) to affect the ability of farmers and therefore their problem detection and definition. Hansson (2008b) found that a higher degree of internal locus of control positively affected farmers' economic efficiency.

A situation where the farmer experiences other major problems should also affect implementation success. Öhlmér (1997) found that presence of other significant problems, something that was called avoidance, negatively influenced the problem detection of farmers, a finding that shows that presence of other problems diverts attention from other possible problems and that problems are addressed sequentially.

The psychological literature on problem solving often emphasizes the way information is interpreted as an explanation for different approaches and results in problem solving. In this respect, Hogarth (2001) provides insights relevant for this study in that two basic systems operate when interpreting information: the tacit and the deliberate systems. The tacit, or intuitive system, interprets information relying on previous experience or feelings; whereas, the deliberate, or analytical, system interprets information based on conscious listings of advantages and disadvantages and careful calculations. The intuitive system is fast, effortless and requires no attention. The analytical system is slower and requires effort and attention, but is more likely to be correct, if previous experience is limited.

Thus, the following set of hypotheses with respect to how personal characteristic and situation of the farmer affect implementation success were formulated:

H2: *Farmers who have more experience in management of an agricultural firm experience more successful implementations*.

H3: *Farmers who have a higher degree of internal locus of control, experience more successful implementations.*

H4: *Farmers who have other major problems, experience less successful implementations.*

H5: *Farmers who use analytical approaches to interpreting information, experience more successful implementations.*

3. Material and methods

This study was based on the observed implementation process of Swedish sugar beet producers' adaptation to a major decrease in revenue caused by the sugar beet reform suggested by the EU commission in 2004 and decided in early 2006. The sugar beet reform implied that the guaranteed output price of sugar would be reduced by almost 40 percent; thus, if sugar beet producers did nothing about their situation, their previous revenue from beet cultivation would be reduced by 40 percent. Even though the reform also implied that sugar beet producers would be compensated for 60 percent of their loss through the decoupled Single Farm Payment and policy interventions were issued to stimulate them to stop producing sugar beets, the reform did imply a substantial reduction of farm revenue. To most farmers growing sugar beet, this meant that a crop previously amongst their most profitable was no longer viable to produce. Therefore, an action program was required and needed implementing.

The hypotheses (H1 – H5) outlined were tested in regression analysis. The size of the farm (measured by its turnover), the perceived size of the problem, dependency on sugar beet production (measured as the percentage of total revenue originating from sugar beet production), and the perceived situation before the sugar beet reform were control variables in the regression analysis, as they were likely to also influence implementation success.

3.1 Data

Data were collected through postal questionnaires sent to a random sample of 354 Swedish sugar beet producers in March 2007 inquiring about action programs, implementation success, and about the farmer and the farms in general. When the questionnaire was sent out, the sugar beet reform had been in place about eight months. To ensure that sugar beet production was a major part of the farm revenue, inclusion in the sample was restricted to farmers with a production quota of at least 100 000 kg, which implied at least 12 hectares reserved for sugar beet production. The response rate was 58 percent (206 replies). Of these, 121 (59 percent) farmers had decided on an action program to meet the new situation, of whom 95 farmers had already implemented an action program in response to the sugar beet reform. The remaining 26 had not yet reached implementation step in their strategic decision process. Seventy-three of the 95 farmers who had implemented a new strategic plan completed all questions of interest for this study, and were thus included in this paper. T-tests were conducted to investigate whether or not there were significant differences between the farms included in the study and those excluded but revealed no significant differences in terms of estimated loss, in SEK, caused by the sugar beet reform. However, the farms included in the study had a slightly larger part of their revenue originating from sugar beet production (p-value: 0.064).

As emphasized previously, successful implementation was measured by taking into consideration whether the implemented action program achieved what it was intended to achieve. This was done by considering whether the action program was enough to compensate for both the decrease in farm profit and the private income of the farmer. The respondents were asked to chose among three alternatives in the questionnaire 1) the chosen action program is not enough to compensate for the decrease in farm profit or in the farmer's private income, 2) the chosen action program is enough to compensate for the decrease in the farmer's private income, but not for the decrease in the farm profit and 3) the chosen action program is enough to compensate for the decrease in both farm profit and in the farmer's private income.

A critique against collecting data via a questionnaire is that respondents may understand questions in different ways, and thus respond to them in different ways. To reduce the risk of this, the questionnaire was discussed with potential respondents and experts. Furthermore, experience gained from the authors' previous work with questionnaires sent to farmers were used to construct clear questions with minimal risks of miss-interpretations.

The descriptive statistics of the 73 farmers analyzed in this study are presented in Table 1. The chosen action program was generally insufficient to compensate for the private income loss caused by the sugar beet reform (Table 1). Most farmers implemented an action program that was to some extent incremental, i.e. it can be tested on a smaller scale, or to a large extent adjusted at a later stage. Thirty percent of the farmers implemented action programs that could not be adjusted. Generally, farmers perceived the sugar beet reform as a middle-sized problem, that is, neither a small problem nor a large problem, and appeared content with the situation before the sugar beet reform. On a five-point scale, this gave an average score of 4.70 (Table 1).

Table 1. Descriptive statistics of the variables use in the study, n = 73.

Variable (abbreviation)	Scale	Mean	Standard deviation
Implementation success *(SUCCESS)*	1: The chosen action program is not enough to compensate for the decrease in farm profit or in the farmer's private income (n = 25) 2: The chosen action program is enough to compensate for the decrease in the farmer's private income but not for the decrease in the farm profit (n = 22) 3: The chosen action program is enough to compensate for the decrease in both farm profit and in the farmer's private income (n = 26)	2. 01	0.84
Non-incremental strategy *(NO-INCR)*	1: yes 0: no	0.30	0.46
Turnover *(TURN)*	1: less than SEK 1000 000… 6: more than SEK 5000 000	3.85	1.52
Revenue from sugar beets in relation to total revenue *(SUGAR)*	Percent	23.16	10.56
Perceived size of problem *(SIZE)*	1: no problem …5: a very big problem	3.04	1.05
Perceived situation before the sugar beet reform *(SIT)*	1: unacceptable….5: very good	4.70	1.06
Experience from business management *(EXPER)*	Years	21.89	10.28
Other problems *(OTHER)*	1: yes 0: no	0.15	0.36
Locus of control *(LOC)*	1: Own decisions have very little effect on the economic results of the farm…4: Own decisions have the largest effect on the economic results of the farm.	3.47	0.87
Analytical thinking *(ANALY)*	1: yes 0: no	0.84	0.37

The Spearman correlation coefficients between the variables in the study are presented in Table 2: the degree of implementation success is significantly negatively correlated with *SUGAR* (p-value: 0.008), *SIZE* (p-value: 0.006) and *EXPER* (p-value: 0.008) and positively correlated with *LOC* (p-value: 0.001), but not correlated with *NO-INCR*. For mutual correlations between the covariates, *OTHER* is correlated with *TURN* (p-value: 0.010), *SUGAR* (p-value: 0.021), *SIZE* (p-value: 0.040) and *EXPER* (p-value: 0.046), which may cause *OTHER* to be insignificant in the regression analyses. Furthermore, there was a strong correlation between *SUGAR* and *TURN* (p-value: <0.001).

Table 2. Spearman correlation coefficients: p-values in parentheses.

	SUCCESS	*NO-INCR*	*TURN*	*SUGAR*	*SIZE*	*SIT*	*EXPER*	*LOC*	*OTHER*	*ANALY*
SUCCESS	1.000									
NO-INCR	0.131 (0.270)	1.000								
TURN	-0.011 (0.929)	0.046 (0.702)	1.000							
SUGAR	-0.308 (0.008)	0.037 (0.755)	-0.550 (<0.001)	1.000						
SIZE	-0.321 (0.006)	0.066 (0.577)	-0.185 (0.116)	0.270 (0.021)	1.000					
SIT	0.143 (0.231)	0.088 (0.457)	0.160 (0.175)	-0.110 (0.356)	-0.245 (0.037)	1.000				
EXPER	-0.307 (0.008)	0.053 (0.659)	-0.019 (0.872)	0.118 (0.322)	0.201 (0.088)	-0.016 (0.891)	1.000			
LOC	0.367 (0.001)	-0.190 (0.107)	0.040 (0.734)	-0.059 (0.619)	-0.126 (0.287)	0.077 (0.515)	-0.259 (0.027)	1.000		
OTHER	-0.054 (0.650)	-0.026 (0.825)	-0.301 (0.010)	-0.270 (0.021)	-0.241 (0.040)	0.074 (0.532)	-0.234 (0.046)	0.093 (0.434)	1.000	
ANALY	-0.082 (0.491)	0.050 (0.677)	-0.150 (0.204)	0.148 (0.212)	0.364 (0.002)	-0.175 (0.138)	-0.039 (0.745)	-0.123 (0.299)	-0.182 (0.124)	1.000

3.2 Statistical methods

As the dependent variable, i.e. how successful the implemented strategy was, was measured at ordinal scale, the initial intention was to fit the data to an ordinal logistic model for assessing the impact of the hypothesized influencing variables and the control variables. The proportional odds assumption was rejected (p-value: < 0.0001) and it implied the ordinal logistic model could not be used; instead, the generalized logits model was fitted to the data.

The generalized logits model implied treating the response variable *SUCCESS* as having no internal order in the responses; thus, the three levels of success were treated as nominal variables. In the generalized logits model, one level in the response variable was treated as the reference category, and logits for the other levels were modelled to compare the response levels to the reference category. This model is expressed as:

$$\log\left(\frac{\pi_{\mathrm{ij}}}{\pi_{\mathrm{ir}}}\right) = \alpha_j + \mathbf{x}'_{\mathbf{i}}\,\beta_j \qquad (1)$$

where π_{ij} is the probability that a farmer with covariates in vector **i** reaches an implementation success level *j*, $j \neq r$ where success level *r* is the reference category. The model produces separate intercept parameters α_j and regression parameters β_j for each logit. In this case, there were three response levels in the response variable. One of these was the reference category, this was response level 1: *The chosen action program is not enough to compensate for the decrease in farm profit or in the farmer's private income.*

Two logits were modelled for the covariates considered: one logit compared the reference category to the second response level (*The chosen action program is enough to compensate for the decrease in the farmer's private income, but not for the decrease in the farm profit*), and one compared the reference category to the third response level (*The chosen action program is enough to compensate for the decrease in both farm profit and in the farmer's private income*).

The proc logistic procedure, with the option link=glogit in the statistical program SAS version 9.1 (SAS institute inc., 2002-2003) was used to fit the model in Equation 1 to the data.

4. Results

The impact of the hypothesized influencing variables was assessed according to the procedure outlined above. The parameter estimates and the point estimates and 95% Wald confidence intervals of the odds ratios are presented in Table 3. Two logits were estimated, one compared implementation success of level 2 to the reference category, i.e. implementation success level 1, and the other compared implementation success of level 3 to the reference category (Table 3, where 2 and 3 in the *SUCCESS* column refer to the level of implementation success as compared to level 1).

The global fit statistics supported a significant model fit, with significant likelihood ratio, score and Wald tests. R-square was 0.611 and the max-rescaled r-square was 0.688, indicating a good model fit. The odds ratio point estimates were defined as e^{β_i} and indicated how the probability of having an implementation success level of 2 compared to the reference category, i.e. failure, or 3 in comparison to 1.

The results in Table 3 show that the two logits had different significant explanatory variables. The control variable *SUGAR* was significant in the logit referring to success level 3, whereas, *SIZE* and *SIT* were significant in the logit referring to success level 2: the control variable *TURN* was not significant. The results implied the probability of being at success level 3 compared to the reference category decreased if income from sugar beet production increased relative to total income. Furthermore, the results imply that the probability of being at success level 2 compared to the reference category decreased if the problem was perceived as larger, and increased if the situation, before the sugar beet reform, was perceived as better. All these findings were plausible.

In terms of the relationships hypothesized, *NO-INCR* was significant for both logits. The estimates were positive, indicating that farmers who chose to implement an action plan that was not possible to implement incrementally, were more likely to be at implementation success levels 2 or 3 than at the reference category.

The degree of internal locus of control, *LOC*, was significant in the logit comparing implementation success level 3 and the reference category. The sign of the parameter estimate was positive, which suggested that having a higher level of internal locus of control increased the probability of being at the highest implementation success level compared to the reference category.

Other major problems, *OTHER*, was significant in the logit comparing implementation success level 3 with the reference category. The estimate was negative, suggesting that other major problems decreased the probability of being at success level 3. Thus, farmers who experienced other problems, in addition to the problems caused by the sugar beet reform, were less likely to be able to implement a strategy that allowed them to experience the highest success level.

An analytical approach to interpreting information, *ANALY*, was significant in the logit comparing the implementation success level 2 with the reference category. The parameter estimate was positive, implying that the probability of being at implementation success level 2, compared to the reference category, increased if an analytical approach to interpreting information was applied.

The hypothesized relationship between the farmers' degree of experience of business management and successful implementation was non-significant in both cases, suggesting that the degree of experience did not affect implementation success.

Table 3. Parameter estimates, odds ratio point estimates, and confidence intervals of the two estimated logits: p-values in parenthesis.

	SUCCESS	Parameter estimate	Odds ratio point estimate	Lower conf. limit	Upper conf. limit
INTERCEPT	2	-3.885 (0.363)			
INTERCEPT	3	-4.805 (0.368)			
NO-INCR	2	2.493 (0.021)	12.093	1.453	100.644
NO-INCR	3	3.043 (0.010)	20.977	2.088	210.703
TURN	2	0.238 (0.472)	1.268	0.664	2.422
TURN	3	-0.593 (0.114)	0.553	0.265	1.153
SUGAR	2	-0.085 (0.125)	0.919	0.825	1.024
SUGAR	3	-0.194 (0.002)	0.823	0.728	0.932
SIZE	2	-1.116 (0.0381)	0.327	0.114	0.941
SIZE	3	-0.757 (0.139)	0.469	0.172	1.280
SIT	2	0.791 (0.087)	2.206	0.892	5.453
SIT	3	0.711 (0.163)	2.035	0.750	5.522
EXPER	2	0.003 (0.944)	1.003	0.918	1.096
EXPER	3	-0.077 (0.105)	0.926	0.844	1.016
LOC	2	0.492 (0.319)	1.636	0.621	4.307
LOC	3	3.056 (0.006)	21.236	2.418	186.488
OTHER	2	0.026 (0.983)	1.026	0.101	10.432
OTHER	3	-3.318 (0.041)	0.036	0.002	0.866
ANALY	2	2.740 (0.047)	15.480	1.043	229.745
ANALY	3	1.002 (0.387)	2.725	0.281	26.398

Global fit statistics of $\beta = 0$: Likelihood Ratio test, p-value < 0.0001; Score test, p-value <0.0001; Wald test, p-value = 0.0698

R-square: 0.611; Max-rescaled R-square: 0.688

5. Discussion and conclusion

This paper aimed at relating the implementation success of action programs that farmers have undertaken in response to strategic problems in their businesses, to the nature of the action program, and to the farmers' characteristics. In particular, implementation success was related to the non-incremental nature of the action program and to personal characteristics and situation of the farmer, i.e., locus of control, analytical thinking, experience and presence of other major problems, while controlling for farm size, perceived problem size, dependency on sugar beet production, and the perceived situation before the problem arose.

The study was based on data collected by surveying a sample of Swedish sugar beet producers about their responses to the strategic problems caused by the sugar beet reform. The data collection process implies that the farmers' perceptions of their implementation success were considered. If the perceptions deviate from the real outcome, this will influence the results. In future studies it would be interesting to follow up the implementation on the studied farms by evaluating the implementation success based on their accounting systems. This would however require that respondents are willing to share their accounting system with researchers.

About one-third of the farmers who answered the questionnaire had implemented a new strategic plan as a response to the sugar beet reform, and were therefore included in this study. The reason the other two-thirds had not yet implemented a new strategic plan might be that for some reason their implementation failed, or they had not had time to do the implementation, at the time of survey. This question needs to be followed up in future research. Among farms included in the study, the distribution of implementation success was about 1/3 at each implementation success level, and the analysis of these farms provided important insights into the research question.

Based on a literature review, a set of hypotheses was formulated and tested in a subsequent regression analysis. Hypothesis H1 was rejected in both logits, the results obtained from both logits suggested that farmers who chose action programs that did not allow for incremental implementation experienced the more successful implementation. Öhlmér et al (1998) suggest that farmers prefer incremental approaches to implementation; however, these finding suggested that the preferred implementation strategy lead to a lower implementation success. One reason for the negative impact of action plans allowing incremental implementation could be that it is more time consuming to conduct and thereby the expected pay-offs are not yet fully realized. Further, implementation of non-incremental action programs, i.e. action programs that cannot be easily adjusted, may cause managers to think in an *ex post* rational way to justify the decision, and thereby perceive a higher degree of implementation success. Another reason why action plans that do not allow for incremental implementation lead to higher success levels is that such action plans might be more innovative and associated with markets that are not yet fully exploited. In such a situation microeconomic theory suggests that the profit margins should be larger. Furthermore, action plans that do not allow for incremental implementation might also be associated with higher risk, something which is normally also associated with higher (but more volatile) return (e.g. Ross et al. 2002). Yet another reason for the higher implementation success caused by action programs that do not allow for incremental implementation is that these action plans may be more thorough and therefore imply a higher level of implementation success. From a farm advisory services perspective, this suggests that advisors should encourage more thorough changes, although this question needs to be further addressed.

Although experience is considered to strongly influence the economic and technical efficiency results in farms (e.g. Wilson et al. 1998; Sharma et al. 1999; Wilson et al. 2001), the statistical results did not support the effect of experience on implementation success; thus, hypothesis H2 was rejected. This finding implied that the more experienced farmers did not achieve higher levels of implementation success, even though they should be more experienced with implementation. Implementation of an action program in response to a strategic problem can be considered as a unique situation, in which case previous experience may not facilitate the implementation. This line of reasoning suggest that the mental models (Klein et al. 2005) of implementation of new action programs are not more developed for people who have been farm managers for a longer period of time. It should however be noted that the average level of experience in the sample was high, with a small standard deviation, suggesting that insignificance of experience might also be due to low variation in this particular sample.

Locus of control was significant and positive in the logit contrasting implementation success level 3 to the reference category, suggesting that a higher degree of internal locus of control increased the probability of achieving higher levels of implementation success. This confirmed hypothesis H3. The positive effect of higher internal locus of control concurs with other research (Öhlmér et al. 1997; Öhlmér 1998; Hansson 2008b). To support farmers in becoming more successful in their implementation processes, their feelings about being able to influence the situation need strengthening.

Major problems other than caused by the sugar beet reform significantly affected implementation success in such a way that those farmers with other problems were less likely to be at the highest level of implementation success, compared to the reference category. Thus, hypothesis H4 was confirmed. One reason for this finding might be that farmers with other problems lacked resources and time for solving the problem caused by the sugar beet reform and suggested that problems were addressed sequentially. This behavior was suggested by Cyert & March (1963) to also occur in larger firms because of limited capacity to handle all problems simultaneously. Similar results are identified by Öhlmér et al. (1997) and Öhlmér (1998). Although the behavior is a natural consequence of managers' limited resources, the consequences are that problems accumulate. This problem needs solving, for instance by developing managerial assistance tools that help managers with other problems to also be able to detect and handle new ones: this would help to develop farm advisory tools.

The farmers' analytical approach to interpreting information increased the probability of being at implementation success level 2 compared to the reference category; thus, hypothesis H5 was confirmed in one of the logits. The result implied that farmers who apply analytical approaches to interpreting information achieve higher levels of implementation success than those who apply only intuitive approaches. To support farmers in becoming more successful in their implementation of new action programs, it would be beneficial to help them become more analytical in their interpretation of information.

In conclusion, this paper has, by relating the implementation success of action programs in farm businesses to the nature of the program and to personal characteristics and situation of the farmer provided insights into what facilitates and inhibits implementation success. Apart from contributing to the academic farm management literature, where studies of farmers' implementation success previously did not exist, and to the general literature on successful implementation, which had previously not considered the effect of incremental implementation, this paper provides a foundation for discussing how farm advisory services can be improved.

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Title: Does the CAP support cohesion objectives? An examination of the distributional impact of agricultural support

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Does the CAP support cohesion objectives? An examination of the distributional impact of agricultural support

Abstract: Using a dynamic multi-product partial equilibrium model, this paper first examines the potential impact of recent policy changes accruing from the mid term review (MTR) of the Common Agricultural Policy (CAP) in 2003, on the cattle and sheep sectors in Ireland. Second, it evaluates the potential impact of the implementation of a CAP, budget neutral, common EU flat area payment across all Member States. The European Commission has signalled that it will be evaluating current differences in the level of support between Member States as, for example, in the explanatory memorandum accompanying the Commission's Health Check proposals the Commission argues that it is "increasingly harder to justify the legitimacy of significant individual differences in the support level which are only based on past support" (CEC, 2008; p.18). This paper demonstrates how there are significant differences in the level of CAP payments per hectare across Member States, as generally farmers in more prosperous Western and Nordic countries receive a much higher level of payment per hectare than farmers in relatively poorer Central and Eastern European countries. In relation to Ireland, similar to most other EU-15 countries, farmers benefit from the current inequitable distribution of payments and the results indicate that any move towards equalising the level of payments per hectare will have a significant negative impact on agricultural production and net trade.

Introduction

The move from coupled payment policy instruments to payments that are decoupled from production in Ireland and in many other countries within the EU has made estimating the future production behaviour of farmers much more challenging. Prior to the move towards the decoupling of direct payments in 2003, income support was linked to production decisions and farmers in the EU, to a large extent, were shielded from fluctuations in the market and agricultural production remained relatively stable. Breaking the link between payments and production, however, is likely to make production more responsive to changes in market prices.

Policy changes such as the shift towards decoupled payments not only have significant effects on agriculture but also rural areas and society more generally (Moreddu et al., 2004; Kantelhardt, 2006; Boel, 2006). Farmers can be viewed as multifunctional providers of a range of commodity and non-commodity goods (Burrell, 2004) as in addition to providing us with food and other raw materials necessary for our survival and maintaining economic activity in rural areas (Kelch and Normile, 2004), farming activity has environmental (Firbank, 2005; Cocklin et al., 2006), aesthetic (Vanslembrouck et al., 2005) and social functions (Gerowitt et al., 2003). Given the significant and wide-ranging effects of farming activity on the agricultural sector and on society more generally, and the budgetary resources devoted to agriculture within the EU, it is important that the effect of policy changes on agricultural activity be assessed.

Two grassland based sectors dominate Irish agriculture: beef production and milk production. Typically, each accounts for close on one third of overall agricultural output value in Ireland. The other main grassland enterprise is sheep production.[1] This paper, utilising a partial equilibrium model of the EU agricultural sector (AGMEMOD), examines the potential impact of recent changes to the CAP on the cattle and sheep sectors in Ireland. This analysis focuses on the beef and sheep sectors as it was felt that it would be beyond the scope of this paper to discuss the dairy sector which faces a fundamental policy change in the form of EU milk quota elimination. This complicates the analysis of the impact of CAP reform on the dairy sector and means that a concise discussion of the impact is not possible in this paper.[2]

Secondly, this paper analyses the effect of introducing a common EU wide flat rate payment across all Member States on the cattle and sheep sectors in Ireland. This is calculated as the sum of the currently agreed national budgetary envelopes divided by utilisable agricultural area in the EU-27. The European Council has called upon the European Commission "to undertake a full, wide ranging review covering all aspects of EU spending, including the Common Agricultural Policy (CAP)…to report in 2008/2009" (CEU, 2005; p. 32). One of the possible results from this review is the recommendation of a move towards a more equitable distribution of income support across Member States.

[1] The other major livestock enterprises are pig and poultry production which together account for about a further 10 per cent of agricultural output in value terms. The area devoted to tillage is relatively small at about 10 percent and it also represents about 10 percent of agricultural output in value terms.
[2] For more details on the potential impact of milk quota reform see http://www.tnet.teagasc.ie/fapri/downloads/pubs2007/outlook2007/ /FAPR I-IE2007Agrregate_Baseline.pdf.

Under the current CAP there are large discrepancies between the payment entitlements per hectare between farmers and such differences in the level of support are particularly pronounced between farmers in the EU-15 (the 15 countries in the EU before the expansion in 2004) and farmers in the new Central and Eastern European Member State countries (CEEC). In the explanatory memorandum accompanying the Commission's Health Check proposals (CEC, 2008; p. 18) the Commission argues that it is "… increasingly harder to justify the legitimacy of significant individual differences in the support level which are only based on past support." Given that the CAP is very much an evolving policy, this paper, in the following section, evaluates the potential for further reforms at the end of the current financial perspective in 2013, with a specific focus on potential measures to address differences in the average levels of direct income support to farmers across countries within the EU. Next a description of the research strategy employed will be given before moving to a discussion of the results of our analysis. Finally, the paper will conclude with a discussion of the main findings and their implications for the agricultural sector.

Further reform

The Mid-Term Review of the CAP sets out the budgetary framework until 2013, but the European Commission has signaled that further reform is likely at the end of this period. The overall budgetary cost of the CAP is large, and although its share in the total EU budget has been decreasing, it still currently accounts for 40 percent of the EU budget. Despite its large budgetary cost, the CAP is a policy which only benefits a small, although sensitive, sector resulting in a significant burden on the EU economy. The European Commission is, however, looking to focus more on other issues such as climate change, global security, energy and the Lisbon Agenda and thus there is likely to be significant pressure to reduce the CAP budget at the end of the current financial perspective in 2013.

In addition to an overall reduction in the level of budgetary expenditure on CAP payments, there is also likely to be significant changes in the structure of these payments.

The European institutions have extended the list of objectives of the CAP outlined in the Treaty of Rome and, broadly speaking, stress the need for the preservation of rural public goods, food quality and a greater consideration of the distributional impact of current payments between persons and nations (Bureau and Mahé, 2008). The structure of CAP payments is expected to change in order to have a greater focus on these issues. In particular, further agri-environment and cross compliance measures may be introduced. Under the current EU Financial Perspective (2007-2013) there is a modest shift in budgetary resources devoted to the first pillar (mainly direct income support payments) towards the second pillar (rural development measures including agri-environmental measures). It is highly probable, given the recent emphasis and discussion surrounding rural development, that there will be a further shift of direct payments towards the second pillar of the CAP. In relation to trade, the CAP, as it is currently formulated, has a paradoxical relationship with EU competition policy. There is ever increasing pressure for the EU to remove what is seen by other agricultural exporters as highly protectionist and market-distorting agricultural policies (Ackrill, 2008). This pressure is likely to lead to large tariff cuts with the result that sectors of EU agriculture such as beef will be much more exposed to competition from outside the EU (see Binfield et al., 2008).

In relation to the distributional impact of the CAP, large disparities in payments across farms and Member States are a source of conflict within the EU. The policy of price support and production linked direct payments evident in the EU agricultural sector prior to the introduction of decoupled payments established a pattern of transfers that favoured larger and more intensive farms (Ackrill, 2008). The recent move towards decoupled payments continues to favour the largest and most affluent farmers as payments are based on previous payment receipts under the CAP as defined by the Agenda 2000 reforms. Furthermore, not only is a disproportionate amount of payments being received by the largest farmers there is also an inequitable distribution of payments between Member States.

With enlargement in 2004 the EU-15 effectively ring fenced their own budget receipts and set accession terms under which new Member States received a lower level of support. All things being equal, farmers in the new Member States (those who joined the EU in 2004) receive a lower payment per hectare than those in the EU-15. Gradually this disparity in payments is being phased out as new Member States received 25 percent of what the EU-15 received in 2004 and this is set to rise to an equivalent level of the EU–15 by 2013.

However, as demonstrated in the results section in this paper even by 2013 there will still be significant differences in the average level of direct income support per hectare of utilizable agricultural area across the EU Member States. These differences are most pronounced between the EU-15 and new Member States. This is because the amount of support for farmers is principally based on the levels of production of agricultural commodities that were mainly farmed in old Member State countries during the reference period for the decoupled payments. Furthermore, new Member State countries, for the most part, have lower yields and intensity of production than that generally found in the EU-15. As Bureau and Mahé (2008) report, the political legitimacy of these differences in payments is no longer justifiable as the current distribution of CAP payments across Member States do not contribute to the European Union's cohesion objectives since the generally more prosperous Western and Nordic countries get a higher proportion of payments than poorer new Central and Eastern European Member States.

Using Ireland as a case study, this paper, in addition, to examining the effect on the Irish cattle and sheep sector of the recent changes in the CAP, such as the decoupling of direct payments and the accession of new Member States, also examines the potential impact of adopting a budget neutral, EU wide flat area payment. Ireland currently benefits from the present distribution of payments in that its average per hectare payments is in excess of the EU average and consequently any move towards a budget neutral EU wide flat area payment is likely to pose significant challenges to the Irish agricultural sector.

Research Design

The modelling approach used in this analysis is the development of an econometric, dynamic, multi-product partial equilibrium model (the AGMEMOD model) in which a bottom-up approach is used. Based on a common country model template, country level models have been developed that reflect the specific situation of the agricultural sectors in individual EU Member States. In all country models, agricultural supply and use data as well as policy data for the years 1973-2005 have been collected for all countries with the exception of Cyprus, Malta and Luxembourg and the two newest members namely Romania and Bulgaria who joined in 2007. Problems with data availability meant that these countries have been excluded from the analysis.

For each commodity modelled, and in each country, agricultural production as well as supply, demand, trade, stocks and domestic prices are derived by econometrically estimated equations. In order to take account of the influence of other Member States on a given country market, when the national level market is not considered as the key market in the EU, the internal price is determined as a function of the chosen key price for the EU and the self sufficiency rate for this market and the self sufficiency rate for the key market. In addition, information from other global models (FAPRI, 2008) is used to reflect the influence of the commodity markets in the rest of the world on those of the EU. More precisely, projections of exogenous data relating to macroeconomic series such as exchange rates and GDP, and projections of world prices for agricultural commodities have been incorporated into this model. The national level models have then been combined into a composite EU model. Hence, the final dynamic, multi-market, multi-country composite model developed allows us to generate projections for each Member State, under the assumption of exogenous world prices (for a more detailed description of the structure of the AGMEMOD model the reader is referred to Chantreuil et al., 2005).

In order to analyse the impact of policy reform, data on all types of direct payments that are and were part of the CAP, were collected for each Member State. This was used to create a database which in a coherent manner across all the Member States incorporated the total budgetary envelopes, the different types of the EU CAP direct support payments, and their allocation from the total budgetary envelopes. The degree to which decoupled payments are expected to impact production decisions is captured via explicit coefficients termed multipliers. Using these multipliers and policy data, a set of country specific variables were developed which calculated the impact of policy instruments on the supply and use of various agricultural commodities. In particular, in the case of Ireland reaction prices for beef and sheep meats were calculated. These variables were then included in the estimated equations in the model. For example, in the case of beef it is assumed that the supply inducing or incentive price faced by farmers is the real cattle price plus the beef reaction price. The reaction price varies according to the degree to which the decoupled payments are assumed to have a supply inducing effect.

Decoupled payments are in the World Trade Organisations (WTO) ‘green box’ of agriculture related subsidies and thus must adhere to the fundamental requirement that the policy has no, or at most minimal, trade-distorting effects. There is considerable uncertainty, however, as to whether these payments are indeed production neutral. The two most extreme viewpoints relating to the impact of decoupled payments are that firstly they will maintain the same supply inducing impact of previously coupled payments or secondly they will have a zero impact on production behaviour. For the purposes of this paper it is assumed that decoupled payments will have an impact in between these two values. More precisely, across all country models within the EU-15 multipliers are given a value of .5 which means decoupled payments are assumed to have 50 percent of the supply inducing impact of previously coupled payments. The true impact of decoupled payments may differ from this point and in any case the actual effect is likely to deviate across farm systems and regions. That said, it is felt that this serves as a reasonable approximation of the supply inducing impact of decoupled payments and enables projections of supply, demand and prices of various agricultural commodities as far as 2020.

Modelling limitations

Analysing the impact of agricultural policy changes at the farm or market levels using econometric models, such as the AGMEMOD model, provides important insights into the effects of policies. However, the projections produced in this paper are conditional in that they depend on data used on the future evolution of the wider economy (economic growth rates, inflation and currency exchange rates), on assumptions relating to the wider set of policies that affect agriculture (WTO, agricultural policy in non-EU countries). Large shocks to the wider macroeconomy and/or unforeseen changes in agricultural and other policies will affect agriculture and will ex post be “missed” by this analysis.

One further important point is that the accuracy of the results will depend on the degree to which our assumptions relating to the supply inducing impact of decoupled direct payments reflect the behaviour of Irish and EU farmers. Decoupling represents a relatively new policy shift for EU agriculture and there is considerable uncertainty regarding the extent to which these payments are treated by farmers as being ‘truly’ decoupled. It is likely that decoupled payments still maintain a supply inducing effect as in addition to profit-maximisation, farmers are likely to derive utility from a variety of other factors that can influence their activities (Kantelhardt, 2006). Decoupled payments can also influence farmers’ behaviour by increasing overall wealth, decreasing risk aversion or making credit more accessible (Hennessy, 1998; Young and Westcott, 2000; Adams et al., 2001; and Goodwin and Mishra, 2005; Bhaskar and Beghin, 2009). One recent study which examined this issue was by Howley et al. (2010) which found that decoupled payments appear to still have a positive impact on agricultural production, although this effect is less than would be observed if these payments were still fully coupled.

One further point is that changes in agricultural policy that have been agreed, such as the ending of the EU milk quota in 2015 if incorporated in our baseline policy assumptions would alter our baseline projections from those presented here. However, given that such a policy change would also be incorporated in the alternative policy scenario analysed in this paper such a change is unlikely to significantly alter our analysis.

Results

In terms of model output, this paper firstly provides projections relating to the cattle and sheep sectors as far as 2020 assuming current policies remain in place. With decoupling of direct payments market signals will play a more important role in EU agriculture. This "baseline" scenario is concerned with analysing the effect of these recent changes. Under this scenario the decoupling decision made by Member States in 2005 cannot be changed. The current mix of historic, static and dynamic regional models and hybrid Single Payment models and simplified area payments system models (that apply in most of the new Member States) is assumed to continue for the complete projection period to 2020. The year 2005 was the last year in which all agricultural supply and use data were collected for all Member States and therefore, the model projections in 2020 are compared with this 'base' year. The CAP budget and national ceilings remain at the levels as set out in Council Regulation EC 1782/2003.

The second scenario analysed is the effect of introducing a common EU wide flat rate payment per hectare calculated as the sum of the currently agreed national budgetary envelopes divided by utilisable agricultural area in the EU-27. While such a policy will not change the level of overall support within the EU it should, however, result in significant changes at a Member State level. For example, in the case of Ireland such a scenario, if implemented, would result in the average per hectare decoupled direct payment falling from €311 per hectare under the Baseline to €247 per hectare.

Baseline scenario: Cattle

Under the Baseline scenario, despite projected increases in nominal cattle prices the Irish suckler cow herd is forecasted to decline by 25 percent between 2005 and 2020 (see table 1). This is a continuation of the trend evident post decoupling as the Irish suckler cow herd declined by 3 percent between 2005 and 2007. The projected contraction reflects the decoupling of direct payments and the decline in the real returns to beef farming. This projected contraction contrasts with the evolution of the suckler herd in the years prior to the introduction of decoupled payments as the numbers of suckler cows rose steadily in response to the introduction of coupled direct payments. The Irish dairy cow herd is projected to decline by 13 percent over the projection period. This decrease is due to an increase in milk yields as the milk quota is fixed at 2008/2009 levels for the Baseline analysis. Due to the projected declines in the Irish suckler and dairy cow herds, total cattle ending numbers, cattle slaughter and the calf crop are projected to decline by 30, 21 and 19 percent respectively over the period 2005-2020. As a result of the fall in total cattle slaughter, Irish beef production is projected to decline by 28 percent over the projection period.

Baseline scenario: Sheep

Under the Baseline scenario the decoupling of the ewe premium results in the ending ewe numbers declining by 42 percent over the projection period, despite nominal lamb prices that are projected to increase strongly. The most recent data indicate that between 2005 and 2008 the Irish ewe flock has contracted by almost 22 percent in response to the introduction of decoupled payments. The significant decline in ewe numbers over the projection period (2005-2020) results in the number of lambs produced declining by 44 percent. With lower lamb numbers produced each year the projected volume of lamb and other sheep slaughtering is projected to decrease over the projection period, with slaughtering of sheep in 2020 46 percent lower than in 2005. The reduction in sheep numbers slaughtered results in a projected decline of 40 percent in sheep meat production between 2005 and 2020.

In this analysis, the supply inducing or incentive price faced by farmers is the market price for each agricultural commodity plus the associated reaction price. Therefore, production decreases for both cattle and sheep even though nominal prices increase in our baseline analysis as the move towards decoupling significantly reduces the incentive for farmers to expand production. In other words, even though nominal market prices rise over the projection period, the payments element of the reaction price falls to the extent that the direction of the overall incentive price is downward.

Table 1: Baseline projections for Livestock Product markets

		2005	2010	2015	2020	Total % change
Beef						
Production	1,000 ton	545.9	468.8	426.4	393.2	-28.0
Beef cows ending stock	1,000 head	1150	1043	951	856	-25
Slaughtering weight	kg/animal	324.0	291.0	294.6	297.5	-8.2
Domestic Use	1,000 ton	89.9	100.0	110.3	116.8	29.9
Consumption/head	kg/head	21.8	22.6	23.4	23.5	7.9
Price	Euro/100kg	136.4	155.4	165.8	171.9	26.0
Sheep meat						
Production	1,000 ton	73.3	57.5	50.0	43.7	-40.3
Ewes ending stock	1,000 head	3208.6	2639.8	2219.4	1849.8	-42.3
Slaughtering weight	kg/animal	20.3	21.0	21.8	22.6	11.4
Domestic use	1,000 ton	18.3	22.0	23.1	24.3	32.9
Consumption/head	kg/head	4.4	5.0	4.9	4.9	10.4
Price	Euro/100kg	152.6	189.4	199.1	204.0	33.7

Source: AGMEMOD Model version 1

Tables 2 and 3 outline the average level of CAP payments per hectare for Member States. Table 2 shows little projected change in the average CAP payment per hectare among old Member State countries. For farmers in new Member States there is a projected significant increase in payments between 2006 and 2013 as the European Commission has agreed to increase CAP direct payments from 25 percent of what the EU-15 got in 2004 to their full entitlement by 2013. The average payment per hectare in the new Member States included in the analysis stood at €59 per hectare in 2006 and this is projected to increase to €183 per hectare by 2013. Therefore, a significant convergence between the levels of budgetary support in new Member States and EU-15 Member states is expected.

