A Sustainability Comparison between Horse Traction and Tractor Traction on Small Farm Holdings in Ireland

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ABSTRACT

The sustainability of horse traction and tractor traction in Ireland was examined in this study. This work sought to address the lack of research relating to modern horse traction and sustainability in Ireland. A literature review relating to modern horse traction in developed countries was undertaken. Indicators of sustainable agriculture were drawn from the FAO (Food and Agricultural Organisation) (1995) and Rigby *et al.* (2001). Factors considered in this comparative study are energy efficiency, costs, crop yields, labour and soil compaction. The information was gathered via interviews with farmers who plough with horses competitively and/or utilise horse traction on farms. Results were also generated by a costing programme for agricultural machinery in Teagasc. Horse traction did, ostensibly, meet a higher number of sustainability indicators than tractor traction. Horse traction is more economical on small farms, it increases a farmer's self reliance, it reduces the vulnerability of the farmer to adverse natural and socio-economic factors etc. However, some findings were overly vague, most notably related to crop yields. Indicators of crop yields, or the ability of horse traction to feed the populace, may outweigh other indicators or considerations of sustainable agriculture. Consequently, a conclusion relating to the measure of sustainability of horse traction in comparison to tractor traction has not been definitively arrived upon. Nonetheless, some of the results have been intriguing especially relating to indicators of quality of life for those who work with horses. This research has also highlighted the potential need for further studies into the sustainability of horse traction.

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This thesis was prepared according to the regulations for postgraduate study by research of the Dublin Institute of Technology and has not been submitted in whole or in part for an award in any other Institute or University.

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Abbreviations

Commission for Sustainable Development	CSD
Fédération Européenne du Cheval de Trait pour la promotion de son Utilisation European (Draught Horse Federation)	FECTU
Food and Agricultural Organisation	FAO
The International Center for Technology Assessment	ICTA
Irish Farmer's Association	IFA
National Ploughing Association	NPA
United Nations	UN

CONTENTS

CHAPTER ONE

INTRODUCTION

The oft-quoted definition of Sustainable Development, originated in the The Brundtland Report (1987), defines Sustainable Development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' Sustainability in agriculture has been 'included as one of the thematic areas along with rural development, land, drought, desertification and Africa in the CSD's (Commission for Sustainable Development) 3rd implementation cycle (CSD-16/17) in 2008-2009.'(UN Department of Economic and Social Affairs 2009). The Commission for Sustainable Development has emphasised the need for Sustainable Agriculture given its 'disappointment....at the slow progress in moving towards sustainable agriculture and rural development in many countries' (UN Department of Economic and Social Affairs 2009).

The Food and Agricultural Organisation (1995) outline the general requirements, or indicators, of sustainable agriculture:

> Ensures that the basic nutritional requirements of present and future generations, qualitatively and quantitatively, are met while providing a number of other agricultural products.
>
> Provides durable employment, sufficient income, and decent living and working conditions for all those engaged in agricultural production.
>
> Maintains and, where possible, enhances the productive capacity of the natural resource base as a whole, and the regenerative capacity of renewable resources, without disrupting the

functioning of basic ecological cycles and natural balances, destroying the socio-cultural attributes of rural communities, or causing contamination of the environment.

Reduces the vulnerability of the agricultural sector to adverse natural and socio-economic factors and other risks, and strengthens self-reliance.

However, since there are no universal indicators of sustainable development, including sustainable agriculture, this study will also include indicators suggested by Ribgy *et al.* (2001) who focused specifically on potential sustainability indicators for farming practices. They studied a large body of research and assembled the following set of indicators:

Improved farm-level social and economic sustainability-

• enhances farmers' quality of life

• increases farmers' self-reliance

• sustains the viability/profitability of the farm

Improved wider social and economic sustainability-

• improves equity 'socially supportive'

• meets society's needs for food and fibre

Increased yields and reduced losses while-

• minimising off-farm inputs

• minimising inputs from non-renewable sources

• maximising use of (knowledge of) natural biological processes

• promoting local biodiversity/environmental quality

Both these sets of indicators will be used in an attempt to measure the sustainability of tractor traction and horse traction in this dissertation.

In many countries, including Ireland, 'current agricultural activities might endanger the continuity of agricultural production systems.'(Cornelissen *et al.*, 2001). It may follow, therefore, that alternative agricultural activities that could improve our sustainability should be examined.

Objective

The objectives of this thesis are:

Evaluate horse traction practices in Ireland in terms of sustainability

Examine whether horse traction may be more sustainable than tractor traction on small farm holdings in Ireland

Reasons:

Horse traction is an agricultural practice that may have the potential to contribute to sustainable agriculture. A critical evaluation regarding the feasibility or sustainability of the working horse for agricultural use has often been hampered by the general view that the working horse is a creature of the past. This view has possibly limited the number of scientific studies that seek to examine the benefits and/or disadvantages the working horse may contribute towards a sustainable small farm holding. The Food and Agricultural Organisation of the United Nations has acknowledged this shortcoming and has suggested modern studies on animal traction are required:

> The neglect of animal power technology in recent years may have affected the availability of essential information. In many areas there may be insufficient facts and understanding to

> allow informed judgements on animal power issues. In such circumstances, participatory appraisal surveys may be required at national or provincial level. (Food and Agricultural Organisation 2009).

Animal traction, consequently, has been consigned to the distant past or seen as a symbol of poverty-stricken countries that continue to utilise animal traction out of a lack of choice; the assumption being that the tractor or, other machines, are far more efficient and progressive:

> Rural and urban based decision-makers and educators do not consider animal power as a modern development option. They should be seen as coexisting effectively with motorised systems, so enhancing the quality of community life. While motorised power is well accepted, animal power can also be portrayed as modern and environmentally acceptable.' (Food and Agricultural Organisation 2009)

This study will examine the potential of the working horse on small farm holdings in the context of Ireland. There is a limit of academic/scientific studies on this subject, specifically in Ireland, over recent years. The absence of up-date information on horse traction may also, conversely, propagate the view that horse traction is a thing of the past not worthy of serious consideration by farmers. Nevertheless, the FAO maintain that:

> Animal power is a renewable natural resource that can assist not only in production, but also in land and water management and conservation. All countries, whatever their degree of industrialisation and urbanisation, can benefit from ecologically sustainable power

> sources…Animal power needs to be seen as a valuable and appropriate technology relevant to modern development aspirations (Food and Agricultural Organisation 2009).

Scope

This thesis will examine horse traction in agriculture as it is in Ireland at present. This will involve interviews with farmers who farm with horses as well as farmers who plough with horses competitively but farm with conventional machines. Additionally, Dermot Forristal of Teagasc, has generated up to date tractor data for the purposes of comparison with horse traction for this study. Several factors of horse traction, linked to sustainability indicators, will be looked at namely energy concerns, cost comparisons, differences, if any, in crop yields, opinions on soil compaction, labour concerns as well as the role of modern machinery and horse traction. Potential differences in local bio-diversity will not be examined in this study.

This dissertation is comprised of six chapters. Chapter one outlines the subject of the dissertation. It will also attempt to place the situation of agricultural horse traction in Ireland. Chapter Two will include a literature review of modern horse traction issues. The methodology, and the rationale behind the methodology of this study, will be examined in Chapter Three. Chapter Four will comprise results from the interviews of this study. Chapter Five will discuss and analysis the results from a sustainability point of view. Finally, Chapter Six comprises the overall conclusions of this project as well as some recommendations.

CHAPTER TWO

LITERATURE REVIEW:

General Trends

The late Charlie Pinney was a leading promoter of animal traction, over recent years, in Ireland and the United Kingdom. One of his studies specifically looked at the potential for animal traction in Ireland. However, it should be noted, from the outset of this report, that general consensus suggests animal traction is sustainable only on small farm holdings. Most proponents of animal traction share this view. On a large scale the use of working horses/animal traction is simply not feasible. Dick Courteau (2007) reports that 'Iowa State University, writing in 1943, estimated that one workhorse was needed to cultivate about 25 or 30 acres of land, and stated categorically that a farm should have more than 75 cultivated acres before replacing horses and mules with a tractor.' This opinion has endured to the present time. Charlie Pinney (2003) maintains that 'Horses are usually seen to be most efficient in relatively small scale operations. It would be absurd for example, to attempt to run a large arable farm of an agri-business type using horses in today's economic climate'. Furthermore, a Teagasc Report by P.D. Forristal (1999) has found that:

> Smaller- and medium-sized farms had much greater cost variation with many farms being over-mechanised, resulting in excessive machinery costs. The importance of selecting an appropriate mechanisation policy for individual farm situations was evident.

The cost of maintaining machinery was allocated per hectare. 'The difference in average machinery costs between large- and medium-size farms was £18/ha. Small farms (<60 ha) had substantially higher costs at £54/ha more than the medium-sized category at £230.96/ha' (Forristal 1999). The high cost of full mechanisation on small farm holdings could also encourage small farm holders to consider work horses/animal traction as a beneficial economical alternative. Dermot Forristal (2009), of Teagasc, contributed several estimates related to tractor costs for this study. These costs were generated by 'The Oak Park machinery costing programmeme [which] uses algorithms to calculate depreciation, interest, repairs and maintenance, fuel and labour costs based on the machine type, size, purchase and trade-in ages and annual use level' (Forristal 2009). These estimates will be listed in the Results Section.

Energy Efficiency

To measure the potential sustainability of horse traction in comparison to conventional mechanised power, it is prudent to examine issues relating to energy. This will generally involve comparing feed for the horses as well as fuel for machines. A direct fuel and feed cost evaluation is important, however, there may be far more variables to consider than presupposed if the sustainability of both operations is to be derived.

Torbjörn Rydberg and Jan Jansen (2002) completed an in depth analysis of energy considerations in relation to horse and tractor traction. The study also includes other factors that may require consideration to obtain an analysis that is more applicable to sustainability. 'Flows of energy, material and service from the environment and the economy were identified for the two traction-producing systems' (Rydberg and Jansén, 2002, p.13). The same study also recognises the difficulty in comparing two forms of energy as 'energy of one kind is often not equivalent in its ability to do work to energy of other kinds' (Rydberg and Jansén 2002, p.14). To put it simply, it is possible to quantify the fuel needed to power a tractor, say, for a given distance. However, it is far more difficult to extrapolate the amount of feed or energy an animal will need to pull a load as an animal is a 'living system' (Rydberg and Jansén 2002, p.14). Furthermore, although the amount of feed a horse requires per day may be estimable, the question of estimating the amount of energy required to produce the feed may need to be asked. Rydberg and Jansén (2002, p.15) suggest the evaluation of 'solar joules' as a means of ascertaining the energy required to produce the food that powers the horse or animal. This is comparable with estimating the real energy cost required to produce petrol.

The real cost of oil has often been evaluated, however, for the purposes of comparison a few of the often 'hidden' costs of oil required to fuel mechanized traction shall be listed here. The International Center for Technology Assessment (1998, p.1) conducted a review of these extra costs including:

> (1) Tax Subsidization of the Oil Industry; (2) Government Programme Subsidies; (3) Protection Costs Involved in Oil Shipment and Motor Vehicle Services; (4) Environmental, Health, and Social Costs of Gasoline Usage.

Inherent in these extra costs include examples such as the 'US Defense Department spending allocated to safeguard the World's petroleum resources total some $55 to $96.3 billion per year' (The International Center for Technology Assessment 1998, p.1). The loss of human lives relating to oil security, consequently, may also be implicated in the cost of oil. Additionally, environmental damage as a direct result of the oil industry should be considered such as oil spills during oil transport, global warming, local air pollution etc. The real cost of oil, consequently, may be impossible to deduct.

It is tempting to convey animal or horse traction as an ideal energy alternative to machines powered by fossil fuel. However this study will attempt to examine the wider factors that need to be addressed. W. Jackson and M.Bender (1982, p.70) suggest that animal traction is the solution to powering the agricultural industry:

> as the price of energy increases, the farmer will be even more pressed than he has been; if he is a small producer, he may be squeezed right off the farm before the palshed hand of bureaucracy can act. It seems prudent to meet future agricultural energy requirements by growing all farm traction energy.

This could be oversimplifying the problem of fossil fuel and exaggerating the suitability of the renewable energy embodied in the use of animal traction. The production of the feedstuff required to power the horse or animal to be used on a farm, although potentially renewable, also comes at a cost that may or may not negate the renewable nature of animal traction. In short, the production of feed to power animal traction may require an unfeasible amount of land which could

compromise the sustainability of animal traction. However, the amount of land required for horse power may seem acceptable if compared to the amount of land that would be required to produce bio-oil. Kris De Decker (2008) claims that 'Powering agriculture with tractors requires almost 2.5 times as much (bio)energy than powering agriculture with horses.'

Charlie Pinney (2003) considers the land consumption problem and acknowledges the argument that 'if horses were to be used again in large numbers on farms and elsewhere, then an unacceptably high proportion of land currently used for the production of crops directly consumable by the human population would have to be given over to the growing of food for the horse.' This factor clearly implies that the widespread use of animal traction would be impossible to sustain. Pinney (2003) estimated that in Ireland horses needed for traction would need. '433,875ha for their fodder requirements, or 11.12% of the total hectares.' Additionally, if Ireland became 'artificial-fertiliser-free' the amount of Irish land required would rise to '731,250ha (18.75%)' (Pinney 2003). However, this is an estimate that excludes 'the improved productivity of horses using modern and different types of machinery, a factor that will affect the old, accepted horse-per-hectare ratio' (Pinney 2003). Pinney (2003) does argue that grazing land for horses 'could be met from marginal or lower quality ground, thus releasing some of the better soils for other cropping purposes….horses can make good, productive use of land which may not be suitable for arable use. Horses happily graze hillsides that tractors can't climb.' Charlie Pinney, however, was a renowned proponent of horse traction and an element of bias cannot be ruled out of this reasoning.

If the amount of land required to feed horses for traction is set aside, there are other benefits relating to the cycle of energy at work in the living system of the horse.

Sandra Schmid (2000) highlights the secondary benefits of the horse which mechanisation cannot compete with. 'A 750 kg horse produces about 7.5 tonnes of manure per year, which can be either sold or, once fully composted, returned to the land as organic fertilizer. During their lifespan, horses return about one third of the food they eat' (Schmid 2000, p.2). Manure could be considered as a double return on the energy produced by foodstuff and may reduce the perceived loss of land involved in the production of the foodstuff. Rydberg and Jansén (2002, p.15) also note the disadvantages of the tractor with its harmful effect on the environment 'different types of pollutants and waste are generated when the tractor is used, and negative environmental effects are also linked to the entire chain of production from mining of metals to use and reuse of metals and degraded wastes.' By comparison, horses 'represent a practical, renewable, low-impact alternative energy source' (Schmid 2000, p.2). Rydberg and Jansén (2002, p.15) also argue that horses are not as dependent on outside industries as the horse 'gets its support for maintenance and reproduction mainly from renewable local energy in plants and water.' In addition, the farmer who works with horses may enjoy more autonomy than a farmer who works with tractors and other machines. 'The information needed for maintenance, renewing and for reproducing is all embedded in the horse. The horse has the ability to learn and develop its skills together with the farmer. The farmer is in control of the information needed for the management of the horse' (Rydberg and Jansén 2002, p.27). Nevertheless, the time cost involved in training a horse may be considerable and will be examined in the section on labour on page 88. In contrast, the use of

tractors and/or other machines may potentially create dependencies on external factors that the farmer may have no control over. 'Most driving forces for the tractor are generated in the industrial technological part of society. The driving forces for the industry, infrastructure and knowledge necessary for the production and maintenance of the tractor are of a non-renewable character. Most of the information is outside the farm and the local environment' (Rydberg and Jansén 2002, p.27).

The energy efficiency of both mechanized traction and animal traction have been examined by W. Jackson and M. Bender (1982, p.73) whose 'conclusion is that even if a farm is powered by ten draft animals, it is still more energy efficient than a tractor powered farm: 8.92 acres (draft animals) vs 9.69 acres (tractor) if all manure and spent mash credits have been added and different kinds of feed have been converted into acres of corn equivalent.' This conclusion originates from their comparison of adjoining farms in Iowa. However, this estimation is based on animal traction power combined with an 'ethanol powered engine' as 'providing the power for threshing or for running most of the moving parts about the wheels of a corn picker would be unnecessarily difficult for the draft animal' (Jackson and Bender 1982, p.72). The introduction of modern technologies to support animal traction, subsequently, may have a role to play if animal traction is to be sustainable.

Estimating the energy efficiency of animal traction may prove difficult, if not impossible to do while so many other variables influence the efficiency or inefficiency of an animal at work. These include the breed of horse, the age of the horse, the fitness level of the horse, the level of training of the horse as well as the type of food the horse has consumed. 'Hard-working horses usually require large amounts of grain to meet increased energy needs.' (Lori Warren 2002, p.3). The horse is a living animal they 'cannot be rushed and simply will not respond to

violence or inconsistent treatment.' (Morris and Newcombe 2008). This consideration is important; a tractor will operate regardless of the temperament of the driver while the horse's willingness, or efficiency, will be susceptible to the temperament of the driver or even to the mood its driver happens to be in on a given day. This factor may also be viewed as a potential benefit since working with horses has been used as a form of therapy which will be looked at in the section on labour. Moreover, horses 'get tired, though, while tractors don't. Horses need regular feed breaks and rest periods but a tractor can be driven continuously with the briefest of refuelling stops' (Pinney 2003). However, there are benefits to working with an animal in terms of efficiency:

> The horse is intelligent and able to learn routines where it is capable of remote control by the use of the voice. This is extremely useful, especially in stop-start work at which the horse excels. Tractors don't start, turn or stop no matter how loudly you yell at them. The horse is infinitely more manoeuvrable than any tractor so, for example, headlands and turning areas can be very small, leading to a greater number of crop plants per acre. (Charlie Pinney 2003)

The working life of both the tractor and the horse will also have an effect on their efficiency. The cost of the tractor and the horse will be compared in a separate section, nevertheless, in terms of energy efficiency, the working life of tractors and horses does need to be examined. The environmental impact and energy involved in the production of a new tractor will have an effect on the energy efficiency of the tractor overall, however, estimating this energy cost is unfeasible for this study. The working life of a tractor can be evaluated. Jackson and Bender (1982, p.12) estimate that the tractor, on average 'can last fifteen years.' This estimate, nevertheless, could

be optimistic given that a more recent Teagasc Report suggests that a tractor is, on average, 'replaced at 5 years.' (Forristal 1999). The horse, on the other hand, 'usually starts productive work at around three years old and continues until its mid 20s, after which its carcass is recyclable as meat and leather.' (Pinney 2003). A major advantage of using horses or animals for animal traction is their ability to reproduce themselves. 'The energy cost for producing a 1,500 – pound draft animal replacement can be determined by calculating the extra feed a mare requires from the time of breeding until the foal is born and the feed costs of the foal from birth until age two' (Jackson and Bender 1982, p.13). Machines, or tractors, require costly replacement in comparison to the '3.53 acres of feed annually' to 'produce a two year old foal every 1.5 years' (Jackson and Bender 1982, p.14).

So far, much of the debate regarding the energy efficiency of horse traction has been mostly theoretical and, consequently, may be easily disputed. However, from 1991 to 2001 'The Land Institute conducted energy accounting of its 85-ha organic farm powered by commercial biodiesel, draft horses, and a photovoltaic array' (Bender 2002). The success of this type of farm may support the argument for animal traction. In terms of energy 'about 90% of the embodied energy in annual inputs not counting capital or labor was in the form of on-farm production of inputs' (Bender 2002).

Rydberg and Jansen (2002, p.14) may have completed the most scientific study of energy comparisons between horse and tractor traction. Their conclusions are compelling. 'The main difference between the systems was found in their energy signature. Sixty percent of the horse inputs were renewable, compared with only 9% renewable inputs for the tractor.' Human labour accounts for the 9% of renewable energy involved in tractor traction. The study compared traction energy between a

farm powered by horse traction in 1927 and a farm powered by tractor traction in 1996. 'The 1996 tractor farmer used two thirds more traction energy/ha than the horse traction farmer according to our calculations' (Rydberg and Jansén 2002, p.24).

This section has dealt with the current debates surrounding energy efficiency and animal traction. Energy efficiency, however, is only one of the many considerations that need to be examined in ascertaining which form of traction may be more or less sustainable. Horse traction, consequently, is a more renewable form of energy, however, other factors may still take precedence over energy considerations such as cost and labour consumption as well as crop yields and soil compaction.

Cost Comparisons

Evaluating the cost differences, if any, between tractor traction and animal traction is crucial. A huge body of evidence supporting the environmental sustainability of one form of traction, or another, will account for nothing if the cost of that form of traction is proven to be prohibitively expensive.