However, even by 2013, the majority of new Member States are still projected to have average payments per hectare below those in the EU-15. The average per hectare payment among the EU-15 in 2013 at €308 per hectare, given currently agreed policy and current agricultural area, is estimated to be almost double the average payment per hectare in the new Member States. Even among the EU-15 Member States there are significant differences in the average payment per hectare. At one extreme are Spain and Portugal, where farmers on average are expected to receive €176 and €150 per hectare respectively in 2013, and at the other extreme are farmers in Greece, Netherlands and Belgium who in 2013 will receive estimated average per hectare payments of €488, €455 and €405 respectively. Due to large tracts of relatively arid landscapes and a relatively large proportion of their land being in agricultural use, Spain and Portugal have a low level of productivity per hectare. Greece, the Netherlands and Belgium have a much higher average per hectare payment due to greater concentration on production of CAP supported commodities during the reference period for the decoupled payments and the higher intensity of production per hectare of agricultural land farmed.

T*able 2: Average CAP spending (€) per hectare in the EU-15*

	2006	**2007**	**2008**	**2009**	**2010 and subsequent years**
Belgium	384	393	402	406	405
Denmark	376	375	377	378	378
Germany	332	335	337	339	339
Greece	553	543	532	529	488
Spain	179	179	176	176	176
France	279	282	277	273	272
Ireland	310	311	311	312	311
Italy	258	260	261	262	264
Netherlands[3]	226	443	451	454	455
Austria	194	225	228	229	230
Portugal	132	150	150	150	150
Finland	246	246	247	248	247
Sweden	213	237	232	230	230
UK	251	253	255	256	256

3 The level of CAP direct payment expenditure per hectare in the Netherlands increased significantly between 2006 and 2007. The increase in support per hectare was due to the introduction of compensation payments for reductions in the intervention prices of certain dairy products. The large impact of these payments on the level of expenditure per hectare reflects the importance of dairy farming within Dutch agriculture

Table 3: Average CAP spending per hectare in New Member States

	2006	2007	2008	2009	2010	2011	2012	2013
Czech	83	105	131	156	179	203	227	251
Estonia	36	44	57	69	81	94	107	119
Latvia	24	33	41	47	54	61	68	76
Lithuania	41	55	69	83	96	109	122	135
Hungary	77	77	112	133	154	175	196	216
Poland	61	79	99	117	135	153	171	189
Slovenia	88	117	145	173	200	228	255	283
Slovakia	66	83	104	124	142	161	180	199

If the total budgetary envelope to be devoted to the CAP at the end of the current financial perspective in 2013 was divided by the total utilisable agricultural area (2005 Eurostat figures) within the EU, then the average payment per hectare across all Member States would be €247. Under the present system Ireland is estimated to have an average per hectare payment of €311 per hectare in 2013. Thus the EU wide flat area payment policy scenario implies a reduction of €64 (20%) in the average per hectare payment for Ireland. Table 4 compares the levels of production and net trade of both beef and sheep meat under the baseline analysis in 2020 with that projected if a CAP budget neutral EU wide flat rate payment of €247 per hectare was introduced. It is important to note that the value of all payments is in nominal terms so that with positive inflation over the projection period their real value and their supply inducing impact will decrease.

As illustrated in Table 4 the introduction of a CAP budget neutral EU wide flat area payment in 2013 is projected to have a significant impact on the cattle and sheep sectors. The lower payment per hectare results in beef production and net trade being projected to be 10 and 17 percent less than under the Baseline. Sheep meat production and net trade are also projected to be lower under the EU wide flat area payment scenario when compared to the Baseline. By 2020 sheep meat production is projected to be 11 percent less than under the Baseline while net trade is projected to contract by 15 percent.

Table 4: Beef and sheep meat scenario analysis - Results in 2020

	Baseline	EU flat rate	% Change
Beef	**1,000 tonnes**		
Production	394	354	-10
Net Trade	278	231	-17
Sheep meat	**1,000 tonnes**		
Production	44	39	- 11
Net Trade	20	17	-15

Source: AGMEMOD Model Version 1

Conclusion

Under the baseline, where current polices continue to 2020 significant changes in the Irish beef and sheep sectors are projected to occur. The decoupling of premiums in 2005 results in the number of suckler cows and ewes being projected to decrease by 18 and 42 percent respectively over the projection period. One potential factor behind the larger decrease in the number of ewes relative to suckler cows are differences in farming systems. Farming sheep is more labour intensive than farming suckler cows and sheep farmers may have more incentive to reduce output or even leave the sector in response to lower real market returns. In addition, there is already a well established long term trend of decline in the sheep sector, with ewe numbers falling significantly since the early 1990s as a result of the introduction of cross compliance obligations initiated to reduce sheep numbers in environmentally sensitive areas. Over the Baseline projection period, the decline in the number of suckler cows and ewes leads to a significant fall in the production of beef and sheep meat.

In Ireland the largest projected impact of the decoupling of direct payments is the reduction in livestock numbers. This should lead to an extensification of farming systems. It has also been suggested that with decoupling, the rational economic response for some farmers may be to abandon land, particularly in marginal rural areas (Osterburg and van Horn, 2006). It seems reasonable, however, to argue that this may not occur on a significant scale as farmers often maintain a certain level of agricultural activity, even when it is not optimal from a purely financial perspective (Hennessy and Thorne, 2005).

In any case, the requirement that farmers maintain their land in good agricultural and environmental condition and satisfy cross compliance criteria to qualify for decoupled direct income support payments will limit land abandonment.

The CAP is very much an evolving policy and the European Commission has signaled that further substantial reforms of the CAP may occur at the end of the current financial perspective in 2013. Reforms could include a reduction in the overall level of support, as well as a more pronounced shift of budgetary resources from the first pillar of the CAP (market support and direct payments) to the second pillar (rural development, including agri-environment). In addition, within the still ongoing Doha Round of the WTO, pressures from agricultural exporters outside the EU is likely to result in a reduction of tariffs which could have significant negative implications for certain sectors such as beef within the EU (Binfield et al., 2008).

One further likely shift in CAP policy post 2013 is a move towards a more equitable distribution of payments between Member States. At the end of the current financial perspective in 2013 there will still be significant disparities between the average per hectare payment to farmers in different Member States. Farmers in new Member State countries (with the exceptions of Slovenia and the Czech Republic) will receive a smaller average payment per hectare than farmers in more prosperous Western and Nordic countries. Given that the distribution of these payments does not support the EU's cohesion objectives or address income inequalities, it is possible that the EU Commission will seek to implement measures to address this imbalance.

To illustrate the impact of introducing a more equitable distribution of payments across Member States, this paper, using the Irish cattle and sheep sectors as a case study, examined the effect of a CAP budget neutral EU wide flat area payment of €247 per hectare. This payment level was calculated as the total level of CAP payments in 2013 divided by the total utilisable agricultural area within the EU in 2005. As expected the adoption of such a policy scenario has a substantial negative effect on the production of commodities such as beef and sheep meat in Ireland

Spain and Portugal and most of the new Central and Eastern European Member State countries will benefit from the implementation of an EU wide flat area payment of €247 per hectare given that their average payments per hectare are less than the EU average of €247. A general conclusion in terms of income distribution is that this policy scenario would result in a transfer from richer Western and Nordic countries to poorer Mediterranean, Eastern and Central European countries. In addition, average productivity per hectare is less in new accession countries than in the EU15. Therefore, at an aggregate level, even though the policy scenario examined here does not result in a change in the overall CAP budget, it seems reasonable to assume that total EU production should fall, to some degree, in response to the implementation of a CAP budget neutral common flat area payment across Member States.

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Relative Technical and Cost Efficiency of No-Till Farms

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Relative Technical and Cost Efficiency of No-Till Farms

Abstract

The objective of this paper was to examine the relative technical and cost efficiency of no-till farms in central Kansas. Data from the Kansas Farm Management Association (KFMA) for farms that have adopted a no-till production system and for farms with a conventional or reduced tillage system were utilized in this study. Technical efficiency was not significantly different between the two groups of farms. However, cost efficiency was significantly higher for the no-till farms. The no-till farms were also larger, produced more feed grains and oilseeds, produced less wheat, had higher operating profit margin and asset turnover ratios, and utilized their labor and capital inputs more efficiently.

Relative Technical and Cost Efficiency of No-Till Farms

Introduction

For the counties in the United States participating in the 2006 Crop Residue Management Survey, the adoption of no-till production has increased from 7.4% of planted acres in 1990 to 31.5% of planted acres in 2006 (Conservation Technology Information Center, 2006). Another way of looking at this increase is to note that two-thirds of the farms surveyed have still not adopted a no-till production system. Given this fact, examining the relative efficiency of a no-till production system would be of interest to both farms that have adopted a no-till production system and to those who have not adopted this system.

The objective of this paper was to examine the relative technical and cost efficiency of no-till farms in central Kansas. Technical and cost efficiency indices were computed using linear programming. Comparisons were made between farm size, financial ratios, technical and cost efficiency, income shares, and cost shares for no-till farms, and farms with a conventional or a reduced tillage production system.

Data and Methods

Table I presents the average and standard deviation of the variables used to compute technical and cost efficiency as well as variables pertaining to farm size, farm type, and tillage system. The data were obtained from the Kansas Farm Management Association (KFMA) databank. Information pertaining to the variables in the KFMA databank can be found in Langemeier (2003) and on the KFMA web site (KFMA, 2010). To be included in this study, a farm had to have continuous data from 2004 to 2008 and be located in central Kansas. Economists working with KFMA farms in central Kansas have been designating farms as no-till or mixed tillage for the last several years. Mixed tillage farms include those with conventional or reduced tillage systems. Because farms in central Kansas have been categorized by tillage system, this study focused on this region of Kansas. To be designated as a no-till farm, a farm had to utilize a no-till production system for all of their crops.

Table I. Summary Statistics for 311 Central Kansas Farms.

Variable	Average	Std. Dev.
Farm Characteristics		
Gross Farm Income ($)	384,651	338,690
Value of Farm Production ($)	360,434	279,910
Net Farm Income ($)	80,660	71,154
Total Economic Cost ($)	410,105	320,622
Total Hectares	760	481
Labor Devoted to Crops (%)	0.8337	0.1775
Less Tillage Index	0.1298	0.0883
No-Till Farms (%)	0.2476	0.4323
Outputs		
Crop (Index)	482,702	443,965
Livestock (Index)	77,851	135,601
Inputs		
Labor (Number of Workers)	1.47	0.90
Livestock (Index)	46,076	191,695
Seed (Index)	29,566	30,248
Fertilizer (Index)	91,648	73,367
Chemicals (Index)	24,790	22,374
Capital (Index)	250,367	171,695
Input Prices		
Labor (Index)	44,687	8,145
Livestock (Index)	0.727	0.000
Seed (Index)	0.750	0.000
Fertilizer (Index)	0.555	0.000
Chemicals (Index)	0.921	0.000
Capital (Index)	0.874	0.008

On average, the sample farms had a gross farm income of $384,651, a value of farm production of $360,434, and a net farm income of $80,660. Total hectares, which included crop, pasture, and farmstead hectares, averaged 760 and ranged from 71 to 3,646 hectares. Approximately 83 percent of the farm operators' time allocated to the farm operation was devoted to producing crops. The less tillage index was computed by dividing herbicide and insecticide cost by total crop machinery cost which included repairs; fuel; auto expense; machinery and equipment depreciation; crop machine hire; and an opportunity interest charge on crop machinery and equipment investment. The less tillage index was used by Nivens, Kastens, and Dhuyvetter (2002) to examine the adoption of reduced tillage practices. A farm that has reduced tillage would have relatively higher chemical costs, relatively lower machinery costs, and a higher less tillage index. The average less tillage index was 0.1298. Approximately 25 percent of the farms were designated as no-till farms.

Data on total economic cost, outputs, inputs, and input prices were needed to estimate efficiency indices. Total economic cost was computed by summing cash costs, depreciation, an opportunity charge for unpaid operator and family labor, and an opportunity interest charge on net worth. The number of operators on a farm and average family living expenditures were used to compute the opportunity charge for unpaid operator and family labor.

Outputs were computed by dividing crop income by a weighted average crop price, and livestock income by a weighted average livestock price. Relative crop and livestock income shares served as weights in the output price computations. Crop and livestock prices were indexed using an index value of 1.00 for 2008.

With the exception of labour, inputs were computed by dividing input expense by input price indices. The input level for labor represents the number of workers on the farm. Part-time workers were designated as a fraction of a full time worker for the computation of the labor input. Input prices, except the price of labor, were indexed using an index value of 1.00 for 2008. Labor price was computed by dividing labor cost, which includes hired and unpaid operator and family labor, by the number of workers on the farm. The chemical, livestock, and capital inputs represent an aggregate of several inputs. The chemical input included herbicides and insecticides. The livestock input covers dairy expense, feed purchased, veterinarian expenses, and livestock marketing and breeding expenses. The capital input is the sum of repairs, fuel, organizational fees and dues, property taxes, insurance, machine hire, conservation expenses, interest expense, cash farm rent, depreciation, and an opportunity interest charge on net worth.

An overall efficiency index was computed for each farm using linear programming (Fare, Grosskopf, and Lovell, 1985; Coelli et al., 2005). The overall efficiency indices ranged from zero to one. Farms with an overall efficiency index of one were producing on the cost frontier and at the most efficient scale of operation. More specifically, these farms were producing at the lowest cost per unit of aggregate output. Farms with a lower overall efficiency index could lower per unit cost by reducing inefficiency. Overall inefficiency could be due to many factors including farm size, technical problems, and a non-optimal input or output mix. To examine possible sources of overall inefficiency, the overall efficiency index for each farm was decomposed into technical and allocative efficiency indices. Farms and ranches that are technically efficient produce on the production frontier. Farms that are technically inefficient could expand output with the same level of inputs by improving their technical efficiency. Allocative efficiency, a component of overall efficiency, examines whether a farm is using the optimal output and input mix. An allocatively inefficient farm is not using the optimal mix of outputs, inputs, or both.

The focus of this study is on comparing the relative efficiency and performance of no-till and mixed tillage farms. With this in mind, efficiency indices as well as farm size, farm type, financial performance, income shares, and cost shares for the no-till farms and the mixed tillage farms were compared. Financial performance was measured using the operating profit margin ratio (net farm income plus interest expense minus unpaid operator and family labor divided by value of farm production) and the asset turnover ratio (value of farm production divided by total farm assets). Income shares were computed by dividing gross income for a particular group of enterprises (e.g., feed grains) by gross farm income. Similarly, cost shares were computed by dividing input cost for each input (e.g., labor) by gross farm income. To determine whether a specific efficiency index or farm characteristic was statistically different between the two groups of farms, t-tests and a 5 percent significance level were used.

Results

The average overall efficiency index was 0.619. Using this level of efficiency, cost per unit of aggregate output could be reduced by 38.1 percent, on average, if all of the farms were overall efficient. The average technical and allocative efficiency indices were 0.861 and 0.720, respectively. Based on these results, allocative inefficiency seemed to be a larger source of overall inefficiency than technical inefficiency.

Table II contains a summary of farm characteristics, income shares, and cost shares by tillage group. This table also indicates whether each variable was significantly different between the two groups of farms. Gross farm income, value of farm production, net farm income, and total hectares were significantly different between the two groups of farms. Thus, on average, the no-till farms were larger than the mixed tillage farms. More importantly, the operating profit margin ratio, the asset turnover ratio, and the overall efficiency index were significantly higher for the no-till farms. At least a portion of this improvement in performance exhibited by the no-till farms could be due to the fact that these farms were larger.

Table II. Characteristics of No-Till and Mixed Tillage Farms in Central Kansas.

Variable	No-Till	Mixed Tillage	Difference Significant
Number of Farms	77	234	
Farm Characteristics			
Gross Farm Income ($)	510,557	343,221	yes
Value of Farm Production ($)	468,629	324,832	yes
Net Farm Income ($)	108,467	71,510	yes
Operating Profit Margin Ratio	0.1676	0.1247	yes
Asset Turnover Ratio	0.4070	0.3199	yes
Technical Efficiency	0.858	0.862	no
Allocative Efficiency	0.773	0.703	yes
Overall Efficiency	0.662	0.605	yes
Total Hectares	879	721	yes
Labor Devoted to Crops (%)	0.8475	0.8292	no
Less Tillage Index	0.1734	0.1154	yes
Income Shares			
Feed Grains	0.2303	0.1805	yes
Hay and Forage	0.0328	0.0440	no
Oilseeds	0.1687	0.1059	yes
Small Grains	0.2271	0.3071	yes
Beef	0.1380	0.1623	no
Dairy	0.0124	0.0274	no
Cost Shares			
Labor	0.1702	0.2299	yes
Livestock	0.0619	0.0642	no
Seed	0.0663	0.0534	yes
Fertilizer	0.1318	0.1353	no
Chemicals	0.0797	0.0552	yes
Capital	0.5626	0.6695	yes

Note: The income shares do not sum to one. Shares for miscellaneous livestock enterprises (e.g., swine; poultry), government payments, crop insurance proceeds, and patronage dividends are not shown.

Technical efficiency was not significantly different between the two groups of farms. In contrast, allocative efficiency was significantly higher for the no-till farms. The average percent of labor devoted to crops was not significantly different between the two groups of farms. However, the less tillage index for the no-till farms was significantly higher.

The results with respect to technical efficiency, allocative efficiency, and overall efficiency suggest that the efficiency problems faced by the mixed tillage farms may be related to either not using the optimal mix of outputs, the optimal mix of inputs, or both. Income and cost shares were compared between the two groups of farms to examine differences in input and output mixes. The income share comparisons show differences in output mix between the two groups. The no-till farms generated more income from feed grains (e.g., corn and grain sorghum) and oilseeds (e.g., soybeans and sunflowers), and less income from small grains (e.g., wheat) than the mixed tillage farms. Beef and dairy income were not significantly different between the groups.

The cost share comparisons can be used to examine differences in input mix between the two groups of farms. As on average the farms in both groups are not covering all economic costs, the cost shares in Table II sum to a value greater than one. The no-till farms used relatively less labor and capital, and relatively more seed and chemicals. Given the difference in the mix of crops grown and the substitution of chemicals for fuel associated with a no-till production system, the results with respect to seed and chemicals were not surprising. Anecdotal evidence supports the difference in labor use between the two groups of farms. Many farmers indicated that they adopted a no-till production system to more efficiently utilize labor. The result with respect to capital was at least partially due to the difference in farm size between the two groups. Previous research found that larger farms use capital more efficiently than smaller farms (Bradford and Langemeier, 2006).

Though not shown in Table II, off-farm wages were not significantly different between the two groups. The smaller farms were either young operators or older operators phasing out of agriculture. Anecdotal evidence garnered from discussions with the KFMA economists who work with these farmers suggests that many small farms are leaving agriculture.

Summary and Implications

The objective of this study was to examine the relative technical and cost efficiency of no-till farms in central Kansas. Data for KFMA farms that have adopted a no-till production system were compared with KFMA farms with a conventional or a reduced tillage production system. In addition to having higher cost efficiency indices, the no-till farms were larger, had a higher level of financial performance, produced relatively more feed grains and oilseeds, relatively less wheat, and more efficiently utilized their labor and capital inputs. There was not a significant difference in technical efficiency between the two groups of farms.

Results of this study have implications for the future adoption of no-till production systems. The no-till farms had significantly higher overall efficiency indices reflected in lower per unit costs. Another possible advantage of a no-till production system that was evident from the results was related to crop mix flexibility. The no-till farms in central Kansas have used the no-till production system to add feed grains and/or oilseeds to their rotations. The combination of lower per unit costs and added crop mix flexibility will certainly attract the attention of farms that currently have conventional or reduced tillage production systems.

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Persistence in Financial Performance

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Persistence in Financial Performance

Abstract

The objective of this paper was to examine the persistence of financial performance measures for a sample of farms over a five-year period. The profit margin ratio and asset turnover ratio were computed for each farm and year, and for the 2004 to 2008 period. The number of years each farm was in the top and bottom performance quartiles was also computed and discussed.

Results indicated that it was relatively difficult for a farm to consistently be in the top quartile over time. However, using five-year average data, there was a substantial difference in financial performance between farms in the top and bottom quartiles. Results suggest that using one year of data to benchmark is problematic. Therefore, benchmarking using data for a longer time period is essential in determining whether a farm has a competitive advantage.

Persistence in Financial Performance

Introduction

It is a widely established fact that profitability, efficiency, and per-unit costs vary significantly among farms and ranches (Fox, Bergen, and Dickson, 1993; Babcock, 1999; Nivens, Kastens, and Dhuyvetter, 2002; and Yeager and Langemeier, 2009). Are these differences in performance due to random events such as weather or to factors such as managerial ability?

The answer to the above question has a direct bearing on benchmarking and the search for competitive advantage. If performance differences are primarily due to weather, benchmarking is not nearly as relevant to farms as it would be if performance differences are due to managerial ability or some other resource advantage (see Barney and Clark, 2007, for further discussion of the importance of identifying unique resource advantages). An examination of the data from a group of farms to determine whether some farms consistently outperform other farms, would be useful to farm operators, farm advisors, and policy makers.

The objective of this paper was to examine persistence in financial performance for a sample of farms over a five-year period. Financial performance was measured using the operating profit margin ratio and the asset turnover ratio. These ratios and corresponding farm characteristics were compared across financial performance quartiles.

Methods

The operating profit margin ratio and the asset turnover ratio were used to measure financial performance for each farm and year using a sample of Kansas farms. The operating profit margin ratio is a commonly used profitability measure while the asset turnover ratio is a commonly used financial efficiency measure (Farm Financial Standards Council, 2008).

The operating profit margin ratio was calculated by adding interest expense and subtracting unpaid family and operator labor from net farm income and dividing the result by the value of farm production. Unpaid operator and family labor was computed using the number of operators on each farm and average family living expenditures. The asset turnover ratio was measured by dividing value of farm production by average total assets. Assets were valued at market values.

The number of years each farm was in the top or bottom quartile for each financial performance measure was computed. Financial performance was also compared across quartiles for each financial performance measure. Variables compared across quartiles included value of farm production, net farm income, interest, unpaid family and operator labor, total assets, total debt, total expense ratio, adjusted total expense ratio, economic total expense ratio, operating profit margin ratio, asset turnover ratio, debt to asset ratio, percent of farms with positive cash flow, percent of farms financially stressed, percent of farms with expense ratios below 1.00, and percent of farms in four value of farm production categories (i.e., less than $100,000; between $100,000 and $250,000; between $250,000 and $500,000; and greater than $500,000). The total expense ratio was computed by adding cash costs, accrual adjustments to costs, and depreciation, and dividing the result by value of farm production. The adjusted total expense ratio was found by adding unpaid family and operator labor to the expenses included in the total expense ratio and dividing by value of farm production. An adjusted total expense ratio below 1.00 indicates that a farm was able to cover accrual expenses, depreciation, and unpaid family and operator labor. The economic total expense ratio was calculated by adding the opportunity cost of owned assets to the expenses in the adjusted total expense ratio and dividing by value of farm production. An opportunity rate of eight percent was used in determining opportunity cost of owned assets. If the economic total expense ratio is below 1.00, the farm is meeting all accrual and opportunity expenses, and is earning an economic profit. A farm was considered financially stressed if it had an adjusted total expense ratio above 1.00 and a debt to asset ratio greater than 0.70. To determine whether specific variables were significantly different between farms in the top and bottom quartiles, t-tests and a five percent significance level were used.

Data

Data for 1,062 farms in the Kansas Farm Management Association (KFMA) with continuous data from 2004 to 2008 were used in this study. These 1,062 farms represent approximately 73 percent of the farms with whole-farm analysis data in 2008. The data were obtained from the Kansas Farm Management Association databank. Information pertaining to the variables available in the KFMA databank, as well as additional summary information, can be found in Langemeier (2003) and on the KFMA web site (KFMA, 2010). To be included in this study, a farm had to have usable income, expense, and balance sheet data. Income and expense were expressed on an accrual basis. Value of farm production included crop income, livestock income, income from government payments and crop insurance proceeds, and miscellaneous income sources such as patronage dividends and custom work income. Livestock income was expressed on a value-added basis. Specifically, accrual livestock purchases were subtracted from accrual livestock sales to arrive at accrual livestock income.

Table I presents summary statistics for the 1,062 farms. Value of farm production averaged $355,001. The average profit margin was 0.1604 or 16.04 percent while the average asset turnover ratio was 0.3305. The average total expense ratio, adjusted total expense ratio, and economic total expense ratio were 0.760, 0.893, and 1.065, respectively. As indicated by the percent of farms with an adjusted total expense ratio below 1.00, approximately 65 percent of the farms covered accrual expenses, depreciation, and unpaid family and operator labor. Approximately 28 percent of the farms met all accrual and opportunity costs and thus were earning an economic profit. Approximately 5.6 percent of the farms were financially stressed.

Table I. Summary Statistics for 1,062 KFMA Farms with Continuous Data from 2004-2008.

Item	Average
Value of Farm Production (VFP)	$355,001
Net Farm Income	$85,239
Interest	$19,074
Unpaid Family and Operator Labor	$47,370
Total Assets	$1,074,187
Total Debt	$312,954
Total Expense Ratio (TER)	0.760
Adjusted Total Expense Ratio (ATER)	0.893
Economic Total Expense Ratio (ETER)	1.065
Operating Profit Margin Ratio	0.1604
Asset Turnover Ratio	0.3305
Debt to Asset Ratio	0.2913
Percent of Farms with Positive Net Cash Flow	93.79%
Percent of Farms Financially Stressed	5.56%
Percent of Farms with TER less than 1.000	92.28%
Percent of Farms with ATER less than 1.000	65.07%
Percent of Farms with ETER less than 1.000	28.34%
Percent of Farms with VFP less than $100,000	13.47%
Percent of Farms with VFP between $100,000 and $250,000	34.18%
Percent of Farms with VFP between $250,000 and $500,000	32.11%
Percent of Farms with VFP greater than $500,000	20.24%

Source: Kansas Farm Mangement Association 2008 Databank.

Results

Table II shows the number of farms and percent of farms by profit margin category. Farms in the first category were in the top or bottom quartile for all five years. Only 26 farms, or 2.45 percent of farms, were in the top profit margin quartile for all five years. Approximately 18 percent were in the top profit margin category for three, four, or five years (i.e., in the first, second, or third profit margin categories). Conversely, approximately 20 percent of farms were in the bottom profit margin category for three or more years. It is important to note that approximately 46 percent of farms were never in the bottom profit margin category. This result can be found by examining the percentage of farms in the sixth bottom profit margin category.

Table II. Number of Farms and Percent of Farms by Profit Margin Categories.[a]

Item	Number of Farms	Percent of Farms
Top Profit Margin Category		
First Category	26	2.45%
Second Category	57	5.37%
Third Category	111	10.45%
Fourth Category	187	17.61%
Fifth Category	260	24.48%
Sixth Category	421	39.64%
Bottom Profit Margin Category		
First Category	63	5.93%
Second Category	61	5.74%
Third Category	85	8.00%
Fourth Category	142	13.37%
Fifth Category	227	21.37%
Sixth Category	484	45.57%

[a] Farms in the first category were in the top or bottom quartile for all five years. Farms in the second category were in the top or bottom quartile for four of the five years. Farms in the third category were in the top or bottom quartile for three of the five years. Farms in the fourth category were in the top or bottom quartile for two of the five years. Farms in the fifth category were in the top or bottom quartile for one of the five years. Farms in the sixth category were not in the top or bottom quartile during the five year period.

Variable comparisons among the profit margin quartiles can be found below. Before discussing this information, some of the characteristics of the 26 farms consistently in the top profit margin quartile will be discussed. These farms had five-year average profit margins ranging from 0.2839 to 0.4586, and an average asset turnover ratio of 0.3991. The average value of farm production for this group was $656,860 or approximately $302,000 higher than that for the entire sample of farms. All these farms were covering accrual expenses, depreciation, and unpaid family and operator labor. Moreover, approximately 81 percent of the farms in this group were earning an economic profit.

The number of farms and percent of farms in each asset turnover category is presented in Table III. Farms in the first category were in the top or bottom asset turnover ratio quartile for all five years. Approximately 13 percent of farms, or 140 farms, were in the top asset turnover quartile for all five years. The fact that it was relatively easier to consistently be in the top asset turnover ratio quartile than in the top profit margin ratio quartile is intuitively plausible. The components of the profit margin ratio, particularly net farm income, tend to be more variable than those making up the asset turnover ratio. It was also relatively easier for farms to stay out of the bottom asset turnover ratio quartile. Approximately 61 percent of farms were never in the bottom asset turnover ratio quartile during the five-year period.

Table III. Number of Farms and Percent of Farms by Asset Turnover Categories.[a]

Item	Number of Farms	Percent of Farms
Top Asset Turnover Category		
First Category	140	13.18%
Second Category	62	5.84%
Third Category	55	5.18%
Fourth Category	65	6.12%
Fifth Category	82	7.72%
Sixth Category	658	61.96%
Bottom Asset Turnover Category		
First Category	139	13.09%
Second Category	64	6.03%
Third Category	52	4.90%
Fourth Category	62	5.84%
Fifth Category	94	8.85%
Sixth Category	651	61.30%

[a] Farms in the first category were in the top or bottom quartile for all five years. Farms in the second category were in the top or bottom quartile for four of the five years. Farms in the third category were in the top or bottom quartile for three of the five years. Farms in the fourth category were in the top or bottom quartile for two of the five years. Farms in the fifth category were in the top or bottom quartile for one of the five years. Farms in the sixth category were not in the top or bottom quartile during the five year period.

Tables IV and V show summary statistics for both the profit margin ratio and asset turnover ratio quartiles. These tables were created using five-year average data for each farm. Statistical differences for all variables except the percentage variables were computed using information from the top and bottom profit margin ratio and asset turnover ratio quartiles. Though not denoted in the tables, all variables were significantly different when comparing the top and bottom quartiles for each financial performance measure. The farms in the top profit margin quartile had an average operating profit margin ratio of 0.2804 or 28.04 percent (Table IV). In contrast, the farms in the bottom profit margin quartile had an average operating profit margin ratio of -0.1419. The farms in the bottom profit margin quartile also had a relatively low asset turnover ratio and relatively high expense ratios. In fact, none of farms in the bottom profit margin quartile earned an economic profit and only 70 percent of the farms covered accrual expenses and depreciation (i.e., had a total expense ratio below 1.00). Over two-thirds of the farms in the top profit quartile earned an economic profit. It is important to note that the asset turnover ratio for the second, third, and fourth quartiles was not significantly different. Thus, having an average asset turnover ratio did not preclude a farm from being in the top profit margin quartile.

Table IV. Summary Statistics for Operating Profit Margin Ratio Quartiles.[a]

	Profit Margin Quartile			
Item	First	Second	Third	Fourth
Value of Farm Production (VFP)	$128,531	$310,053	$452,291	$528,932
Net Farm Income	$8,371	$49,930	$102,486	$180,237
Interest	$8,664	$19,502	$24,049	$24,058
Unpaid Family and Operator Labor	$35,270	$45,559	$52,645	$55,993
Total Assets	$625,226	$906,357	$1,213,741	$1,551,531
Total Debt	$144,629	$301,857	$391,714	$413,362
Total Expense Ratio (TER)	0.935	0.839	0.773	0.659
Adjusted Total Expense Ratio (ATER)	1.209	0.986	0.890	0.765
Economic Total Expense Ratio (ETER)	1.508	1.142	1.035	0.937
Operating Profit Margin Ratio	-0.1419	0.0770	0.1634	0.2804
Asset Turnover Ratio	0.2056	0.3421	0.3726	0.3409
Debt to Asset Ratio	0.2313	0.3330	0.3227	0.2664
Percent of Farms with Positive Net Cash Flow	80.75%	96.24%	98.87%	99.25%
Percent of Farms Financially Stressed	11.70%	9.40%	0.75%	0.38%
Percent of Farms with TER less than 1.000	70.94%	98.12%	100.00%	100.00%
Percent of Farms with ATER less than 1.000	0.38%	61.65%	98.50%	99.62%
Percent of Farms with ETER less than 1.000	0.00%	5.26%	39.47%	68.68%
Percent of Farms with VFP less than $100,000	44.53%	6.02%	1.50%	1.89%
Percent of Farms with VFP between $100,000 and $250,000	44.53%	48.50%	26.69%	16.98%
Percent of Farms with VFP between $250,000 and $500,000	10.94%	33.08%	46.24%	38.11%
Percent of Farms with VFP greater than $500,000	0.00%	12.41%	25.57%	43.02%

[a] The first quartile is represented by farms with the lowest operating profit margin ratio. The fourth quartile is represented by farms with the highest operating profit margin ratio.

The farms in the top asset turnover ratio quartile had an average asset turnover ratio of 0.6653 while those in the bottom asset turnover ratio quartile a ratio of only 0.1424 (Table V). It is important to note that the asset turnover ratio is dependent on farm type and percent of acres owned. It is particularly important to note that farms that own a relatively high percentage of their acreage tend to have relatively lower asset turnover ratios. Farms in the bottom asset turnover quartile owned approximately 62 percent of their acreage. In contrast, the farms in the top asset turnover quartile owned approximately 11 percent of their acreage. The average profit margin for the farms in the bottom asset turnover ratio quartile was 0.0565. In contrast, the average profit margin for the farms in the top asset turnover ratio quartile was 0.1619. However, the operating profit margins for the second, third, and fourth quartiles were not significantly different. Thus, consistent with the results with respect to the operating profit margin, having a high asset turnover ratio is not essential to obtaining a high operating profit margin.

Table V. Summary Statistics for Asset Turnover Ratio Quartiles.[a]

	Asset Turnover Quartile			
Item	First	Second	Third	Fourth
Value of Farm Production (VFP)	$164,461	$349,693	$438,688	$466,866
Net Farm Income	$34,771	$91,856	$107,355	$106,866
Interest	$10,765	$20,358	$23,880	$21,268
Unpaid Family and Operator Labor	$36,236	$49,491	$51,197	$52,534
Total Assets	$1,154,755	$1,319,425	$1,119,760	$701,710
Total Debt	$178,865	$344,449	$396,410	$331,661
Total Expense Ratio (TER)	0.789	0.737	0.755	0.771
Adjusted Total Expense Ratio (ATER)	1.009	0.879	0.872	0.884
Economic Total Expense Ratio (ETER)	1.484	1.102	1.004	0.947
Operating Profit Margin Ratio	0.0565	0.1794	0.1824	0.1619
Asset Turnover Ratio	0.1424	0.2650	0.3918	0.6653
Debt to Asset Ratio	0.1549	0.2611	0.3540	0.4726
Percent of Farms with Positive Net Cash Flow	87.92%	93.61%	96.61%	96.98%
Percent of Farms Financially Stressed	1.13%	3.38%	6.77%	10.94%
Percent of Farms with TER less than 1.000	81.89%	94.74%	96.24%	96.23%
Percent of Farms with ATER less than 1.000	41.51%	66.54%	77.44%	74.72%
Percent of Farms with ETER less than 1.000	0.38%	13.16%	39.85%	60.00%
Percent of Farms with VFP less than $100,000	39.62%	5.26%	3.76%	5.28%
Percent of Farms with VFP between $100,000 and $250,000	42.64%	43.61%	27.07%	23.40%
Percent of Farms with VFP between $250,000 and $500,000	15.85%	30.83%	40.60%	41.13%
Percent of Farms with VFP greater than $500,000	1.89%	20.30%	28.57%	30.18%

[a] The first quartile is represented by farms with the lowest asset turnover ratio. The fourth quartile is represented by farms with the highest asset turnover ratio.

The farms in the top profit margin ratio and top asset turnover ratio quartiles tended to be larger than those in the bottom quartiles. None of the farms with a value of farm production above $500,000 were in the bottom profit margin ratio quartile. Approximately 2 percent of the farms in the bottom asset turnover ratio quartile had a value of farm production above $500,000.

Summary and Implications

This paper examined the persistence of financial performance for a sample of farms over a five-year period. Financial measures examined included the operating profit margin ratio and the asset turnover ratio.

Results suggest that weather and other external factors made it difficult for a farm to consistently be in the top profit margin ratio or top asset turnover ratio quartiles over time. However, using five-year average data there was a substantial difference in financial performance between farms in the top and bottom quartiles. For example, farms in the top profit margin ratio quartile had an average operating profit margin ratio of 0.2804 and an average asset turnover ratio of 0.3409. In contrast, farms in the bottom profit margin ratio quartile had an average operating profit margin ratio of -0.1419 and an average asset turnover ratio of 0.2313. Farms did not necessarily need to have an above average asset turnover ratio to be in the top operating profit margin quartile. However, farms in the bottom operating profit margin ratio had below average asset turnover ratios.

Results also stress the importance of using several years of data to benchmark financial performance and suggest that it is possible for farms to have a sustained competitive advantage. Given the wide variability of financial performance documented in this study, further examination of the characteristics of the farms in the top quartiles, including obtaining information pertaining to management styles, experience, and decision making abilities, would be a fruitful area for further research.

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Attitudes of Australian sheep farmers to animal welfare

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Abstract

Previous research has indicated that Australian sheep farmers believe that long-term welfare issues, such as parasite control and poor stockmanship, are more important welfare problems for sheep than short-term painful procedures, such as castration, whereas the reverse was true for animal welfare activists. There is therefore an incongruity between the welfare issues that Australian livestock farmers believe to be most serious on their properties and those that are the focus of activist campaigns. This could either be due to farmers becoming desensitized over time to the exhibition of pain by their stock following invasive procedures or because of their better understanding of the factors affecting their animals' welfare. A nominated sample of 22 Australian sheep farmers were visited to conduct semi-structured interviews on the major welfare problems on their properties and those facing the industry, as well as factors influencing their sensitivity to animal welfare issues and how these had changed over time.