Chet Kendell (2005) conducted a study focusing on the cost or economics of farming with work horses. However, this study was based in Utah 'on a diversified farm of approximately 25 to 30 acres.' (Kendell 2005). Neverthless, Kendell's method of calculating cost may be applicable to an Irish study. Kendell (2005) considered such variables as:

Farm labor rate, Consumption rate of fuel, Price of diesel fuel, Farm Size, Investment- initial for horses, Investment -initial for tractor, Additional labor-horses, Tractor or team hours per acre per year, Manure value, Years in farm career (age 25 to 65), Operational cost for tractor, tires, oil, filters, etc., Replacement cost for tractor, Operational cost for 2 horses, feed, vet, etc. Replacement cost for horses, Sales of horse progeny, (4/5x2x1,000) Value at end of useful life- horses, Useable life of horses and tractor (5,000 hours), Trade in value on tractor.

Kendell (2005) also formulated an equation to estimate the cost of both the tractor and work horses. The formula is as follows:

The career cost of using a tractor = initial cost + replacements + operating cost - trade in value = I+(Px(N/U-1))+Nx(O+(DxCxLxF))-(N/UxV)

The career cost of using horses = initial cost + replacements + operating cost and extra labor - value of manure and progeny - value for the horses and PTO cart at the end of their useful life.= H+(Rx(N/U-1))+Nx(Q+(AxJxLxF))-Nx(S+M)-(N/U xT)-K.

In the Utah study, the economic comparison concluded in favour of the farm powered by animal traction. This Utah study did make a few assumptions such as including the assumption that the tractor would be brand new and that both horses in the study would produce foals '4 out of 5 years.' (Kendell 2005). This reasoning, however, assumes that the horses do not suffer illnesses or fail to reproduce; nevertheless, the same criticism could be made with regards to the tractor as possible breakdowns or rising fuel costs are not incorporated. Additionally, Kendell's arrival at his conclusion is based on comparative costs over a forty year period:

> A tractor powered sustainable farm over a 40-year career would have total costs of $90,000 and total revenues (trade-in on old tractors every 10 years) of $20,000, for a net cost of $70,000 associated with using the tractor.
>
> A horse powered farm over a 40-year career would have total costs of $61,200 and total revenues of $82,300, for a net revenue of a $21,100 associated with using horses.

The extra revenue of $21,100 does put the working horses ahead of the tractor in terms of cost. Nonetheless, over forty years this figure amounts to $527.50 per year and may not be significant enough to encourage horse traction for economic reasons. It should be noted that Kendell (2005) did include the extra labour cost required to work with horses. Labour costs may be an important factor for those considering the sustainability of animal traction. The cost and amount of labour involved in horse maintenance will be looked at again in the Discussion Section, on page 91.

M.H. Bender (2000) completed a study of cost comparisons between tractor traction and horse traction. Bender (2000) compared production between conventional farmers and Amish farmers who use animal traction in Ohio. The findings of this study are surprising, however, it should be noted that Bender (2000, p.4) has made allowances for certain differences between conventional farmers and Amish farmers such as the fact that Amish farmers do not 'charge for helping each other on farms.' Consequently, the economic results may be treated as realistic. The scarcity of horse traction research in the developed world has made it necessary, again, to include overseas research that may seem inapplicable to an Irish scenario, however, the principles of the economics should be the same.

Given that Amish farmers do not to pay for labour 'Farm production expenses were disaggregated into two categories, labor and other expenses, to permit separate analysis of labor costs' (Bender 2000, p.5). Furthermore, the Amish farms fed their own animals, including the work horses, from their own crops, consequently, 'an indirect measure for the proportion of on-farm crop production fed directly to animals was calculated as the marketed value of animal products minus expenses for purchased feed and animals, the net difference then divided by the marketed crop value for the county' (Bender 2000, p.6). The study found that the Amish farms using animal traction inevitably had the 'smallest ratios of machinery depreciation to gross farm income' (Bender 2000, p.11). These indications may suggest that animal traction is ahead of conventional traction in economic terms, however, the issue of the human labour involved in animal traction could be an overwhelming obstacle to the economic sustainability of animal traction. This disadvantage has been reviewed. 'Compared to conventional dairy farms in this study, the Amish farms required 2.4 times as many labor hours per ha of farmland, or 2.4 times the labor charge, assuming the same hourly labor rates for Amish and conventional farms' (Bender 2000, p.12).

Bender (2000) has suggested that animal traction requires over double the amount of labour per hectare. This reasoning is based on comparisons between modern conventional farming and farming around 1920. Bender (2000, p.12) claims that, at present, the requirement for 'row crops is approximately 10 hr ha-1' while in 1920, using animal traction the same work required human labour for '25hr ha-1.' Farmers, understandably, could be discouraged by the prospect of more than doubling the amount of their time needed to grow crops they could otherwise grow

with less effort, on their part, by using tractors etc. The labour factor involved in animal traction will be covered again on page 88.

Chet Kendell (2005) and M.H. Bender (2000) have found the cost of animal traction favourable over conventional traction. It should be emphasised again, however, that both these studies focus only on small farms which supports the rule that animal traction is only suitable for small farms. Kendell (2005) also asserts that animal traction is only sustainable or economical up to 'a farm size of 174 acres. Meaning that at 174 acres the farmer would switch from horses to a tractor as the source of traction.' Bender (2000, p.1) also only focused on farms with a 'small mean farm size of 50 and 62 ha.' This falls under the Teagasc category of a small farm in Ireland (Forristal, 1999). In addition, the cost of conventional farming may, inevitably, rise in the future due to the non-renewable energy required to power conventional farms. Arthur Bolduc (2009) suggests that for 'tractor farmers dependent upon petroleum for gasoline, fertilizer, chemicals... it would become increasingly expensive for them to continue farming.' Bolduc (2009) hypothesises that for farms farmed by work horses and conventional farms 'the playing field (is) being levelled.' With regards to costing, Gene Logsdon (2009) reasons that 'With peak oil upon us, think of it this way. You may be able to grow enough extra grain or biomass to make ethanol for a tractor, but it will always be cheaper to grow the extra hay to feed a horse. You don't have to distill the hay.'

On a more curious note, Logsdon (2009) highlights the potential economic resilience of farmers using working horses. Logsdon (2009) cites the example of an American bank that has endured the economic crisis and in 2008-2009 is 'having its best year ever.' The bank is also 'one of the few, that has drive-by window service designed to accommodate horses and buggies. Some 95% of the bank's customers

are Amish farmers.' (Logsdon 2009). The explanation for the banks success, according to the bank owner, is that the customers obviously 'don't have auto loans to pay off and do. They might not need bank loans at all except to buy farmland' (Logsdon 2009). Logsdon (2009) reasons that the farmers 'are buying farm land that can cost them ten thousand dollars per acre or sometimes more, and paying for it with horse farming.' This could be interpreted as evidence of the viability of working horses but there may be too many other variables to simply presume that the bank or farmers' profitability can be directly attributed to horses. Additionally, using an Amish model as a comparison could be unreliable as:

> There are many differences, social, climatic, soil type, cropping possibilities, field size and so on between this agrarian, mid-western, highly organised religious society and the current norms applying in Europe, which make the blanket imposition of an Amish blueprint for a horse-drawn future inappropriate. (Charlie Pinney 2003)

This point has also been highlighted by one of the interviewees in this study and is reported in the Results Section on page 79. However, the trends in the Logsdon (2009) article could support the potential feasibility of working horses on farms which could make it 'very difficult to see how economists or agribusiness experts can claim that farms using horses or mules for motive power are any more backward, or any less profitable, than farms using tractors' (Logsdon 2009). Forristal (1999) estimates that one tractor on a 40 hectare farm (98 acres) will cost IR£172.46 (€218.98) per hectare or €88.65 per acre. This working will be compared to horse traction cost results in this study

Tony McQuail (1993) who uses horses in Ontario, has reported details of the profit he has enjoyed from working with horses in comparison to working with a tractor:

> We bought our team in 1976 and the net cash flow from our horses was a positive $10,000. We bought a used tractor in 1981 and traded it on a new tractor in 1985. The tractors had generated a negative net cash flow of $25,000 for purchase, fuel and repairs.

Charlie Pinney (2003) does make a very valid point that, regardless of those who question whether work horses are 'economically viable units,' farmers who use working horses must do well, economically, as 'they would not remain in business long if they didn't.' He also suggests that 'that vegetables grown on a horse-drawn farm are in great demand.'

In conclusion, it may be marginally cheaper to utilise work horses over machines on farms. This dissertation will attempt to estimate cost differences applicable to Ireland. However, from previous studies, it may be supposed that economically, the horse is not as costly to use as machines but this does not take into account the profitability of farms whose profits may be able to carry the expenses of machines and do not need to economise by using horses.

Crop Yields

The lack of research in the area of horse traction in Ireland, or Western Europe as a whole, has been cited as reasons for undertaking this project. Although this reason may justify the need for this research, and further research, it also presents a problem in the lack of previous studies from which presumptions or hypothesis might be drawn. Again, much of the literature on crop yields in relation to horse traction has been sourced from overseas. It should be stated, however, that Africa has produced a large body of journals and texts related to horse traction and specifically, crop yields,

nevertheless, the application of these findings to an Irish scenario does not seem appropriate given the differences in our agriculture, climate and societies. A few findings from research in Africa may be compelling and some will be cited in this section.

M.H. Bender (2002, p.18) does suggest that 'small farms almost always produce far more agricultural output per ha than large farms, denoted by agricultural economists as the inverse farm size productivity relationship.' As mentioned earlier, working horses are generally believed to be suitable only on small farms and, consequently, may be linked in general, to high productivity due to the size of the farm in which they are utilised. However, this does not demonstrate that farms using working horses are more productive due to the use of horses and this factor should not be forgotten in the following comparative research. Also, the question of crop quality may be worthy of consideration. Julian Rose (2007, p.1) presented the results of British researchers which show that the nutritional value of food has been declining since WW II, the era of the introduction of intensive agriculture industry to the countryside.' This research could suggest that the switch from animal power to mechanised power on farms has had a negative impact on crops, but again, this is over-simplifying the matter as factors such as fertilisers, pesticides, preservatives etc. would have to be ruled out before this decline could be attributed directly to mechanisation. This problem, in relation to crop yields, will recur as detailed research, specifically, on crop yields and animal traction does not seem to have been conducted on a large scale in developed countries. Jackson and Bender (1982) do suggest that animal traction has been linked to reduced yields on Amish farms where 'Illinois Amish farm yields from 70-130 bushels of corn per acre while the neighboring English farms yield 150-170…but different amounts and kinds of

fertilizer were applied. Amish farm fertility counted on legume-fixed nitrogen and manure, whereas the English rely on a huge petroleum expenditure.' Consequently, this finding cannot be blamed solely on animal traction.