Responses were examined for themes, and a report was circulated to the farmers with mean responses and anonymised common viewpoints in a Delphi process. Sheep farmers reported that poor nutrition was considered the biggest welfare issue on their farms, but public opposition to the mulesing operation was recognised as the biggest challenge for the industry. Farmers proclaimed a caring attitude towards their animals, which they believed was mostly self generated, influenced in part by their spouse and father. Most farmers thought that their sensitivity to welfare was unchanged over time. They also considered that husbandry advances had improved the welfare of their animals over the course of their involvement in the industry. Farmers made little use of pain control, mainly because of the cost and time required to administer it. The importance of long term welfare issues, in particular nutrition, was confirmed in interviews with the sheep farmers. There was little evidence of farmers becoming desensitized to pain responses in their sheep, although they did not generally seek to mitigate these with pain relief.

Keywords: Animal welfare, Attitude, Australia, Farmer, Sheep

Implications

This research found that Australian sheep farmers had concern for the welfare of their animals and that their sensitivity was believed to be largely self-generated and constant over time. Their belief that inadequate nutrition was the most serious welfare issue on their farms confirms a recent survey finding that farmers view long term husbandry issues as their most serious welfare problems, but it conflicts with the previously recorded views of activist groups, who tend to regard invasive practices and mutilations as the major issues. Activist groups may be influenced by this in their choice of campaign focus. The lack of use of pain relief is a source of concern given the previously-reported view in Australia that it could play a major role in improving the welfare impact of potentially aversive procedures.

Introduction

The Australian sheep industry contains many extensive farms, which are acknowledged to have different welfare issues compared to intensive sheep production farms (Goddard et al., 2006). The public perception that extensive farms are naturally better for animals may be driven by media misconceptions and be inaccurate (Goddard et al., 2006). In a review of sheep welfare issues in Australia conducted by scientists and industry/welfare groups' representatives in 2002, it was reported that the industry had received little attention from animal welfare groups, but that this was likely to change (Cronin et al., 2002). Five priority welfare issues were identified: land transport; emergency planning during live export; mortality of lambs, and adults post-shearing and during transport; mulesing and stockmanship. Of less importance were environmental planning (for drought, fire and flood); disease control; mortality during live export as a result of salmonellosis, inanition, etc; feedlots; predation; and husbandry procedures: castration, shearing, dipping and tail docking. A subsequent review conducted in 2005 of welfare priorities for sheep production in Australia compared the views of seven stakeholder groups identified for the industry: farmers, livestock transportation representatives, veterinarians, meat processors, animal welfare advocates, animal welfare scientists and government officers (Phillips et al., 2009). Differences in opinion were evident between respondent groups, with animal welfare advocates tending to focus more on painful procedures more than those with direct involvement in the industry. Mulesing (surgical removal of loose skin on the hindquarters of sheep) was rated as the most serious issue by animal welfare advocates, whereas other groups all rated parasite control highest, supporting the view of British hill sheep farmers that ectoparasites are the most serious health issue that impacts on welfare (Waterhouse et al., 2003). The use of pain relief during routine aversive husbandry procedures, rather than the method, was believed to have significant influence on the welfare impact. As evidence of the impact of activist groups on painful procedures, a recent campaign by the activist group, People for the Ethical Treatment of Animals, resulted in a decision by the Australian wool industry representative body to terminate mulesing in Australia by the end of 2010. The focus of activists' attitudes on painful procedures is also evident in Europe. In a survey of Belgian citizens and farmers on their beliefs about contributors to animal welfare one of the biggest differences was the citizen's much stronger belief than farmers that avoidance of pain is essential for good welfare of farm animals (Vanhonacker et al., 2008).

This incongruity between the perceptions of the major welfare issues by members of the welfare groups (painful procedures) and livestock farmers (long-term husbandry issues) (Phillips et al., 2009) could derive from several factors. Farmers could have become desensitized to exhibitions of pain by their animals. Alternatively welfare advocates could focus on painful procedures because of their appeal to the public, who may have little understanding of husbandry systems, or they themselves may lack an adequate understanding of the welfare implications of different husbandry practices or they may view painful procedures as easier to change than long term issues. A series of interviews with Australian sheep farmers was conducted to explore their attitudes to the welfare of sheep on their farms, how their sensitivity to welfare issues, and in particular painful procedures, had changed over time, how it was influenced, and their attitude to the use of pain relief during husbandry procedures.

Materials and Method

A sample of Australian sheep farmers was selected for on-farm interview, in order to determine their attitudes to welfare issues. The sample was obtained using contact details of suitable farmers provided by the main industry body, Meat and Livestock Australia (MLA), and also through personal contacts. Farmers were chosen by MLA on the basis of their leadership in livestock production, their geographic distribution and their willingness to receive a visit. MLA staff sent out an explanatory, supportive letter to 22 farmers identified as suitable, requesting that those who did not want to receive a visit should notify them. No responses were received. Farmers were told that the study aimed firstly to investigate attitudes of sheep farmers to animal welfare and secondly to learn more about how sheep were managed in their production system, the latter being necessary for the research team to adequately interpret the former. Care was taken to ensure that farmers were not aware of any preconceived hypotheses about the major welfare concerns. Following receipt of the contact details from MLA the research team sent an e-mail to 19 farmers outlining the study and proposing a date for the visit, with three farmers being considered unsuitable because of their location. Five farmers did not reply to this e-mail and were not contactable by phone. All other farmers indicated that they were willing to receive a visit, with a follow-up phone call made where necessary. Two farmers wanted to be visited but it was impossible to arrange a mutually acceptable time. Twelve farmers from the original MLA list were therefore visited. In addition, 11 farmers were added following personal recommendations by other farmers or government officers, making 23 in total. One farmer was visited but not interviewed due to time constraints. The final nominated sample was therefore 22 farmers, including seven from New South Wales, one1 from Victoria, eight from South Australia and six from West Australia (approximately representing the national distribution of sheep farmers [AWI, 2006]). In all cases the oldest male member of the household, who actively managed the farm, had been identified as ‘the farmer’ and was interviewed, except for two instances of joint management by father/son and brothers, who were separately interviewed, and two instances where the identified ‘farmer’ was female. To preserve anonymity, all respondents are referred to as masculine.

Visits were conducted from January to April 2008. They usually commenced in the late afternoon/evening, spending time with the farmer and his family in the evening to gain their confidence, seeing the farming operations the following morning and finally conducting the interview. Prior to each interview the interviewee was provided with an information sheet concerning the survey, which detailed the objectives, informed them that they could withdraw at any time and who they could complain to in the event of dissatisfaction. Interviewees signed a disclaimer to acknowledge that they had read the information sheet and confirming that the results would remain confidential, that they waived the right to any payment and that they could withdraw at any time. The survey method was approved by the University of Queensland Human Ethics Committee (license number 2007001754). Each interviewee was provided with a T-shirt from the Centre for Animal Welfare and Ethics, University of Queensland.

During the interview a semi-structured questioning procedure was followed, with initial questions obtaining background information from the farmer: the size of the breeding ewe flock and its genotype, land area, length of involvement in the industry and extent of training. Subsequent questions addressed the interviewees' sources of information about animal welfare issues[1], the major welfare issues on their property (farmers were not asked to prioritise these in their answer, but the first mentioned was treated as the most important if they did not specifically mention that it was), major welfare issues for the Australian sheep industry, changes in their attitude over time and the reasons for this, external influences on their attitude, such as their partner, father or children, the impact of husbandry and other changes on animal welfare, and their attitude towards pain control for invasive procedures. The majority of the farmers answered the questions in approximately this order, but given the semi-structured nature of the questionnaire, deviations were permitted as considered expedient by the interviewer (CJCP). Questions were open-ended and sometimes participant-driven. The interviews lasted on average 45 minutes, range 30 to 90 minutes, and were recorded in note form by one of us (APP) and later transcribed *verbatim* into electronic form using voice-to-text software, with additional notes and recollections from the interviewer. Following the interviews, farmers were anonymised in a report and given pseudonyms using a list of common names of

[1] Where necessary, welfare issues were defined as events which could adversely affect sheep at any stage in their life.

boys born in Australia in the 1960s (Anon, 2008a), which were randomized using a random number generator. The interview records were examined by the project team for themes pertaining to the farmers' interpretation of the major issues, values and influences on attitudes of the farmers. Responses were coded, often qualitatively. The report was then circulated to each farmer, who were informed of their pseudonym and given the opportunity to change any comments attributed to them, or to make further comment if they wished. Three farmers clarified their comments and no farmers offered new comments.

Results and Discussion

Background information

Mean farm size was 4370 (SEM 450.0) ha and total number of breeding ewes 3044 (SEM 436.7), indicating that the sample was of relatively large Australian farms (Anon, 2009). All were privately owned. The mean duration of time spent by the farmer in livestock farming was 31 (SEM 2.88) years. Most of the farmers (88%) had been brought up on a farm. Regarding training in livestock production after leaving school, the most common form of education was short courses, which was the highest level of training achieved for 47 % of farmers. The highest level for 18% of farmers was a diploma, 12 % a first degree, 6 % a Master's degree and 6% a PhD. The remainder, 12%, had only learnt about livestock on farms, with no formal training. The sample population was therefore of similar age (47, assuming a mean entry age of 16, compared to a mean of 54 for sheep farmers in Australia, [Anon 2008b]) but was better educated than the average Australian sheep farmer (42% being tertiary qualified, compared to 23% of Australian sheep farmers

[Anon, 2008b]). This was believed to increase the reliability of the survey, with interviewees likely to be more knowledgeable about the industry.

Sources of information about animal welfare

The main sources of information on animal welfare and the proportion of farmers citing them were: radio (76 %), newsletters from the industry body (65 %), rural newspapers (53 %), popular press (29 %), consultation with other farmers (18 %), television (12 %), workshops and courses (6 %), consulting services (6 %) and their own experience (6 %). In relation to discussions with other farmers, Graham believed that “there is more communication between farmers nowadays, there used to be more competition and rivalry and now people help each other. In the past you didn't tell people if things went wrong”. However, Ian found sharing information with farmers who had problems difficult. There was an acknowledgment by many farmers that the ‘bottom 5%’ of farmers brought the industry into disrepute, and discussion about how they could be encouraged to manage their sheep better. Some favored talking to them, recognizing that peer pressure may be most effective, but others, such as Ian, thought that they were reluctant to learn in this way; a small minority favored reporting them to the RSPCA. Both Peter and Mark commented that bad farmers leave the industry. Tom believed that the availability of advice had increased considerably. Jason thought that it was important to use the information on animal welfare to predict what the market would require in ten years time.

Welfare issues on interviewees' farms

The most serious animal welfare issues on the interviewees' farms, as judged by the number of farmers nominating them were nutrition, fly strike, drinking water availability and intestinal parasites, followed by mulesing, general health issues and low management input, with stress, footrot, lamb survival, long distance transport and predation nominated by one farmer (Table 1).

Table 1. Reported major welfare issues on sheep farmers' own farms and for the Australian sheep industry, with number (and %) of respondents

	Own farm	Australian sheep industry
Nutrition	13 (59)	8 (41)
Mulesing	3 (14)	10 (45)
Health	3(14)	0 (0)
Stress	1 (5)	0 (0)
Low management input	3(14)	0 (0)
Intestinal parasites	7 (32)	5 (23)
Flies	8 (36)	4 (18)
Water	7 (32)	0 (0)
Footrot	1 (5)	0 (0)
Lamb survival	1 (5)	2 (9)
Long distance transport	1 (5)	5 (23)
Predation	1 (5)	1 (5)
Slaughter	0 (0)	1 (5)

A mean of 2.1 issues was raised by each farmer. Bias in this result is considered minimal because farmers had no incentive to emphasize any particular issue, other than perhaps to minimize the importance of issues that would be expensive to address. Nutrition is a much greater expense on farms and would therefore be more expensive to change compared with, for example, pain relief for invasive procedures. Therefore the suggestion that nutrition was the biggest welfare issue demonstrates that it was possible in the interviews to obtain an accurate understanding of farmers' beliefs. Any bias that emphasized low cost solutions to welfare issues was not evident.

Nutrition was the most common primary welfare issue for 37 % of farmers. Four farmers believed that by lowering stocking rates at pasture, they could reduce the risk of undernutrition caused by drought and avoid having to purchase expensive concentrate feed. Overstocking moved them "out of their comfort zone", according to Geoffrey. However, Tom, recognizing the delicate balance between stocking density and profitability, believed that "if you are not worrying about feeding your sheep, then you probably don't have enough". For wool farmers the restriction in wool diameter when sheep are in drought (Thompson and Hynd, 1998), resulting in potential downgrading of the wool because of reduced staple strength, encouraged them to mitigate the nutritional effects of drought. Stephen favoured running a prolific flock to enable him to build stock numbers up rapidly after destocking during a drought. A recent survey of major sheep welfare issues in Australia found that food supply was rated important but not in the top five issues (Phillips et al., 2009). A high mortality in a live export shipment just before that survey may have influenced reported priorities, just as the on-going drought in many of the sheep production regions of Australia may have influenced findings in this survey. However, the prevalence of nutrition as a major welfare issue has been recognized elsewhere. In a review of the welfare of sheep in extensive British farms, Goddard et al. (2006) identified nutrition of the pregnant ewe as a major concern.

Many farmers emphasized the close link between welfare and productivity, commenting that happy sheep are productive and farmers didn't want to see them suffer. In a survey of Scottish sheep farmers there was broad agreement in the ranking of perceived welfare and productivity impacts from ectoparasites (Morgan-Davies et al., 2006). Productivity impacts were generally rated as less severe than the welfare impacts, demonstrating that most farmers could distinguish between the two. However, in this survey Jason had difficulties understanding the term 'poor welfare' which he associated directly with unproductive sheep. The close link between farm profit and maintaining Australian sheep in optimum body condition, neither too fat nor thin, has been demonstrated in a comprehensive simulation model (Kingwell, 2002).

General health issues varied and were specific to the farm in question. They included intestinal parasites, flies, pneumonia, joint ill and seed penetration into the skin, each stated by one or two farmers. In total, these comprised 41 % of the primary welfare issues nominated by farmers. The importance of health issues has also been reported by Scottish sheep farmers (Waterhouse et al., 2003).

Mulesing received limited support as a welfare issue, and farmers generally believed that its importance had been exaggerated by the public. For example, John said that "mulesing is only an issue because of public pressure; and sheep have got a lot more serious issues in life, especially in the last few years when nutrition has been important". Anthony believed that "the pain and suffering in fly strike[2] is much worse than the short-term pain that I see due to mulesing and tail docking". Hence several farmers, including Philip,

[2] Authors' note: cutaneous myiasis

believed that sheep welfare would be worse without mulesing, not only because of increased breech strike, but also because of a greater number of skin cuts at shearing. Anthony thought that tail docking was more painful than mulesing, especially if the rubber ring was used. However, several farmers reported that they disliked mulesing their sheep and in some cases their wives or children refused to do it.

Some farmers were trying to breed sheep that did not require mulesing, with bare and wrinkle-free breeches. Both Gregory and Stephen focused on bare breeches, in the latter case because he found it difficult to get shearers to shear sheep with wrinkles on their hind quarters. He was breeding sheep with loose skin on their brisket, since the shearers' blade could follow a wrinkle if the skin was loose. However, he was trying to avoid wrinkles on the shoulders because they retain moisture easily, whereas wrinkles on the side of the sheep allowed water to run off. Although he still mulesed his sheep, he was taking much less skin off, perhaps 40 % less than when he had sheep with many breech wrinkles. He believed that it would take ten years of breeding before farmers had sheep that were sufficiently bare in the breech to enable them to stop the operation. However, Neil believed that farmers would not wait for welfare problems to happen, they would leave the industry. Colin and Philip were both aiming to reduce the suint content of wool, by reducing the sweat to grease gland ratio, although they conceded that sheep in hotter parts of Australia would need to maintain sweating capacity. Colin admitted to feeling "a sense of hopelessness if I cannot conduct the mulesing operation because some of my flock will get fly strike". He did not want to use fly-controlling chemicals because it would tarnish the 'clean, green' image of wool and the possible buildup of resistance.

Similarly two farmers cited the buildup of resistance as the major concern in relation to intestinal parasites. However, several farmers had bred sheep with good worm resistance, which they believed to be due mainly to a better immune reaction. Many were now using a less radical mulesing operation, and anticipated reducing the amount of skin removed over the next few years as they moved towards wrinkle-free sheep.

Most farmers emphasized feeling a strong empathy with their stock. At least two admitted to being considerably stressed themselves by welfare issues. Mostly the stress was generated on the farm, for example Barry said that “if animals are suffering you agonize about them and worry”. Sometimes the stress came from pressure from government officials, for example in the case of David, whose farm was quarantined because of suspected footrot. Perhaps because of this stress, Anthony believed that “If an animal is severely sick I believe that the kindest thing to do is to kill it, I would rather put it down and not see it suffer any more. Farmers feel for their animals and when they find an animal that has been suffering for some time they feel bad.” He acknowledged, with some apparent regret, that he breeds lambs just so that they can be killed, but he also said that he felt a sense of wonder at God's creation every time he saw newborn lambs. There was evidence of the sensitivity of some farmers to ethical as well as welfare issues, for example slaughter of lambs for meat production caused concern for Robert, who therefore preferred to look after sheep for wool production rather than prime lamb production. Robert was particularly concerned about predation of lambs, chiefly by foxes and birds (wedge-tailed eagles, ravens and crows).

Increasingly low management inputs, necessitated by a competitive industry, were a concern for some. Jason had a policy of breeding an easy care flock, which he acknowledged may challenge sheep, because it is based on survival of the fittest. Because of this, he believed that to improve welfare it is necessary to pay more attention to the selection of individual sheep and not just the whole flock. Conversely, Anthony believed that in relation to lambing, intruding often did more harm than good: “I'm not a midwife and it is best to let the ewes do their work”.

Welfare issues for sheep farmers in Australia

The most serious animal welfare issues for Australian sheep farms, as judged by the number of farmers’ responses, were mulesing and nutrition, followed by intestinal parasites and long distance transport, then flies, lamb survival, predation and slaughter (Table 1). Of these flies and mulesing were mentioned as the most serious issue the most times (29 % of farmers). A mean of 1.9 issues were raised by each farmer.

Although many farmers raised the issue of mulesing and fly strike, most talked about their own farm experiences, and many emphasized that mulesing was a welfare issue primarily because it was the focus of public attention. Several commented that the clips that were being developed as an interim measure by Australian Wool Innovation (AWI, undated) were not believed to be successful by farmers, falling off in the fields, requiring extra handling of the sheep and creating a problem of plastic remaining on fields. There was also concern that more chemical treatments would be necessary after mulesing was discontinued, and this would tarnish the chemical-free image of wool and lead to the development of resistance. The discomfort caused to sheep by faecal contamination of the breech area was a concern, as well as the accidental cutting off of the wrinkles by shearers. At a time when shearers were hard to recruit, the difficulty and longer time required to shear unmulesed sheep was a concern. Similar concerns about the availability of labour on British sheep farms have been reported recently (Morgan-Davis et al., 2006).

One farmer, Jason, believed that the primary problem was that Australian environmental conditions predisposed sheep to welfare issues, such as flystrike and predation, and that the control measures themselves, such as mulesing, were not welfare problems. However, the general perception was that mulesing and flystrike were the most serious issues facing the Australian sheep industry. Barry added that he liked keeping animals in a natural environment and would not like to work in a pig or poultry farm. Although reported by only a single individual, this view is at odds with the common perception that farmers are not interested in their animals' ability to live a natural life (Vanhonacker et al., 2008).

Fluctuating food supplies and the risk of undernutrition were perceived as major issues for the Australian sheep industry, especially at lambing time according to Robert. Neil was concerned that undernutrition was often very evident to the public, for example if the farm was near a busy road. Being easily avoided by purchasing feed, even if this was uneconomic, made some farmers, such as Neil, deplore those that allowed their stock to become undernourished. John added that supplementary feeding had the added benefit that sheep are regularly inspected. David thought that market pressures sometimes had adverse effects on sheep welfare and could, for example, prevent supplementary feed being purchased. Several farmers repeated that it was the bottom 5% of farmers who brought the industry into disrepute. Stephen felt so strongly that he was prepared to report farmers with sick and dying sheep to the RSPCA; others believed peer pressure to be preferable.

The primary long distance transport problem was believed to be shipping sheep from Australia to the Middle East, supporting the survey of Cronin et al. (2002), with long distance vehicular transport within Australia a secondary issue. The major problem with sea transport, according to Peter, was the different culture in the Middle East, which did not require the animals to be handled as well as in Australia. The solution, he believed, lay in research and development of the transport process. Colin believed that inanition on the ship was the biggest problem, which could be overcome by effective training of sheep to consume pellets prior to embarkation. This demonstrates a good understanding by some farmers of the problems that sheep experience in long distance sea transport (Pines et al., 2007). Jason pointed out that the mortality rates had fallen in recent years.

Lamb mortality was only nominated by 12% of farmers as a welfare issue for sheep farmers in Australia, but for these it was the most serious issue. Currently indicators of welfare on extensive livestock farms are based on mortality and morbidity but this is believed to be because they are easily measured rather than their importance (Turner and Dwyer 2005). In relation to lamb mortality Anthony believed that genetic selection for maternal influence on weaning weight would be advantageous, which would bring benefits in terms of good growth rates and ewes keeping their lambs close to them.

Barry did not believe that there were any major welfare problems in Australia because of the numerous checks in place. In this respect he believed that there were far fewer bad farmers today than previously.

Changes in sensitivity over the period of time that farmers had been working with livestock

When asked whether their sensitivity to animal welfare had changed during their period of involvement with livestock, 37 % of farmers said that it had not, with 21 % commenting that they had always had a strong empathy with their stock, or similar sentiments. Eleven percent commented that it had only changed (increased) because they had gained more knowledge. Sixteen percent believed that their sensitivity had definitely increased and 11% commented that it had definitely decreased. Thus there was little evidence that farmers believed they had become desensitized to pain and other welfare issues over time. However, both John and Ian mentioned that they became hardened to the impact of drought after a very bad year, and had learnt how to cope better, and one farmer, Neil, believed that with painful procedures such as mulesing, “the more you do it, the more you become steeled to it”. When he was young he remembered mulesing as being “gruesome, awful”, and couldn't even watch animals being killed, then when he was dealing with these issues all the time he got conditioned to it because he had to. “If you're a farmer you have to deal with dying animals and doing things that are best for them. People in industry are good shepherds; if they can't mules they will leave the industry”. Robert believed that his sensitivity had increased from when he was a teenager, but that it had been quite constant throughout his adult life. The possibility of bias in the level of sensitivity of the sample farmers is real, because they were of above average education level which has been shown in other countries to increase concern for animal welfare (Keller, 1994). However, farmers were not being asked how sensitive they were, rather whether their sensitivity had changed over time. In addition they were able on most occasions to qualify their answers with reasons and elaborate on particular changes at specific times of their lives, e.g. following a severe drought.

Several farmers commented on their close contact with their animals. Michael said that although he was not necessarily religious he believed that he had a close contact with nature and its cycles. Tom believed that his sensitivity to animal welfare was in part because he had grown up with stock and it was his passion. Barry believed that over time he had come to work in closer harmony with all the animals' instincts, which he called a holistic approach, for example by reducing stress in handling and allowing animals to move at their own pace.

How changes in husbandry over time influenced welfare

Most farmers believed that husbandry developments had improved welfare over the time that they had been farming. Michael believed that welfare issues had not changed, but there was now greater public awareness, and Richard thought that the introduction of codes of practices and other methods of regulating husbandry standards were potent forces for change. Robert believed that stockpeoples' attitudes had remained the same, but the techniques for sheep production had improved considerably. Only in the area of chemical use had progress in improving production been limited, because many of the most effective chemicals had been banned due to human safety concerns. Addressing welfare issues may therefore conflict with environmental and human health concerns and a holistic approach is necessary (Milne et al., 2008). However, Colin believed that there were other ways to address infectious disease challenges, in particular by creating flocks that are closed to the importation of live animals.

Even though nutrition was identified as a major welfare issue on most farms, it was generally acknowledged that improvements in nutrition still represented the biggest husbandry advance. Most improvement in knowledge was attributed to supplementation (especially during pregnancy), climatic and parasitic challenges, as well an improved understanding of trace element requirements. The identification of trace element deficiencies had been essential to enable several of the interviewees' farms to be used for livestock at all. Pasture quality was believed to have improved, in some cases through soil improvements but mostly through the introduction of more valuable pasture species, such as clovers. Philip believed there was generally a better awareness of the impact of seasonal climatic changes and the challenges that these present to the sheep's digestive system, which can precipitate scouring and attractiveness of the sheep to flies. Barry also believed there was greater recognition that gradual changes in the diet were important in maintaining productivity and that differential feeding of single and twin bearing ewes could improve ewe reproduction. David thought that improvements in facilities had been a major factor in improving welfare, for example the advent of mobile handling yards and covered races to encourage the easy movement of sheep. He also believed that increased competition had been a major driving force, with inefficient farmers no longer able to generate an income. Tom thought that improvements in veterinary advice had been particularly useful. Peter believed that there was now a more preventative approach to welfare issues. As a result of competition and contraction in the industry, only those that were passionate about their work could develop an efficient production system and survive, whereas previously the majority of the Australian population was involved in livestock farming. The wool industry was challenged more than the meat industry in this respect, because people were more likely to avoid using wool than consuming meat. Colin, a prime lamb producer, had found it profitable to increase his ewe surveillance at lambing time. Peter commented that increasingly farms were managed by large corporations, which could access resources more easily and maintain high standards of welfare. Such economies of scale have also been demonstrated for the treatment of ectoparasites in large Scottish sheep flocks (Milne et al., 2007).

Influences on farmers' attitudes towards sheep welfare issues

When asked who had been an important influence on their attitude to animal welfare, 50% of farmers nominated their partner, but 20 % commented that she had not been an influence, perhaps because she was present at the interview. Many of the farmers' partners undertook some work off farm, and in some cases outside the agricultural industry, to provide additional income. Women naturally have a more caring attitude to animals (Phillips and McCulloch, 2005), and John thought that their declining involvement in sheep farming could reduce welfare standards. They clearly provided little support to their husbands in several cases, not understanding the work that he was engaged in and being fully occupied with children or other activities. Anthony's wife commented that “she was not a farmer’s wife, she married a farmer”, so close involvement with the farming operations was rare in some instances. This is in line with changes in women’s expectations of marriage, which have been transformed from an economic provision to an emotional relationship, recognizing the benefits of such (Weston, 1999). The lack of involvement of women on sheep farms is not necessarily just the product of female emancipation, since women’s efforts on farms diminish in value over the early stages of agricultural industrialization (Rau and Wazienski, 1999). Sheep farming, being less adaptable to industrialization than other forms of farming, is probably still in the early stages. Later a more egalitarian structure may emerge, but the strong gender bias towards male sheep farmers suggests that this has not yet been achieved.

Approximately 20% of farmers believed that their father had had a major influence on their attitude to animal welfare. John believed that inter-generational transfer of husbandry skills was important in maintaining high welfare standards, and that this could be threatened by the flexibility in jobs that exists today. Animal husbandry was a lifelong learning process, and both Geoffrey and Ian commented that the knowledge required by farmers was much greater than previously. Several farmers commented that there had not been any external influence on their attitude to animal welfare, that they had developed it themselves.

Attitudes towards the use of pain relief

There was a general recognition that pain relief was beneficial, confirming the belief espoused recently by stakeholders in the Australian sheep industry that use of pain relief with invasive procedures was more important than the method employed (Phillips et al., 2009). John even believed pain relief was the major aim of all sheep farmers, however, 50 % had never used it, 33 % had tried it, and only 17 % used it routinely. Several farmers sedated their rams before shearing and their ewes before artificial insemination. Some farmers commented that they would use pain relief if it was cheaper or took less time, but Colin believed it would eventually become mandatory, because the public wanted it. In this respect, several farmers expressed concern that animal welfare advocates' activities, although well intentioned, were not always focused on the right issues. They were often anthropomorphic, according to Geoffrey, and demonstrated a lack of understanding of farming systems held by city dwellers, according to Gregory. The survey of Vanhonacker et al (2008) supports this contention, finding that citizens had little understanding of the animal welfare issues associated with certain husbandry operations. Philip believed that the problems that necessitated painful operations, such as tail docking or mulesing, should be tackled by genetic change, not pain relief.

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Labour use in Swedish production of red veal

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ABSTRACT

Swedish production of red veal is based on rearing dairy-breed calves to the age of 8 months and carcass weight ~160 kg. The short rearing period, young age of the animals and mixing of calves from many different herds place high demands on work organisation and working routines for cost-efficient production. This study investigated labour use and working routines on 31 farms, 61% of all Swedish red veal farms rearing 100-1500 calves annually, and identified factors with a high influence on labour input. The median labour input per week for small (SF) (100-399 calves/year), medium (MF) (400-699 calves/year) and large (LF) (700-1150 calves/year) farms was 22, 24.5 and 31 h/week, respectively. The median labour input per calf for pre-defined work tasks was 5.7, 2.3 and 1.8 hours for SF, MF and LF, respectively. A non-linear relationship was found between labour efficiency and veal unit size, and no effect on labour efficiency was found when unit size increased from 550 to 1150 calves/year. Some suggested strategies for increased labour efficiency are to lower the level of farm fragmentation, reduce the frequency of work tasks and plan for strategic handling of animals.

Key words: calf, beef cattle, work load, work efficiency, questionnaire

INTRODUCTION

During the past two decades, consumption of beef in Sweden has increased from 18 kg per capita in 1990 to 26 kg per capita in 2008. At the same time, competitive imports and low produce prices have led to a continuous decrease in the number of production units and animals produced, so that in 2008 only 48% of beef consumption was of domestic origin. (SJV, 2009). Input costs are increasing in agriculture and labour costs are no exception. In Swedish veal production at present, about 25% of the total cost is associated with labour (Agriwise, 2009). Furthermore, shortage of labour from outside the family is a growing concern. The time left after all routine work associated with red veal production could be used for other work on farm or increased time with the family. The issue of labour use is attracting increasing attention in different sectors of livestock farming (O'Shea et al. 1988; Kung et al. 1997; Leahy et al. 2004; Schick, 2005; Schrade et al. 2005; Fallon et al. 2006; Gillespie et al. 2008; O'Brien et al. 2006a; O'Brien et al. 2006b; Gleeson et al. 2008; Madelrieux and Dedieu, 2008; Martel et al. 2008; Madelrieux et al. 2009; Olsson et al. 2009; Quendler et al. 2009) but very few studies on labour input have been found as regards finishing calves or young cattle for beef. This livestock sector plays a large role in utilising practically all male calves, pre-weaned (2-8 weeks) or weaned (≥8 weeks), from the dairy industry. The short rearing period, young age of the animals and mixing of calves from many different herds place high demands on work organisation and working routines for cost-efficient production. Swedish veal production concentrates entirely on red veal and represents slightly less than 10% of total beef cattle production in Sweden. In addition to the EU Council directives on rearing and finishing of calves (91/629/EEC; 97/2/EC; 97/182/EC), Swedish red veal production is regulated by some national standards, (SJV, 2007) e.g. group housing after 8 weeks of age, no tethering of calves under 6 months, free access to roughage from week two and no restrictions on the iron content in feed or water. To prevent cross-infection and spread of diseases, the newly arrived calves must be kept separate from older calves for a minimum five-week quarantine period before being moved for the last months of fattening (SJV, 2007). Calves are weaned from 8 weeks. The calves are primarily of dairy breed (Swedish Holstein and Swedish Red) and are bought through meat marketing agencies or bilateral contracts between dairy farmers and red veal producers. Male (bull) calves are mainly used but also some female (heifer) calves not required for replacement in the dairy herd. The calves are purchased either as pre-weaned or weaned and reared according to abattoir preferences regarding carcass weight and body conformation. The desired slaughter age is 8 months with carcass weight ~160 kg, but some different standards can apply at regional abattoirs and certain meat retailers.

When estimating the labour cost for Swedish young cattle producers a labour input of 1 min/calf/day is typically used as a rule of thumb (Taurus, 2009). The estimation is based on small studies but no extended work time analysis from the Swedish intensive calf finishing producers has been published. Internationally, labour input in calf rearing during the milk feeding period in dairy production has predominantly been investigated. An American study on labour input and calf performance using different milk feeding and management methods in a dairy herd found an average daily time requirement for group-housed calves of slightly less than 1 min/calf (Kung et al., 1997). A recent Irish study (Gleeson et al., 2008) found an average daily labour input of 2.1, 1.7 and 1.8 min/calf within small, medium and large size dairy herds with different calf rearing methods. A Danish study of labour use in quarantine areas for newly introduced calves on 12 farms averaged between 30-60 minutes per day for daily tasks including milk feeding (Dalgaard *et al*., 2007). Danish finishing house equivalents from a similar study of 13 farms (Dalgaard, 2009) spent an average of 16 sec/calf/day, ranging from 5 to 37 seconds of daily work per calf.

Red veal production typically comprises several systematic work tasks performed daily, weekly or monthly, with no particular seasonal changes in labour input typically found on suckler beef or dairy farms (Fallon et al. 2006; O'Brien et al., 2006a; Madelrieux et al. 2009). The objectives of the present study were to investigate the current use of labour during common pre-defined work tasks in red veal production units of different size categories and to identify factors that affect labour efficiency.

MATERIALS AND METHODS

Records of all Swedish farms producing red veal during 2007 were obtained from the Swedish Board of Agriculture in April 2008, under rules of confidentiality. The distribution of veal unit size was highly positively skewed, with 155 farms with a median production of 53 finished calves per year, ranging from 21 to 1500 calves/year. The overall response rate to the questionnaire was 45%, with a low representation of farms with less than 100 calves (25 responses out of 80 farms). Therefore this paper focuses on the farms with annual production of 100-1500 calves in 2007 (response rate 67%). The responding farms were categorised into small-scale farms (SF) = 100-399 calves/year (n=14); medium-scale farms (MF) = 400-699 calves/year (n=11) and large-scale farms (LF) = 700-1150 calves/year (n=9), representing 50 %, 85 % and 82 % of farms within the three size categories, respectively.

Questionnaire

A semi-structured questionnaire was designed and tested on experts within different areas of red veal production (farmer, advisor and researcher) and refined before being posted together with a covering letter at the end of April 2008 to the 155 farms with annual production of 21-1500 calves. Twenty-one questions divided into three sections addressed the following topics

1) farm structure and facilities (i.e. age of farmer, number of employees, type of buildings/housing, age of calves at purchase, length of rearing period and number of calves produced); 2) labour input (work time and frequency of work tasks) and 3) perceived work strain related to the work tasks (not presented in this paper). Open questions addressed the farmers' own opinions and attitudes about work efficiency and the working situation, as well as possible future plans for investment in labour saving implements.

Field study

For a close-up study of labour patterns, 10 of the 21 largest red veal farms (producing ≥500 calves/year) from the 2007 records were contacted for field studies with interviews supplementing the questionnaire. The farms were contacted according to calf production numbers, beginning with the largest farm, until 10 farms had consented to participate in the study. The farm manager or main worker involved in the pre-defined work tasks was interviewed about labour use and working routines. Farm layout and facilities, such as buildings, housing system, machines and equipment, were recorded, as well as strategies and techniques related to the different work tasks. Main characteristics of the field study farms are shown in Table 1.

Table 1: Descriptive data on 10 farms involved in the field study; number of calves/year, group sizes in QH (calves/pen), housing system and number of buildings for quarantine house (QH) and fattening house (FH), respectively.

Farm no.	No of calves	Housing system QH	No. of QH	Housing system FH	No. of FH
1	500 (w[1]/not w[2])	*Group. Straw litter [cl] (20-50/pen)*	2	*Straw litter & cubicles with paved alleys[op] + slatted floors[cl]*	2
2	520 (w[1]/not w[2])	*Group. Straw litter[cl] (20-50/pen)*	2	*Straw litter[op]*	1
3	550 (w[1])	*Group. Straw litter[cl] (20/pen)*	2	*Straw litter with paved alleys[cl] + straw litter[cl]*	2
4	700 (w[1]/not w[2])	*Group. Straw litter[cl] (15-20/pen)*	2	*Straw litter with paved alleys[op] + slatted floors[cl]*	2
5	700 (not w[2])	*Group. Straw litter[cl] (4/pen*24)*	1	*Straw litter with paved alleys[op] + slatted floors[cl]*	2
6	720 (w[1])	*Group. Straw litter[cl] (100/pen)*	1	*Straw litter with paved alleys[op]*	1
7	800 (w[1])	*Group. Straw litter[cl] (70/pen)*	1	*Straw litter with paved alleys[cl]*	1
8	1000 (w[1])	*Group. Straw litter[cl] (40/pen)*	1	*Straw litter with paved alleys[op]*	1
9	1000 (w[1])	*Group. Straw litter[cl] (40/pen)*	3	*Slatted floor[cl] + straw litter[cl]*	3
10	1150 (w[1])	*Group. Hutches+ straw litter[cl](12-50/pen)*	3	*Straw litter with paved alleys[op] + slatted floors[cl]*	2

[1]w=weaned calves; [2]= not weaned calves
[op]permanently open building, at end or long sides; [cl]closed building

Definition of terms

Eleven common work tasks were investigated, 9 of which concerned the frequent handling of feed, bedding, animals and manure and two tasks involving administrative work and labour management. Labour input for unpredicted tasks, maintenance and repair of farm equipment and outdoor seasonal work were not included. 'Feeding' was defined as the time taken for the worker to load and supply the animals with feed, including milk. The feeding techniques were defined as 'tractor', 'automatic' and 'manual', referring to the degree of mechanisation of the work task. 'Bedding' referred to transporting and spreading of fresh straw in the pens. The techniques for straw litter work were defined as 'tractor' (with or without blower), 'semi-mechanical' (strewing machines) and 'manual'. 'Manure removal' referred to removal of the deep litter after the animals had been shifted from a pen, scraping of yards and cubicles. Manure removal techniques were defined as 'tractor', 'mechanical' or 'manual'. 'Cleaning' referred to high pressure cleaning of group pens between batches. Animal handling tasks were divided into five sub-categories; 'unload calves', 'shifting', 'weighing', 'medical treatment' and 'load calves' referring to the unloading of new calves off vehicles and into pens, relocating or regrouping calves, moving destined calves up through the weighbridge and back, medical treatment of calves and loading finished calves onto vehicles, respectively. 'Administrative work' and 'labour management' referred to paper-/computer work and management of employees, respectively.