Given that studies relating to crop yield levels and animal traction are scarce, it may be acceptable to examine whether mechanisation alone (excluding the use of artificial pesticides and fertilisers) has been proven to increase crop production. David Pimentel (2009) claims that 'Mechanization decreases labor significantly, but does not contribute to increased crop yields.' There is a wide range of research on increased crop yields since mechanisation. 'The contribution of agricultural mechanization has been well recognized in enhancing the production together with irrigation, biological and chemical inputs of high yielding seed varieties, fertilizers, pesticides and mechanical energy.' (S.R. Verma 2008, p.1). Nonetheless, there does seem to be a far more limited amount of research based purely on the effect of mechanisation on crop yields. This could be of particular relevance to organic farmers who may, more than any other niche farmer, consider switching to farming with horses. Similarly, research on the effect of mechanised farming related to crop yields could also be used to gauge any increase or decrease in crop yields when working horses are used. Jim Sparks (1988), a farmer who uses work horses, reports that 'crop yields are better because horses don't pack the ground as much.' This claim, however, is based purely on the personal experience of this farmer. Anthony Panin (1995) conducted a survey in Botswana and found that 'survey evidence refutes any economic justification for the current use of tractors in the area by the smallholding farmers. In fact, the results show that the use of tractors has a significant negative impact on crop production.' However compelling these findings

are, they still do not provide sufficient evidence to support or detract from claims that animal traction produces higher crop yields.

Scientific evidence regarding horse traction and crop yields may be discovered at a project in Hof Hollergraben, Germany. The 'Humussphäre' (Klaus Strüber 2004) project is focusing specifically on potential methods that may increase soil fertility. Ploughing with horses was included in the study. Preliminary results have found that horse traction has had several beneficial effects on the soil in the first year and it is expected that continuous ploughing with horses would continue to improve soil fertility. 'Die günstigen Auswirkungen des Pferdes auf den Boden waren im Probejahr zu sehen, noch deutlicher würden sie nach Jahren und ausschließlicher Pferdearbeit werden' (Strüber 2004). The project also entails comparisons between horse traction and tractor traction. A field was divided in half, with one side worked with horses and the other side worked with tractors. The soil was later tested for soil density, harvest results (in this case the size of beet root and the number of leaves) and soil chemistry. Harvest yields on the side of the field that was ploughed with horses showed a 15% increase in the size of the beet root as well as the number of leaves. 'Ertrag: bei Pferdeseite um bis zu 15% höher in Frucht und auch Blattmasse Rote Bete' (Strüber 2005). The results are compelling and suggest that horse traction may have a positive effect on crop yields. Nevertheless, it is not categorical evidence that horse traction will increase crop yields.

Consequently, this study may highlight the limited amount of research in the area of animal traction, research that is necessary to provide conclusive evidence of the benefits or disadvantages of animal traction

Labour

Fortunately, there is a larger amount of research relating to animal traction and the labour necessary for its utilisation as this factor is a predominant issue in both academic and informal discourse regarding comparisons between animal and mechanised traction. Charlie Pinney (2003) has listed the demands of labour related to working with horses on farms:

> It is physically demanding, and has to be highly skilled if it is to be effective. It is also labour intensive. A proposition that the agricultural industry, already in crisis prompted by other factors, should give up its cost-saving machines, sprays and fertilisers will be greeted with groans of despair and snorts of cynical disbelief.

Pinney (2003) further suggests that the issue of labour will often deter any farmer from switching to animal traction 'if one suggests to a farmer that he should, let alone could, pay a normal farm wage to a ploughman whose efforts yield one acre of ground ploughed per day with his team, the answer will usually be negative, if at all printable.' Bill Ganzel (2009) compared the time involved in ploughing 40 acres of land, four horses took '55 hours to plough 40 acres – with 1,320 passes up and down the field,' while a '1997 John Deere 8100 Tractor with 125 hp took 66.25 minutes for 40 acres with 53 passes up and down the field.' This is clearly a huge difference in the time and labour necessary for the same work. David Pimental (2009) also shares similar findings when he estimated the labour difference needed if farmers switched to working with horses 'farm labor required per hectare would probably increase from 11 hours to between 30 and 40 hours per hectare using draft animal

power.' A societal shift would be necessary if farmers switched back to animal traction on a wide scale. Dick Courteau (2007) suggests that 'The agricultural labor force would have to be greatly increased and farm size drastically reduced, or some system worked out for putting more people back on the land.' This may not necessarily be a bad thing, as Pinney (2003) states that work horses would 'create employment, not replace it. They are a source of companionship in the workplace, a source of pride and pleasure when seen to be working to perfection in harmony with man and his surroundings.' This leads into the next point regarding work horses – the difference in the labour itself or the potential time quality that may be derived from working with horses. Quantifying the hours necessary to work with horses is important for research, however, it may also make the issue too black and white when there are other qualitative factors that should be taken into account. Qualitative data will also be integrated into the findings of this study in a separate section on page 88.

Erika Friedmann (1997) states that 'The healing power of companion animals is increasingly accepted as one of many forms of complementary therapies used to improve quality and even the quantity, of life.' Morris and Newcombe (2008) also refer to idea that the 'therapeutic effect of working in partnership with horses is becoming well known.' A machine cannot compete with this effect of the horse. Don De Beyer (2001) reasons that horses 'offer companionship. No one develops the rapport with a rototiller or a tractor that a teamster inevitably has with a team.' Other researchers have referred to the fact of measuring the differences in the work between mechanised traction and horse traction. Kris De Decker (2008) does highlight the problem of comparing the two forms:

> They (horses) are more work. This may depend on how you measure work. Do you count the work required to pay for the tractor and to buy the fuel and pay for the repairs or just the time spent on the tractor seat vs the time spent harnessing, feeding, cleaning out and working the horses?

A debate, consequently, seems to be unfolding in the sphere of horse traction and tractor traction, namely; should emotional bonds be included in comparisons between both these methods of farming and, if so, –how could an emotional bond or a farmer's enjoyment of his work be measured? If a farmer could enjoy the labour itself, which seems more likely, while working with horses, could this be a factor to consider when comparing the amount of labour required for animal traction? Integrating these factors in comparisons between animal traction and mechanised traction could lend itself open to accusations of romanticising animal traction. Dick Courteau (2007) states that he has:

> Tried to avoid romanticizing, but working with our fellow creatures is romantic—if you're content to farm a small acreage, if you don't mind being tied down, if you have the necessary self-discipline and family cohesion, and, especially, if you like the smell of horse sweat, the jingle of trace chains, and the cosy munching sounds when you've pulled the harness off your tired team and thrown them their sun-drenched hay.

This study will include findings relating to the quality of life involved in horse traction that may not be found in mechanised traction. In fact, this researcher has found that it is almost impossible not to include such findings as throughout this research, the issue of quality of life has arisen while meeting those farmers who utilise animal traction – and some will continue to utilise animal traction almost regardless of the quantitative data due to the fact of their choosing animal traction

because they value working with the animals themselves, this will be examined further on page 91. Bill Ganzel (2009) claims that 'mechanized farmers are much more efficient. Any given task – like plowing a field or harvesting an acre – is much easier. But most farmers would probably tell you they worry more and many still are susceptible to the romance of farming with horses.'

Soil Compaction

Once again, research in the area of modern horse traction and soil compaction is limited, especially research where findings could be appropriate to Ireland. Fall and Faye (1999) conducted research into soil management, however, this research was based in Zimbabwe. Their findings, nonetheless, might serve to highlight the difference between horse traction and tractor traction on soil compaction levels:

Animal traction 65 J/dm^3 of soil

Small to medium tractors 104 J/dm^3 of soil

Heavy machinery 350 J/dm^3 of soil.

There is, however, a significant amount of data regarding soil compaction in relation to horse logging. This data could be significant as it could be applied to farming with horses - the concept is similar; that is, comparing machinery use and horse use. P.W. Adams (1998, p.4) states that, in forest management 'to prevent soil compaction one has to prohibit machinery operations on certain soil types or wet soils that seem particularly susceptible to compaction.'

The solution to soil compaction and environmental damage in some forests has been the introduction of horse logging. 'Although horses' hooves produce

substantial ground pressure, the ground area affected by horse travel is normally small and dispersed enough to be of little concern' (Adams 1998, p.5). Guy Dunkle (2008) also argues for horse logging maintaining that:

> There are significant environmental advantages to horse logging. The first is the absence of chemicals, which means no spills and fewer emissions. Another benefit is reduced soil compaction. Compacted soils take longer to grow plants, hold less water, and are more prone to erosion.

It could then follow, that horse traction on farms could see an improvement in soil conditions as has been experienced by the logging industry. On a separate note, 'one researcher noted that a horse can be maintained for a year for less than the cost of one mechanical skidder tire' (Bolgiano 2009).

Cuba may serve as a case study for animal traction since the country was forced to revert to animal traction 'after the collapse of trade relations with the Soviet Union in 1989, (Cuba) could no longer obtain new machinery or parts or fuel for its by-then highly mechanized agriculture.' (Courteau 2007). Again, however, the differences between Ireland and Cuba must curtail any detailed application of Cuban findings to an Irish scenario. There are, nonetheless, a few principles experienced by Cuba that may allow us to draw hypothesis on animal traction. Fundamentally, 'by the end of the 1990s, a revamped Cuban agriculture was successfully powered mostly by oxen, and the acute food shortage was a thing of the past' (Courteau 2007). This achievement might convince sceptics that animal traction is still a viable power in today's world. In relation to soil compaction in Cuba, 'soil scientists approved (of animal traction), mainly because compaction had become a severe problem on Cuban soils through the excessive use of tractors and other heavy

equipment' (Courteau 2007). Animal traction, consequently, had a direct effect on soil improvements in Cuba.

This study will make reference to soil compaction and animal traction in Ireland, however, it will not include measurements or soil compaction tests as this type of analysis is beyond the scope of this project. Nevertheless, research on soil compaction and animal traction in Ireland would be an area worthy of further study in the future.

Conclusions:

This literature review should have provided a general indication of research related to animal or horse traction in the developed world. The subject may have been neglected in recent times; however, a revival of working horses seems to be emerging. Ryszard Kolstrung (2007) made reference to a 'Heavy Horse Renaissance in Europe' evident in the creation of 'new farms, orchards and gardens which restrict use only to horsepower and introduce themselves as ecological and healthy food producers.... Companies which produce modern horse gear are developing... There are some protected areas like the national parks where heavy machinery is prohibited and horses are in use.' Ireland, consequently, may also be on the brink of this revival. Further research, specific to this island, may be of value and pre-empt the return of the working horse to small farm holdings. This study will strive to contribute to modern European research on animal or horse traction, however, it will be more specific to Ireland's situation with regards to animal traction.

CHAPTER THREE

METHODOLOGY

Overview

Denis Walsh (2006) advises 'that tension exists regarding the extent to which a researcher should search out and establish the state of knowledge about the topic being explored before undertaking the primary data collection and analysis.' The reason behind this theory was suggested by Glaser and Strauss (1967) who believe examining previous research 'will pre-empt and unduly influence emerging theory, and therefore stifle original insights into the area.' Nevertheless, Walsh (2006) maintains that 'because researchers approach an area of enquiry with existing pre-suppositions based on their personal history and interest in the topic, such detachment is at best unrealistic and at worst dishonest.' The personal history of this researcher includes both a practical and a theoretical knowledge of horses which may both benefit the study as well as potentially leave the study open to criticism as a certain level of bias cannot be ruled out. The benefits of this researcher's background have proven to be an advantage while gathering qualitative data. Regarding the question of bias, 'all research is inherently political and thus contains a degree of bias. To suggest that something *can* be biased is to by default suggest that there is an

unbiased 'truth' that we could access. This is simply not true' (Alex Broom, 2005). Nevertheless, this study has tried to remain as objective as possible.

Qualitative Research

The decision to use qualitative research was arrived at based on a number of factors including the type of data required, the limited number of potential informed respondents as well as the idea that quantitative research may not have been suitable for this kind of study. The limited number of potential respondents to this study is a reflection of the situation of horse traction in Ireland which, may also be argued as a reason this study was deemed necessary. M. Sandelowski and J. Barroso (2002) refer to the 'apologetic stance some authors of qualitative studies take when describing small sample size as a limitation to the applicability of their findings' and defend small sample sizes as 'qualitative enquiry seeks to explore the "how" and "why" of human interactions, and is therefore communicating meanings and interpretations in the main.' Qualitative research was chosen, not merely due to the limitations of a potential sample survey but because 'Qualitative research is about subjectivity and complexity; it seeks not to count or reduce, but to represent rich, subjective experience in such a way as to reflect on consistencies and parallels, but to also retain the nuanced nature of the data.' (Broom 2005) The choice of a farmer to use, or not use, horses on his or her farm cannot be arrived at by a simple survey, this research hopes to reveal the complexities of how or why a farmer chose a particular form of traction.

Similar studies in animal traction were examined to gauge how best to proceed with a study based in Ireland. Paul Starkey (2000, p.91), a leading researcher on animal traction in Africa, states that:

> Structured, quantitative surveys are unlikely to identify all the factors that are crucial in determining the success (or failure) of animal traction in any one village, region or country. Animal traction involves a very large number of variables. If quantitative surveys relating to animal traction attempt to be comprehensive, they have to record a vast amount of information.

The data for this study was collected via semi structured interviews. Martyn Denscombe (2007, p.174) advises that interviews are 'better exploited when they are applied to the exploration of more complex and subtle phenomena.' Consequently, the use of interviews as a method of data collection is justified by the wide range of variables associated with animal traction.

Identifying Respondents

A difficulty encountered during the earlier stages of this dissertation, which may have compromised the viability of the study itself, was sourcing potential respondents and obtaining their consent to participate in an interview. Potential respondents, or informants, were chosen by 'non-probability sampling' (Denscombe 2007, p.189). This method was chosen because the issues relating to horse traction may not be widely known and thus, respondents were selected 'deliberately because they have some special contribution to make' (Denscombe 2007, p.189). Respondents, therefore, would, ideally, know what was involved with horse traction making their views valuable to this work.

In practical terms, finding the right people to participate in the study involved further deliberate research and networking. An article in *Organic Matters* on horse traction by Siobhán Morris and Martino Newcombe (2008) identified a few potential respondents in Ireland. Contact details of one of the respondents were obtained by contacting the magazine. Additionally, the Fédération Européenne du Cheval de Trait pour la promotion de son Utilisation (FECTU) or the European Draught Horse Federation were contacted. Amongst this information was an article by Sandra Schmid who consented to be interviewed. The Irish Farmer's Association (IFA) were contacted and were very helpful however they could not, ultimately, locate farmers who worked with horses. From the beginning it was clear that farmers who worked with horses were scarce in Ireland and, consequently, it was recognised that horse ploughing competitions would, inherently, involve participants who would be good candidates for this research. Following this reasoning, an application was made to the National Ploughing Association (NPA) for permission to conduct research amongst horse ploughing competitors at the 2009 National Ploughing Championships in Athy, Co. Kildare. The National Ploughing Championships played a crucial role in the generation of data for this study as most of the respondents for this study were sourced at the championships.

The Theory behind Interviews

Denscombe (2007, p.172) refers to how deceptively simple research interviews may appear to be as researchers may presume that they already possess the necessary skills to conduct an interview which they could deem to be conducting a 'conversation.' However, Michael Myers and Michael Newman (2007) advise that

the ‘qualitative interview is not as straightforward as it appears at first sight. The qualitative interview is an excellent means of gathering data, but it is fraught with difficulties. These difficulties, problems and pitfalls are often ignored.’ The factors that could, potentially, invalidate findings from an interview arise because:

> the interview is a very artificial situation – it usually involves a researcher talking to someone who is a complete stranger. The researcher is essentially asking the interviewee to answer (or to create an answer), often under time pressure. The researcher is also intrusive – the interviewer intrudes upon the social setting and potentially interferes with people’s behaviour. (Michael Myers and Michael Newman 2007)

Myers and Newman (2007) listed a number of recommendations that could be followed to alleviate the research difficulties inherent in interviews. These codes were adhered to as closely as possible, as such; some of the codes, mainly of conduct will be outlined here. One of the rules Myers and Newman (2007) suggest is to ‘Minimise social dissonance.’ This involves trying to minimise any factor that could lead the interviewee to feel ‘uncomfortable.’ In practical terms ‘this usually involves trying to manage first impressions, dressing appropriately, and using the appropriate language/jargon.’(Myers and Newman 2007). This rule was adhered by dressing appropriately in casual clothes with suitable footwear. In this study, wearing a formal suit and polished shoes could have had the effect, not normally associated with formal attire, of appearing ridiculous given the location of the interviews.

A second rule that was observed was ‘represent various voices’ (Myers and Newman 2007). To simplify, this involves interviewing ‘a variety of people...to try avoid elite bias.’ (Myers and Newman 2007). This problem may have occurred at the National Ploughing Championships. Amongst the horse ploughers themselves, it was

discovered that some of the horse ploughers were rated higher than others by spectators, for example, in terms of their skills in the competition. This researcher interviewed the usual winners of competitions as well as competitors or onlookers that were not in the main spotlight of the crowds. Myers and Newman (2007) also suggest that researchers or interviewers should 'Use Mirroring in questions and answers.' This rule proved hard to consciously observe in this study but it was attempted to word questions in a way that would not deter the interviewees. For example, one of the original interview questions included, 'What category is your farm?' However, the researcher found that this question had to be repeated before the respondent understood what response was appropriate. The first few interviewees replied by stating that their farm was either 'tillage, livestock or mixed.' The researcher, subsequently, changed this question to 'is your farm tillage, livestock and/ or mixed?' This question was understood quicker as it seemed to be the language generally used by the farmers.

'Flexibility' (Myers and Newman 2007) is another rule that this researcher endeavoured to practice. 'The interviewer should be prepared to explore interesting lines of research, and look for surprises' (Myers and Newman 2007). The use of semi structured interviews did facilitate flexibility. Several of the respondents recounted several factors that this researcher may not have included or considered important in this research, however, the unexpected responses have convinced this researcher to consider the factors that may not have arisen in a more quantitative style of research. An example includes the attachment many of the farmers have towards their horses and which may prove to be worthy of inclusion in measuring the sustainability of horse traction since the same attachments could improve the

quality of life for a farmer (as referred to in the Labour Section of the Literature Review).

'Confidentiality of disclosure' (Myers and Newman 2007) is suggested as another guideline for research interviewers to adhere to. Each respondent was assured of the confidentiality of their responses and that their responses would only be used for research purposes. This code is also collaborated by Alex Broom (2005) who suggests that interviews should begin by 'introducing yourself, providing a written summary of the project (and giving them time to read it), and making sure they fully understand the project that they are participating in. The last thing you should do is rush through this stage as this is probably the most crucial point for beginning to develop rapport with the interviewee.' Each respondent was provided with a full outline of the study as well as background information and identification. The presence of a horse at all the interviews was also an icebreaker; any initial awkwardness was easily overcome by referring to the horses .

Alex Broom (2005) advises that interviewers should be aware of what motivations the interviewee may have for participating in the research. He states that 'A good qualitative researcher will be able to work with different motivations, adapting to the needs to the participant, and maximising the quality of the data that the interview produces.' (Broom, 2005). This researcher did try to surmise the motivations of each interviewee. This was important as some of the interviewees did have different motivations. Some interviewees had been 'pushed into participating by somebody else' (Broom 2005) which occurred when some officials at the National Ploughing Championships asked the respondents to participate. However, the consent of each interviewee was obtained and it was ensured that each participant was comfortable and willing to respond. The researcher did come across

interviewees 'who purely want company' (Broom 2005) but their input was just as valuable as they had the specialised knowledge of horse traction. In addition Broom (2005) also advises that researchers will 'get some participants who passionately want to tell their story.' This was the case for some of the interviewees, especially those who utilise working horses and wanted their experience known. Broom (2005) also advised that 'at some point in a qualitative study a participant will get emotional.' This researcher did assume that this would not be the case in this study, however, this assumption was wrong. One of the participants did become emotional while discussing a horse they had had for thirty years. This emotional response was evidence of the real attachment farmers can have to their working horse.

These considerations are just some of the factors that this researcher tried to abide by. The interview questions themselves were also designed with the theory behind qualitative research in mind.

The Interview Schedule

Since the interviews would be semi-structured, this researcher again consulted research theory articles prior to developing the types of questions that would be both appropriate and which would be more likely to generate relevant data. Broom (2005) advises that the researcher should 'create a list of questions that will facilitate an exploration into each theme you have developed, focusing on creating questions that are as open as possible, rather than closed questions that restrict the interviewee to one or a number of possible answers.' To this end, 'Descriptive/linear questions, Narrative questions, Contrast questions, Evaluative questions,' (Michael Larkin 2004) were included. Similarly, 'Over-empathic, Manipulative, Leading'

(Larkin 2004) questions were avoided. There were two groups of interview questions, one for farmers who do not farm with horses but plough with horses competitively and one for farmers who actively farm with horses. Figure 1 is a sample of the interview questions for the first group and Figure 2 is a sample of the interview questions for the second group.