Labour efficiency

Labour efficiency was calculated as min/calf/day and min/calf per batch in quarantine houses (QH), fattening houses (FH) and over the entire rearing period, based on the average number of calves and days in the quarantine and finishing houses. Labour inputs related to 'feeding', 'bedding', 'manure removal' and 'cleaning' were analysed separately for the period in the quarantine houses and the finishing houses (FH). Labour inputs for animal handling and administrative tasks were analysed on the basis of the entire rearing period (QH + FH).

Statistical analysis

Labour use in min/calf/day or min/calf/batch was analysed by the Kruskal-Wallis test (non-parametric analysis of variance) in Minitab 15.1. The effect of farm size was tested using Mann-Whitney test (non-parametric t-test).

Labour inputs were analysed for 31 farms (91%), due to incomplete details regarding work time for each work task in three questionnaires. Labour input data for two of the pre-defined work tasks were not further analysed in the study; the labour input during 'medical treatment of calves', which in many cases was not a routine task and therefore difficult to assess for the farmer, and the work time related to 'labour management', as few farmers had employees specifically involved in veal calf production.

RESULTS

Characteristics of respondents and farms

The average age of farmers was 47.2 years (range 31-68 years) and the median area of arable land per farm was 103 hectares (range 25-500 ha). Nineteen farms combined red veal calf production with other animal enterprises. Additional common farm enterprises were machinery contracting, forestry and tourist accommodation. Eight farmers (28%, 5 replies missing) considered the correlation between work efficiency and productivity on their farm to be very high. A 'quite high' relationship was reported by 55% of the farmers, while 14% and 3% considered it to be quite low and very low, respectively.

Overall, 32% of the farms bought pre-weaned calves. Forty-four percent of the farms bought calves only from the meat marketing agency (always weaned), 22% bought calves only from neighbouring farms and 6% kept calves from their own herds. The remaining farms (28%) obtained calves from two or all three sources. Age of calves at purchase and length of the rearing period (no. of days in QH + FH) are presented in Table 2, along with the number of calves continually managed in QH and FH. Small farms bought calves with more variable ages and also had higher variability in length of rearing period compared to the medium and large farms (Table 2).

Farm layout and housing

The median year for the most recent investment in a new building or rebuilding for red veal production was 2003 (range 1991-2008). Ninety percent of the farms used only one housing system in the quarantine houses, mainly full litter group pens (85% of farms). For finishing houses 35% of farms utilised buildings with up to three different housing systems. These were full straw litter pens (38%), combined straw litter pens with an alley (tractor- or mechanically scraped) along the feed table (29%) or slatted floor pens (23%).

Table 2. Number of calves managed daily (median and inter quartile range, IQR) in the quarantine (QH) and finishing houses (FH), age of calves at inset and slaughter, and length of rearing periods in QH, FH at small (SF), medium (MF) and large (LF) size veal units.

		No. of calves				Age at start (days)		Age at end (days)		Rearing period (days)					
Veal unit size* range (mean)		QH		FH						QH		FH		QH+FH$_{tot}$	
	n	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*	median	*IQR*
SF 100-399 (204)	12	40[i]	*20*	107	*50*	54	*34*	267	*65*	42	*28*	189	*70*	219	*79*
MF 400-699 (528)	11	95[ii]	*83*	220	*110*	56	*9*	244	*23*	56	*30*	132	*68*	193	*49*
LF 700-1150 (853)	8	100	*120*	300	*52*	61	*7*	244	*38*	42	*14*	150	*42*	192	*48*

*= number of finished calves per year
[i]= Quarantine houses were not used on three farms of the SF-category
[ii]= Quarantine houses were not used on one farm of the MF-category

Labour input

The farmers estimated their weekly median labour input in red veal production to be 20, 22.5 and 40 h/week for small (SF), medium (MF) and large (LF) farms. Corresponding median values from the work time analysis for the pre-defined work tasks were 25, 24.5 and 31 h/week for the three farm size categories (Table 3), indicating a tendency to underestimate among the small and medium sized farms. For large farms the additional work load of about one hour per day might be expected for additional tasks not included in the study, presumably the result of a higher awareness of the labour input on the most specialized farms. Median labour input per calf for the whole rearing period was 5.5, 1.9 and 2.0 h, resulting in an index of 1.5, 0.6 and 0.6 min/calf/day based on both quarantine and fattening houses. Daily labour input was generally higher in FH than in QH, however with fewer calves in QH, labour efficiency was generally twofold in FH, and in MF even 60 % higher (Table 3). A positive correlation was found between work time on the individual farm for daily routines (feeding and strewing) in QH and FH (r=0.4) indicating that a labour efficient farm tends to operate with well designed systems in both housing sections.

Effect of farm size

Labour input per calf was positively correlated with veal unit size up to 300 calves/year, from where the relationship turned negative with veal unit size to a break point of 550 calves/year (r = -0.663). A further increase in farm size up to 1150 calves/year had no effect on labour input per calf (r = -0.045). As a result labour efficiency was no different between MF and LF except for the individual work task of manure handling (Table 3). The non-linear relationship between labour efficiency and veal unit size is illustrated in Figure 1. ‘Loading on truck’ and ‘weighing’ were the only animal handling task where veal unit size had an effect on labour efficiency (Table 3).

Table 3: Labour input for pre-defined work tasks in red veal production for small (SF), medium (MF) and large farms (LF) prod. 100-399, 400-699 and 700-1150 calves/year.

	Labour input																	
	SF (100-399)						MF (400-699)						LF (700-1150)					
	n	Q_1	Median	Q_3	mean	%*	n	Q_1	Median	Q_3	mean	%*	n	Q_1	Median	Q_3	mean	%*
Daily labour input[i]																		
Labour input QH *(min/calf/day)*	9	1.4	*2.4*^{b}	3.5	2.5	-	10	0.6	*1.1*^{a}	1.3	1.2	-	8	0.5	*0.6*^{a}	1.0	0.8	-
Labour input FH *(min/calf/day)*	12	0.8	*1.2*^{b}	1.5	1.3	-	11	0.2	*0.4*^{a}	0.5	0.4	-	8	0.2	*0.3*^{a}	0.4	0.3	-
Labour input 'other' *(min/calf/day)*	12	0.09	*0.15*	0.40	0.24	-	11	0.07	*0.10*	0.12	0.10	-	8	0.08	*0.10*	0.16	0.11	-
Labour input QH *(h/day)*	9	0.9	*1.5*	2.5	1.8	*0.41*†	10	1.3	*1.4*	2.3	1.7	*0.40*†	8	1.0	*1.2*	2.4	1.6	*0.35*†
Labour input FH *(h/day)*	12	1.2	*1.8*	2.9	2.3	*0.49*†	11	0.7	*1.6*	2.4	1.6	*0.46*†	8	1.1	*1.5*	2.5	1.7	*0.44*†
Labour input 'other' *(h/day)*	12	0.2	*0.4*	1.8	0.5	*0.10*†	11	0.4	*0.5*	0.6	0.5	*0.14*†	8	0.6	*0.7*	1.1	0.8	*0.21*†
Total labour input (h/day)	12	2.4	**3.6**	5.8	4.1	-	11	2.6	**3.5**	4.5	3.7	-	8	2.6	**4.4**	5.2	4.2	-
Labour input per batch																		
Total QH *(min/calf/batch)*	9	80.0	*118.9*^{b}	226.2	150.7	*0.35*	10	31.2	*64.8*^{a}	76.8	62.0	*0.48*	8	22.7	*33.3*^{a}	43.7	34.2	*0.31*
Total 'FH' *(min/calf/batch)*	12	133.9	*185.3*^{b}	298.1	225.6	*0.55*	11	25.3	*48.7*^{a}	92.8	58.8	*0.36*	8	36.6	*53.6*^{a}	62.7	56.4	*0.49*
Total 'other' *(min/calf/batch)*	12	22.5	*33.6*^{b}	71.3	49.3	*0.10*	11	14.8	*20. 3*^{a}	22.3	21.2	*0.15*	8	15.4	*21.4*^{b}	30.0	23.0	*0.20*
Total (h/calf/batch)	12	*3.6*	**5.5**^{b}	*9.6*	*6.2*	-	*11*	*1.7*	**1.9**^{a}	*2.9*	*2.3*	-	*8*	*1.2*	**2.0**^{a}	*2.1*	*1.9*	-
Labour input per work task																		
Quarantine house (QH)																		
Feeding *(min/calf/batch)*	9	56.0	*71.4*^{b}	143.7	108.3	*0.22*	10	12.0	*43.1*^{a}	57.0	37.1	*0.32*	8	7.6	*24.3*^{a}	33.5	23.7	*0.22*
Bedding *(min/calf/batch)*	8	8.5	*20.7*^{b}	93.3	31.0	*0.06*	10	5.1	*8.6*^{a}	46.7	12.6	*0.06*	8	2.7	*5.3*^{a}	9.0	6.5	*0.05*
Manure removal *(min/calf/batch)*	9	2.2	*4.7*^{b}	21.0	11.1	*0.01*	10	1.9	*4.5*^{b}	8.1	7.9	*0.03*	8	0.6	*0.8*^{a}	3.8	2.1	*0.01*
Cleaning *(min/calf/batch)*	9	0.9	*3.1*^{b}	5.6	3.6	*0.01*	9	1.2	*2.9*^{a}	6.7	4.9	*0.02*	8	0.8	*1.3*^{a}	1.7	1.9	*0.01*
Finishing house (FH)																		
Feeding *(min/calf/batch)*	12	69.9	*122*^{b}	229.4	170.1	*0.37*	11	11.2	*38.1*^{a}	63.7	39.6	*0.28*	8	8.6	*37.6*^{a}	51.2	37.6	*0.34*
Bedding *(min/calf/batch)*	10	29.5	*54.5*^{b}	72.1	64.6	*0.17*	10	7.0	*12.8*^{a}	17.8	14.1	*0.09*	8	6.8	*13.6*^{a}	19.9	15.0	*0.12*
Manure removal *(min/calf/batch)*	11	5.4	*16.2*^{c}	26.5	26.3	*0.05*	11	2.6	*4.0*^{b}	5.1	4.1	*0.03*	8	1.7	*2.1*^{a}	2.9	2.2	*0.02*
Cleaning *(min/calf/batch)*	10	2.5	*6.9*^{b}	9.1	7.9	*0.02*	9	0.8	*2.3*^{a}	4.3	3.0	*0.02*	6	0.8	*1.1*^{a}	3.7	2.0	*0.01*
Other common tasks																		
Unload calves *(min/calf/batch)*	12	1.6	*4.0*	26.7	11.2	*0.01*	11	0.7	*2.8*	7.3	3.8	*0.02*	8	1.3	*2.8*	7.8	4.0	*0.03*
Shifting *(min/calf/batch)*	10	2.2	*3.3*	18.1	8.4	*0.01*	6	1.6	*2.9*	5.8	3.6	*0.02*	8	0.8	*3.5*	6.8	3.9	*0.03*
Weighing *(min/calf/batch)*	8	5.6	*13.0*	19.0	18.8	*0.04*	6	3.6	*5.7*	8.1	5.8	*0.04*	5	3.8	*6.2*	7.9	5.9	*0.06*
Load on truck *(min/calf/batch)*	12	2.5	*6.2*^{b}	10.9	9.1	*0.02*	10	2.0	*3.2*^{a}	6.7	4.3	*0.02*	8	1.6	*2.8*^{a}	3.4	2.5	*0.03*
Administration *(min/calf/batch)*	9	4.9	*7.8*	19.0	12.6	*0.02*	10	4.8	*6.1*	9.7	8.7	*0.05*	6	5.1	*7.5*	20.9	12.0	*0.07*

[n] number of farms

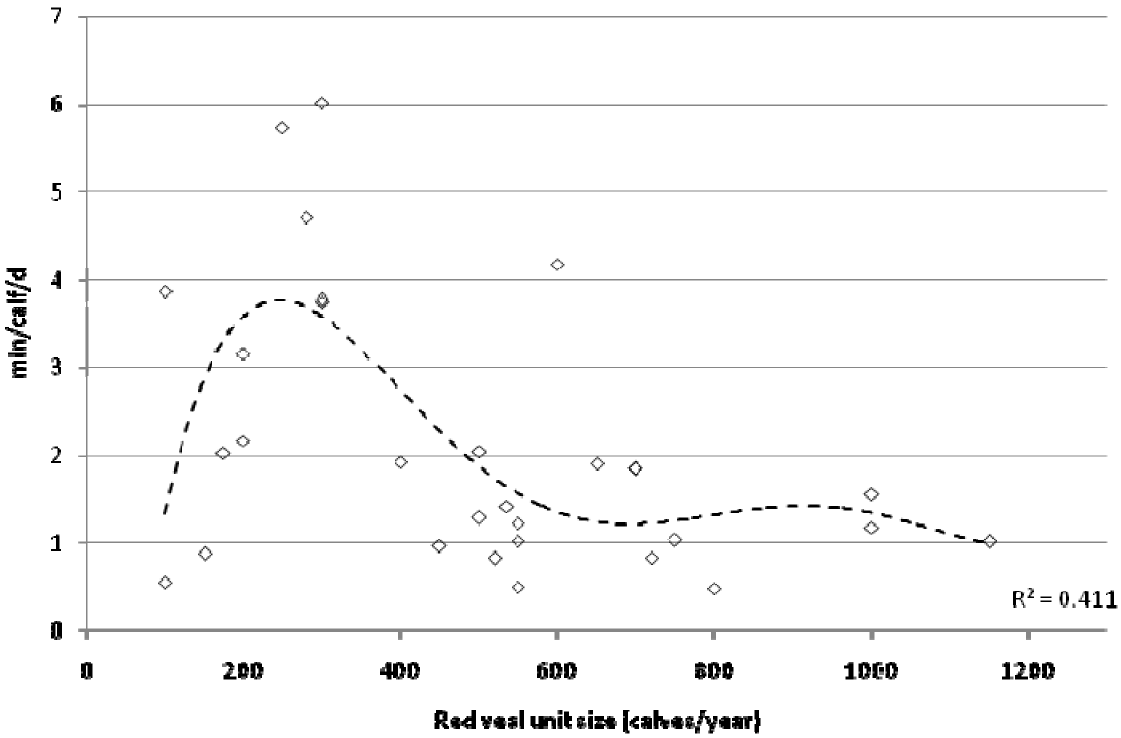
[i]All labour data refers to work time for 9 pre-defined work tasks (see table), and does not include work time e.g. for supervision, medical treatment of calves and infrequent unforeseen tasks.

*relative amount of total labour input per calf specific to work task

†relative amount of labour input on daily basis specific to combined work tasks ('QH',' FH' and 'other').

[ab]Values (within rows) with different superscripts are significantly different (P<0.05)

Figure 1. Labour input (min/calf/day) on Swedish red veal farms producing 100-1150 calves/year.



Factors influencing labour efficiency

Feeding tasks required the greatest proportion of labour input per calf, with 59%, 60% and 56% of total labour input on SF, MF and LF, respectively (Table 3). This was also the most frequent task, with a majority (50-80%) of the farmers having once or twice daily feeding routines. Daily labour input for feeding in QH was correspondingly 120, 47 and 31 sec/calf/day. The most common feeding strategy was to feed roughage and concentrate separately, both in QH and FH, with only 6% of the farms using a total mixed ration (TMR). Different techniques were used for feeding, even within the one farm, and partly or completely manual work was not uncommon.

The variation within farm categories decreased with a higher number of calves (Table 3), indicating that the largest farms were applying similar strategies. However, the inter quartile range (IQR) of 0.9 h/calf/batch on LF reveals that a labour input of up to ~750 working hours per year could be saved by the average farm in this size category, a considerable increase in the allocative efficiency of the farm. On the whole, the large IQRs in Table 3 indicate possibilities for improved labour efficiency within every farm size category and for every work task. As regards the largest farms (LF), IQR for 'feeding' was more than one hour per calf/batch in QH+FH (Table 3).

The field study confirmed the variation in work patterns and facilities between farms, and with seven of eight farms in the LF category being studied in detail, differences in labour efficiency could be examined in depth. Field study farms no. 6 and 7 (Table 1) were examples of farms within Q1 for feeding tasks in both QH and FH. These farms had several common factors for the efficient use of labour during feeding such as a) relatively large groups of weaned calves in QH; b) one single farm building centrally located for QH and FH, respectively; c) automated concentrate feeders; d) roughage feeding at low frequency (2-3 times/week). The field study farms no. 8-10 placed around the median value for feeding in QH. Farms with labour input above Q3 were the two LF field study farms, characterized by purchasing pre-weaned calves reared in small groups of 4-10 calves (farm no. 4 and 5, Table 1).

In FH, the feeding tasks consumed 46, 17 and 16 sec/calf/day on the three farm size categories, respectively. The 50% most efficient farms included field study farms no. 6 and 7 (described above) followed by farms no. 5 and 10 (Table 1). The two latter farms both had a supplementary old slatted floor building, affecting the overall labour efficiency negatively with the need for manual feeding techniques. Farm no. 8 feeding twice daily using TMR was in the third quartile together with a non field study farm producing 750 calves/year performing once daily feeding of 60 minutes in FH. Common for farms with the highest labour input was twice daily feedings in two or three different buildings for each calf age category (i.e. farms no. 4 and 9).

Labour input for bedding in QH was 3.7, 1.7 and 1.0 min/calf/week for SF, MF and LF, respectively. Bedding tasks consumed correspondingly 23%, 15% and 17% of the total labour input per calf. In FH, bedding tasks consumed 1.8, 0.7 and 0.7 min/calf/week. Overall, 51% of the farms handled the bedding material daily or every second day, in general more frequently in FH (daily basis) than in QH (weekly basis). Manual bedding was most common on SF, with 67% and 81% of QH and FH, respectively. A general increase in mechanization was found with increased farm size, but as a result of large variations in techniques within farms, bedding tasks on LF were still manually performed on 38% and 25% of QH and FH.

Quarantine houses were typically cleared for manure, high pressure cleaned and dried before putting new calves in, but also the majority of farms cleared and cleaned the pens in finishing houses between batches (Table 3). Overall, manure removal was in 52% of cases performed monthly. At 61 % of the farms, starter stables were washed once a month or every fifth week, followed by 13 % washing every second month. The remaining 26% washed 1-4 times a year. As seen in Table 3, the median time for manure removal was significantly shorter on LF compared to MF and SF, whereas work time for cleaning was affected by farm size already from the medium farm size category.

Animal handling tasks consumed proportionally higher labour input per calf as farm size increased, with 10%, 15% and 20% of total labour input on SF, MF and LF. Within the LF-category the 25% farms with highest total work efficiency were categorized by operating few buildings, centrally located on the main farm facilitating efficient loading, unloading and shifting of calves, concentrated weighing and limited transportation between houses. Buying pre-weaned calves and collecting the calves with their own vehicles characterized some of the farms with the work time above the median value for animal handling tasks. Work efficiency for administration was not increased by a larger veal unit size but a high proportion of work time was spent recording individuals entering and leaving the enterprise (7% of total labour input per calf on LF). Shifting, unloading and loading of calves consumed ~10 min/calf/batch on MF and LF and ~15 min/calf/ batch on SF and might, like the administration tasks, represent tasks that can hardly be expected to have a clear linear relationship between labour efficiency and unit size. Weighing of calves was done weekly or every second week and performed on 45-50% of SF, MF and LF, respectively, and was relatively labour intensive comprising 4%, 4% and 6% of the total labour input, respectively.

DISCUSSION

Different techniques have been used in previous studies of work time, such as observing the worker by use of a handheld computer, (Schrade et al. 2005) using digital stopwatches (Gleeson et al. 2007; Ferris et al. 2008) or keeping a work journal (Leahy et al. 2004; Schrade et al. 2005; O'Brien et al. 2006a; Gillespie et al. 2008; Gleeson et al. 2008). All these techniques have advantages and disadvantages for the accuracy of labour studies. In the present study, labour input data were based on the farmer's assessment of the labour input during common pre-defined work tasks on a normal working day. On-farm measurements would have required a large number of farm visits, as the time interval between many of the work tasks on red veal farms could be weeks, compared to pig or dairy farming where more work tasks are performed on a daily basis. With the questionnaire, the farmers had a 3-4 week deadline and thus the possibility to consider the labour input during several work tasks before the questionnaire was returned. Data from every farm were carefully evaluated after retrieval and checked for ambiguities or possible errors before analysis, and the good agreement between reported labour inputs from the questionnaire and data obtained on farm visits validated the choice of methodology.

The index for labour input of 1 min/calf/day currently used by farm advisors (Taurus, 2009) calculates costs for Swedish beef cattle producers on a total work time of 3 hours per calf for a 6 months rearing period. From our results in Tables 2 and 3 we found that the median rearing period is 7.2 months for SF and 6.2 months for MF and LF, and a labour use of 1.5, 0.6 and 0.6 min/calf/day, respectively, for the predefined work tasks only. Considering factors such as the additional work hour of about one hour per day for tasks not included in the study on large farms, a more than halved herd size for the average Swedish red veal producer and the difference in labour input per calf and day in QH and FH it appears that labor assessment in commonly used cost estimation guides for Swedish beef cattle producers might underestimate the true labor demand for red veal production.

Although the end-product was the same, the Swedish red veal production units studied were diverse. Housing systems, level of mechanisation, age and group size of calves during the production period differed not only between farms, but even within farms. All work tasks were not performed on every farm, which influenced the total labour input, and thus the variation between farms. Further, not all farms had a QH. This large variation in facilities and time management among farms is not exclusive to Swedish beef cattle producers, but has been reported for other types of farm (Leahy et al. 2004; Schrade et al. 2005; Fallon et al. 2006; Gleeson et al. 2008). Labour efficiency was not significantly different between medium and large farms, which may indicate that the trend towards high mechanisation and effectiveness has not been as noticeable in veal calf production as in the dairy, pig and poultry industries. This might illustrate the limitations of many farming facilities used at present, with a minimum amount of time per calf that can be put into production.

With the present economic situation in the Swedish veal calf industry, it is common to use old buildings or buildings originally designed for other livestock production, even when calf herd size increases, alone or as a complement to new buildings. However, this reduces the possibilities for the farmer to run his enterprise without employees, as the labour demand is too large and inadequate animal handling systems require at least two people to perform some tasks. In this study, using older buildings typically involved several houses and the number of quarantine and finishing houses could range from one to four or five, diversifying the strategies and techniques on the individual farm and sometimes involving considerable distances between the farm centre and certain calf houses. However, with this trend being common, it seems very relevant not only to discuss how expensive investments can reduce labour costs, but also to highlight how labour costs can be reduced in low-cost buildings. Feeding frequency as a labour saving method in beef cattle production has been discussed in some other studies (Schrade et al. 2005; Fallon et al. 2006) but little information is available on the effect of roughage feeding frequency on finishing cattle. Estimating the cost of labour using the value obtained in this study of a 42.6 min/calf difference between the large farms with the 25% lowest and 25% highest labour input during feeding in finishing houses gives a difference of 9741 EURO (700 calves*42.6 min/calf*current wage of 19.6 EUR/h; January 2010) (Agriwise, 2009) on a farm producing 700 calves annually.

Relative to the number of days that calves stay in the QH, the daily labour input per calf here had a large effect on the total labour input. The medium size farms had particularly low labour efficiency (48% of total time), which might be explained by the longer rearing period for calves in QH. Efficient use of QH is thus crucial. Using neighbouring buildings for the same age category of animals would concentrate the work tasks and make it possible to focus on the needs of the different groups of calves. Keeping quarantine houses close to the farm centre and using farm buildings further away as finishing houses could be one strategy for improving the supervision of younger calves.

Over the entire rearing period, feeding and bedding tasks accounted for 73% (LF) to 81% (MF) of the pre-defined tasks. The frequent and repetitive physical work with feed and bedding material involves not only a high work load in time, but also a risk of developing work-related musculoskeletal disorders (Hagberg et al. 1997; Kolstrup et al. 2006) as well as involving a risk of impacts from animals, particularly in the finishing houses. Large groups are admittedly efficient from a workload point of view (Neindre, 1993; Hanekamp et al. 1994; Gleeson et al., 2007; Pedersen et al. 2009), but are nevertheless agreed to be a challenge from several other aspects such as transmission of illnesses, conflict situations as to social ranking of calves, work safety and lower individual control and supervision by the farmer (Kung et al. 1997; Andrighetto et al. 1999; Lensink et al. 2001; Xiccato et al. 2002; Svensson and Liberg, 2006). Taking calves that are not weaned requires extra time and effort, as calves at this age are at a very sensitive period. A drawback taking weaned calves is that the farmer cannot control quality at this stage or be sure that the calf has been weaned in a way that ensures a proper uptake of roughage and concentrate after weaning. Being weaned on the truck can leave a calf with many stress factors at the same time.

The relationship between a reduction in labour input per animal with increased size of the enterprise is well established (Langvatn, 1960). Nevertheless, labour input per calf for handling animals was similar for all three farm size categories. The present result is apparently another effect of the use of older buildings or buildings not originally constructed for red veal production. The great variation between farms in work time for animal handling indicates an urgent need for proper animal handling facilities. In general, beef cattle advisors recommend weighing as an important tool for planning slaughter maturity and for optimal utilisation of buildings and input resources (Taurus, 2009), but 53% of the respondents in the present study never weighed the calves. The farmers who weighed calves regularly were convinced about the value of this, however those who did not weigh their calves argued that the scales could not tell more about carcass measurements than a skilled eye. From a work efficiency point of view, where the facilities are inappropriate, the ability to judge a mature animal would save valuable work hours and even avoid stressful situations with risk for injuries to both animals and humans.

Adequate systems for efficient handling of animals, shifting them between pens and loading and unloading the transport vehicle are not only labour saving but also crucial for a safe working environment, above all as the farm expands and the size of the veal production unit increases. The proportion of work time needed for administration work (Table 3) confirmed the issue commonly stressed by farmers, that paperwork is taking more and more time. The increased availability of electronic identification of animals will probably reduce this burden and also facilitate safe and efficient animal handling in the future.

CONCLUSIONS

This study of labour use on Swedish red veal farms revealed that the median labour input per calf for pre-defined work tasks was 5.5, 1.9 and 2.0 hours on small, medium and large farms, respectively. Labour efficiency was not significantly increased by herd size once the unit size exceeded 550 calves per year. Some strategies to reduce labour requirements are to lower the level of farm fragmentation, reduce the frequency of work tasks and plan for strategic handling of animals. Improvements are particularly crucial in quarantine houses, where the number of animals is low and the batch period short.

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Evaluation of Crop Rental Arrangements in the Louisiana Rice Producing Region of the United States

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Abstract

Rising production costs have forced many rice producers to renegotiate their crop rental agreements with their landlords as a means of increasing producer net returns per acre. By evaluating different share rental agreements and the degree in which production costs are shared, equitable crop rental arrangements can be achieved for all parties with a vested financial interest in the crop. The purpose of this paper is to identify the overall affect that alternative rental arrangements have on landlord and tenant profitability. Different gross and net share rent scenarios are presented, each with the allocation of production costs dependent upon the grower's financial contribution to their crop and risk preference. The optimal rental arrangement can be identified between the grower and landlord so that the agreement is profitable to both parties. A financial simulation model was constructed to examine net returns while comparing the risk for each party for common share rental arrangements in Louisiana.

Keywords: rice production, crop rental arrangements

Introduction

A total of 182,183 hectares of rice were produced in Louisiana in 2009 (LSU Agricultural Center, 2009). Leading rice-producing parishes in the state included Jefferson Davis (31,795 hectares), Acadia (32,146 hectares), Vermilion (16,614 hectares), Evangeline (17,168 hectares), Morehouse (18,728 hectares) and St. Landry (10,707 hectares). Average rice yield per harvested hectare for the state in 2009 was 7,057 kilograms.

In Louisiana, rental arrangements for rice production are predominately share rent with the landlord possibly sharing in some expenses. However, in recent years, rice producers have been renegotiating rental arrangements in response to increased variable costs and declining net returns. Energy-related inputs, which require a large appropriation from the total rice farm operating budget, have seen the largest increase in per unit costs to date.

Typical rental arrangements for rice production in the area include crop share arrangements with the landlord in some cases paying the irrigation pumping costs as well as a share of other major variable production costs. Landlords would receive a specified share of crop revenue proceeds as gross income. In addition, landlords might also pay the fuel costs for rice irrigation pumping, as well as a share of some other production expenses as specified in the rental agreement. Net income to the landlord for leasing land for rice production would be the gross rental income received less the production expenses paid by the landlord.

Many rice producers in Louisiana are renegotiating their crop share rental arrangements away from traditional cost-shares (i.e., a gross share arrangement) and towards a predetermined net share percentage. Under this method, landlords do not share in paying any of the costs of producing the rice crop and receive a “net” share payment negotiated to be approximately equal to what net income would have been in the standard gross share arrangement. The magnitude of this “net crop share percentage” of the crop’s market return, which is paid to the landlord in exchange for land and/or water rights, can influence the degree of risk borne by the producer. By comparing the equity of a traditional cost share rental arrangements in terms of the degree to which returns are shared relative to production cost contribution(s) against those of paying a determined percentage of the crop, a producer can better evaluate their risk level. Current irrigation pumping costs and which party pays that expense has resulted in a distribution of net returns between grower and landlord which is not proportional to the contribution of inputs for many rental arrangements. A study was conducted to evaluate rice share rental arrangements and to estimate the impact of critical factors on net returns to both grower and landlord.

Background

Land tenure is a primary factor influencing the allocation of resources and the net profitability of crop production. Many family farms have expanded farm size over the years to reduce fixed production expenses per farm acre. National data from 2001 on U.S. farms reported that approximately 80 percent of the large family farms in the country leased some or all of the agricultural land farmed (Hoppe and Korb 2004). The “part owner” tenure group accounts for over two-thirds of all medium farm sales in the U.S. (Hoppe et al 2007). The decoupled nature for U.S. farm program payments influences cash rental rates for agricultural land (Roberts 2005).

Agricultural land lease arrangements are generally of two basic types: cash rent or share rent. Hence, contract type substantially affects the tenant/landlord relationship, e.g. sharing of revenue, costs, risk, and managerial responsibilities (Rainey et al 2005). Share rent arrangements involve the landowner and tenant operator sharing in the proceeds from crop production, generally in a similar proportion to the contribution of production inputs. Equitable crop share arrangements identify all contributions made separately by a landowner and the tenant. Income is then shared in that same proportion. Leasing allows farm operators to control more acreage with less equity, carries lower financial risk, and allows for greater managerial flexibility than purchasing land with debt financing (Rainey et al 2005). Equitable lease theory suggests that returns to land are similar to the returns to non-land inputs. Thus, shares received by each party need to change as relative input contributions change (Dhuyvetter et al 1999).

The contribution of land as a production input is the central issue in determining an equitable cropland lease arrangement. The land charge can be evaluated and addressed in the enterprise budget in three ways: (1) what it would cost to cash rent similar land, (2) the net cost of a share-rent lease for this crop on similar land, and (3) for owned land, the opportunity cost of the capital invested (Kay et al. 2004). These three methods can generate different land value estimates relative to the current rural real estate land markets. From an investment perspective, a lending institution's interest rate will also influence the attraction of a land investment.

Typically, irrigation pumping cost is the most common rice production expense that may be paid in-full or in-part by the landlord. Other production expenses such as seed, fertilizer, chemical, and drying may or may not be shared by the grower and landlord in the same percentage that the crop proceeds are shared. Since landlord income is dependent upon variable crop yields and market prices, share contracts warrant additional financial and managerial compensation and are typically negotiated to induce landlords to utilize these types of contracts/arrangements (Rainey et al 2005).

Rising energy prices incurred by rice farming to power irrigation pumping systems have resulted in land tenure renegotiations over the past few years in efforts to reach equitable rental arrangements for both grower and landlord. Variable production costs associated with rice production have increased significantly this decade. Variable production costs for Louisiana rice production in 2010 were projected to total $1,423.70 to $1,540.72 per hectare, dependent upon variety planted (Salassi and Deliberto, 2010). The projected fuel and fertilizer component of rice production alone accounts for 40.8 percent of the total variable expenses per hectare in 2010. Table 1 reports direct operating expenses for Clearfield (CL) rice grown in southwest Louisiana from 2007 to 2010 Input price volatility in the agricultural production sector from 2007 to 2009, resulted in larger operating budget appropriations of fertilizer, fuel and seed. During that time interval, per hectare costs of fertilizer and farm diesel increased by 43 percent and 38 percent, respectively.

Irrigation pumping costs and which party pays that production expense has resulted in a distribution of net returns between grower and landlord which is not proportional to the contribution of inputs for many rental arrangements. Returns to both parties are calculated with 2010 projected rice production expenses coupled with a $0.33 per kilogram rice price and a 6,949 kilogram per hectare yield. (Figure 1) These estimates are for traditional/customary rental arrangements in southwestern Louisiana. In the sections that follow, a more detailed description of the proportional cost sharing strategies is presented.

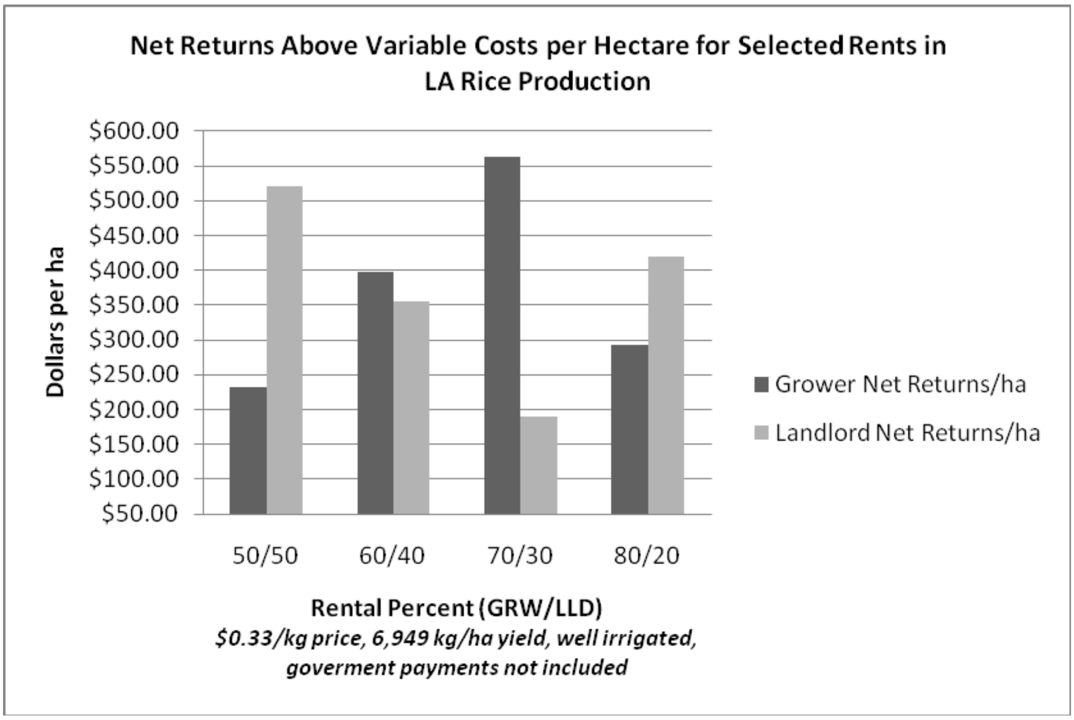

Figure 1. Grower and landlord net returns under common share rental percentages in Louisiana using 2010 production expenses.

Table 1. Variable production expenses per hectare for Clearfield rice produced in southwest Louisiana.

	Amount per hectare			
Expense Category	2007	2008	2009	2010
Custom Activities[1/]	$160.00	$167.17	$167.17	$205.96
Drying	$144.56	$144.56	$144.56	$151.23
Fertilizers	$181.87	$270.33	$368.43	$244.63
Chemicals	$176.53	$173.49	$181.43	$199.61
CL Seed	$111.20	$123.55	$155.68	$217.45
Diesel Fuel	$350.52	$484.15	$367.25	$383.95
Other[2/]	$149.87	$158.05	$164.20	$137.89
Total Costs	$1,274.55	$1,521.30	$1,548.71	$1,540.72

[1/] Custom field activities include spraying, fertilizer application, planting, and hauling expenses.
[2/] Other costs include irrigation supplies (excluding fuel), labor, repairs, and interest on capital.

Materials and Methods

Following Dillman, 2000, a survey conducted in 2008 identified the variability of rental percentage paid for land and water rights in Louisiana rice production. A questionnaire was mailed to 1,128 rice contacts in the major rice producing parishes of the state to solicit the type of rental arrangement, rent mechanism, planted rice acreage, and the percentage of variable production costs paid by the landlord on a per tract basis. Data on variable production costs shared by producers and landlords included: irrigation pumping, seed, fertilizer, chemicals, and drying. Parishes surveyed included Acadia, Calcasieu, Evangeline, Jefferson Davis, Morehouse, and Vermilion. The purpose of this study was to identify current rice rental arrangements. The results showed that lease rates varied throughout of the state. The landlord may or may not contribution a proportional share of selected production inputs relative to his portion of the crop.

Of the 202 respondents, 158 reflected standard land tenure systems for rice. Another 44 survey respondents were not usable due to operator retirement or death, change of address, movement away from rice farming activities, termination of lease, and/or loss of cropland. The 158 respondents represented a 14.0 percent sample response rate. Of those respondents, 146 were from the southwestern rice-producing parishes while only eight were from the northeastern part of the state. Four of the questionnaires were from an unidentified origin within the state. In total, 487 land tracts were reported of which 100 were rented on a cash basis, 350 were share rented, and 37 tracts had an unidentified rent mechanism.