1.	How long have you been ploughing with horses?
2.	What size is your farm? Small (<60 ha)<91 acres Medium (60 - 160 ha)(91-244) Large (>160 ha) (244 acres)
3.	What category is your farm? (crops/dairy/beef/lamb/pork/mixed)
4.	Do you currently use horses for operations on your farm?
5.	Why do you keep horses?
6.	What machines do you have on your farm (tractor/combine harvester)?
7.	How much was your tractor/machine at time of purchase?
8.	Could you estimate the cost of running your tractor per year?
9.	How much to you spend on fuel per week?
10.	Do you expect a depreciation or appreciation in the value of your tractor if you were to sell the vehicle after five years?
11.	Would you ever consider using your horse for operations on your farm? (if yes, question 12, if no question 13)
12.	What factor s would need to be present in order to enable you to work with your horses? (Cheaper feeds, further training, modern equipment, motivation)
13.	What factors have influenced your decision not to utilize your horses in a workable way? Not realistic – time constraints Working with horses is not economical at present Do not believe working with horses is viable
14.	If working with horses were proven to be more economical/environmentally friendly/better for the soil than tractors/conventional machines, would you consider using working horses on your farm?

Figure 1 Interview Questions for Farmers who farm conventionally and plough with horses competitively

Figure 3 Acres Assigned per horse for feed by each interviewee

1.	How long have you been ploughing with horses?
2.	What size is your farm? Small (<60 ha)<91 acres Medium (60 - 160 ha)(91-244) Large (>160 ha) (244 acres)
3.	What category is your farm? (crops/dairy/beef/lamb/pork/mixed)
4.	Do you currently use horses for operations on your farm?
5.	Why did you choose to work with horses on your farm?
6.	How much was your horse at the time of purchase?
7.	Do you use work horses for all traction all your farm or do you use them alongside machinery? (if alongside machinery, would it be possible to farm solely with horses?)
8.	Have you experienced any benefits of working with horses?
9.	Have you experienced any disadvantages of working with horses?
10.	For what operation do you use your horse (ploughing, harrowing, seeding, weeding, harvesting, crop processing)
11.	How much time, per week, do you spend caring for your horses (feeding, mucking out, grooming etc)
12.	Do you keep your horses at grass or stabled?
13.	How much do you feed your horses, on average per week? (if at grass, how many acres/hectares to you assign your horses). April to Sept and Oct to Feb
14.	What do feed your horses (oats/beet pulp specific horse mixes/feeds (which brand))?
15.	Do you grow your own hay/feed or is hay delivered? (how much land assigned for hay?
16.	If you have used tractors in the past, have you noticed a cost difference between using a tractor and using horses?
17.	Do you have regular visits by a farrier or do you trim the horse's hooves yourself? (how often, how much per horse, are the horses shod)
18.	How often, on average, do you require a vet to see your horses (including vaccines etc)? (cost, if willing to give it)

19.	Do you breed from your horses and if so, how many foals per mare?(do you make a profit with their sale)
20.	On average, how long does each horse take to be fully trained?
21.	What is the average working life span of each work horse?
22.	At the end of the horse's life, do you sell the carcass?
23.	How much time, if any, have you lost due to a horse's illness/injury?
24.	Have you noticed any difference of soil compaction from working with horses in comparison to neighboring farms that may use conventional machines?
25.	Where do your source your equipment? Locally, overseas?
26.	How old is your equipment?
27.	At what cost is the average plough etc?
28.	Is your farm organic?
29.	What do you do with the manure from your horses?
30.	Do you know other farmers who farm using horses?
31.	Do you have any other comments/opinions you would like to share regarding horse traction (its future etc.)

Figure 2 Interview Questions for Farmers who farm with horses

The interviews were recorded by field notes written during the interview because the use of a Dictaphone was not conducive to the environment of the interview locations. Interviews at The National Ploughing Championships were generally conducted away from the crowd affording some privacy for each interview. At on-site interviews, the interviews were conducted whilst the farmer demonstrated their equipment as well as the skills of the horse. Denscombe (2007, p.195) states that interviewers' notes can act as 'some permanent record of their interpretation of what was said.' However, resorting to note taking may leave the study open to query as 'there will never be an objective record of the discussion' (Denscombe 2007, p.195). Taking field notes, nevertheless, was the only suitable method of recording the interview in the interview locations. Furthermore, photographs were taken for the purpose of records and will be included in the Results Section of this dissertation. Consent to the taking of photographs was requested from each interviewee.

Additional Data From Teagasc

In the midst of researching the relevant literature for this dissertation, an article on machinery costing in Irish agriculture by Dermot Forristal (2009) of Teagasc was found to be a valuable source of comparative data between horse traction and tractor traction. This article is referred to in the Literature Review on page 8. The article was published in 1999 and, consequently, an application was made to Teagasc for more up to date data relating to machinery costing. Dermot Forristal responded to this application and offered to generate data specifically for a comparison between

horse traction and tractor traction for this study. The results from the costing programme will be listed in the Results Section on page 70.

CHAPTER FOUR

RESULTS

Overview

For the purposes of consistency, the results of this study will be presented in the same subject order as the literature review. Additional sections have also been added. Due to confidentiality, the names of the respondents will not be given; instead each respondent will be referred to by letter, for example, Farmer A or Farmer J. The results of thirteen interviews are incorporated in these results. Interviews A to K were conducted at the 2009 National Ploughing Championships. Interviews with Farmer L and Farmer M, who farm with horses, were located on their corresponding farms. Five of the interviewees actively use horses for farm work. All the interviewees have ploughed with horses either competitively and/or have used horses to farm in the past. Out of twenty nine horse ploughing competitors at the National Ploughing Championships, eleven were interviewed for this study. Only one potential interviewee refused to participate. However, not all competitors were asked to participate due to the limitations of time on both the researcher and the competitors. Additionally, some interviewees did not wish to disclose certain details such as farm size, cost and/or amount of machinery etc. This researcher did not attempt to force this issue as per Martyn Denscombe's (2007, p.192) advice on research ethics:

The good researcher must also respect the rights of the interviewee. This means accepting if a person simply does not wish to tell you something and knowing when to back off if the discussion is beginning to cause the interviewee particular embarrassment or distress.

Energy Efficiency

Feed estimates for horses will include information regarding the amount of land assigned to each horse. Each interviewee was asked to estimate the amount of land (if any) they assigned to each horse. There were many varied results however; twelve of the thirteen respondents grew most, if not all, feed requirements for their horse(s). For example Farmer C stated that his 'Horses are kept at grass in summer and stabled in winter. 4 acres per horse. Has pair of horses. Grows own hay but does buy in mixed cool mix for horses.' Farmer I assigns '3 acres per horse for grass and hay. Also fed mangles and oats.' Farmer J keeps his horses 'at grass in summer, stabled in winter. Grows own hay and oats – 10 acres for 5 horses.' The possible explanations for the diversity in the assignment of acreage per horse will be examined on page 74 of the Discussion Section. The table on the next page illustrates the results:

		Acres Assigned Per Horse	Size of Farm
Farmer	A.	1	80
Farmer	B.	2	70
Farmer	C.	2.5	150
Farmer	D.	2.5	200
Farmer	E.	2	200
Farmer	F.	3	38
Farmer	G.	4	27
Farmer	H.	2.5	Not given
Farmer	I.	3	250
Farmer	J.	2	40
Farmer	K.	3	Not given
Farmer	L.	2	13
Farmer	M.	2	8.5

Shaded Area Denotes Interviewees who farm with horses

Figure 3 Acres Assigned per horse for feed by each interviewee

A calculation of the average acreage would work out at 2.4 acres per horse (total number of acres/number of interviewees). This calculation, nevertheless, may be inadmissible as an average estimate of the feed or acreage requirements of a working horse. The reasons behind this potential restriction will be covered on page 73. In addition to assigning land for the grazing as well as hay requirements of each horse, Farmers B, C, D, H, I, J, L and M also fed cereal feedstuff that were either produced on the farm or imported. Farmer L provided a detailed account of his feeding routine for his working horses:

'6 acres assigned for the 3 horses – farmed organically. 30 round bales from 6 acres. For the months October, November, December, January, February, March, and April, need 1 bale a week for 3 horses – 28 bales. – For the months October, November, December, January, February, March and April. Self sufficient (for horse feed). Hard feed only from St Patrick's day (hay has lost nutritional value over time) to May - builds the horses up again for tilling. Horses can lose condition very quickly. Also feeds1 ½ kg of rolled oats per day – 2 weeks of march, 4 weeks of April and 2 weeks in May. In summer kept out at night and in by day (when not working), in winter out during the day. Gives hay until May when spring grass comes up. Horses need to be restricted or will eat all the time.'

Farmer D also offered a more detailed estimate of his horses' feed requirements 'Horses at grass 6-8months. Feeds them 1 kg rolled oats twice daily and half a bale of hay in Winter. Also cooked Maize.' Farmer C also suggests 'mangles' as a good crop staple for horses. These results do suggest that it may be difficult to arrive at a reliable estimate of how much feed is required per horse.

Additionally, all the interviewees used horse manure as a fertiliser on their soil.

Some of the farmers also breed from their horses. Farmer J 'does breed from horses but only for replacing.' Farmer B is now on the '6th generation of breeding horses.' Farmer F also breeds from his horses. However, these were the only 3 farmers who bred from their horses. Farmer L does intend to start breeding from his horses in the future.

Fuel Estimates

Queries regarding fuel amounts and fuel costs for machinery did not yield precise findings, for instance, Farmer A who uses 'Uses (conventional) machinery on his farm including a tractor and teleporter' suggested that the 'Amount of fuel depends on season.' The interviewer did arrive at this problem of fuel estimates. Dermot Forristal's (2009) estimates, on page 70, may help to counteract the lack of precise findings from the interview results.

Cost Comparisons

The cost of feeding each horse may be difficult to estimate given that most of the farmers grow their own feed. This is not to suggest that there is no cost involved in feeding each animal. Feed requirements consume land that may have yielded crops, nevertheless, each farm is different. Consequently, it may be advisable for farmers to estimate how much profit they turnover per acre to arrive at an idea of how much horse feed requirements will be. This estimate will be specific to each farm and depends on too many variables such as crop type, soil fertility etc for a general estimate to be arrived upon for a national estimate. Farmer M, nevertheless,

imports around ‘200 bales at approx. €3/bale.’ This cost may allow an estimate of potential costs to be arrived at.

Opinions regarding cost comparisons between animal traction and tractor traction vary. Those farmers who only plough with horses competitively do not have a firm opinion about cost differences (perhaps because they would not consider the idea). Farmers who plough with horses believe it is either as costly or less costly to do so. Farmer F maintains that there is ‘No cost difference, in his experience, of working with horses compared to tractors.’ Farmer F, on the other hand, implies that the cost considerations might be irrelevant as it ‘Would be impossible to source equipment now for working with horses’ and, consequently, difficult to ascertain potential cost. However, Farmer F also stated that ‘tractors have put a lot of neighbours into debt.’ Farmer D, meanwhile, ‘Uses tractors on the farm. €50,000 for a new tractor’ and maintains that ‘Tractors lose their value rapidly.’ Farmer H farms with horses and stated ‘that tractors have put a lot of neighbours into debt. Horses do not.’ Farmer J, meanwhile, claims that farming with horses is ‘More natural and less expensive.’ Farmer M, who farms with horses reflects that ‘in our economic climate and with the state our agriculture is in at present it would not make sense to promote the return to horse power for big commercial farms. But for small-scale operations horses can be a cost-effective and practical alternative.’ The depreciation in value of a tractor was a general concern although Farmer K claims that a‘Tractor does hold its value – not like a car.’

The cost of purchasing a horse was, overall, hinted at being low. Farmer L states that a suitable horse for farm work would cost around ‘€1,500,’ moreover, Farmer L could sell the same horse for ‘€2,500 at end of winter’ as training the horse for farm work would increase its value. Consequently, Farmer L trains horses

over winter for a net profit. The type of horse for farm work does not need to be a specific breed, this was evident at the ploughing championships where a variety of horses, of different breed types and sizes were used for ploughing. As a result, the purchase of a specific breed may reflect more on the personal choice of the farmer than any real necessity. One of the farmers, for example, imported a pair of French Comtois draught horses while another imported a pair of Percheron horses. Additionally, one of the farmers works with Clydesdales. The potential benefits and disadvantages of these choices will be examined in the Discussion sections. Some of the farmers have also bred the horses they work with such as Farmer B who 'got six foals in a row from current mare.' The sales of these foals could, furthermore, counteract the cost of the horses. Farmer B also 'believes it costs €60 euro to remove a dead horse now' which calls into question claims that a horse's carcass can be sold.

The care of the horses also incurs additional costs. Farmer M lists these as 'vaccinations once a year. Other illnesses/check-ups approx. 3 times a year. About €90 per visit on average.' Farmer F states that a 'Vet needed 2/3 times a year.' Farmer J estimates that 'vet (needed) maybe every six months.' Additionally, all horses need to have their hooves monitored and trimmed. However, not every farmer retains the services of a farrier. Farmer M states that 'I do not shoe my horses and carry out the trimming myself.' Farmer F, meanwhile, does not incur the cost of a farrier as a family member is trained as a farrier. Farmer C suggests that a farrier 'would come about three times a year to shoe them (horses).' Farmer J states that a 'Farrier needed every 4 months.' Generally, most farmers suggested a trim would cost about €20 although again, frequency of trims varied between three times a year to six times a year. Many of the farmers do not have their horses shod which is less costly, however, Farmer A spends '€75 three times a year for shoes.'

The cost of equipment for work horses was suggested by a few of the farms. Farmer M states that a horse plough might cost around '€100' while Farmer F 'Sources equipment from around the county – however, equipment is always old and he has to repair and restore it – some over 100 years old.' Farmer G, who farms with horses, stated that he 'has no idea of cost as (he) uses same plough for years.' Farmer L imports some of his equipment from oversees (Dalton, Ohio) or adapts machinery designed to be pulled by quad bikes to be pulled, instead, by his horses. Again, estimating the exact cost of the equipment is difficult. In addition, Farmer L stated that a lot of old machinery for horse ploughing has been left to rust away and may no longer be suitable for use. Farmer L possesses modern horse traction machinery which will be illustrated in a later section.

Crop Yields

Opinions on potential crop yield differences between horse traction and mechanised traction were varied. Many of the farmers who farm with mechanised traction do not seem to hold strong views on the potential yield differences which may imply that there is no perception of any yield differences, again this will be examined in the Discussion Section. In contrast, those farmers who farm with horses possessed more outspoken views on yield differences. Farmer A, a farmer who farms with tractors, 'believes the tractor is better and yields better crop.' Farmer G, on the other hand 'Uses horses for scuffing, making drills is better with horses as they have no weight – better potato crop.'

Labour

Interviewees were far more open regarding the differences in labour relating to tractor traction and horse traction. Farmers B, C, I and J have over fifty years experience of ploughing with horses. Farmers B, C and I offered a significant amount of information relating to the changes in farming that have occurred since the onset of mechanisation, they have personal experience of farming with horses and farming with tractors. Farmer J, meanwhile, has farmed with horses for over fifty years. However, all the interviewees had firm views regarding the differences in labour, linked with quality of life, related to the different ways of farming. For this reason, all the opinions on labour comparisons of interviewees will be outlined here.

Farmer A has ploughed with horses for 9 years. However, he ploughs only for competition purposes. He believes 'Working with horses would be much too slow and would be too laboursome for him.'

Farmer B has ploughed with horses for 55 years. Up to the 1950s he farmed with horses, however, since then he has farmed with tractors. He suggests that the labour involved in horse ploughing requires too much time. 'Time was major disadvantage – would have ploughed 1 acre in a day – his father told him (idea held throughout his community – to plough one acre involved a 12 mile walk).'

Farmer C has ploughed with horses for 60 years. He switched from work horses to mechanised farming in the 1960s. He states that 'Time (cost) makes it impossible to use horses now.'

Farmer D has ploughed with horses for 20 years. He only ploughs with horses competitively. He states that the labour involved could be too costly and that 'There are also no grants for working with horses, they would be needed to make working with horses worthwhile.'

Farmer E has ploughed with horses for 4 years, again he only ploughs with horses for competitions. He would not farm with horses as the work involved would make it 'unfeasible.'

Farmer F has been farming with horses for 13 years. The labour itself is the attraction for Farmer F as the 'Benefits of horses is that they are relaxing.'

Farmer G has been farming with horses for 20 years. He was 'raised with (horse) ploughing' and is teaching his son to do the same. He works with horses because he thinks they are better, overall, than tractors.

Farmer H has been ploughing with horses for 10 years, he only ploughs 'for show.' Would not consider farming with horses as the work (for him) would be too much.

Farmer I farmed with work horses 'from 1938 up to 1950s on farm.' Farmer I stated that he 'would never go back to using horses. Tractor saves a lot of time. Just put the key in ignition and you've started. Horse must be seen to all the time if used for ploughing.'

Farmer J has farmed with horses for 50 years. He believes farming with horses is 'More natural and less expensive.....A lot of time taken up with caring for horses but does not see this as a loss – the time is quality time, not an expense.'

Farmer K has been farming with horses for 40 years. He only ploughs for show. He states that the labour involved in work horses 'Takes too much time. When tractor

arrived it was 'like a holiday'. Tractor does hold its value – not like a car. Would hate to go back to horses.'

Farmer L has been farming with horses for around 20 years. He farms with horses because he enjoys it and believes it is beneficial on his farm. Farmer L cites tradition as one of the reasons he farms with horses, however, he does not like to be seen as 'sentimental' and is adamant that the horses are the 'right tools' for his work.

Farmer M has been ploughing with horses for 4 years. Farmer L maintains that working with horses 'adds to the contentment we get out of the work and adds to the social aspects of working as a team, as they are living thinking creatures, co-operating with us to help us get the job done.'

The interviewees were also asked to estimate the amount of time they spend caring for their horses. Most of the interviewees did estimate that the horses needed around 30 mins of care a day, however, if kept at grass (usually during Summer) then the time needed to care for them could be around 5 mins per day. There were exceptions to this rule, Farmer J suggested he spent 4 hours a day looking after his horses, but he regarded this as quality time not a time expense.

Soil Compaction

Interviewees were far more outspoken on soil compaction than they were on crop yields. The links between soil compaction and crop yields will be examined in the discussion section. Farmer B claims that 'Horses are better for the soil.' However, this opinion is contradicted by Farmer A who believes tractors 'are better

for the soil.' Farmer A, nevertheless, was the only interviewee to believe soil compaction was improved with tractors. The opinions regarding horse traction and soil quality is not as straightforward. Farmer D, maintains that 'Ireland has heavy soils that are not good for working with horses' Farmer D travelled to Amish farms in Ohio and suggests that Amish farmers 'have the best sort of land with sandy soils that make it easier to plough with horses.' Farmer I suggests that 'Tractors can be up to 9T and can really compact the soil.' Farmer I also observed 'at the championships, the land was very compacted, difficult to get below a 3 inch depth even though 6 inches was (depth) needed for competition.' Farmer I attributed the problem of this soil compaction to machinery. Farmer F offered his observation on his farm that 'after a second year of using horses the soil is not as compacted.' Farmer M, who farms with horses, also observed that 'I noticed significant soil compaction on our land when heavy machinery had to move through one field for drainage work.' Farmer J remarks that 'In spite of size of (his) Clydesdales, soil compaction is better with horses.'

Time Estimates for Training Horses

Time estimates for training horses up to the point where they are a useful member of a team vary. Farmer F suggests that it 'Takes 6-8 weeks to train a horse until horse is usable for farm work.' Farmer G states that on it takes on 'averages two months to train a horse but depends on horse.' Farmer J estimates that it takes '6 weeks to train them to be useable.' Farmer L suggests it does 'take a Winter to train them for use.' Farmer M, meanwhile, stated that 'Starting training as a foal, they should have learned most things they need to know at age 6 or 7.'

Working Lifespan of Horse Estimates

Farmer C suggests an 'average 20 yr working life' in his experience. Farmer F estimates an average of a '25 year working life' for a horse. Farmer G suggests a more modest '18 year working life span per horse.' Farmer M predicts that a working horse will work into 'their late teens or early twenties.'

Further Insights from Interviewees

Farmer B reflected on the change, in his experience, that mechanisation has brought to agriculture. 'Working with horses was great healthy work, kept farmers fit. The life was nice and relaxed. Would meet more people and talk.' Farmer B also expressed a strong attachment to his horses. He had one horse in particular for 27 years. When the horse died, he would not dispose of the carcass; instead he buried

the horse on his land. Farmer B also 'Believes no future for working horses except competition or show, his children have no time for it though, (he) does not want the tradition and skill to be lost.'