The reported crop share rental percentages (percent of crop going to pay for land and water) on 334 rice tracts varied greatly, with the majority in the 20 to 40 percent range. (Figure 2) Low crop percentage arrangements were generally associated with payment for land only, with the producer paying the irrigation pumping cost. Notably, 31.4 percent of the sample utilized a 20 percent crop share agreement. A 40 percent arrangement was followed by 17.4 percent of the sample; the 30 percent share agreement by 9.6 percent; the 25 percent share agreement by 8.1 percent; the 16.7 percent by 5.4 percent; and 33 and 50 percent crop shares accounted for 5.1 percent each of the share rented respondents, respectively. These arrangements represented 82.1 percent of all reported share rent tracts. Recently, several lease arrangements have been renegotiated to require the grower to pay the irrigation costs, particularly where relatively low cost surface water is the irrigation water source. In crop lease agreements in which the grower is paying less than 30 percent as a lease payment, irrigation costs are paid by the rice grower. Most lease arrangements in which the landlord crop share is 30 percent or more, the landlord is paying the irrigation pumping costs. (Figure 3)

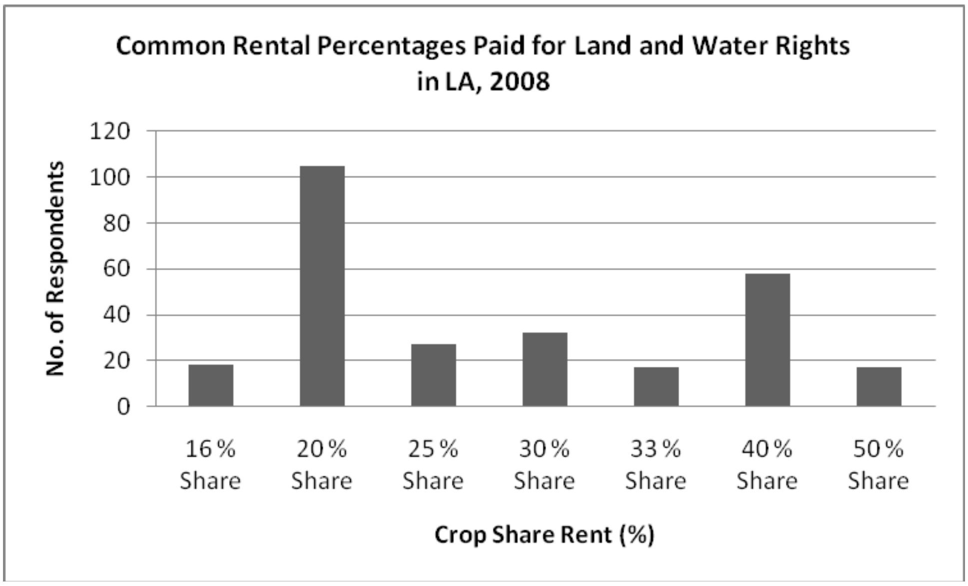

Figure 2. Common share rental percentages paid for land and water privileges, southwestern Louisiana 2008.

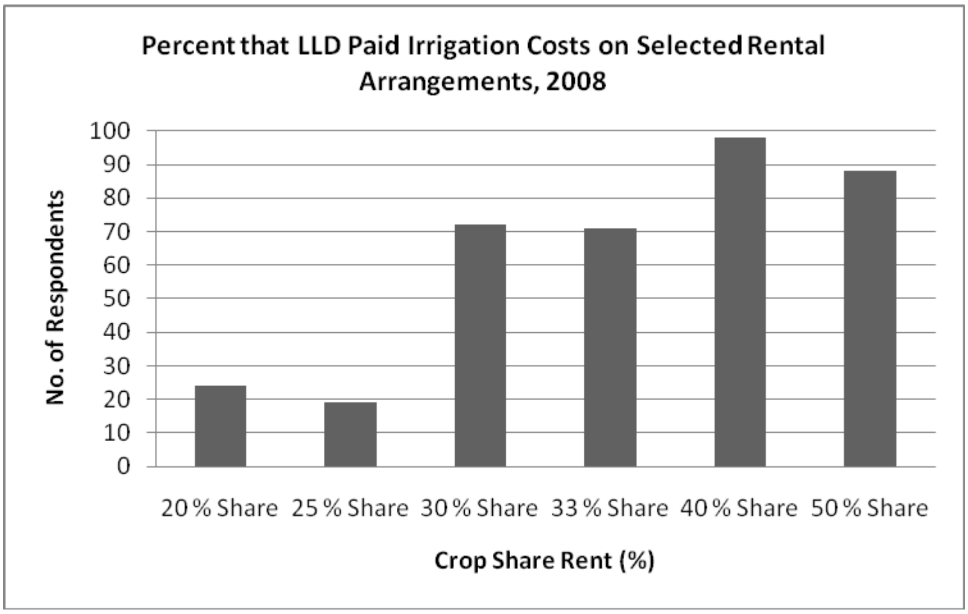

Figure 3. Landlord contribution to irrigation pumping cost expense in selected share rental arrangements.

In order to evaluate grower net returns for common share rental arrangements, as indicated by the survey responses, a rice production financial simulation model was developed to evaluate the impact of alternative rental arrangement parameters, along with price and yield level and variability, on grower net returns above variable cost. The simulation model incorporated provisions of crop share rental arrangements, as well as crop income and production expenses on a per acre of rice planted basis. U.S. farm program price support payments for rice were included in the model with direct and counter-cyclical program provisions in effect for the 2010 crop year (USDA, FSA, 2008). Rice net returns above variable production costs per acre of rice for the grower were simulated over 1,000 iterations in the financial simulation model under various scenarios and parameters. The basic structure of the financial simulation model is presented below.

The basic structure of the financial simulation model is present below.

[1] $grwmktinc = (mktprc*yld1*grwshr) + (mktprc*ratoon*yld2*pctrat*grwshr2)$

[2] $grwpginc = (dp*pyld*(0.85/pctplt)*grwshr) + (ccp*pyld*(0.85/pctplt)*grwshr)$

[3] $grwinc = grwmkinc + grwpginc$

[4] $grwvcost = (grwirrg1 + grwirrg2 + grwfert1N + grwfert1P + grwfert1K + grwfert2N + grwchem1 + grwchem2 + grwappl + grwfuel1 + grwfuel2 + grwdry1 + grwdry2 + grwhaul + grwothr1 + grwothr2)$

[5] $grwnetvc = (grwinc - grwvcost)$

Total grower gross income (*grwinc*) is the sum of market income from rough rice sales and income from federal commodity price support programs. Grower market income from rough rice sales (*grwmktinc*) is a function of:

mktprc = the market price of rough rice, in dollars per kilogram,
yld1 = rice yield from the first crop harvest, in kilograms per hectare,
grwshr = grower's share of first crop proceeds relative to rental arrangement, in percent,
ratoon = binary variable for ratoon crop production,
yld2 = ratoon crop yield, in kilograms per hectare,
pctrat = ratoon crop acreage harvested as a percent of first crop acreage,
grwshr2 = grower's share of ratoon crop proceeds relative to rental arrangement, in percent.

Income received by the grower from government farm commodity price support programs for rice (*grwpginc*) is the sum of direct and counter-cyclical payments from those respective programs where:

dp = direct program payment, in dollars per kilogram,
pyld = established program rice yield, in kilograms per hectare,
pctplt = percent of rice program base acres planted, in percent,
ccp = counter-cyclical program payment, in dollars per kilogram.

Grower net income above variable production costs (*grwnetvc*) is defined as the sum of market and program income less the grower's share of variable production costs. Variable rice production costs paid by the grower (*grwvcost*) include, in dollars per hectare:

grwirrg1 = grower's share of first crop irrigation pumping cost,
grwirrg2 = grower's share of ratoon crop irrigation pumping cost,
grwfert1N = grower's share of first crop nitrogen fertilization cost,
grwfert1P = grower's share of first crop phosphorus fertilization cost,
grwfert1K = grower's share of first crop potassium fertilization cost,
grwfert2N = grower's share of ratoon crop nitrogen cost,
grwchem1 = grower's share of first crop herbicide, fungicide and insecticide cost,
grwchem2 = grower's share of ratoon crop herbicide, fungicide and insecticide cost,
grwappl = grower's share of input application cost,
grwfuel1 = grower's share of first crop fuel cost,
grwfuel2 = grower's share of ratoon crop fuel cost,
grwdry1 = grower's share of first crop drying cost,
grwdry2 = grower's share of ratoon crop drying cost,
grwhaul = grower's share of harvested rice hauling cost,
grwothr1 = grower's share of other first crop variable costs,
grwothr2 = grower's share of other ratoon crop variable costs.

Random numbers were obtained using the SIMETAR software package for each selected farm input by following the procedure outlined in Richardson et al 2008. There were six variables incorporated into the model: rough rice price per hundredweight, farm diesel price per gallon, nitrogen fertilizer price per pound, phosphorus fertilizer price per pound, potash fertilizer price per pound, and average first crop yield per planted hectare. Values were based on historical data from 1999-2008. The detrended mean values for the variables were selected as the "means" for the random number generation. These values resembled current and expected market conditions for variable estimation. Our analysis was for the 2010 marketing year, therefore trends in the price, yield, and input values were removed. The model conducted 1,000 iterations per input. Mean values used for the simulation period were: a $0.33 rice price ($/kg), $0.61 diesel price ($/l), $0.93 nitrogen price ($/kg), $0.86 phosphorus price ($/kg), a $1.06 potash price ($/kg), and a crop yield of 6,949 kilograms per hectare.

Rice farm level simulation parameters evaluated in the study are shown in Table 2. Four typical rice share rental arrangements were analyzed, with the landlord crop share ranging from 20 percent to 50 percent. Irrigation pumping costs were assumed to be paid by the grower on the 80/20 rental arrangement and by the landlord on the other three arrangements (70/30, 60/40 and 50/50). Both deep well and surface irrigation water sources were included in the analysis. The landlord was assumed to pay his share of fertilizer, chemicals, drying, and hauling expenses. The ratoon (second) crop rice yield was assumed to be 30 percent of the first crop yield and ratoon crop acreage scenarios of 0, 25 and 50 percent were included in the simulation analysis.

Table 2. Assumptions made for typical cost share rental arrangements for rice in southwestern Louisiana.

Rent Share (GRW/LLD)	Irrigation Pumping Financed by	Production Costs Shared Relative to Arrangement Percentage
50/50	LLD	Applications, Chemicals, Drying, Fertilizers, and Hauling
60/40	LLD	Applications, Chemicals, Drying, Fertilizers, and Hauling
70/30	LLD	Applications, Chemicals, Drying, Fertilizers, and Hauling
80/20	GRW	Drying and Hauling

A "gross" rent model evaluated grower/landlord (GRW/LLD) rice crop share rental arrangements of 50/50, 60/40, 70/30, and 80/20 percent shares. In this scenario, the landlord receives as rent a gross percentage share of the crop proceeds and also shares in paying some of the variable production expenses. The farm is assumed to plant 85% of base acreage in rice while electing to remain in the direct and counter-cyclical revenue payment programs. The grower and landlord each receive their share of program payments relative to the agreed upon crop rental percentage. Net returns above variable production costs (NRAVC) measured farm profitability per arrangement. Risk under each arrangement was based on the coefficient of variation (as a percent of income) within the farm model simulation.

As an alternative to the common share rent arrangement, a "net" rent model was constructed. In this scenario, the landlord receives a crop proceed share, roughly equivalent to what would have been received net of the landlord's share of variable expenses, and does not pay any variable production expenses. The landlord's net returns, in terms of percent of total income to both parties under a traditional crop share served as the net percentage number determining the landlord's rent payment. Similar to the "gross" rent model, the same farm inputs were varied. However, in this model the landlord received a flat percentage of the crop and contributed no production costs in exchange for land privileges. Similar to the gross model, grower and landlord each receive their share of program payments corresponding to the net rental percentage. Net landlord crop share percentages evaluated in this analysis in comparison to the 50/50, 60/40, 70/30 and 80/20 gross share arrangements were 21%, 15%, 8% and 18%, respectively. In the net share arrangement percentage of 18%, to be compared with a gross share arrangement of 80/20, the grower is assumed to pay the irrigation pumping cost, whereas in all other arrangements the landlord is assumed to pay irrigation pumping costs.

Results and Discussion

Results from the farm simulation model per rental percentage are presented in Tables 3 through 6. These indicate that growers benefit from higher gross income levels under a "net" rental model. It is once again noted that the net percentage rate is calculated as the equivalent percentage of the landlord's net returns above variable costs under a traditional cost-share agreement. However, since the landlord pays no production expenses the grower's production risk increases significantly compared to the traditional gross rent model. This is evident by the significant increase in coefficients of variation for the 50/50, 60/40 and the 70/30 models. The grower is financing the entire production expense of the crop including the irrigation pumping charge. For the 80/20 gross arrangement, the landlord contributes 20% of the drying and hauling expenses only. Therefore the grower under this agreement bears additional production risk through a greater financial investment in the crop compared to the other gross rental models where irrigation costs are paid by the landlord.

Gross income variation or risk, is the same for both parties since gross income is calculated as the rental percentage of the crop's yield times the rice price plus the rental percentage share of farm program payments per rental rate examined. Net returns above variable costs (NRAVC) will shift risk, in all cases, as the "net" rental model assumes the complete production expense is borne by the grower compared to the proportional cost sharing in the "gross" model.

Simulation results for first crop rice production (no ratoon crop) are shown in Tables 3 through 6 for a deep well irrigation water source. Table values represent the party's net returns above variable production costs and percent deviation from the mean return value (coefficient of variation). Results indicate that for rice farms with deep well irrigation water, crop lease arrangements with high landlord participation are more favorable from a grower perspective than arrangements with relatively low landlord participation. With the grower paying irrigation pumping costs in the 80/20 arrangement, the net returns declined. Although the 70/30 arrangement resulted in the highest average returns for the grower ($776.87/ha), this particular lease arrangement was least advantageous for the landlord ($199.34). With increased diesel prices, landlords paying rice irrigation pumping costs would prefer a lease arrangement paying them more than 30% to adequately cover land and irrigation costs.

Table 3. Grower and landlord returns under a 50/50 gross rental arrangement versus a 21% net rental arrangement for rice production under deep well irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$1,269.85	7.9	$2,006.37	7.9
Grower Costs	$835.83	2.2	$1,563.46	3.5
Grower NRAVC	$434.02	21.9	$442.89	31.5
Landlord Income	$1,269.85	7.9	$533.33	7.9
Landlord Costs	$727.65	5.3	--	0
Landlord NRAVC	$542.20	16.0	$533.33	7.9

[1] Landlord receives a 21% net share of crop proceeds with no sharing in production expenses.

Table 4. Grower and landlord returns under a 60/40 gross rental arrangement versus a 15% net rental arrangement for rice production under deep well irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$1,523.82	7.9	$2,158.73	7.9
Grower Costs	$918.37	2.4	$1,563.46	3.5
Grower NRAVC	$605.53	19.0	$595.28	25.4
Landlord Income	$1,015.87	7.9	$380.96	7.9
Landlord Costs	$645.09	5.8	--	0
Landlord NRAVC	$259.58	18.4	$380.96	7.9

[1] Landlord receives a 15% net share of crop proceeds with no sharing in production expenses.

Table 5. Grower and landlord returns under a 70/30 gross rental arrangement versus an 8% net rental arrangement for rice production under deep well irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$1,777.80	7.9	$2,336.53	7.9
Grower Costs	$1,000.92	2.5	$1,563.46	3.5
Grower NRAVC	$776.87	17.3	$773.04	21.3
Landlord Income	$761.90	7.9	$203.17	7.9
Landlord Costs	$562.56	6.5	--	0
Landlord NRAVC	$199.34	25.7	$203.17	7.9

[1] Landlord receives an 8% net share of crop proceeds with no sharing in production expenses.

Table 6. Grower and landlord returns under a 80/20 gross rental arrangement versus an 18% net rental arrangement for rice production under deep well irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$2,031.75	7.9	$2,082.55	7.9
Grower Costs	$1,523.33	3.6	$1,563.46	3.5
Grower NRAVC	$508.44	27.9	$519.09	28.0
Landlord Income	$507.95	7.9	$457.41	7.9
Landlord Costs	$40.13	2.7	--	0
Landlord NRAVC	$467.79	8.6	$457.41	7.9

[1] Landlord receives an 18% net share of crop proceeds with no sharing in production expenses.

For rice farms with surface irrigation sources, the 70/30 arrangement was again the most favorable type of rental arrangement for the grower. The landlord's net return was again less favorable, but substantially greater (92%) than the return generated by the deep well irrigated system. This increase can be attributed to the fact that surface irrigation system costs are roughly 40 percent of the pumping costs associated deep well systems.

Therefore, the type of irrigation method is crucial in determining the rental percentage, especially across tracts that have different irrigation technologies e.g. well versus surface sources.

The production of a ratoon (second) crop of rice impacted on grower net returns for all crop share arrangements evaluated. Grower and landlord net returns and percent variation in mean return values are presented in Tables 7 through 10. Two ratoon crop options evaluated assumed 25 and 50 percent of the first crop rice acreage harvested again as a ratoon crop. The production of a ratoon crop generates a greater increase in grower net returns relative to the marginal increase in the landlord's net return. For instance, in the 70/30 well-irrigated rental arrangement the expected mean return for the grower increases by $81.59 and $163.19 per hectare compared to $12.33 and $24.64 increases in landlord return with 25% and 50% ratooned, respectively. The result is that the decision to produce a ratoon crop can be a major factor to consider in determining equitable rice crop lease arrangements.

Table 7. Grower and landlord returns under a 50/50 gross rental arrangement versus a 21% net rental arrangement for rice production under surface irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$1,442.03	8.0	$2,278.41	8.0
Grower Costs	$901.96	2.3	$1,720.02	3.7
Grower NRAVC	$540.44	20.2	$558.38	28.6
Landlord Income	$1,442.03	8.0	$605.65	8.0
Landlord Costs	$818.07	5.7	--	0
Landlord NRAVC	$623.96	15.9	$605.65	8.0

[1] Landlord receives a 21% net share of crop proceeds with no sharing in production expenses.

Table 8. Grower and landlord returns under a 60/40 gross rental arrangement versus a 15% net rental arrangement for rice production under surface irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$1,730.45	8.0	$2,451.45	8.0
Grower Costs	$990.37	2.4	$1,720.02	3.7
Grower NRAVC	$740.08	17.8	$731.43	23.7
Landlord Income	$1,153.63	8.0	$432.61	8.0
Landlord Costs	$729.65	6.1	--	0
Landlord NRAVC	$423.96	18.5	$432.61	8.0

[1] Landlord receives a 15% net share of crop proceeds with no sharing in production expenses.

Table 9. Grower and landlord returns under a 70/30 gross rental arrangement versus an 8% net rental arrangement for rice production under surface irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$2,018.85	8.0	$2,653.34	8.0
Grower Costs	$1,078.76	2.5	$1,720.02	3.7
Grower NRAVC	$940.06	16.4	$933.32	20.2
Landlord Income	$865.21	8.0	$230.72	8.0
Landlord Costs	$641.26	6.8	--	0
Landlord NRAVC	$223.98	26.4	$230.72	8.0

[1] Landlord receives an 8% net share of crop proceeds with no sharing in production expenses.

Table 10. Grower and landlord returns under a 80/20 gross rental arrangement versus an 18% net rental arrangement for rice production under surface irrigation.

	Gross Rental Arrangement		Net Rental Arrangement[1]	
	Dollars per hectare	Risk Measure (%)	Dollars per hectare	Risk Measure (%)
Grower Income	$2,307.24	8.0	$2,364.94	8.0
Grower Costs	$1,673.86	3.8	$1,720.02	3.7
Grower NRAVC	$633.40	25.6	$644.92	25.8
Landlord Income	$576.82	8.0	$519.14	8.0
Landlord Costs	$46.16	2.7	--	0
Landlord NRAVC	$530.66	8.7	$519.14	8.0

[1] Landlord receives an 18% net share of crop proceeds with no sharing in production expenses.

Summary

The relative proportion of costs and returns from a rice share rental arrangement standpoint will determine the risk preference for both the grower and the landlord. With irrigation water as a major production input, irrigation water source and which party incurs that expense is a major factor in determining equitable crop share rental arrangements for rice production. In addition, the production of a ratoon crop impacted the relative split of net returns between grower and landlord. This rental analysis examines the returns to variable costs only. As an alternative to traditional gross cost shares, net percentage paid as rent were calculated based on the landlord's net returns under a traditional gross rent scenario. Therefore, returns are consistent under both rental regimes to invested parties for the purpose of isolating the degree to which risk is shifted. Results from the analysis indicate that the grower increases his net return risk by electing to pay a flat percentage of the crop as rent for land and water compared to a traditional cost share agreement.

By evaluating different share rental agreements and the degree in which production costs are shared, equitable crop rental arrangements can be achieved for parties with a vested financial interest in the rice crop. Crop rental arrangements differ in terms of specific year(s) of land use, frequency and methods of payment, price and yield shares (i.e. risk allocation), sharing of production expenses, authority in making farm management decisions, rotational crop mapping, and adjustments made to price and yields relevant to conditions determined by the market. A producer must consider his risk preference, current financial situation, technology adoption rate, resource proportionality being contributed, compensation for unused portion of investments, and management methods in order to determine an optimal agreement while still remaining profitable.

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Managerial Organization of U.S. Farms: Importance for Classifying Farms and Evaluating the Distribution of Farm Payments

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ABSTRACT

A new typology of U.S. farms is constructed focusing on the managerial organization of farms. Single operator farms are distinguished from those with multiple operators which are divided into four classes: (single generation farms with 1) operators of the same gender, 2) operators of opposite gender, and multiple generation farms with 3) an elder primary operator, and 4) a younger primary operator). The utility of this classification scheme for understanding farm structure is analyzed and findings show that the managerial organization represents an important classification for understanding the distribution of farm payments.

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Introduction

The 20th century saw dramatic changes in U.S. agriculture. Technological advancement and increased connections between rural locations and urban labor markets simultaneously combined to greatly reduce the number of occupational farmers and the size of the farm population even as agricultural output steadily grew (Huffman, 1991; Mishra and El-Osta, 2008). These factors significantly changed the structure of agriculture in the United States to its current form, with a relatively small percentage of farms producing the majority of agricultural output (and receiving a majority of agricultural income). The structure of U.S. farming continues to be an important policy concern. Political rhetoric surrounding farm program subsidies routinely appeals to support for family farms and more recently the rhetoric has focused narrowly on the distribution of payments. In particular, editorial and investigative reporting have used data on actual payment recipients to publicize many of the cases where the "family farm" most taxpayers support in concept is far different from the actual recipients of this support.

The distribution of income and government support is a longstanding concern in agriculture. While the majority of the population continues to favor supporting U.S. agriculture and its farm families, that same majority is increasingly wary of seeing their tax dollars used to develop a more corporate agriculture. Thus, discourse over distribution and policy effectiveness potentially suffer from a lack of commonality in conceptualizing the type of farm which is either most deserving or for which there exists significant public goodwill for provision of income support. The analysis reported here addresses this issue through an examination of heterogeneity of family farms. Specifically, we develop a typology of farms which uses information on the farm manager(s) present on an operation to examine several common perceptions of the family farm (e.g. a husband and wife or father and son co-managing a farm). We empirically examine similarities and differences among the classes elucidated and discuss the insight this analysis provides toward understanding farm policy and distribution. The remainder of the paper is organized as follows: section two reviews relevant background research in typology development and its application to policy analysis. Section three develops the typology conceptually using available information from a survey of farm households. In section four, we offer a comparative analysis of the mutually exclusive classes of farms identified. The paper closes with implications and directions for further development.

Background

The proliferation of economic data has created a significant demand for categorization. Monitoring and evaluation of economic performance, well-being, and policy effectiveness all represent key demand sources that have spurred the increased availability of data for research analysis. As data collection expands at both the extensive and intensive margins, classification systems for organization and comparison become increasingly necessary to understand the story being told by the data. Thus, concurrent with the growth of data has been research effort and expenditure into descriptive analysis of observables (e.g. countries, counties, households) that populate data sets.

Landais (1998) argues for a systematic or taxonomic approach to typology construction. This fosters a classification system that is free of bias in its representation of the policy or outcomes it is constructed to summarize. The considerable heterogeneity that exists in farms poses a serious challenge to this ideal however, as farms may be usefully distinguished in a host of dimensions. Briggeman *et al*. (2007) try to overcome this dimension problem by using a variety of farm business and household decision variables and statistical cluster analysis to identify similarities between farms. This approach has the appeal of its data driven information support but a serious limitation on the interpretive side since households fall into classes for unspecified similarities (e.g. off-farm income, asset level) that may differ when applied to different data sets. Additionally, typologies that use choice variables in construction run the risk of selection bias in subsequent analysis using the classification system.

While the Briggeman *et al.* (2007) approach might be classified as being data driven, other typologies would stand in contrast as being indicator driven. For example, the European Union's Common Agricultural Policy explicitly requires development and updating of a farm classification system for monitoring and evaluation of payments and their impacts. As implemented, this classification closely resembles industry classification with the additional dimension of farm size overlain (Andersen *et al*. 2007). This typology is readily extended, but suffers serious dimension problems for summarizing policy performance.

One of the most widely recognized typologies for characterizing farm household diversity has been the USDA-ERS farm typology (and its contractions and extensions). This typology functions over two dimensions with the first being a determination of the farm size as measured by the volume of sales. With most farms residing in the lower sales category, further subdivision of small farms is achieved by differentiating farms according to the farm operator's primary occupation (on or off-farm), life stage (at or near retirement), and household income position (see Johnson 2002).

The need for the USDA-ERS typology arose as a means of describing the USDA-ERS' annual data collection of farm households. The Agricultural Resource Management Survey is a survey of farm households annually implemented by USDA-NASS to monitor and evaluate the financial situation of the agricultural sector. The data itself consists of numerous household income and demographic variables as well as agricultural business characteristics suitable for a cross section analysis of the farm population. We use this data and its reporting on farm operators to develop the typology discussed in the next section.

Typology Development

As opposed to typologies more oriented toward short run outcome variables (e.g. farm sales, primary products) we opt for a long run structural choice in defining classes of farm households. Specifically, we develop and implement our typology using the 2004 version of the ARMS survey data, keying on variables that report information about farm operators to devise mutually exclusive groups representing alternative compositions of the farm management input. The ARMS survey records information on the number of farm operators, their age and gender for up to three individuals responsible for farm decision making, which provides the necessary information to generate the five classes of farms we will examine.

Figure 1 presents the classification scheme diagrammatically, using a tree structure to identify points of differentiation between groups. At the first level, we distinguish single operator farms from those with more than one operator. A farm with a single operator comprises the most common type of farm and is a group that could be functionally divided in many ways. In fact, many typologies focus specifically on the farm practices and household choices of this individual for differentiating farm types. Because our objective is to provide a better understanding of how distribution is affected by the structural organization of the farm's management, we leave single operators as a final stage category and pursue further level divisions within the remaining group of farms that have multiple decision makers.

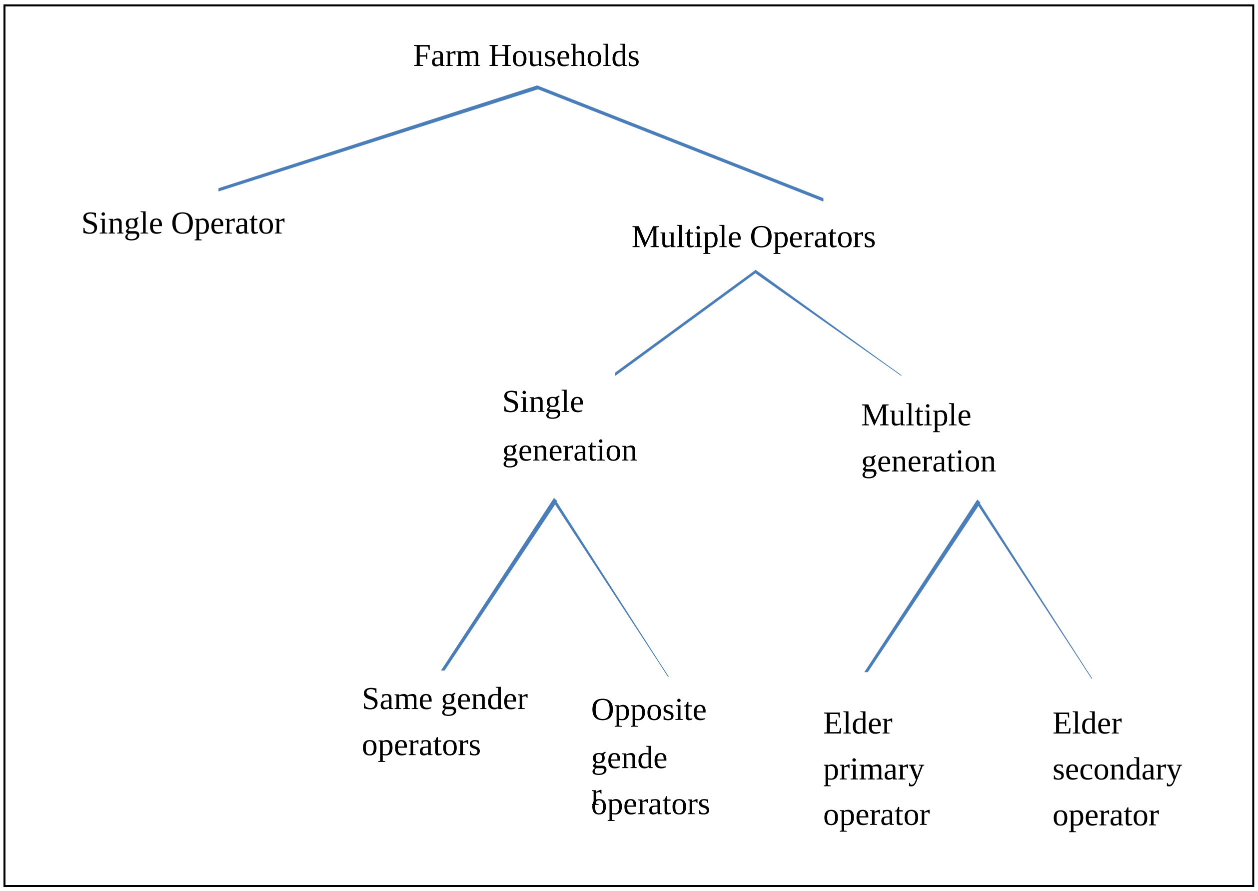

Figure 1. Classification scheme used to organize farm households.

The second level identifier recognizes the generational content of the multiple operators farm management team. We identify farms on which the primary and secondary operators have an age difference of less than twenty years as single generation farms. Conversely, those farms with an age difference of twenty years or more are considered to be multiple generation farms. At the final level, we further distinguish the single generation multiple operator farms based on whether the two operators are the same or opposite gender. At this same level, we distinguish multiple generation farms based on the elder operator being designated as the primary or secondary operator.

Conceptually, the typology as constructed resembles many views of the family farm that may be important for differentiating farm households according to their management organization. By definition, a single operator farm can have its farm management input summarized by an understanding of the characteristics of that individual. For households with multiple farm operators, description of the farm management component is more difficult since the separate individuals will embody different skills and proficiencies (beyond the additional time that can be allocated) which may substitute or complement each other in the generation of farm income. Division of the multiple operator single generation farms to the two constituent groups is organized to give a generic form of the family farm composition we often see with familial relationships (husband and wife operation or brothers farming together) and associated with family farms. The other multiple operator farms have multiple generations participating in their management. We view these farms as being differentiated by their placement on the management transition path with either the younger or older operator having primary decision making responsibility.

With these five types identified and defined based on characteristics of the manager(s), we investigate the similarities and differences of these categories of farm households to better understand how this typological view might provide relevant information on farm structure, distribution, and policy.

Analysis

We begin our analysis by comparing single (59% of farms) and multiple operator farms (41%) in the dataset. Table I reports means of variables related to the farm and farm earnings for each type. We first note that household income for the primary operator of a multiple operator farm is higher than that of a single operator farm despite the fact that multiple managers have potential claims on the farm business earnings. This is consistent with efficiencies of scale tied to a larger management input. A majority (78%) of the household income advantage ($88,000 - $77,000 = $11,000) that individuals on multiple operator farms have over single operators arises from a higher realized net farm income. Taking the ratio of net farm income to household income (NFI/HHI) for the average farms of each type, we see that the two groups are differentiated by a higher reliance on farm income for the multi-operator household. This is to be expected as farms with more than one manager operate nearly twice as much agricultural land and report considerably more investment (40% higher farm net worth). Agricultural area is most closely associated with row crop production and we see that in terms of sales, multiple operator farms are less specialized in crop production (50-50 split between crops and livestock) than are single operator farms (57% of sales are crops). This would be consistent with the presence of multiple operators allowing the farm to be more diversified to realize some economies of scale or to manage income volatility.

Table I. Comparison of single and multiple operator farm households.

Variable	Single Operator Farm	Multiple Operator Farm
Household Income (HHI)	76,927.63	87,968.62*
Gross Farm Income	70,204.21	128,499.01
Net Farm Income (NFI)	16,937.10	24,320.04
Net Worth	527,998.27	732,109.47
Acres	327.69	630.25
Tenure	0.77	0.78
Operator Age	56.67	55.98
Oper. Hhld Size	2.55	2.84
Govt. Payments (GP)	4,215.14	5,641.49
NFI/HHI	0.22	0.28
GP / NFI	0.25	0.23
Debt/Asset Ratio	0.08	0.10
Labor Expense (Share)	0.09	0.13
Crop Share in Sales	0.57	0.50
Number Observed	10,300	9,168
Population	1,211,140	849,682

Notes: Values are authors' estimates using the 2004 ARMS survey conducted by USDA NASS & ERS. An asterisk indicates an estimated mean for which the coefficient of variation is larger than 0.25 but less than 0.50.

To gain some insight into the top level distinction between single and multiple operator farms, we overlay the two-way distinction from Table I with the ERS-USDA typology of farm households. Recall that the ERS typology uses both an occupational status and the size of the farm as indicated by the value of sales to distinguish seven groups. In Figure 2 we present these seven types on the horizontal axis and report the mean value of production (in $1,000, right axis) for each group. We see that the three distinctions of small farms (limited resource, retirement, and rural residents) all have similar agricultural output and that for occupational farms agricultural output is rapidly increasing as we move across groups. On the vertical (left) axis we report the cumulative percentage of households for each ERS typology group separately for single and multiple operator farms. Here we see that the cumulative probability for each of the ERS small farm classes is lower for multiple operator farms, such that empirically we attach a higher likelihood to observing multiple operator farms in larger sales categories. While the relationship between sales and our top level distinction is of interest, there is still considerable heterogeneity within each of these two groups.

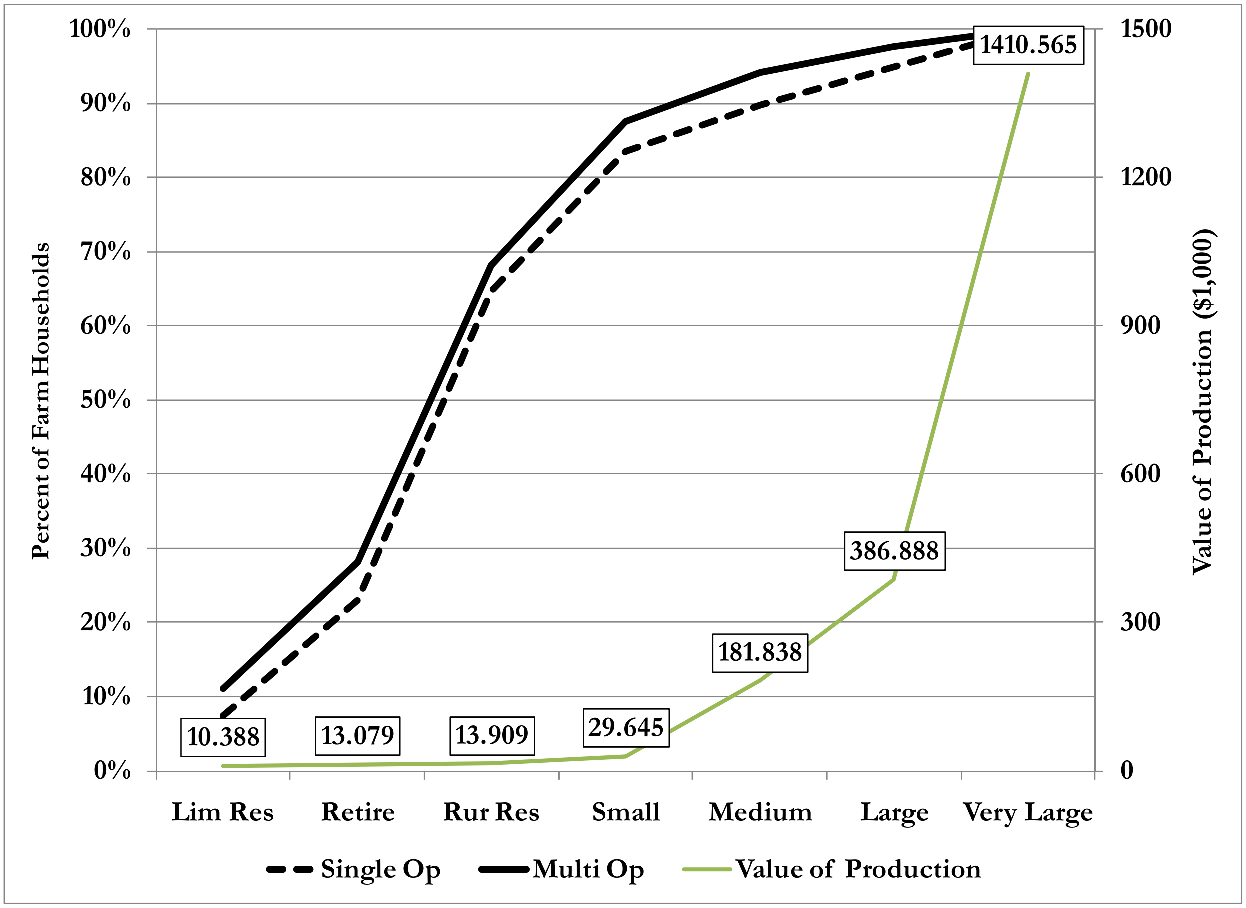

Figure 2. Comparison of single and multiple operator farms, overlaying the USDA-ERS farm typology.

Progressing down the right side of our tree in Figure 1, we next report on differences between single (87 percent of farms) and multiple generation farms (13%) in Table II. The average household income for these two groups is nearly identical, but the composition of this income is quite different across the two groups on average. The level of farm income is much higher for multiple generation farms representing fifty-six percent of total household income. As has been noted in other studies (e.g. Gray and Keeney, 2008), as farm size (in terms of sales) and dependence on farm income increases for a group of farm households we see diminishing importance of government payments for those farms. This result is confirmed in Table II with multiple generation farms receiving government payments equal to nineteen percent of their net farm income while single generation farms have around one-quarter of their net farm income attributable to government support.

Table II. Comparison of generation types for multiple operator farms.

Variable	Single Generation Farm	Multiple Generation Farm
Household Income (HHI)	87,864.74	88,656.60
Gross Farm Income	115,293.70	215,959.15
Net Farm Income (NFI)	20,562.36	49,207.48*
Net Worth	690,737.50	1,006,120.21
Acres	569.55*	1,032.24*
Tenure	0.79	0.74
Operator Age	55.00	62.51
Oper. Hhld Size	2.88	2.55
Govt. Payments (GP)	5,091.89	9,281.60
NFI/HHI	0.23	0.56
GP / NFI	0.25	0.19
Debt/Asset Ratio	0.10	0.10
Labor Expense (Share)	0.29	0.50
Crop Share in Sales	0.51	0.46
Number Observed	7,519	1,649
Population	738,221	111,461

Notes: Values are authors' estimates using the 2004 ARMS survey conducted by USDA NASS & ERS. An asterisk indicates an estimated mean for which the coefficient of variation is larger than 0.25 but less than 0.50.

As we would expect due to the generation driven distinction in Table II, we see a significant difference in the average operator age between single (55 years) and multiple generation (62.5 years) farms. This age difference is important when we recognize that the distinguishing characteristic of these farms is a minimum twenty year age difference between the two operators. The older average age of the multiple generation farm helps explain many of the differences from a life-cycle point of view, since this operator will have been managing the farm longer and had more time to acquire assets (a net worth 45% larger), agricultural land (81% more acres), and capacity to prepare for bringing the second operator into the business. Thus, conceptually we can envision the average characteristics of a multiple generation farm as being an operator who has at least partially planned for a successor and made the investments and acquisitions necessary to support continuation of the farm and to support the two generation family. This is in contrast to a single generation farm with two or more operators for which the average outcomes more likely represent a common timeframe for planning and acquisition.

Before moving to the final comparisons across all five groups given in Figure 1, we comment on the distinctions so far made with respect to the distribution of government payments. At the top level, we separate single and multiple operator farms with the former representing fifty-nine percent of the population. Despite a nearly 3:2 advantage in farm numbers, these farm households receive only a small majority of government payments (52%). On the surface then, it would seem that government payments are disproportionately distributed toward the larger, multiple operator farms[1]. However, the fifty-nine percent of single operator farms only generate one-half of the total net farm income in the U.S. Thus, it can be argued that as farm payments are designed to support farm incomes, single operators claim a (marginally) higher than fair portion of subsidies. We see a similar story emerge for the two classes of multiple operator farms identified in Table II. The majority class (single generation farms) account for seventy-three percent of farm income but seventy-eight percent of government payments. This six percent advantage (0.78 / 0.73 = 1.06), highlights the need to evaluate distributional outcomes on a relative basis when dealing with such a heterogeneous population.

We continue our discussion of how government payments are distributed to the farm population in Table III. Previously we identified multiple operators as having a slightly lower reliance on government payments (relative to their farm income) than single operator farms. As we move to the lowest levels of the typology structure given in Figure 1, we see that the average for multiple operators is a result of two very different levels of reliance on government payments. In Table III, we see that both opposite gender single generation (column 3) farms and multi-generation farms with a younger primary operator have a higher average government payment receipts relative to their farm income levels than do single operator farms (column 1). Combined, these two classes of farms in column 3 and 5 represent only about thirty percent of

[1] Of course some of the motivation for moving to multiple operator status may be tied to relaxing payment limitations as a constraint on government receipts.

farms and observing the other variable means (top section of Table III) we see that apart from the importance of government payments they appear quite different with respect to the structure of the farm business. In terms of net farm income relative to household income, the multi-generation younger operator farm earns about half of household income from the farm while opposite gender farms have the lowest share on average at around thirteen percent of household income.

In terms of policy and the distribution of payments we thus have an interesting distinction emerging from comparing the relative income and payment receipts for different households. We formalize two summary calculations in expressions (1) and (2) below, as shares δ^i, for a farm type group g in the total population of a particular variable $i \in \{PMT, POP, INC\}$ with elements government payments, population, and net farm income respectively.

$$R_1^g = \frac{\delta^{PMT}}{\delta^{POP}} \tag{1}$$

$$R_2^g = \frac{\delta^{PMT}}{\delta^{INC}} \tag{2}$$

We report the results of these calculations for the average farm in each group in Figure 3. The white bar indicates that the groups with the largest farms receive disproportionate government payments, with relative shares (R1) exceeding 1.5 for all multiple operator farms except the single generation opposite gender farm. The graph of R1 represents a commonly offered critique of farm payments as going to those in least need. This perspective on farm policy implicitly assumes that engagement in farming warrants some payment, but that it should be progressive in nature (i.e. lower earners should receive the highest rates of transfer).

Table III. Comparison of variable means for five types of households in typology.

Variable	Single Operator Farm (1)	Single Generation Same Gender (2)	Single Generation Opposite Gender (3)	Multi-generation Elder Primary (4)	Elc
Household Income (HHI)	76,927.63	117,867.48	81,063.49	83,779.91	
Gross Farm Income	70,204.21	286,370.33	76,512.70	211,709.55	
Net Farm Income (NFI)	16,937.10	63,949.69	10,726.98*	49,312.24*	
Net Worth	527,998.27	1,319,274.89	548,255.70	1,005,262.91	
Acres	327.69	1,297.09*	404.63	1,077.65*	
Tenure	0.77	0.66	0.81	0.78	
Operator Age	56.67	53.16	55.42	68.87	
Oper. Hhld Size	2.55	2.76	2.91	2.34	
Govt. Payments (GP)	4,215.14	12,295.41	3,458.93	8,125.60	
NFI/HHI	0.22	0.54	0.13	0.59	
GP / NFI	0.25	0.19	0.32	0.16	
Debt/Asset Ratio	0.08	0.09	0.11	0.09	
Labor Expense (Share)	0.09	0.17	0.11	0.13	
Crop Share in Sales	0.57	0.54	0.47	0.44	
Number Observed	10,300	2,180	5,339	1204	
Population	1,211,140	136,421	601,800	85,535	

Notes: Values are authors' estimates using the 2004 ARMS survey conducted by USDA NASS & ERS. An asterisk indicates an estimated mean for which the coefficient of variation is larger than 0.25 but less than 0.50.

While this ideal is certainly present in much of the public view on government payments and the rhetoric which sells farm payments to that same public, farm payments in practice work to support prices. Moving to the black bar in Figure 3, we see that the values of R2 confirm this perspective on farm policy with many of the farm groups being very near a ratio of 1.0 indicating correspondence between their shares of total government payments and total farm income. Using the R2 ratio, only the single generation opposite gender farms are significantly above the benchmark value of 1.0. This is consistent with a response to an incentive of payment limit constraints which might cause a husband-wife to organize as a multiple operator farm to relax limits on government support.

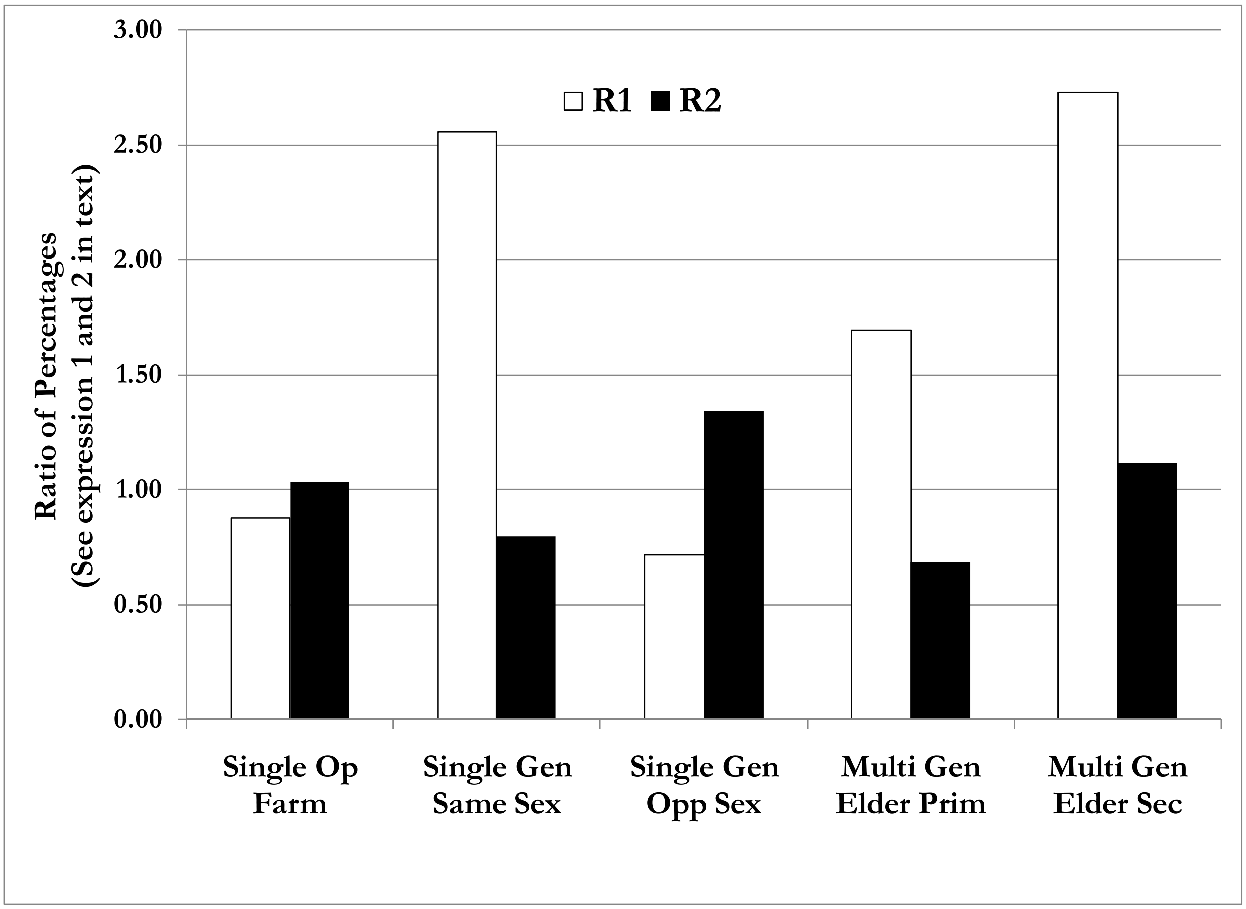

Figure 3. Comparison of payment ratios: average shares in total payments relative to share in the population (R1) and share in national farm income (R2).

Returning to Table III, we identify some similarities among farm types and some important differences. Single operator farms (column 1) and single generation opposite gender farms (column 3) are strikingly similar on average. This would support the idea that these farms may be jointly managed as a consequence of a legal business structure than actually representative of a multiple operator management team. Table IV (top section) provides results for pair-wise test statistics on differences in means for each level variable in Table III and each household. In this table, the presence of a number in a farm type's column indicates that we reject the hypothesis that the two types have equal means for a particular variable. The summary of test statistics here confirms our observation from Table III on the similarity of single operator and opposite gender farms as only the tenure (percentage of operated acres that are owned), variable differs significantly across these two types. Moreover, we see that other defined groups in the typology tend to be significantly different for the reported variables than both single operator and opposite gender farms.

Table IV. Result of two-way test of differences in means across types.

Variable	Single Operator Farm (1)	Single Generation Same Gender (2)	Single Generation Opposite Gender (3)	Multi-generation Elder Primary (4)	Multi- Elder
Household Income (HHI)	2,5	1,3,4	2,5	2	
Gross Farm Income	2,4,5	1,3	2,4,5	1,3	
Net Farm Income (NFI)	2,4,5	1,3	2,4,5	1,3	
Net Worth	2,4,5	1,3	2,4,5	1,3	
Acres	4,5		4,5	1,3	
Tenure	2,3,5	1,3	1,2,5	5	
Operator Age	2,4,5	1,4,5	4,5	1,2,3,5	1
Oper. Hhld Size		5		5	
Govt. Payments (GP)	2,4,5	1,3	2,4,5	1,3	
Groups					
(1)	--				
(2)	7	--			
(3)	1	6	--		
(4)	6	2	6	--	
(5)	8	2	8	3	
Total	22 (0.61)	17 (0.47)	21 (0.58)	17 (0.47)	

Notes: Values are authors' estimates using the 2004 ARMS survey conducted by USDA NASS & ERS. An asterisk indicates an estimated mean for which the coefficient of variation is larger than 0.25 but less than 0.50.

A comparison of particular interest relates to the two multiple generation farm classes distinguished by the primary versus secondary role the elder operator plays in management. In particular, these farms have nearly identical levels of net farm income and net worth. Returning to Table IV, we see that the only significant distinction between the groups in columns 4 and 5 relate to the operator's age, household size, and land tenure. Consistent with our earlier discussion of the full class of multiple generation farms, these few differences are to be expected. Multiple generation farms will tend to have outcome variables such as farm earnings potential and wealth that are consistent with the career and bequest motive activities of the senior operator whether that individual continues as the primary operator or relinquishes this role. We preserve the distinction in our typology as the reporting in Tables III and IV focus on the means of only a few variables out of the many that might explain differences in these two types[2].

Tables III and IV combine to confirm that our classification scheme outlined in Figure 1 usefully differentiates the farm household population. We summarize the differences for these nine variables in the last column of Table IV, reporting the number of significant pair-wise differences for each variable (maximum of 10 for five groups). Most of the outcome variables used are different for at least one-half of the pair-wise comparisons of groups, the exceptions being acres (a high variance variable) and household size (a tightly distributed variable). Thus, to the extent the nine variables compared are representative of the larger set of farm structure variables of interest we can be confident that the typology developed captures heterogeneity in the farm household population in a manner consistent with management organization. The bottom section of Table IV reports the (symmetric) matrix of differences (maximum of nine) between each class defined. The final row of table IV reports totals (9 variables by 4 comparison classes = 36 total) and percentages of total variables tested which were found to be significant. Thus, types in column 1, 3, and 4 were found to be the "most" different with sixty percent of possible tests producing a rejection of the like means hypothesis. Groups in column 2 and 5 show like mean rejections for just under half of the possible tests.

Conclusion

[2] Remble, Keeney, and Marshall (2010) focus on the distinction between these two groups of farms in their analysis of farm management transition and succession.

In the preceding discussion and analysis, we proposed a new typology of U.S. farms oriented toward the managerial organization of farms. As a first stage of differentiation, we separate single operator farms from those with multiple operators. Multiple operator farms are subsequently divided into four classes: (single generation farms with 1) operators of the same gender, 2) operators of opposite gender, and multiple generation farms with 3) an elder primary operator, and 4) a younger primary operator). In examining the similarities and differences we were able to identify significant commonality between single operator farms and farms with two operators similarly aged and of opposing gender. This similarity was shown to have important implications for the distribution of government payments as the classification of a second operator (e.g. spouse) might increase the eligibility for subsidies of the multiple operator farm relative to the single operator farm. In addition to the analysis of government payment distribution, the utility of this classification scheme for understanding farm structure was tested and confirmed using a set of two-way statistical analyses keyed to common farm outcome variables (e.g. household income, net farm income). These results and the structure of the typology as developed indicate the variability in common perceptions of family farms.

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Complexity of transition to alternate farming systems – more than substitution of inputs

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Abstract: This paper reports on aspects of doctoral research that explores ways of enhancing farmers' capacity for transition towards more sustainable farming systems. The study was conducted in Australia and India to explore the learning experiences of those who had pursued a transition to more sustainable food production. The research was conducted using action research methodology in which qualitative data were collected using convergent interviewing methods. The themes that emerged suggest that making the transition to more sustainable production systems involves more than a mere substitution of inputs. Effective transition requires a fundamental change in the way soil is viewed. We generalize some relevant learnings for the transition process through elaboration on the emergent themes.

Introduction

The rate of conversion from conventional to alternative farming systems is relatively slow. Many recent studies have acknowledged that the complexity and integrity of the living systems in alternate farming can impose further challenges for addressing the transition process (Norton *et al.* 2009). The objective of this paper is to focus on the learnings of those who have made the transition process in two contrasting contexts - Australia as an example of modern western agricultural practices and India as an example of the developing world with indigenous farming practices. Farmers making the transition in both countries were interviewed through a convergent interviewing process that sought to explore their transition journeys. The themes that emerged during the transition process are discussed in two parts in this paper. The first part highlights the themes and the second part elaborates on the complex nature of the system with a case study on soil health.

Background

Transition to alternative farming cannot be attained through simply applying a new package of practices or through mere substitution of inputs. It is a complex, multifaceted process that requires a paradigm shift through learning (Röling & Wagemakers 1998). According to Silvasti (2003), there are a number of reasons that farmers do not make the transition. First, they fear that it will affect the economic performance of their farm, and second, they still consider that modern, industrial ways of farming are harmonious with nature. Thompson (1995) states that the transition from conventional agriculture to organic farming involves a difficult period for several reasons: (1) it occurs at a time of least experience for the growers who are getting into organic farming; (2) the predator–prey links are not fully developed within the farm ecosystem; (3) farmers usually do not receive a full premium for their products until organic certification has been achieved; and (4) initial yields may be low. The four reasons discussed by Thompson (1995) reveals the complexity in the transition process. The complexity increases as transitioning from conventional to organic farming is at the very least, region-specific and frequently, farm-specific in nature (Katsvairo *et al.* 2007) implying that a package of practices may not be the solution.

Methodology

This research was based on the premise that farmers who had made or were making the transition from conventional to alternative forms of production could provide guidance suitable for developing into learning tools. These learning tools will be suitable for individuals contemplating it themselves or supporting the change by others. Among the wide choice of methodologies available, action research was chosen as the research aims to study the system and concurrently collaborate with members of the system in making the change. In this study, the information was collected during different phases of the research using different methods. In the initial phase, information was collected through immersion and field observations recorded in a field diary. Reflections on the immersion stage led to the development of the broad research question, which was addressed by collecting information through convergent interviews undertaken in Australia and India. By analyzing the information collected through the convergent interviews learning tools were developed. The application of the learning tools was assessed using case study methods.

Convergent interviewing

Convergent interviewing method was used as one part of the research to collect data. This is an in depth interviewing method developed by Dick (1990) in Australia to collect, analyze, and interpret qualitative data about people’s experiences, opinions, attitudes, beliefs, and knowledge and to converge on important research issues (Driedger *et al.* 2006). The interviewing process began with a broad question and progressed with secondary questions that emerged due to the agreements and disagreements on themes. The secondary questions on themes were raised with the subsequent interviewees until agreement or an explanation for the disagreement was established. The interviewing process was stopped on obtaining answers to the secondary questions or when no new themes emerged. Recording the information was done with the use of audio tape, field notes and diaries. Audio taped interviews were converted to audio files and stored on a computer disc. These audio files were transcribed. Soft and hard copies were made for analysis. The transcripts averaged from 10 to 20 pages of single spaced 12 point font.

Analysis of the information commenced during transcription as it was not mere typing of the audio conversation into text. Analysis was also done simultaneously through highlighting the text using different colours to ease the coding process. The purpose of transcribing the interviews was to quote the participant's views in their own words. The NVivo - 7 software aided in managing the data and thereby, all the audio files, transcripts and nodes could be referred through their links to each other to develop the themes. The software was chosen as it allows the researcher to work in languages apart from English, such as Tamil, as the interviews were conducted in Tamil in India.

Results and discussion

Part One: Themes for transition

Themes that emerged from the convergent interviewing process in both the countries are highlighted in this section. Themes are not independent of each other but are interlinked. Furthermore, for successful transition the themes need to be understood not only by the farmer intending to make the change but also the change agent supporting the farmer. The main themes that emerged are: Enriching soil health; Knowledge sharing; Diversity; Learning; Indigenous knowledge/local knowledge; and Farm Sufficiency.

Each theme is highlighted below, and the theme on enriching soil health is explained in detail as a case study to understand the learning involved in transition.

Knowledge sharing through networking

Participants from both countries had informal networks for sharing knowledge enhancing the transition process. However the participants in Australia were more selective in sharing knowledge in comparison to those in India, plausibly due to the existence of competitive markets and peer pressure. Participants in India were prepared to share most of the knowledge due to lack of competitive markets and in the interests of attaining ecological balances. This agrees with the statement of van de Fliert et al., (2007) that small holder farmers need to take collective decisions as ecological processes are not restricted to artificial boundaries. Other than sharing knowledge, networking was used for collective marketing in Australia and for group certification processes in India. The majority of participants in Australia were involved in collective marketing such as farmers markets and community supported agriculture. This has definitely reduced the distance of food travel and helped farmers and consumers to directly connect with each other. Participants in India were involved in group certification processes for organics and marketing. This agrees with the argument of Faure (2004) that collective action is likely to occur to solve concrete and short term problems at the farmers' organization level with benefits limited to few farmers.

Diversifying through biophysical and sociocultural methods

Biodiversity is essential for human life and plays an important role in farming. During the interviews, diversifying farming for both economic and ecological benefits was mentioned by the participants. As stated by Baars and Baars (2007), the first step to enhancing biodiversity is to stop applying chemicals on the farm, the second is to follow ecological principles and the third is to respect the integrity of other living organisms. These principles were followed by the majority of the participants. The themes that emerged are classified as biophysical and socio-cultural. Biophysical ways of gaining diversity are through species diversity, genetic diversity and through respecting integrity of organisms. Socio-cultural ways of regaining diversity are through preserving native culture and intrinsic values.

Bio-Physical diversity

Species diversity: Participants in both countries followed diversified cropping practices such as growing different crops at the same time (intercropping) or different crops over a period of time (crop rotation). This helped in maintaining the ecological balance in different ways (Youyong *et al.* 2000).

Genetic biodiversity: The loss of genetic biodiversity was mentioned by the participants in India as the 'improved' hybrid varieties replaced the traditional varieties. The traditional gene-rich system fulfilled the needs of a diverse diet for both human and animals, and did not involve high investments or technology thereby minimizing risk (Altieri 1994).

Integrity of other organisms: Participants practicing alternate farming have begun to understand farming as a part of the ecosystem as weeds and insects are no longer eliminated but managed through multiple methods.

Socio-cultural

Preserving native culture for biodiversity: Participants in India attempt to revive their culture as traditional farming practices are embedded in the cultures of habitat. This agrees with Nabhan's views that "Preserving biodiversity requires preserving native cultures and their ideas and practices, and probably vice versa" (Nabhan, 1997). However, the rest of the farming communities, in Australia and India, were influenced by modern agricultural technologies, which had brought rapid cultural transition and destruction to the environment (Nabhan 1997).

Preserving intrinsic values for diversity: Farmers interviewed in both countries insisted that to maintain diversity, participants need to have certain values. These values included self interest to preserve the land for future generations, and the desire to produce healthy food, for both family and society. This falls under the 'conservationist' position that favours the protection of natural areas with self-interest thus, conserving land and resources for later human use (Robinson 2004).

Learning through experience

Participants had been through an experiential learning process of trial and error and observation making judgements rather than relying on external expertise alone. Participants in both countries had been through a learning process as a result of observations in the field, cross checking with fellow farmers, conducting trials, and reflecting on their results. They also gathered information through reading a wide range of material, including magazines and consulting internet sites. This agrees with the statement of Röling and van de Fliert, (1994) that the paradigm shift from dependence on external advice to empowerment may happen through experiential learning. The change in farmers' learning styles in turn demands a change in learning styles of the researchers and practioners.

Indigenous knowledge/local knowledge through acculturation

The indigenous/local knowledge theme emerged with participants from both countries emphasizing revisiting old practices. The incidence of belief and faith developed within one's culture causes conflict with new knowledge. The majority of the Australian participants had followed Western science principles and incorporated local knowledge with rationality. Indian participants, who had given up indigenous practices, perhaps because of the domination of Western science for its truth and political power relationship had returned to revisit them through their faith and values. It may be concluded that some see incorporating indigenous/local knowledge as a selective strategy to overcome certain issues in farming, whereas others use indigenous/local knowledge to address complex issues in sustainable farming. It may be concluded that neither indigenous/local knowledge nor Western science is always correct and as a result, a balance of both is required.

Self sustaining through recycling farm resources

Participants in India practiced alternative farming as a method of empowerment, reducing dependence on seeds, fertilizers and other off farm inputs. On the other hand, participants in Australia practiced alternate farming as a method for healthy living. It may be concluded that farms may be regenerated through seed, soil, ecological preparations and knowledge that may lead to empowerment and self reliance.

Part two: A case study on the theme soil health

Enriching soil health

Participants from both the countries emphasized improving soil health, which consequently emerged as an important theme. In Australia the term ‘soil health’ was mentioned by the participants following organic and biodynamic practices. These farmers have a desire to manage the soil differently to prevent ecological problems of pest, disease and weed outbreaks, and to help crops thrive during unfavourable conditions like drought. This agrees with the insurance hypothesis stated by Yachi & Loreau (1999) that biodiversity helps farmers to survive during ecosystem imbalances of stress and disturbances which applies to soil biodiversity as well (Brussaard *et al.* 2007).

In India, participants of both the conventional and the organic system believe that soil is a living system which reflects the cultural dimension of environmental stewardship (Appiah-Opoku 2007). This also agrees with the statement of Leopold (1949) that land is more than a physical landscape for the native people and it includes the living environment. Although the participants benefited from escaping the ecosystem imbalances, conservation of land for future generations was emphasized. Although participants from both countries emphasized soil health there seem to be differences in the perception of soil health.

Perceptions of soil may be classified as belonging to either hard or soft systems paradigms. As stated by Blaikie et al., (1997) there are three types of development paradigms: classic, neo-liberal and neo-populist and each of these paradigms constitutes a system of thought that influences theoretical and normative assumptions about development. Perception of soil differs in each of these paradigms. The classic paradigm in reference to agriculture development, associated with replacing local knowledge with technological solutions and thereby eliminating farmers’ participation, resulted in viewing soil as matter. As a result soil is seen as a ‘hard’ system with principles evolved from natural science as shown in the Figure 2. The neo-liberal paradigm attempts to balance local knowledge with technological solutions and practically reinforced the technical solutions. Soil is therefore seen as a living system, a view that is not hard systems alone but that integrates principles of both the natural and social sciences. The neo-populist approach, which emerged in contrast to the classic approach, respects local knowledge and empowers the farming community. This results in respecting the indigenous views of seeing soil with dimensions of spirituality. As represented in Figures 1, 2, and 3, there are no firm boundaries for any discipline. However the integration of principles and philosophies from natural sciences and social sciences occurred consistent with the paradigm represented in Figure 2. Theories that evolved within this paradigm are discussed in detail below.

Soil is seen as matter in Classic Paradigm

The basic soil science derived from the principles of natural science focused on soil surveys to assess the world's soil resources through soil classification, for land use management (van Baren *et al.* 2000) which is referred as Pedology, as shown in Figure 1. The influence of soil components on other living organisms inclusive of crops referred to as 'edaphology' is widely referred to as soil science. The findings on soil components greatly influenced management practices which are emphasized by many international organizations. Hence the influence of soil components on crops receives greater attention in the literature as elaborated below. Soil is seen as matter, supplying nutrients for the growth of the plants through organic constituents or through mineral nutrients. The organic constituent principle was suggested by pioneers J.G. Wallerius and Albrecht Thaer, laying the fundamentals of the alternative farming through the humus theory (Manlay *et al.* 2007).

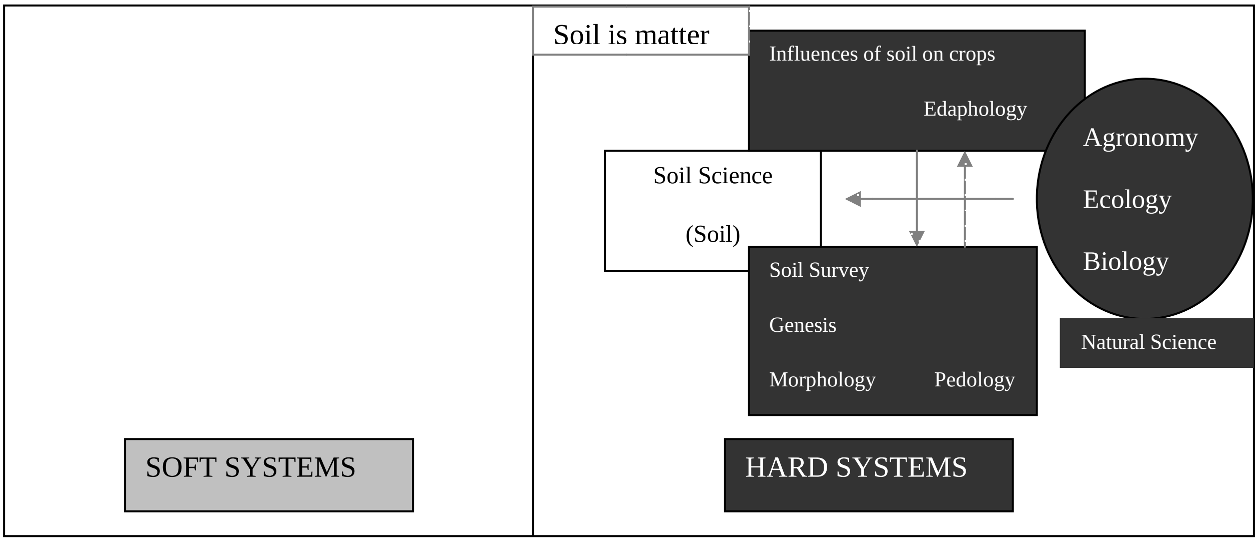

Figure 1. Perception of soil in the Classic Paradigm

The mineral nutrients principle was suggested by Justus von Liebig, Carl Sprengel, Bossingault, Lawes and Gilbert through rendering the humus theory with the Law of Minimum. This theory formed the basis for the modern High External Input Agriculture in the west and the green revolution in the east. Thus the education and research systems of the Western world mobilized to the rest of the world, through education, trainings and research projects, the theories derived from the hard systems perception of soil as matter (Mermut & Eswaran 2001). However the classic paradigm's technological solutions lead to the degradation of agricultural land through intensification in the production methods and causing environmental degradation (Houghton *et al.* 1983).

As environmental protection gained importance after the 1992 Earth Summit, soil came to be considered as a biological system. Thus the perceptual boundaries of soil expanded from the physical and chemical dimensions towards biological composition.

This put forth the need for integrated soil fertility management to balance inputs and output judiciously using both mineral nutrients and biological inputs. The hard system, through the integrated nutrient management approach, was challenged to optimize the mineral and biological inputs and encouraged farmers to manage nutrient flow through biological methods like nitrogen fixing crops, animal manure and applying fertilizers to complement them (Deugd *et al.* 1998). The latest development is precision farming that aims to maintain field diversity through decisions made with a combination of data inclusive of soil physical parameters (Jones & Barnes 2000).

It may be concluded that in spite of the discipline broadening from mineral constituents to biological constituents the perception of soil being matter has continued to exist in the classical paradigm.

Soil is seen as a living system – Neo liberal paradigm

The results of the classic paradigm as discussed in the previous section paved the way to the neo-liberal paradigm where the need was realized for integrated soil fertility management involving inputs and outputs being manipulated in a judicious way (Stoorvogel *et al.* 1993). Management practices maximizing local inputs and optimizing external inputs gained importance (Pretty 1995). This brought a change in management practice from High External Input Agriculture (HEIA) to a Low External Input Agriculture (LEIA) as shown in Figure 2. Soil fertility is a key component in both HEIA and LEIA with the goal of sustaining or improving yields. Soil fertility mining is compensated through fertilization with synthetic minerals in HEIA and organic nutrient sources in LEIA systems. LEIA, in spite of integrating natural resources causes adverse effects due to exploitation of natural resources (Shivakoti *et al.* 2005).

As locally available renewable resources remained the major nutrient source, LEIA also balanced the local knowledge of people with scientific solutions. Thereby the biological composition of the soil and indigenous knowledge on soils became widely recognized. Studies focused on biological composition inclusive of earth worms revealed the benefits and influences on the soil properties (Ester & van Rozen 2002). The biological components are used as an indicator for a healthy soil along with the physical and chemical factors (Pattison *et al.* 2008). The indicators are not only used as tools for assessing the favourable conditions of the soil but are also used as warnings for any serious damage. This agrees with the views of Barrios *et al.* (2006) that the indicators will be useful as the unobservable changes in the soil will be revealed before leading to visible changes, like soil degradation.

The knowledge of people interacting with the soil for a long time was recognized by some researchers (Barrios & Trejo 2003; Birmingham 2003), and began to be included to increase scientific understanding on soil. Studies showed that farmers' assessment of soil properties, although purely qualitative, yielded very similar results to those derived by scientific analysis of soil samples (Ali 2003). This suggested the need for a multidisciplinary approach (Sandor & Furbee 1996), combining both the hard and soft systems views (Payton *et al.* 2003), as it changed the perception of soil from matter to a living system.

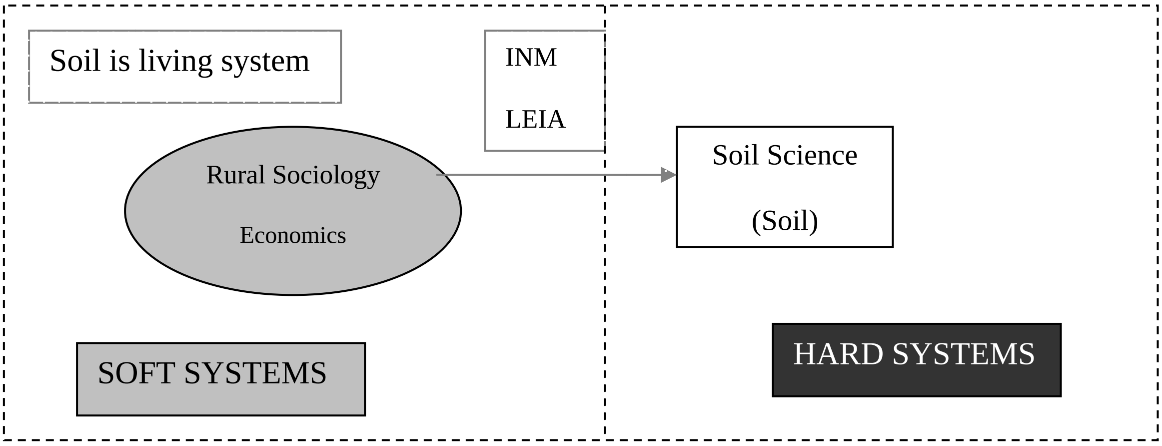

Figure 2. Perception of soil as living system – Neo-liberal Paradigm

INM – Integrated Nutrient Management LEIA – Low External Input Agriculture

Soil seen as a spiritual system – Neo-populist paradigm

The Neo-populist paradigm emerged opposing the classic paradigm demanding a change in the ways of thinking and knowing. As a result, alternative farming systems gained importance. These farming principles are strongly opposed to the mineral nutrition theory derived in the classic paradigm as the minerals are perceived to cause lethal effects on living soil organisms. Thus the biological organisms central to the philosophy of the alternative farming like natural farming, organic farming, biodynamics etc. became indicators of healthy soil (Paoletti 1999), and also served as tools to compare both the alternative and conventionally managed soils.

In this paradigm, indigenous knowledge is considered to be indispensable rather than a mere addition to scientific findings, hence disciplines like EthnoEcology, Ethnopedology etc, emerged, as shown in the Figure 3. It is accepted that farmers perceive soil more holistically than researchers do (Ingram *et al.* 2008) and that the cultural connection with the soil is spiritual rather than for its fertility utility alone. As stated by Barrera-Bassols and Zinck (2003) the assumption underlying the ethno-ecological approach is that the human use of landscape is beyond the merely materialistic, and that the techno-productive phenomenon can be better understood through exploring cultural connections.

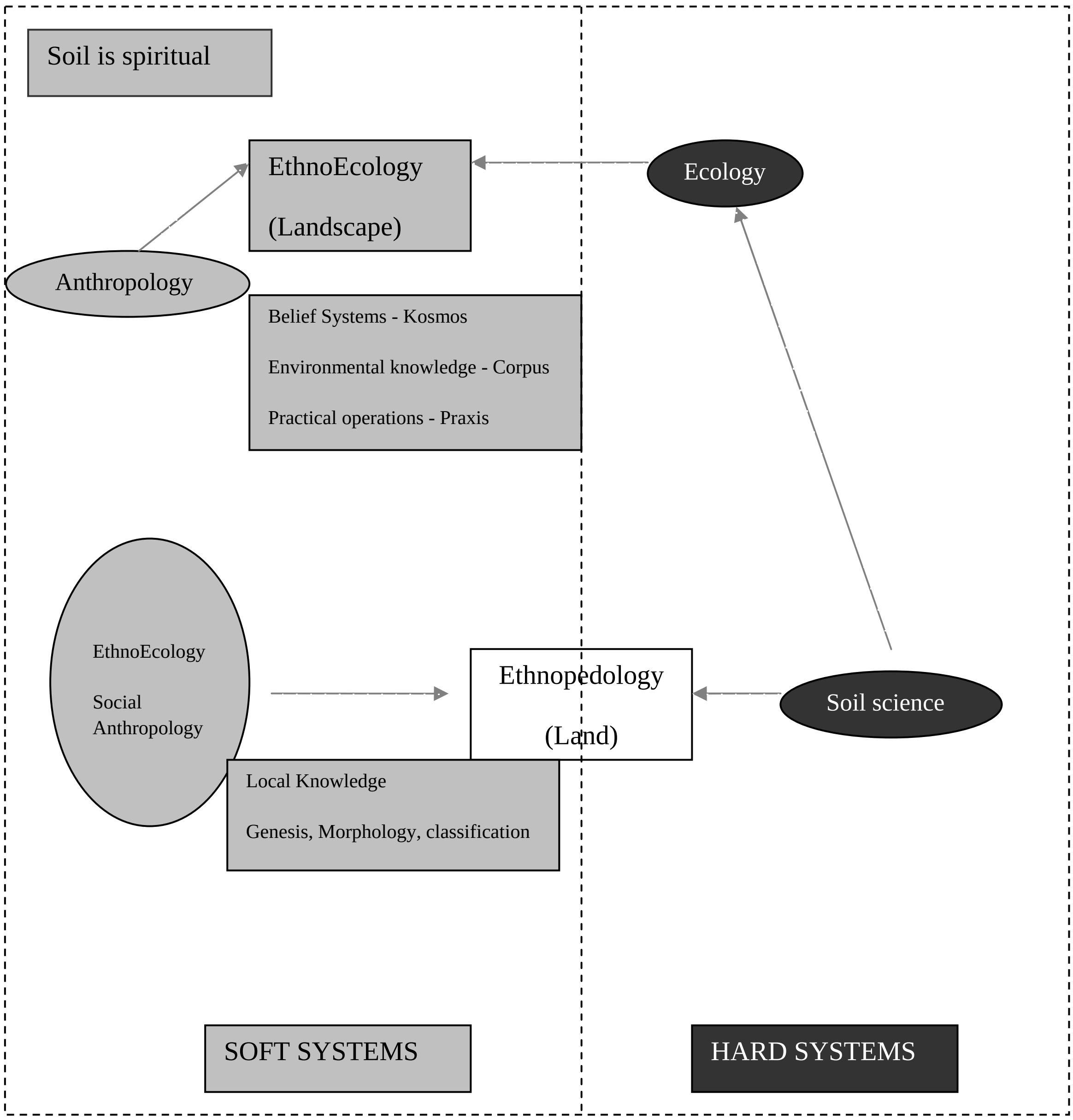

Figure 3. Perception of soil as spiritual - Neo-populist paradigm

'Ethnopedology'-is the local knowledge and understanding of soil genesis, morphology and classification. The discipline initiated as a sub discipline of 'EthnoEcology' has broadened as a hybrid discipline by combining both the soft and hard systems. Ethno Ecology is an interdisciplinary study of local environmental knowledge with the K (Kosmos) - C (Corpus) – P (Praxis) frame work.

The cultural connection with nature as spiritual includes soil as a component of earth. Earth is respected for its feminine qualities for bearing and protecting vital processes. For instance, Earth is denoted as Bhoomadevi in southern parts of India (Tamil name meaning goddess) and in the Andean region considered as Pachamama (Winklerprins & Barrera-Bassols 2004). Many cultures considered Agriculture as a part and parcel of nature and with the sun playing a major role. It is believed that nature is beyond human control and so is agriculture. Agriculture is made to operate successfully through offerings of ritual tributes made to the Mother Earth. Many cultures practiced patterns of offerings and sacrifices. Human sacrifices were made long back in history (eg. in Athens and India). Thanksgiving rituals are also commonly practiced in many cultures - as Zimmerer puts it 'Earth Mother needs to be constantly thanked through ritualistic tribute'(Zimmerer 1996). A thanksgiving festival called Thai Pongal is celebrated to thank Nature, the Sun and Farm Animals in providing a successful harvest in the Southern part of India.

The interviews in India revealed that some farmers, despite having implemented conventional practices for some time, continue to reflect spiritual connections with the soil. For example, one observed *'like any other living thing the soil needs to breathe, Soil needs water when it is thirsty, Soil needs to be fed with organic manures, Soil needs be covered with a blanket (soil mulch) etc'.* This is also observed by Winklerprins and Barrera-Bassols (2004, p. 146) as follows: *'Soil "strength" is balanced through periods of "weakness" and "recovery." The land "works," thus requiring "resting" when it is "tired;" it needs to be fed when "hungry" and needs to "drink" when thirsty to recuperate its strength. A fertile soil may become unfertile after "working" for several years and then needs to be left to "rest" (fallow) as any other living being'.*

The shift in paradigms clearly explains the changes in the perception of soil by the scientific disciplines, covering the entire spectrum from viewing soil as matter at one extreme, to seeing it as a living system and to be respected in a spiritual context, at the other. Farmers in both the countries are subjected to these influences through interventions. Hence it may be concluded that practitioners or farmers making transition to alternate farming systems need to be aware of the alternate perceptions of the soil, if they are to make a long term change towards sustainability. Table 1 below sets out an extension of the three paradigm view (seeing, knowing and doing) of soil with a six-part typology, with the characteristic perceptions and related approaches to management of cost and benefit.

Table I. Typology of views of soil and associate management approaches

Typology	**Characteristic**	**Management**
High Reductionist perception	People perceive that soil is a *non living entity*.	Cost: *Remedial measures* of application of inorganic inputs for increasing production and for immediate solutions Benefit: Profit on harvest and *farm residues*
Less Reductionist perception	People perceive that soil is *a non living entity encompassing living organisms*.	Cost: *Remedial measures* of application of both organic and inorganic inputs for increasing production and for immediate solutions Benefit: Profit on harvest, *reducing inorganic inputs*
Intermediary between reductionist and holistic perception	People perceive that soil is a *non living entity constituting living* organisms.	Cost: *Managing* application of on farm residues, organic inputs and using inorganic inputs where ever essential Benefit: Profit on harvest, reducing inorganic inputs and *to retain the efficiency of inorganic inputs*.
Less Holistic perception	People perceive that soil is a living entity constituting living organisms.	Cost: *Substituting* on farm residues and organic inputs for inorganic inputs as a requirement for market values Benefit: Profit on harvest and reducing inorganic inputs, preventing loss due to erosion, pest out break, biodiversity etc
Holistic perception	People perceive that soil is a living system.	Cost: Soil balance attained through combination of practices, Environmental degradation costs Benefit: Profit on harvest and avoiding non renewable inorganic inputs, recycling farm produces, protecting the land for future generations and ecosystem diversity
Spiritual perception	People perceive soil as a myth and possessing blessing of spiritual power.	Cost: Farm activities based on faith and belief Benefit: Living on harvest and keeping the land and the spirits happy with rituals

High Reductionist perception

This is the first level of perception reflecting the ethos of the reductionist paradigm or the conventional paradigm. It strongly reflected non-acceptance of transition either through ignorance or denial.

Less Reductionist perception

This is the second level of perception that reveals little acceptance of transition. This is the first stage where attempts to transition may be initiated.

Intermediary between reductionist and holistic perception

The third level of perception is caught between the conflicting ethos of the reductionist and holistic paradigms. Questioning the underlying assumptions may help the transition process.

Less Holistic perception

The fourth level of perception is favourable for transition. However, the ethos of the previous paradigm still exists unconsciously.

Holistic perception

The fifth level of perception reveals a satisfactory transition to the holistic paradigm. The ethos of the holistic paradigm is built in strongly.

Spiritual perception

The ethos of the sixth level of perception reflects neither the reductionist nor the holistic paradigm. Studies still need to be conducted to understand if it favours the transition process.

The typology of the perception of soil tool will help people to understand where they fit in within the typology and will be useful to explore different options to improve practices.

Conclusion

Several common themes including Enriching soil health, Knowledge sharing, Diversity, Learning, Indigenous knowledge/local knowledge and Farm Sufficiency emerged through interviews with farmers in Australia and India who had experience in transition from conventional to alternate farming approaches. These themes suggest that the transition process is more complex than merely changing approaches to manipulation of inputs and outputs as the themes are interrelated and thus, contribute to the complexity. The case study on the theme enriching soil health reveals the complexity of transition as the interrelations of the themes are discussed during different stages. For instance the perception of soil reflects on the biophysical and socio-cultural principles of soil discussed in the theme – 'Diversifying through biophysical and sociocultural methods'. Also, the existence of the indigenous knowledge/local knowledge built on faith and values also plays a vital role in influencing the perception. It may be concluded that the typology of soil will extend to deep perceptions and beliefs about the nature of soil and how one should relate to it.

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BIOFUELS EXPANSION AND THE LIVESTOCK INDUSTRY IN WESTERN CANADA

by

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Abstract

The continuous expansion of grain based biofuel production poses a complexity of challenges and opportunities for various industries. For the livestock producer in the Prairies, there is the availability of wheat distillers dry grains (DDGS) a by-product of ethanol production which can substitute for high priced grains. Additionally, dependent on market forces, there is the tendency for the importation and use of US corn DDGS. The question of what to feed and when becomes one of utmost significance for livestock producers. This paper analyzes this problem and finds potential positive economic impacts of the availability of DDGS on the livestock industry in western Canada. These impacts are however subject to market forces such as exchange rate and the prices of other feed grains.

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1.0 Introduction

Although significantly smaller than the United States (US), the biofuel industry in Canada is not exempted from the recent enthusiasm for renewable fuel production. The industry is made-up of 17 plants with a total operating capacity of about 1.45 billion litres per year (Ethanol Producer Magazine 2009). Not unlike other major ethanol producers, grains are the main feedstock used in the production of biofuel in Canada. Geographically, Canadian wheat based ethanol production is predominant in the west and corn based production is mostly in central Canada. The use of these grains creates synergies between the energy and agricultural markets.

For western Canada, the expansion of grain-based ethanol production could have important consequences considering the significance of both the grains and livestock industries in the region. On the one hand, the expansion could increase demand for feed grains, drive up feed grain prices and thereby increase feed costs for livestock producers. Higher grain prices could have unequal sectorial implications, especially on the beef cattle and hog industries which are dependent on the market to set prices.

On the other hand, ethanol is produced in conjunction with valuable by-products (i.e. distillers grains) which can be used in the livestock industry as animal feeds and can substitute for higher priced feed grains in animal rations. Depending on the volumes of distillers grains produced, and the form (i.e. wet or dry) and extent to which they can be incorporated in animal rations, part of the potential increase in livestock feeding costs could be off-set by this by-product. Moreover, given the proximity of western Canada to the US there is the additional possibility of the importation and use of corn DDGS by some feedlot operators in western Canada depending on exchange rates and other cost advantages.

In the light of these issues, this paper examines the competitive implications of the availability of both wheat and corn distillers in the western Canadian feed market. The choice of which type of distillers grains to include in livestock rations is one of key significance for both livestock and ethanol producers. In addition to the potential reduction of feeding cost for livestock producers, a market for distillers grains could be a secondary stimulus for the expansion of ethanol production in the region as margins tighten.

The paper is organized into four sections. The next section presents a review of literature related to the economics of distillers grains inclusion in livestock rations. Section three presents the methodological framework used. Results and discussion are presented in the last section.

2.0 Literature Review

A compendium of studies exist on the on the economic impact of the production of ethanol on the livestock industry. Macro-level studies such as those by Tokgoz et al., (2006), Babcock et al., (2008) and Birur (2008) captured the effect of grain-based ethanol expansion on grain prices. Characteristic of such broad based models however, limited micro-level effects are quantified.

Evidence from farm-level analysis (e.g. Anderson et al., 2008; Vander Pol et al., 2006; Mussell et al., 2007) indicates that the economic impact of the by-product has not been consistent. These conclusions are highly dependent on underlying assumptions of pricing, animal performance, inclusion of other factors such as transportation cost etc. Thus whilst Van der Pol et al., (2006) alluded to positive benefits, results from Anderson et al., (2008) and Mussell et al., (2007) conclude otherwise. Others such as Fabiosa (2008) and Bista et al., (2008) observed positive benefits of feeding DDGS in hog rations.

In a market of continuous price fluidity, estimating the value of a feed ingredient against that of other major substitutes for different prices better enhances producers' decision making. This paper therefore presents an economic valuation of corn and wheat DDGS in a dynamic framework for the hog and beef industries in western Canada.

3.0 Analytical Approach

Least cost rations are formulated for two growth stages (i.e. grower and finisher stages) for hogs and beef cattle. The diet problem entails the selection of the least cost combination of feeds that meet a specified level of nutritional requirement for livestock. An LP model is well-suited to this kind of problem that includes a single performance measure or objective (to minimize feed cost) and constraints (here the nutritional requirements of the animal) (Wachemheim and Mattson 2002).

An LP least cost ration formulation in algebraic terms has the following specification

(Tozer 2000):

$$\text{Minimize T}=\sum_{j=1}^{n} CjXi \qquad (1.0)$$

$$\text{Subject to} \sum_{j=1}^{n} aijxj \leq (\geq,=)bj \qquad (2.0)$$

$$xj\geq 0 \qquad (3.0)$$

Where:

T= total cost of ration

C_j= cost of ingredient j

X_j= quantity of ingredient j in the ration

a_{ij}= the quantity of the nutrient in ingredient j,

b_j =the required amount of nutrient *i* in the ration; the equality or inequality of the constraint is determined by the nutrient of interest.

In many applications involving linear application problems, the shadow prices may be at least as important as the solution to the problem. Pesti and Miller (1993) noted that most LP programs provide information indicating the extent to which the cost of a feed ingredient has to fall before it becomes feasible for inclusion in diets. This paper reports these values for DDGS for scenarios when the by-product is not included and the maximum values in cases when optimal. This is to provide an understanding of the economic value of the feed ingredients in the various rations when the prices of other competitive feed ingredients change.

4.0 Data

Table I presents the price data used for analysis. Ten year price averages for various feed ingredients are used. Data is obtained from a variety of sources i.e. USDA Feed Grain Database (2009); Alberta Canola Commission (2009); AFSC (2009) Agriculture and Agri-food Canada (2009); Alberta Department of Agriculture and Rural Development (2009). Since the livestock industry in Western Canada is relatively young there is paucity of price data for wheat DDGS. According to industry sources the price of wheat DDGS is approximately an average of the

Lethbridge feed barley cash price and the F.O.B Vancouver canola meal price[3] (Holman 2009). Hence this price approximation is used.

Table I Descriptive Summary of Price Data

	Price/Tonne	Standard deviation
Barley	156.09	35.73
Canola meal	206.00	46.40
Corn DDGS	163.79	24.12
Barley silage	32.90	7.31
Wheat DDGS	153.13	36.89
• Min	100.05	
• Max	246.44	
Hay	82.31	22.58
• Min	55.35	
• Max	137.85	
Limestone	105.00	
Dicalcium phosphate	900.00	
Field Peas	185.50	
Soybean meal	320.18	
Canola Oil	783.29	

Source: USDA Feed Grain Database (2009); Alberta Canola Commission (2009); AFSC (2009) Agriculture and Agri-food Canada (2009).

5.0 Results and Discussion

Least cost rations for grower and finisher diets for cattle and hog sectors are run using General System Inc.'s Formulation software. Tables II, VII and XII are the specifications for typical western Canadian beef cattle grower, finisher rations and hog grower rations respectively. To capture the scenario of DDGS unavailability base rations are run with the prices of both corn and wheat DDGS at prohibitively high levels. The ethanol by-products are then introduced into the ration at their market levels to assess the impact on feed costs.

[3] Less $45 for rail freight and terminal charges.

Table II Backgrounding Diet Specification

Nutrients	minimum level	maximum level
Crude Protein (%)	13.00	15.50
T.D.N (%)	66.50	69.50
Calcium (%)	0.60	0.80
Phosphorus	0.25	0.40
Barley silage		90

Source: McKinnon (2009)

Table III Beef Cattle Backgrounding Base Ration Results

Ingredient	Percent	Weight	Cost	Low	High
Barley	21.29	35.69	156.09	107.84	166.08
Canola meal	3.49	5.85	206	191.51	1043.34
Limestone	0.58	0.98	105	-97.35	851.07
Barley silage	53.69	90.00	32.90	0	34.87
grass hay	20.95	35.11	82.31	77.09	111.26
Totals	100	167.63	12.73		
			Total Cost=$75.49		
Not selected	Cost	Value			
wheat DDGS	1000	175.11			
corn DDGS	1000	182.09			
Dical Phos	900	15.95			

The base ration (Table III) is predominately barley silage (54%) and barley (21%). The total cost of the diet is $75.49/tonne as fed ($126.53/tonne on DM basis).

The relative shadow values of wheat DDGS and corn DDGS are $175.11/tonne and $182.09/tonne respectively. Given that the actual prices of wheat DDGS and corn DDGS are $153.13/tonne and $163.79/tonne, the latter with its higher energy content seems to represent a more competitive feed in beef background diets relative to the former. To validate this assertion, the model is re-run with the actual price values of distillers grains under separate scenarios.

Table IV Beef Cattle Backgrounding Ration (Wheat DDGS)

Ingredient	Percent	Weight	Cost	Low	High
Barley	15.95	26.70	156.09	148.66	212.36
Wheat DDGS	10.06	16.83	153.13	11.72	160.84
Limestone	0.62	1.04	105.00	-90.13	1495.69
Barley silage	53.77	90.00	32.90		34.60
grass hay	19.60	32.81	82.31	77.73	108.49
Totals	100.00	167.38	12.52		
			Total cost=$74.77		
Not selected	Cost	Value			
canola meal	206	183.69			
corn DDGS	1000	166.72			
Dical Phos	900	18.74			

The least cost ration is estimated assuming the availability of wheat DDGS. The by-product with its high protein content replaces the protein supplement i.e. canola meal and partly replaces some of the barley (barley reduces from 21.29 to 15.95%) in the base ration. Diet cost however reduces from $75.49($126.53/tonne DM basis) to $74.77 ($125.16/tonne DM basis). Savings made amount to approximately $0.72/tonne ($1.37/tonne DM basis).

5.1 Availability of Corn DDGS

The least cost ration is estimated assuming the availability of corn DDGS. Wheat DDGS is kept at a prohibitively high price. Relative to the results of the base ration (Table III corn DDGS replaces canola meal and the percentage composition of barley also reduces by about 50% (from 21.29% to 10.69%). This is unsurprising considering the relatively higher energy value of corn

DDGS. Diet cost further reduces to $74.43/tonne ($123.15/tonne DM basis), $0.34/tonne ($2.01/tonne DM basis) less than the wheat DDGS diet. Compared to the base ration however, savings on total feed costs amounts to approximately $1.06/tonne ($3.38/tonne DM basis).

Table V Beef Cattle Backgrounding Ration (Corn DDGS)

Ingredient	Percent	Weight	Cost	Low	High
Barley	10.69	17.90	156.09	149.16	242.08
corn DDGS	13.09	21.87	163.79	-214.87	172.11
Limestone	0.64	1.08	105.00	-90.15	1880.88
Barley silage	53.75	90	32.90		34.83
grass hay	21.86	36.61	82.31	77.07	108.84
Totals	100	165.45	12.46		
			Total cost=$74.43		
Not selected	Cost	Value			
canola meal	206	174.09			
Wheat DDGS	1000	150.80			
Dical Phos	900	-426.80			

5.2 Effect of Substitute Feed Prices on the Value of Distillers Grains

From the analysis in the preceding section, it seems that the competitiveness of the distillers co-product is largely dependent on its energy and protein value vis-a-vis other feed ingredients particularly barley and canola meal. To further explore these interactions a price matrix (Table VI) is constructed for the different price ranges of canola meal and barley.

The relative values of wheat and corn DDGS at the various prices are reported in the inner rows and columns. For clarity, the price of the latter is written in brackets. A feed ingredient is included in a least cost ration if its shadow value is equivalent or exceeds its market price value.

The market price of wheat DDGS and corn DDGS used are $153.13 and $163.79 respectively. This implies that at a shadow value equivalent or exceeding these market values, the feed ingredient would be selected as a constituent of the least cost ration. In the present analysis, these inclusion shadow values are italicized and highlighted. Maximum values for corn and wheat DDGS are reported for values that exceed the market value.

It can be deduced that wheat DDGS attains a higher value as canola meal price increases. This pattern is observed at low barley prices. The high protein content of the wheat DDGS ensures that it becomes valuable as its protein substitute in the diet becomes expensive. Considering that the 10-year average price of canola meal was $206/tonne, increased supplies of wheat DDGS in western Canada could have a significant impact on the competitiveness of canola meal. Corn DDGS has a lower shadow value at lower price levels of barley (<$160/tonne).

Given the price of canola meal, as the price of feed barley increases, the value of corn DDGS increases and replaces wheat DDGS as price of the latter falls below its market value. The price matrix further confirms the higher economic value of corn DDGS relative to wheat DDGS in beef cattle backgrounding rations[4]. The price matrix also confirms the absence of complementarity between the by-products as none of the price combinations had both ingredients simultaneously reaching its market value.

The price analysis suggests interdependencies among values of the feed ingredients. This is a consequence of the high rate of substitutability among feed ingredients. Further, the present analysis indicates that the economic value of distillers by-product in a feed ration varies depending on the price and nutritional value of other nutrients.

[4] Indicated by the number of barley-canola meal combinations at which the value of corn exceeds wheat distillers grains.

Table VI Effect of Substitute Feed Prices on the Value of Distillers Grains in Beef Backgrounding Diets

	Price of Canola Meal				
	140	160	180	200	220
Price of Feed Barley 120	124.19 (129.32)	143.89 (143.10)	***163.60*** (149.56)	***173.49*** (149.56)	***173.49*** (149.56)
140	127.90 (139.33)	139.10 (148.88)	***155.78*** (159.07)	***159.88*** (159.07)	***159.88*** (159.07)
160	131.94 (149.50)	143.47 (159.05)	149.19 (***167.06***)	149.19 (***167.06***)	149.19 (***167.06***)
180	135.99 (159.68)	140.95 (***169.23***)	140.95 (***173.88***)	140.95 (***173.88***)	140.95 (***173.88***)
200	132.71 (169.86)	132.71 (***179.41***)	132.71 (***180.71***)	132.71 (***180.71***)	132.71 (***180.71***)
220	124.47 (***180.04***)	124.47 (***187.53***)	124.47 (***187.53***)	124.47 (***187.53***)	124.47 (***187.53***)
240	116.23 (***190.22***)	116.23 (***194.36***)	116.23 (***194.36***)	116.23 (***194.36***)	116.23 (***194.36***)
260	108.00 (***201.18***)	108.00 (***201.18***)	108.00 (***201.18***)	108.00 (***201.18***)	108.00 (***201.18***)

5.3 Beef Finisher Rations

The analysis presented in the previous section is repeated for the finishing rations. Unlike the backgrounding diets, the base ration (Table VIII) is predominately grain based with higher energy content. The cost of the finishing cattle base ration is approximately $122.60/tonne ($166.057/tonne DM basis).

With the introduction of wheat DDGS into the ration (i.e. Table IX), the cost of feed is reduced by $1.06/tonne ($1.26/tonne DM basis[5]) as part of the feed barley in the ration is replaced by the by-product. Juxtaposing this against the case of the backgrounding diet, it is obvious that the savings are lower in the finishing ration relative to the backgrounding diet.

Table VII Beef Cattle Finisher Ration Specification

Nutrients	minimum level	maximum level
Crude Protein (%)	11.50	16.0
T.D.N (%)	78.00	
Calcium (%)	0.50	
Phosphorus	0.250	
Barley silage		90

Source: McKinnon (2009)

Table VIII Finishing Cattle Base Ration

Ingredient	Percent	Weight	Cost	Low	High
Barley	72.34	97.98	156.09	114.85	164.40
Limestone	0.82	1.11	105	-110.26	759.65
Barley silage	26.85	36.36	32.90	22.70	34.70
Totals	100	135.45	16.16		
			Total Cost=$122.60		
Not selected	Cost	Value			
Wheat DDGS	1000	160.93			
Canola meal	206	193.68			
Corn DDGS	1000	173.02			
Grass hay	82.31	77.48			
Dical Phos	900	10.20			

[5] $166.057-$164.80/tonne DM basis

Table IX Finishing Cattle Ration (Wheat DDGS)

Ingredient	Percent	Weight	Cost	Low	High
Barley	59.81	81.09	156.09	148.58	205.37
Wheat DDGS	11.98	16.24	153.13	11.71	160.93
Limestone	0.78	1.05	105.00	-107.40	1424.78
Barley silage	27.44	37.20	32.90	15.28	34.60
Totals	100	135.59	16.48		
			Total Cost=$121.54		
Not selected	Cost	Value			
Canola meal	206	185.65			
Corn DDGS	1000	167.52			
Grass hay	82.31	77.73			
Dical Phos	900	11.58			

Reductions in feed ration cost is higher with the introduction of corn DDGS (Table X)- approximately $7.29/tonne ($2.13/tonne DM basis) as the cost of diet reduces to $115.31/tonne ($163.93/tonne DM basis) from the base scenario of $166.06/tonne DM basis. It appears that the higher energy value of corn DDGS enables it to replace greater proportions of barley in finishing rations thereby reducing feed costs.

Table X Finishing Cattle Ration (Corn DDGS)

Ingredient	Percent	Weight	Cost	Low	High
Barley	49.22	69.98	156.09	148.49	1304.81
Corn DDGS	16.21	23.04	163.79	67.85	173.02
Limestone	0.77	1.1	105	-105.04	1524.45
Barley silage	33.80	48.05	32.90	- 22.30	34.55
Totals	100	142.17	16.39		
			Total Cost= $115.31		
Not selected	Cost	Value			
Wheat DDGS	1000	147.83			
Canola meal	206	180.20			
Dical Phos	900	12.52			
Grass hay	82.31	77.90			

5.4 Effect of Substitute Prices (Finisher Ration)

The price matrix (Table XI) shows a common trend of rigidity in the value of wheat DDGS across several rows of price combinations. As a result of the higher energy requirements for finishing rations, the shadow value of wheat DDGS is low; ranging from $67.07 at low canola meal-high barley price combinations to $145.16 in high price canola- average price barley combinations. This notwithstanding, similar deductions of a higher protein value of wheat DDGS can be made[6].

Relative to backgrounding rations however, it seems that corn DDGS has a higher economic value in finishing rations as shown by the high values of the by-product at high price levels of canola meal and barley. Moreover, none of the price combinations yielded a shadow value for wheat DDGS that was equivalent to its market value. It can therefore be deduced that the availability of Corn DDGS has a greater impact on the competitiveness of wheat DDGS in beef cattle finisher diets relative to backgrounding diets.

[6] As shadow values generally tend to increase across rows and decrease along the columns.

Table XI Effect of Changes in Substitute Feed Grain Prices on the Value of Distillers Grains in Beef Cattle Finishing Diets

		Price of Canola Meal			
	140	160	180	200	220
Price of feed Barley 120	123.24 (129.05)	123.41 (129.17)	123.41 (129.17)	123.41 (129.17)	123.41 (129.17)
140	115.22 (133.04)	134.66 (146.74)	144.21 (153.47)	144.21 (153.47)	144.21 (169.83)
160	107.20 (137.03)	126.63 (150.73)	145.16 (***164.43***)	145.16 (***169.41***)	145.16 (***169.41***)
180	99.17 (141.02)	118.61 (154.72)	131.47 (***168.42***)	131.47 (***179.05***)	131.47 (***179.05***)
200	91.15 (145.01)	110.58 (158.71)	117.79 (***172.41***)	117.79 (***186.11***)	117.79 (***188.70***)
220	83.12 (149.00)	102.56 (162.70)	104.10 (***176.40***)	104.10 (***190.10***)	104.10 (***198.34***)
240	75.10 (152.99)	90.42 (***166.69***)	90.42 (***180.39***)	90.42 (***194.09***)	90.42 (***207.79***)
260	67.07 (156.98)	76.73 (***170.68***)	76.73 (***184.38***)	76.73 (***198.08***)	76.73 (***211.78***)

5.5 Hog Rations

The analysis conducted in the previous section is repeated for hogs. Table XIII shows the hog grower base ration. Feed wheat and field peas are the dominant feed ingredients used. Canola meal serves as a supplementary protein source, complementing the lower levels of methionine and cystine in peas (Hickling 2003). The availability of field peas ensures that the shadow value of soybean meal is lower than its market value. The total feed cost of the ration is $174.42/tonne.

Table XII Hog Grower Diet Specification

Nutrients	minimum level	maximum level
Crude Protein (%)	16	18
DE Swine KC/KG	3150	
Calcium (%)	0.80	
Phosphorus (%)	0.650	
Lysine (%)	0.850	
Canola meal (%)		12.00
Corn DDGS (%)		18.00
Soybean meal		
Limestone (%)		3
Canola oil (%)		3
Wheat DDGS		18.00

Source: Racz (2010)

Table XIII Hog Grower Base Ration

Ingredient	Percent	Weight	Cost	Low	High
Feed wheat	59.51	59.51	153.19	135.76	156.50
Canola meal	12.00	12	206	0	220.48
Peas	24.36	24.36	185.50	173.64	224.30
Limestone	3.00	3	105	0	128.66
Dical Phos.	1.13	1.13	900	511.69	2202.79
Totals	100	100	17.44		
			Total Cost=$174.42		
Not selected	Cost	Value			
barley	156.09	152.77			
wheat DDGS	1000	180.18			
Soybean meal	320.18	232.77			
Corn DDGS	1000	177.68			
Canola oil	783.29	128.66			

With the availability of wheat DDGS (Table XIV), canola meal is displaced from the diet and the percentage of feed wheat significantly reduced. Barley enters the diet at a high percentage of 44 per cent. The composition of feed peas also increase to make-up for the lower protein (wheat DDGS relative to canola meal) and energy value of wheat DDGS. It can be observed that the economic value of wheat DDGS in the diet is dependent on the prices of other feeds such as field peas.

Table XV, shows the corn DDGS based diet, as a protein or energy feed, the co-product replaces most of the canola meal in the base ration and a proportion of feed wheat. Diet cost reduces to $173.56/tonne. It can therefore be deduced from the preceding analysis that feeding the co-product can reduce hog grower feeding cost by $0.86/tonne and $1.63/tonne for the corn DDGS and wheat DDGS based diets respectively.

Table XIV Hog Grower Ration (wheat DDGS)

Ingredient	Percent	Weight	Cost	Low	High
Wheat	0.21	0.21	153.19	152.87	155.47
Barley	44.61	44.61	156.09	154.38	156.44
Wheat DDGS	17.89	17.89	153.13	122.39	155.69
Peas	33.07	33.07	185.50	177.76	188.80
Limestone	3.00	3.00	105	0	140.52
Dical Phos	1.22	1.22	900	755.28	1031.61
Totals	100	100	17.28		
			Total Cost=$172.79		
Not selected	Cost	Value			
Canola meal	206	202.42			
Soybean meal	320.18	208.40			
Corn DDGS	1000	160.45			
Canola oil	783.29	150.30			

Table XV Hog Grower Ration (Corn DDGS)

Ingredient	Percent	Weight	Cost	Low	High
Wheat	44.86	44.86	153.19	152.45	153.71
Canola meal	0.61	0.61	206.00	205.29	220.48
Peas	32.30	32.30	185.50	173.64	186.33
Corn DDGS	18.00	18.00	163.79	0	164.44
Limestone	3.00	3.00	105.00	0	141.74
Dical Phos	1.23	1.23	900.00	511.69	941.74
Totals	100	100	17.36		
			Total Cost=$173.56		
Not selected	Cost	Value			
Barley	156.09	155.06			
Soybean meal	320.18	213.92			
Wheat DDGS	1000	159.33			
Canola oil	783.29	150.30			

5.6 Effect of Substitute Prices (Hog Grower)

The price matrix constructed for cattle is repeated for hogs. In this section however, the resultant values of wheat DDGS and corn DDGS in response to changes in the prices of field peas and feed wheat prices are examined- the two appear to be the dominant feeds in hog rations.

From Table XVI it can be observed that across rows the shadow value of wheat DDGS shows little variation, aside initial reductions in shadow values at low values of feed wheat. Similar trends can be observed across rows for corn DDGS. This is expected because the restrictions placed on the percentage of distillers grains in the diet make them a protein source. Feed wheat is primarily an energy source and hence changes in its price seem to have a limited effect on the value of distillers grains- especially when feed barley is also available.

The relatively high shadow value of wheat DDGS at average price values of field peas, indicate that the presence of field peas enhances the economic value of the by-product. However, as the price field peas continues to increase (price range $240-$260/tonne), the shadow value of wheat DDGS reduces from $132.22 to 89.01/tonne. This reduction in value may largely be a result of the availability of other protein feed substitutes such as soybean meal and canola meal that become economically valuable as field peas become increasingly expensive. Corn DDGS is generally less competitive in hog rations and come into the diet at high price levels of field peas (>$200/tonne) to provide supplemental protein and energy once field peas are priced out.

Table XVI Effect of Changes in Substitute Feed Grain Prices on the Value of Distillers Grains in Hog Grower Rations

	Price of Feed Wheat			
	140	160	200	220
Pea Price				
120	94.69 (112.36)	82.50 (106.25)	82.50 (106.25)	82.50 (106.25)
140	150.38 (150.12)	129.22 (139.51)	129.22 (139.51)	129.22 (139.51)
160	***163.19*** (154.27)	***162.04*** (157.89)	***162.04*** (157.89)	***162.04*** (157.89)
180	***153.75*** (159.08)	***158.75*** (160.07)	***158.75*** (160.07)	***158.75*** (160.07)
200	***160.55*** (159.08)	***155.78*** (162.03)	***155.78*** (162.03)	***155.78*** (162.03)
220	***156.76*** (161.48)	152.46 (***164.24***)	152.46 (***164.24***)	152.46 (***164.24***)
240	132.22 (150.61)	149.14 ***(166.44***)	149.14 (***166.44***)	149.14 (***166.44***)
260	89.01 (125.59)	148.84 (***166.48***)	148.84 (***166.48***)	148.84 (***166.48***)

5.7 Influence of Market Factors

This paper assesses the effect of variations in exchange rate on the competitiveness of the two types of distillers grains. Given the freight cost of $50/tonne and the domestic price of corn DDGS, the price of the by-product (delivered) i.e. $163.79 corresponds with a mean exchange rate of CAN$1.27/US$ (0.79 US$/CAN$). The corresponding least cost ration is reported in Table XVII.

Table XVII Beef Cattle Ration Results at the Exchange of 0.79 US$/CAN$

Ingredient	Percent	Weight	Cost	Low	High
Barley	10.69	17.90	156.09	150.42	401.56
corn DDGS	13.09	21.87	163.79	-214.90	165.72
Limestone	0.64	1.08	105.00	-90.16	1042.59
Barley silage	53.75	90	32.90	0	34.83
grass hay	21.86	36.61	82.31	77.07	93.52
Totals	100	165.45	12.46		
			Total cost= $74.43		
Not selected	Cost	Value			
canola meal	206	174.09			
Wheat DDGS	153.13	150.80			
Dical Phos	900	-426.80			

As the Canadian dollar depreciates i.e. $0.79 to $ 0.76 the price of corn distillers grains increases from $163.79/tonne to $166.73/tonne. Priced at this level, corn DDGS becomes less competitive and is displaced from the diet by wheat DDGS. Table XVIII reports the resultant least cost ration. It can be deduced that a weaker dollar seems to enhance the competitiveness of wheat DDGS and vice versa.

Table XVIII Beef Cattle Ration Results at the Exchange of 0.76 US$/CAN$

Ingredient	Percent	Weight	Cost	Low	High
Barley	15.95	26.70	156.09	148.66	156.11
Wheat DDGS	10.06	16.83	153.13	11.71	153.14
Limestone	0.62	1.04	105.00	99.66	1495.59
Barley silage	53.77	90.00	32.90	0	34.60
grass hay	19.60	32.81	82.31	82.26	108.49
Totals	100	167.38	12.52		
			Total cost= $74.77		
Not selected	Cost	Value			
canola meal	206	183.69			
Corn DDGS	166.73	166.72			
Dical Phos	900	18.73			

6.0 Conclusions

From the analysis, the availability of distillers grains in the western plains could impact positively on the livestock industry. Additionally, the competitiveness of corn DDGS in beef cattle rations relative to wheat DDGS can be observed. Even within the beef cattle sector, the unequal impact of corn DDGS is evident as cattle finisher operations would tend to benefit more relative to backgrounding. Alternatively, wheat DDGS seems to be more competitive in hog rations. The general pattern is that wheat distillers grains may be more competitive in high protein diets and are more economical when the price of protein feed ingredients such as canola meal increases. The reverse holds for corn DDGS whose economic value seems to be tied to its energy value. Wheat DDGS marketers may therefore enhance their profitability by targeting the high-protein segment of the feed market.

For the livestock producer, the key point is that, the economic value of distillers grains varies relative to the prices substitute feeds in both hog and cattle rations. An understanding of these dynamics is essential to reaping maximum benefit from the ethanol boom. Furthermore, market factors particularly exchange rates affects the competiveness of both wheat and corn DDGS. A stronger Canadian dollar tends to accentuate the economic value of the latter relative to the former. The recent increases in the value of the Canadian dollar (0.94$/CAN) and the surge in corn DDGS imports into southern Alberta and other parts of western plains seems to confirm this observation (Boaitey 2010). The continuous expansion of US grain-based ethanol production is therefore likely to impact the feed grains market in western Canada as favourable market conditions persist.

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Examining the socio-economic factors affecting willingness to adopt bioenergy crops

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Numerous studies exist reporting estimates of the theoretical potential for growing bioenergy crops in Ireland; however a knowledge gap exists on the extent to which Irish farmers would actually choose to grow these crops. We investigated the influence of selected individual and farm characteristics on willingness to consider growing bioenergy crops among farm operators in Ireland. A probit model was used to determine the extent to which these selected characteristics influence the willingness of farmers to consider alternative cropping systems. The results showed that willingness to adopt bioenergy crops in Ireland was significantly influenced by the agricultural educational level of farmers, farm size, and farm system. In the final model specification, farm profit, land tenancy, general education level of the farm operator, contact with extension agents and age of the operator were not significant variables affecting willingness to adopt. The policy implications of the research findings are discussed.

Keywords: Farm level decision making, Bioenergy crops, Adoption, Innovation, Probit

1. Introduction

The debate regarding the future role of bioenergy crop production in Ireland has heightened in direct response to a number of issues. Firstly, in response to the reform of the EU Common Agricultural Policy (CAP), Ireland replaced production-indexed farm subsidies with production 'decoupled' single farm payments (SFP) in 2005, based on land area farmed during 2000-2002. The introduction of decoupling is expected to lead to a reduction in Irish livestock numbers (Binfield et al., 2003). The land areas dedicated to both cereal production and sugar-beet in Ireland are also forecasted to decline due to this reform (Thorne, 2004; Thorne, 2006). Secondly, dramatic increases in oil, gas and coal prices have recently made fossil-based electricity and heat production substantially more expensive. These high prices may reflect a new era of higher energy costs perpetuated by limitations in the rate of oil supply and rapidly increasing demand from the growing economies of China and India. Thirdly, the introduction of the EU Emission Trading Scheme (ETS) in 2005 provides financial incentives for carbon-neutral fuels, including bioenergy, under the EU ETS legislation (2003/87/EC; 2004/101/EC).

Ensuing from the aforementioned factors there have been numerous studies estimating the theoretical potential for growing bioenergy crops in Ireland (Rice, 2007), however a knowledge gap exists on the extent to which Irish farmers would actually choose to grow these crops. Hence, this piece of research is focused on modelling the factors influencing the adoption decision at farm level. The hypothesis that there are explanatory variables that could explain the reason why some individual farmers are reluctant to consider alterations to their farm profile is examined. It is hypothesised here that farmers' reluctance to change may be a result of individual and farm circumstances. An understanding of the factors that influence the structural change process is important as it provides information for the policy making process, so that desired structural change can be achieved, based on prevailing social, political and economic goals (Austin et al., 1998). Furthermore, innovative behaviour is a topic of practical as well as academic interest because the willingness of farmers to adopt new techniques is an important determinant of the success of policy initiatives (Willock et al., 1999). In addition to influencing the agricultural policy debate, the understanding of farmer response to policy adjustments has important implications for other sectors in addition to agriculture, as the vibrancy of rural areas can also be affected.

The following section outlines the background to the research question with reference to insights from the literature on the adoption process. This section assists in the identification of explanatory variables that influence the decision making process in the context of bioenergy crop adoption. The next section outlines the econometric model (probit model) that was developed to answer the identified research question. Following this, the data used in the analysis is described and the empirical results of the model are outlined. Conclusions and discussion of the results are then identified, followed by possible areas of future work.

2. Background

As the debate regarding the future role of bioenergy crop production has heightened, so too has the debate regarding the potential uptake or supply of bioenergy crops at farm level in Ireland. Due to the fact that these crops are relatively new to Irish agriculture, limited knowledge from past experiences can be used to assist in the identification of the determinants which will influence the farmer adoption process. There is however a considerable body of literature documenting research on the adoption and diffusion of innovativeness theory (Rogers, 1995). This literature has been widely used to identify factors that influence an individual's decision to adopt or reject an innovation (Boz and Akbay, 2005). While such models do not explicitly model the willingness of farmers to consider or investigate the conversion of land to bioenergy crop production, they do assist in the identification of variables which could characterise 'early adopters'. Boz and Akbay (2005) identified various models in which credence is assigned to individual characteristics and farm level variables in the determination of farm level decision making.

In the context of identifying individual farm characteristics that could influence the farmer adoption process, a number of useful literature sources were identified. To begin with, neo-classical economic theory suggests that individuals are profit maximisers. Clancy et al. (2009) stated that widespread adoption of bioenergy crops in Ireland is only likely when the economic merits of these crops have been proven over an extended period. Many studies have applied this premise to the farmer decision making process, with Perloff (1991), Ryan and Gross (1943) and Hennessy (2002) all citing relative profitability as an explanatory variable of the adoption process in the farming sector. The literature indicates that existing farm profit levels have a significant positive influence on the willingness of farmers to adopt new farming practices. Other farm level characteristics identified in the literature as explanatory variables in the adoption process were farm size (Hennessy, 2002; Rogers, 1995, Ryan and Gross, 1943; Rogers and Pitzer, 1960); production system (Austin et al., 1998; Rosenqvist et al., 2000); and contact with extension personnel (Boahene et al., 1999; Rogers and Pitzer, 1960).

Farm size is hypothesised to have a positive influence on the adoption process, as is contact with extension personnel. Austin et al., (1998) and Rosenqvist et al., (2000) both found that existing farmers involved in crop production were more likely to be early adopters of bioenergy crop production, given that they have previous experience of cropping systems. Furthermore, Austin et al., (op. cit) and Rosenqvist et al., (op. cit) also found a negative relationship between bioenergy crop adoption and total forage area of the farm.

Demographic characteristics identified from the literature that were assumed relevant for this research question included age (Tatlidil, 1989; Brander and Kearl, 1964; Rogers, 1995) and educational level (Rogers, 1995; Ryan and Gross, 1943; Rogers and Pitzer, 1960). Consistent with the literature, it is hypothesised that age of the farm operator will have a negative relationship with adoption. Furthermore, many models have found supporting evidence for the hypothesis of a life cycle (Huffman and Lange, 1989), which indicates alternative propensities of work etiquette at different stages during the life cycle of the farmer. In relation to education level, it is hypothesised that farmer operators with higher levels of agricultural education will be more willing to consider or investigate the growing of bioenergy crops.

All of these issues identified from the literature will be examined in the paper. Empirical studies which have tried to capture the influence of socio-economic variables on farmers' adoption decision have predominantly used a probit or logit model (Rahm & Huffman, 1984; Kebede et al., 1990; Rahji,1998; Vanslembrouck et al., 2002; Damisa, 2007), with probit in particular being very common (Rigby et al., 2001). In these models, farmers are assumed to make adoption decisions based upon an objective of utility maximization. The benefits of adopting these technologies as well as the cost of adoption are likely to vary across farmers that are heterogeneous in the availability of human capital and technical skills, and in other socio-economic characteristics (Nkamleu and Adesina 2000). The results of these papers indicate that the socio-economic characteristics of the farmer influenced the decision they made. Therefore, specific information on the influence of socio-economic characteristics of adoption would be helpful in the design and implementation of more effective programs to promote the adoption of agricultural innovations (Nkamleu and Adesina 2000). The methods used to model the explanatory factors of the adoption process at farm levels are outlined in the following section.

3. Methodology

In this study, farm-related and individual determinants for the adoption of bioenergy crop production among Irish farmers are identified and estimated. This research question was tested empirically by the model:

$$P\{y_i = 1|x_i\} = F(x_i, ß) \qquad (1.1)$$

This binary choice probit model describes the probability that $y_i = 1$, the vector x_i containing individual and farm level characteristics, and where F is a cumulative distribution function which is bound by the [0,1] interval i.e. $0 \leq F(x_i, ß) \leq 1$. So, the probability that a farmer has considered or investigated converting land to bioenergy producing crops depends on specified characteristics.

For the standard probit model adopted for this research a standard normal distribution was assumed, specified as a log-likelihood equation and estimated using a Maximum Likelihood Estimation (MLE) model. As the co-efficients from this probit model can not be interpreted in the same manner as an OLS regression, it was necessary to compute marginal effects and elasticises to interpret the output from this model.

The goodness of fit of this model was examined using the pseudo R^2 value. It is to be expected that the pseudo R^2 would not be very high in this instance, as cross sectional data is used. Likelihood ratio tests were used to determine the appropriateness of restricted versus unrestricted models i.e. whether or not certain variables are necessary in the model.

4. Data

Data from the National Farm Survey (NFS) (Connolly et al. 2007) was used to examine the research question. The primary objective of the NFS is to collect and analyse information relating to farming activities. To achieve its objective a farm accounts book is recorded for each year on a random sample of farms throughout the country. For 2006, 1,177 farms were included in the analysis. In addition to the individual farm accounting, performance and farmer demographic data collected from the NFS on an annual basis, special studies on individual topics are also conducted. The 'special study' survey conducted in 2006 was concerned with, among other issues, farmers' intentions/considerations regarding converting land to producing bioenergy crops. While this survey was conducted by the NFS not all respondents from the main survey were participants in the special study. As a result, to link data from the main survey with the special study it was necessary to construct a matched balanced dataset. Consequently, the sample size of the final dataset used in the analysis was slightly less than in the original survey, with 998 individual farms included.

In contrast to other empirical studies which have analyzed the determinants of farm structural change, either on the basis of accounting data and census data (such as Kimhi, 1994; Stiglbauer and Weiss, 2000) or survey data (such as Glauben et al. 2004), this approach to examining structural change has an advantage in that the survey data is actually linked to the individual accountancy and demographic data. Thus, the 2006 farm survey database provides data on individual characteristics which will be used as explanatory variables in the probit model. The special survey database provides data on farmers' considerations regarding planting intentions of bioenergy producing crops, which will provide the data for the dependent variable in the model specified.

The explanatory variables selected which were hypothesised to affect WILLINGNESS were: farm size (SIZE), farm size squared (SIZE2), amount of land owned, expressed as a percentage of total area farmed (LANDOW), amount of land rented out expressed in hectares (RENTOUT), farming system was captured as a dummy variable with 1 representing specialist tillage farms and zero for all other farms (SPECCROPS), total forage area in hectares (FORAGE), farm profit in thousands of euro per farm (PROFIT), education level of the farm operator (EDUC) represented by a scale, agricultural education of the farm operator (AGEDUC) captured as a dummy variable, contact with extension agents (EXTEN) captured as a dummy variable, age of the operator (AGE), and age of the operator squared (AGE2). All of the variables used in the probit model are outlined in Table 1, with variable definitions and the mean values for the sample of farms.

Table 1: Variable Definitions and Descriptive Statistics

Variable	*Variable Definition*	*N*	*Sample Mean*	*Standard Deviation*	*Minimum*	*Maximum*
WILLINGNESS	Willing to produce bioenergy crops (0=No/1=Yes)	998	0.07	0.26	0.00	1.00
SIZE	Farm size in hectares	998	52.42	39.52	5.86	377.20
SIZE2	Farm size squared	958	4308.94	10166.53	34.34	142279.80
LANDOW	Amount of land owned (proportion of Utilisable Agricultural Area)	998	0.93	0.29	0.00	3.85
RENTOUT	Hectares of land rented out	998	0.93	4.77	0.00	52.65
SPECROPS	Specialist crop farm (0 = Not spec; 1 = spec. crop farm)	998	0.07	0.26	0.00	1.00
FORAGE	Total forage area (hectares)	998	43.44	31.35	0.00	346.30
PROFIT	Family Farm Income in 2005 (€'000)	998	27.05	27.97	-32.01	235882.30
EDUC	Education level of the farmer (Scale 1-6)	998	2.13	0.98	1.00	6.00
AGEDUC	Formal agricultural education (scale 0-1, 0=No/1=Yes)	998	0.57	0.50	0.00	1.00
EXTEN	Contact with extension agent (0=No/1=Yes)	998	0.60	0.49	0.00	1.00
AGE	Age of operator (years)	998	53.14	11.96	20.00	83.00
AGE2	Age of operator squared	998	2966.46	1299.89	400.00	6889.00

5. Results

As mentioned above, a standard probit analysis on the likelihood of the farmer considering or investigating the decision to grow bioenergy crops was applied. The estimation results of the specified probit model are presented in Table 2. The model is statistically significant at the 1 percent level or better, as measured by the likelihood ratio test. Overall, the results in Table 2 suggest that the probability of innovation at farm level is significantly influenced by a number of personal and farm characteristics. The marginal effect of each variable on the probability of the adoption decision is presented in Table 3. The marginal effects show the change in the probability of choice j given a change in x_i . In the case of continuous explanatory variables, the marginal effect relates to a change of one unit in the variable. For the binary explanatory variables, the marginal effect is the difference in probabilities between setting the explanatory variable to one and setting it to zero, given that all other explanatory variables are set at their sample means.

The size of the farm is shown to have a significant positive impact on potential adoption behaviour of farmers. The marginal effects in Table 3 show that for a one unit change in farm size, the willingness to grow bioenergy crops increase by .002. It is interesting to note that farm profit is not a significant variable in the adoption decision making process. In a stepwise regression process, farm profit on its own was significant; however when farm size is controlled for and included as an explanatory variable the profit variable no longer remains significant. Since farm profit is positively correlated with farm size (as seen in Appendix 1 in the correlation matrix), one might conclude that existing farm profit is not an important explanatory factor in the adoption decision making process when farm size is accounted for. Hence, the analysis supports the hypothesis that the size of the farm, in terms of land area farmed, is a more reliable estimator of the expected future earnings from bioenergy crop production than the current level of farm income.

Table 2: Results of the probit model on the probability of bioenergy crop adoption

Variable	*Symbol*	*Co-efficient*	*Standard Error*	*Z statistic*	*Prob > |z|*
SIZE	Farm size in hectares	0.02	0.01	3.05	0.00
SIZE2	Farm size squared	-0.00	0.00	-1.62	0.11
LANDOW	Amount of land owned (percent of UAA)	0.08	0.29	0.27	0.78
RENTOUT	Hectares of land rented out	0.01	0.01	0.50	0.62
SPECROPS	Specialist crop farm (0 = Not spec; 1 = spec. crop farm)	0.87	0.23	3.74	0.00
FORAGE	Total forage area (hectares)	-0.01	0.01	-2.53	0.01
PROFIT	Family Farm Income in 2005 (€'000)	0.00	0.01	0.54	0.59
EDUC	Education level of the farmer (Scale 1-6)	0.06	0.08	0.82	0.41
AGEDUC	Formal agricultural education (scale 1-2, 1=No/2=Yes)	0.76	0.20	3.71	0.00
EXTEN	Contact with extension agent (1=No/2=Yes)	-0.07	0.16	-0.45	0.65
AGE	Age of operator (years)	-0.04	0.04	-0.92	0.36
AGE2	Age of operator squared	0.00	0.01	0.84	0.40
_cons		-1.82	1.09	-1.66	0.10
Number of observations	998				
LR chi2	129.93				
Prob>chi2	0.000				
Log Likelihood	-187.99				
Pseudo R2	0.2488				

Table 3: Marginal effects from probit model

SYMBOL	*Marginal Effect*	*Standard Error*	*Z statistic*	*Prob > |z|*
SIZE	.002	.00053	2.93	0.003
SIZE2	-.000	.00000	-1.61	0.107
LANDOW	.007	.02402	0.27	0.784
RENTOUT	.000	.00113	0.50	0.620
SPECROPS	.134	.05545	2.42	0.016
FORAGE	-.000	.00039	-2.41	0.016
PROFIT	.000	.00000	0.54	0.593
EDUC	.005	.00643	0.82	0.415
AGEDUC	.060	.01479	4.11	0.000
EXTEN	-.006	.01370	-0.45	0.655
AGE	-.003	.00343	-0.92	0.359
AGE2	.000	.00003	0.84	0.399

In accordance with similar research conducted on the adoption decision making process, an additional two land area variables, namely total land owned as a percentage of Utilisable Agricultural Area (UAA) and total land area (hectares) rented out, were included as explanatory variables in the model. Neither of these two variables were significant, indicating that size of the farm is the only important variable in the adoption decision making process and land tenure systems are not important explanatory variables, as was seen in other studies such as Rosenqvist et al., (2000).

The existing system of farming is shown to be highly significant in the adoption decision making process. The dummy variable for specialist cropping system shows that existing specialist tillage farms are more likely to consider or investigate the growing of bioenergy crops, which one could consider as a proxy for tradition or experience contributing a significant role to the adoption decision. The marginal effects in Table III show that being a specialist tillage farmer increases the probability of considering adoption of bioenergy crop production by 10 percent. Further evidence of the role of traditional farming practices influencing the adoption decision is shown by the variable total forage area, which shows forage area has a significant negative effect on the willingness of farm operators to investigate or consider the growing of bioenergy crops.

The influence of and inter-relationships between individual farm operator characteristics on the willingness to consider bioenergy crop production is worthy of note. When the age of the operator is controlled for on its own (in a step wise regression) it appears to be negatively correlated with the willingness to adopt new farming practises, whereby younger farmers are more willing to consider bioenergy crop production, and there is no evidence of the existence of a significant lifecycle influence. However, when the agricultural education level of the farm operator is controlled for in the model, agricultural education appears as a highly significant variable and age of the operator no longer remains as a significant explanatory variable. Hence, one could consider that age of the operator was not initially explaining a time horizon factor, i.e. younger farm operators were not willing to consider bioenergy crop production because of their reduced discount rate applied to future cash flows, but rather age of the operator was a proxy for education levels of the operator. The inter-relationship between the age and education variables included in the model show that age on its own is not a significant variable in the adoption decision making process of bioenergy crop production but agricultural education of the farm operator is an important factor. Hence, farmer operators with agricultural education may be more open to new ideas and be more willing to investigate alternative farming systems. The marginal effects reported in Table III show that farm operators with formal agricultural education are 6 percent more likely to consider growing bioenergy crops than farm operators with no formal agricultural education.

Contact with extension agents did not appear as a significant variable affecting the adoption decision. While the relationship was positive it was not significant. This is contrary to other findings in the adoption literature where contact with extension agents was a significant factor affecting the adoption decision (Boahene et al., 1999; Rogers and Pitzer, 1960).

6. Conclusions

The purpose of this study was to determine the influence of farm and individual level characteristics on the willingness of farmers to investigate the adoption of bioenergy crops in Ireland. Innovation theory was used as a framework to develop an empirical model. The probit regression procedure was used to determine the extent to which the selected explanatory variables influenced the willingness of the farmer to consider adopting the aforementioned crops. Overall the results confirm that both farm and individual farmer characteristics are important in the adoption process.

The research findings related to the farm characteristics: system of farming and farm size, are consistent with the general literature on the adoption process within agriculture. Consistent with adoption theory (Boz and Akbay, 2005), this research has shown that farm size is a positive socioeconomic characteristic, whereby farm size has a positive impact on the willingness of farmers to consider or investigate the growing of bioenergy crops. Given that existing farm profit level was not a significant explanatory factor in the adoption process when farm size was accounted for, it could be concluded that size of the farm is a more reliable estimator of the expected future earnings from bioenergy crop production than the current level of farm income. This finding is in accordance with Wiemers and Behan (2004) who found an unwillingness to switch enterprises for higher returns when examining the reasons behind the poor uptake of forestry grants.

Unlike other empirical research which has applied innovation theory to examine the adoption process in agriculture, the importance of extension contact in promoting bioenergy crop adoption in Ireland did not appear as a significant variable in this research. Given that a number of the bioenergy crops being highlighted as suitable for Irish growing conditions (such as willow and miscanthus) incur substantial establishment costs and at the time the survey was conducted no establishment grant aid was available from the government, it is possible that farmers and extension agents were adopting a wait and see approach. Rice (2007) highlighted the need to improve the profitability of growing and processing bioenergy crops if the industry is to develop to a significant scale. Also, development of extension activities must be based on, and take into account, the socioeconomic status of the farmer. As shown in this research a number of variables are highly significant in influencing the adoption process, whereas other farm level and individual specific variables are less significant in the adoption process. Following from recommendations outlined by Boz and Akbay (2005), agricultural extension services must identify and work together with early adopters, or potential early adopters. Once the early adopters of the innovation or cropping system accept the idea they will play an important part in influencing other people in the industry. This can facilitate the work of extension agents in promoting the crops and lowering program delivery costs.

At the policy level, national government must put in place a coherent policy to encourage bioenergy crop production in order for Ireland to meet national targets for bioenergy production set by the European Commission. Mullins (2007) criticised Ireland's 'piecemeal approach to biofuel production' which has hindered the ability of biofuel production companies to operate in the Irish market. The importance of the research findings outlined in this paper is that policy makers will now be assisted in distinguishing between firms regarding their likelihood of bioenergy crop adoption.

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Appendix 1: Correlation Matrix: Coefficients and Significance Levels

	WILLINGNESS	SIZE	SIZE2	LANDOW	RENTOUT	SPECROPS	FORAGE	PROFIT	EDUC	AGEDUC	EXTEN	AGE	AGE2
WILLINGNESS	1.00												
SIZE	0.22	1.00											
	0.00												
SIZE2	0.18	0.88	1.00										
	0.00	0.00											
LANDOW	-0.02	-0.08	0.04	1.00									
	0.53	0.01	0.19										
RENTOUT	0.09	0.16	0.20	0.48	1.00								
	0.01	0.00	0.00	0.00									
SPECROPS	0.35	0.17	0.15	0.06	0.18	1.00							
	0.00	0.00	0.00	0.05	0.00								
FORAGE	0.02	0.81	0.65	-0.06	0.11	-0.14	1.00						
	0.47	0.00	0.00	0.05	0.00	0.00							
PROFIT	0.19	0.62	0.46	-0.04	0.11	0.15	0.57	1.00					
	0.00	0.00	0.00	0.26	0.00	0.01	0.00						
EDUC	0.13	0.17	0.12	-0.03	0.12	0.12	0.14	0.21	1.00				
	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00					
AGEDUC	0.19	0.23	0.10	-0.09	0.01	0.12	0.23	0.32	0.28	1.00			
	0.00	0.00	0.00	0.01	0.65	0.00	0.00	0.00	0.00				
EXTEN	0.09	0.22	0.11	-0.08	0.00	0.08	0.18	0.28	0.09	0.29	1.00		
	0.01	0.00	0.00	0.02	0.85	0.02	0.00	0.00	0.00	0.00			
AGE	-0.09	-0.07	-0.01	0.20	0.07	-0.00	-0.08	-0.14	-0.40	-0.40	-0.16	1.00	
	0.00	0.02	0.64	0.00	0.03	0.98	0.01	0.00	0.00	0.00	0.00		
AGE2	-0.09	-0.07	0.25	0.21	0.08	0.00	-0.08	-0.15	-0.40	-0.40	-0.16	0.99	1.00
	0.01	0.02	0.43	0.00	0.02	0.99	0.01	0.00	0.00	0.00	0.00	0.00	

The value of suitable working time for crop production machinery activities

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Abstract

The value of suitable field time is an important element in making several machinery management decisions and is examined within this study. A whole farm planning optimization model is used to determine marginal value product (change in mean net returns) and marginal willingness to pay for suitable field time for a Kentucky corn and soybean producer. The typical risk and return tradeoff is found wherein reduced fluctuation in net returns is possible at a cost of reduced mean net returns. While earlier planting dates for both corn and soybean production are initially relied upon for the risk neutral producer, greater diversity of crop production practices is used as a means of reducing yield risk. When suitable field time is constrained it can have values as high as US$266.09 per hour during harvest for the risk neutral farmer. Given the variability of change in farm returns resulting from additional suitable field time dependent on weather, a risk averse producer is only willing to pay a discounted amount from the mean change in farm net returns. The risk averse farmer's willingness to pay for additional suitable field time nonetheless can remain substantial ranging from about US$100-US$200 per hour during constrained harvest time.

Keywords: Farm machinery management, whole farm planning

Introduction

Farm management involves a host of interrelated components that have to be considered. Issues related to successful machinery management are not least among these. Indeed, of paramount importance to the success of most farm operations is good machinery management. What is the appropriate machinery complement? Should I own or custom hire? What if weather prohibits me from performing farm machinery operations in a timely manner? When should I replace my machines? What if my machinery operator performs poorly or fails to show up on time? What size of equipment should I acquire given the tradeoff for the need for timeliness versus the cost of larger machinery? This and a host of other questions must be addressed. The ability to timely perform machinery operations in as cost effective way as possible is crucial. The interrelationships of land management and machinery management become obvious in the timely performance of the required farm machinery activities. Human resource management also becomes interrelated in that machines typically require an adequately skilled operator. Additionally, a farmer's attitude towards risk influences various machinery management decisions as well.

Machinery management is further complicated by issues of suitable field working time. While the direct analysis of each of the above machinery management questions is beyond the scope of this paper, a difficult element underlying most machinery management decisions regards the value of time spent on farm machinery operations. Sometimes the calculations regarding costs of operations are not as difficult as more subtle element such as the marginal value of an additional or reduced hour of suitable field time. Addressing this issue is the primary focus of this paper. Specifically, a case example of a hypothetical Kentucky crop producer is used in developing estimates of the marginal value of suitable field time. In the achievement of this purpose, three objectives will be pursued:

1. A whole farm planning model is developed and solved with a discussion included on the farm net return results and the optimal crop production practices.
2. Economic and agronomic results are compared and contrasted for three different attitudes towards crop yield risk: risk neutral, low risk aversion and high risk aversion.

3. The lost average (mean) farm net returns due to reduction of suitable field time by period (week) is determined as well as the corresponding willingness to pay by the farmer for this lost suitable field time.

Methods

A hypothetical commercial sized corn and soybean producer in Kentucky, USA is considered. The farm has 1052 ha (2600 ac) of cropland with four soil types representative of Henderson County, Kentucky. Based on examination of soil survey data, an assumption of 80% of soil was assumed to have deep topsoil and the rest was considered shallow. Furthermore, 75% was assumed to be a silt loam with 25% a silt clay soil. These soil types guided use of default soil parameters used in DSSAT version 4 (Decision Support System for Agrotechnology Transfer), a crop growth simulation model (Hoogenboom et al., 2004). Thirty years of historical weather data was simulated to reflect a broad spectrum of weather conditions.

Several crop production practice considerations were modeled to reflect the complexity and breadth of agronomic decisions a farm manager needs to make. Possible corn planting dates ranged from March 25th to May 20th on a weekly basis. Three seed varieties were used reflecting different lengths of maturity: 2625, 2675 and 2725 growing degree days (GDD) mean requirements to reach maturity. When ready to harvest a two week window was allowed. Treatments also included various nitrogen fertilizer and plant population levels which are not reported in detail herein. Possible soybean planting dates ranged from April 22nd to June 17th on a weekly basis. Maturity group 2, 3 and 4 soybean varieties were included. Treatments also included various plant population levels which are not reported in detail herein. For further information see Shockley 2010.

Required machinery operations are based on University of Kentucky Cooperative Extension Service recommendations and common practice for the region and reflect a no-till operation. Four weeks before planting corn or soybeans, a burn down treatment with herbicide occurs. Then planting of corn and soybeans occurs for the given weeks analyzed. A pre-emergence herbicide application on corn occurs two weeks after planting. A post-emergence herbicide application on both corn and soybeans occurs four weeks after planting. Nitrogen application on corn occurs five weeks after planting. Insecticide application on soybeans occurs 15 weeks after planting. Harvest was determined by the average (across 30 years) maturity date in DSSAT for each planting date and maturity group combination. Physical harvest of the crop occurred three weeks after the maturity date determined for corn and four weeks after the maturity date determined for soybeans. Then, the farmer was allowed two weeks of harvest time to complete the harvest. Furthermore, stalk shredding of corn also occurs during the harvest weeks.

These farm machinery activities are performed using a typical machinery complement reflective of a commercial sized operation in the region. A 250 horse power 4WD (four wheel drive) tractor and a 200 horse power combine (with an 8 row header for corn harvest and a 7.62 m flex header for soybean harvest) are owned. Farm implements include a 12.80 m anhydrous applicator, a split row no-till planter for 16 rows, a grain cart with a capacity of 12.7 tonnes and a 6.10 m stalk shredder. A 27.43 m boom self propelled sprayer is also owned. Machinery data standards (performance rates, machinery costs, etc.) are embodied in the Mississippi State Budget generator which is used for both its price data and ability to perform the calculations of such coefficients (Laughlin and Spurlock, 2007).

Farm machinery operations are limited by field conditions which dictate whether or not a given time is suitable or not for fieldwork. Following Shockley 2010 a suitable field day was defined as one that did not experience precipitation in excess of 0.38 cm per day. The monthly median level across all 30 years is used to depict suitable working field days which are further separated into weeks for the machinery constraints.

A whole farm economic optimization model is formulated using linear programming to represent this decision-making environment. Production activities reflecting crop mix and crop production practices are included. Likewise, requirements of performing all necessary farm machinery operations, purchasing adequate inputs and not exceeding available resources such as land are included as well. Especially noteworthy here is the inclusion of weekly constraints such that the suitable working field times available are not exceeded in the performance of required farm machinery activities. Marketing constraints embody the fact that commodity sales may not exceed the amount produced on the farm for any given year. Corn price is US$0.1677/kg ($4.26/bu) and soybean price is US$0.3586/kg ($9.76/bu) after hauling costs. Crop rotation constraints reflect a two year rotation between corn and soybean production activities. The farm manager is maximizing expected farm returns net of operating costs under the risk neutral case. Thus, farm net returns reflect a return to land, machinery ownership and management. Under the cases reflecting a farm manager who is risk averse, a standard mean-variance modeling procedure is used to discount mean net returns by a risk aversion penalty multiplied by the variance of net returns across years reflecting uncertainty in crop yields due to varying weather patterns across years. Two attitudes towards risk are examined: a low and a high aversion to yield risk. Based upon the underlying conditions and the farm manager's attitude towards risk, an optimal whole farm plan is determined regarding the crop production practices to be undertaken.

Results and Discussion

The base risk neutral case wherein a farm manager is unconcerned with fluctuation in net returns from varying yields displays an expected net return of US$1,064,615 (Table 1). This represents an average across the 30 years of weather analyzed and depicts a return above operating costs. Notably, these returns have not been reduced for land, machinery ownership and management expenses. The typical resulting risk and return tradeoff is displayed in the results. Specifically, as risk aversion increases there is the opportunity to reduce risk as measured by standard deviation of net returns but at a cost of lower mean net returns. Furthermore, the coefficient of variation (CV) and minimum observed net returns lowers as risk aversion increases. While the risk neutral farm experienced a 17.52% CV (meaning about two thirds of the time net returns are within plus or minus 17.52% of the mean of US$1,064,615) the highest risk averse solution results in a drop to a CV of 11.58% for a mean return of US$972,824.

Table 1. Summary farm net return results by risk aversion attitude

	Risk Neutral	Low Risk Averse	High Risk Averse
Mean Net Returns (US $)	1,064,615	1,052,901	972,824
Maximum Net Returns (US $)	1,417,453	1,398,218	1,224,121
Minimum Net Returns (US $)	688,761	702,152	733,239
Standard Deviation Net Returns (US $)	186,495	163,662	112,665
Coefficient of Variation (%)	17.52	15.54	11.58

The economically optimal corn production practices varies dependent upon risk attitude (Table 2). For risk neutrality, heavy emphasis is placed on the early March 25th planting at about 84% of corn planted with the remainder planted April 15th. As yield risk aversion increases, greater diversity in planting dates is used with shifts to later planting dates. April 15th corn planting is foregone with a preference for planting on April 22nd with the addition of April 1st initially and then April 8th as well. A combination of early and late harvest is used as needed. A dominance of 2725 GDD maturity corn at 72% of land planted gives way to greater diversity as risk aversion increases but with about half of corn planted in the earlier 2625 GDD variety. Greater diversity of corn production practices is used to reduce yield risk as well as relying upon more stable yielding production practices. Notably, corn yield drops from 10,261 kg/ha for the risk neutral solution to 9,352 kg/ha for the high risk averse solution, a decrease of about 9%.

Table 2. Optimal corn production practices (ha) and yields (kg/ha) by risk aversion attitude

Planting date, harvest time, maturity[1]	Risk Neutral	Low Risk Averse	High Risk Averse
March 25 Early harvest 2625 GDD (ha)			70
March 25 Late harvest 2625 GDD (ha)			127
March 25 Early harvest 2675 GDD (ha)	146	146	
March 25 Early harvest 2725 GDD (ha)	146	146	15
March 25 Late harvest 2725 GDD (ha)	148	81	71
April 1 Late harvest 2725 GDD (ha)		67	76
April 8 Early harvest 2625 GDD (ha)			74
April 8 Early harvest 2725 GDD (ha)			4
April 15 Late harvest 2725 GDD (ha)	86		
April 22 Early harvest 2725 GDD (ha)		4	
April 22 Late harvest 2675 GDD (ha)			88
April 22 Late harvest 2725 GDD (ha)		82	
Corn Yield (kg/ha)	10,261	10,025	9352

[1] Harvest time refers to early (first week of two) or late (second week of two) harvest and maturity refers to average growing degree days (GDD) required

The economically optimal soybean production practices varies dependent upon risk attitude just as corn did but to a lesser degree (Table 3). For risk neutrality, almost the entire soybean planting occurs April 22nd at the earliest opportunity with a mere 1% being planted the week following. Harvest is fairly evenly distributed and maturity group 4 soybeans are all that is planted. As yield risk aversion increases, greater diversity in planting dates is used with shifts to later planting dates. Early planted soybeans (April 22nd are eliminated in favor of April 29th and May 6th planted soybeans again with entirely maturity group 4 soybeans. However, the high risk averse solution results in a combination of four different weeks of planting from the earliest to the latest on June 17th. Furthermore, all three maturity groups of soybean are planted. Notably, harvest time can be partially managed through the use of varying maturity groups in the spreading out of harvest requirements. As for corn, greater diversity of soybean production practices is used to reduce yield risk as well as relying upon more stable yielding production practices. As partial evidence of this, soybean yield drops slightly (6.50%) from 4188 kg/ha for the risk neutral solution to 3915 kg/ha for the high risk averse solution.

Table 3. Optimal soybean production practices (ha) and yields (kg/ha) by risk aversion attitude

Planting date, harvest time, maturity[1]	Risk Neutral	Low Risk Averse	High Risk Averse
April 22 Early harvest MG 3 (ha)			19
April 22 Early harvest MG 4 (ha)	241		
April 22 Late harvest MG 4 (ha)	281		
April 29 Early harvest MG 2 (ha)			220
April 29 Early harvest MG 3 (ha)			118
April 29 Late harvest MG 4 (ha)	5	250	
May 6 Early harvest MG 4 (ha)		276	
May 13 Late harvest MG 4 (ha)			47
June 17 Early harvest MG 4 (ha)			123
Soybean Yield (kg/ha)	4188	4171	3915

[1] Harvest time refers to early (first week of two) or late (second week of two) harvest and maturity refers to standard maturity group 2, 3 or 4 soybeans

The question of the value of time suitable for performing field work can be determined in two different ways. One is to consider what the change in mean net returns would be from one additional hour of suitable field time. This therefore represents the marginal value product of suitable field time, or the value of the additional yield resulting from using this extra resource. Another way to think of value is to consider what the farmer is willing to pay for an additional hour of suitable field time. While this is the same as the change in mean net returns for a risk neutral producer, it is not the same for a risk averse farmer. Risk averse farmers won't be willing to pay the full additional average net returns earned on the extra suitable field time available. This is because there is undesirable variability on the amount of additional yield enjoyed from the additional time because of weather. Thus, the risk averse farmer discounts this value given the gamble being faced. Consequently, both the marginal value product and willingness to pay perspectives on the value of suitable field time are calculated and discussed.

The marginal value products (or change in mean net returns) for the relevant weeks are displayed in Table 4. Notably, if a given weekly machinery operation constraint has more than adequate suitable field time available, additional suitable field time does not increase yield. Likewise, the farmer is not willing to pay anything for suitable field time during those weeks where suitable field time is not constrained. When time is constrained, however, varying marginal values are realized. Planting time during week 17 for the risk neutral scenario results in a value of US$21.08 per hour. Harvest time experiences even higher marginal values with US$217.86, 266.09 and 266.09 for weeks 35, 36 and 37 respectively. These results provide numerical evidence to support what the authors and many farmers have anecdotally noted previously; there is a high value at some times for the performance of machinery operations at critical periods such as harvest. Under risk aversion, the marginal values associated with planting, albeit shifted to week 18, steadily increases and the marginal value of harvest time when constrained remains quite high but at an often slightly reduced level. Notably, these marginal value products increase for planting time but generally decrease for harvest time as risk aversion increases. This is the result of the different combinations of crop production practices used across attitudes towards risk.

While the discounts under risk aversion to the willingness to pay for additional suitable field time are less than the mean change in farm returns, harvest time remains quite valuable. At the lowest (other than zero for unconstrained weeks) level, there is a willingness of a highly risk averse farmer to pay US$101.28 for an additional hour of suitable field time. However, willingness to pay for planting time is reduced to a value of only US$8.52 for the highly risk averse farmer during week 17. Notably, these values represent a marginal willingness to pay and should not be extended excessively. For example, a farmer with low risk aversion may be willing to pay US$197.19 for one more additional suitable field hour in week 36 but not ten times that for ten additional hours.

Table 4. Marginal value and willingness to pay for suitable field working time by week and risk aversion attitude

	Risk Neutral	Low Risk Averse	High Risk Averse
Marginal Value – Week 17 (US$/hr)	21.08	0	0
Marginal Value – Week 18 (US$/hr)	0	85.11	117.73
Marginal Value – Week 35 (US$/hr)	217.86	208.77	231.89
Marginal Value – Week 36 (US$/hr)	266.09	259.88	231.89
Marginal Value – Week 37 (US$/hr)	266.09	259.88	231.89
Willingness to Pay – Week 17 (US$/hr)	21.08	0	0
Willingness to Pay – Week 18 (US$/hr)	0	32.47	8.52
Willingness to Pay – Week 35 (US$/hr)	217.86	158.14	101.28
Willingness to Pay – Week 36 (US$/hr)	266.09	197.19	101.28
Willingness to Pay – Week 37 (US$/hr)	266.09	197.19	101.28

Summary and Conclusions

The value of suitable field time is an important element in making several machinery management decisions. A whole farm planning optimization model was used to determine marginal value product (change in mean net returns) and marginal willingness to pay for suitable field time for a Kentucky corn and soybean producer. Optimal solutions results for farm net returns summary statistics and optimal crop production practices were determined. The typical risk and return tradeoff is found wherein reduced fluctuation in net returns is possible at a cost of reduced mean net returns. Earlier planting dates of both corn and soybean were most profitable but greater planting date diversity and a shift to later planting dates were used to manage risk with increasing risk aversion. A greater diversity of other crop production practices was used to reduce yield risk. Furthermore, yield risk also is lowered by relying upon more stable yielding production practices but with slightly deceasing average farm crop yields as risk aversion increased. When suitable field time is constrained it can have values as high as US$266.09 per hour during harvest for the risk neutral farmer. Given the variability of change in farm returns resulting from additional suitable field time dependent on weather, a risk averse producer is only willing to pay a discounted amount from the mean change in farm net returns. The risk averse farmer's willingness to pay for additional suitable field time nonetheless can remain substantial ranging from about US$100-US$200 per hour during constrained harvest time.

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