Farmer C has also lived through the change from farming with horses to mechanisation. He recalls that farmers 'Did everything with the horses prior to tractor, the horses also meant a lot to him...but time makes it impossible to use horses now.'

Farmer D does not believe working with horses is feasible. In addition, he suggests that 'the horses are not bred for real work anymore. The Irish Draught has lost a lot of bone as the breed is now geared towards producing 'sport' horses.'

Farmer F suggests, of himself, that he has a 'a touch of madness' (eccentricity) in his commitment to working with horses but he would not work any other way.

Farmer J 'wouldn't farm any different, horses make him love farming.'

Farmer M, meanwhile, suggests that 'A lot of people seem to have moved away entirely from the idea of working horses, and see this as a nostalgic luxury – unfortunately. A lot of positive promotion about what horses can really offer us needs to be done.' In practical terms Farmer M states that with work horses 'you have a lot of options to work them together, alongside each other on different tools or just with one horse at the time. An older horse can be used as a help to train younger horses which could be sold on as an extra income.'

Farmer L has found the horses' intelligence has directly helped him to farm. Farmer L can harrow around crops with his horses as a horse 'need 20 inches width for a drill. Horses walk in between crops..they are trained to step over each row and

respond to oral commands such as 'mind the broccoli with the furrow - horses can be trained to do anything.' This is of particular benefit to Farmer L who farms organically as the horses aid in weed control which is difficult without pesticides. Farmer L also has experienced a further benefit to working with horses. He drives his horses to his vegetable stall in the local farmer's market and has found that his 'Horses also increase sales at market as they draw a crowd and regular customers.'

One for the interviewees also confided that on return from holidays or nights away from his farm, the first thing he does on his return, prior to 'seeing my wife' and family in the house, is 'go to the stables to check and pet his horses.'

On a side note, a supervisor at the National Ploughing Championships did offer his own observation related to the horse ploughing. The supervisor has overseen competitive ploughing with both tractors and horses. He remarked that competitors who plough with tractors often loose their tempers and seem to be more anxious overall while the competitors of the horse ploughing are generally more relaxed and do not 'lose their heads' as the tractor ploughers tend to do.

Modern Horse Traction Machinery in Ireland

Responses regarding horse traction machinery or equipment has been varied. Farmer B states that new machinery or equipment would 'be impossible to source.' Farmer C collaborates with this opinion as he states 'no where supplies the equipment.' Farmer F 'sources equipment from around the county – however, equipment is always old and he has to repair and restore it – some over 100 yrs old.' Farmer H also states that it is 'hard or impossible to find new equipment, has no idea of cost as uses same plough for years.' Meanwhile. Farmer J also uses 'old

equipment, a woman in Cavan makes the harnesses for him.' Farmer L and Farmer M import their equipment from overseas. Farmer M had customised equipment imported from Sweden while Farmer L imports from Amish counties in the United States.

Farmer L also possesses a wide selection of modern machinery for his farm work. Photographs and explanations of each piece of equipment will be outlined in the following few pages:

Figure 4 Hay Turner

Farmer L states that 'all hay turner machines are based on same principle as this one- 4 miles per hour with horses – 15 miles per hour for tractor. Much slower with horses but believes hay is sweeter with slower treatment.'

Figure 5 Round Bale of Hay Carrier

Farmer L has adapted from quad bike implement. Farmer L suggests that any machine designed to be pulled by quad bikes can be 'pulled by horses.'

Figure 6 Hitch Cart

This is a hitch cart, Farmer L states that it can be ‘pulled by one or two horses. Came from US – has built in breaks – does any job a quad bike can do,’ and is an example of how the ‘Amish are adopting machines for all farm tasks.’

Figure 7 Ride on Plough (seated)

Farmer L imported this machine from ‘Dalton, Ohio....it is pulled by two horses .’ With this machine Farmer L ploughs ‘1/2 acre in 2 hours with Dalton ,’ it cuts out walking for the farmer.

Figure 8 Mowing Machine for cutting Hay

Farmer L describes this as a 'mowing machine for cutting hay ....1 ½ hour to cut 1 acre – much slower than tractor.' The horse mowing machine 'cuts 4 1/2 feet wide (while) tractors are 10 feet wide and do 15 miles per hour.'

Figure 9 Muck Spreader

Farmer L states that his ‘land is marginal (and)needs constant enrichment – this is an old machine totally reconditioned- spreads farm manure and compost. 2 ½ tonnes a time – can travel on wet ground on 4 inch wide wheels to limit soil compaction.’

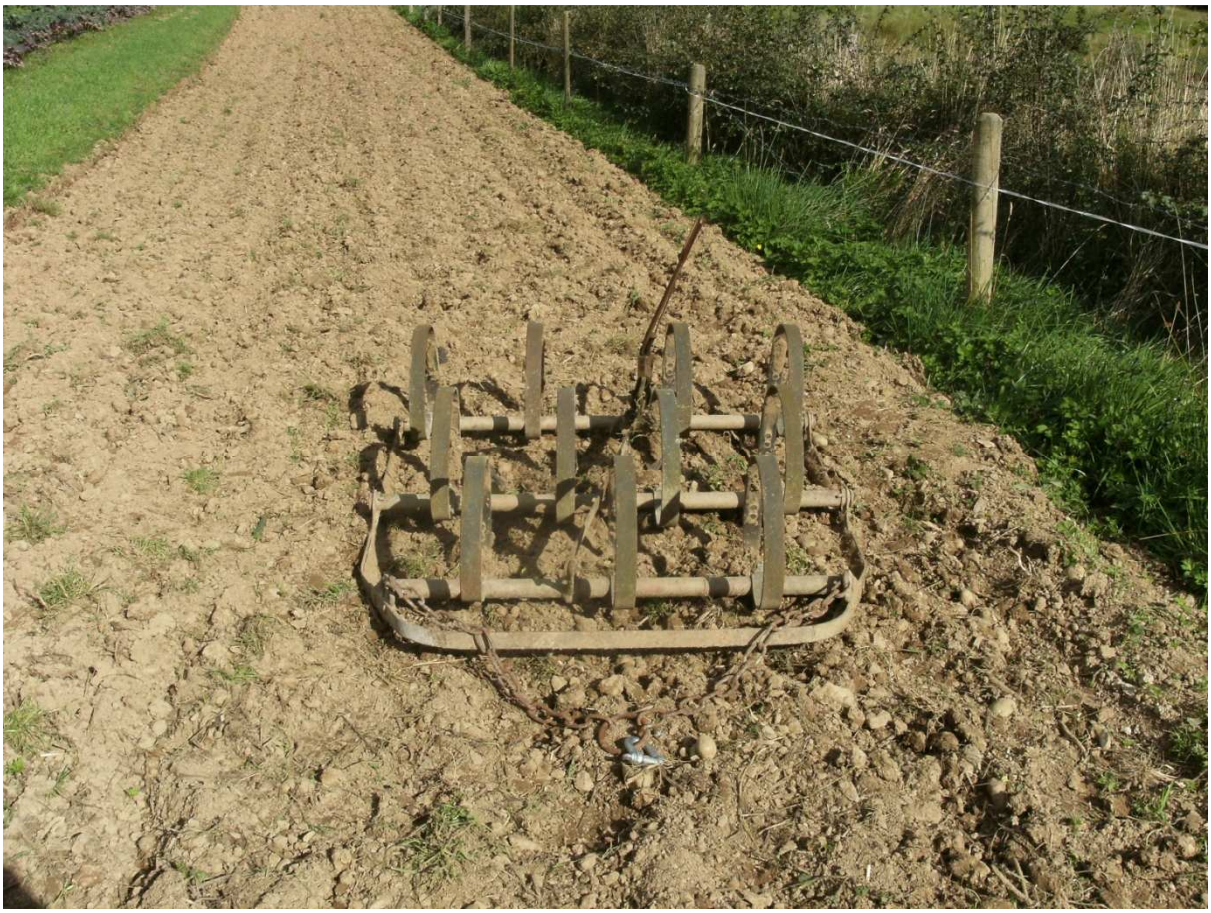

Figure 10 Harrow

Farmer L uses this harrow to 'spread manure and remove weeds....Organic farms in constant battle with weeds – weeds need to be harrowed 5-6 times a year, plough in September. Sows rye grass for green manure and control of weeds. February harrow again - usually too wet for a tractor then ....harrows for weed and slug control.'

60 acre (24 hectare) unit

This farm size is now considered small for machinery ownership. Consequently only secondhand equipment is used. The Oak Park machinery costing programme uses algorithms to calculate depreciation, interest, repairs and maintenance, fuel and labour costs based on the machine type, size, purchase and trade-in ages and annual use level.

Assumptions

- Owned tractor and plough used
- 200 hours annual use assumed for the tractor
- €0.70 / litre diesel fuel cost
- Secondhand 75kW (100hp) tractor purchased at 10 years old and kept for 15 years.
- Secondhand 4 furrow plough purchased at 10 years old and kept for 15 years.
- Net workrate of unit is 0.63 ha /hr (1.6 acres/hr)

Costs

Plough depreciation, interest and repairs	€23.40 / hectare
Tractor depreciation, interest and repairs (€8.63/hr)	€13.75 / hectare
Fuel (€0.70/ litre)	€17.64 / hectare
Labour	€12.76 / hectare
Total	**€67.55 / hectare**

Smaller size units

Ownership of machinery on 12 acre (4.8 ha) or 40 acre (16 ha) would not be viable. Contracting in those operations would be the only option pursued on these units.

Ploughing contracting charge	€70 / hectare

If a secondary cultivation and sowing operation needs to be considered, a combined cultivation / sowing operation for cereals would cost approximately €80 / hectare when supplied by a contractor.

Conclusions:

The main results of this study have now been outlined. They will be analysed and discussed in the next chapter. Original notes will be retained by this researcher. Many of the interviewees have also requested a copy of these results and this researcher will forward these details to them.

CHAPTER FIVE

DISCUSSION

The central question of this study will now be evaluated by a discussion of this study's results. Again, the analysis of factors will be examined in the same order as in the previous sections. In an attempt to measure the sustainability of horse traction, this section will evaluate the sustainability indicators, if any, that can be incorporated into horse traction and tractor traction. The FAO (1995) indicators of sustainable agriculture, on page 3, and the Rigby *et al.* (2001) indicators of sustainable agriculture, on page 4, will be used throughout this section.

However, the potential limitation of indicators applied to qualitative data is acknowledged. Simon Bell and Stephen Morse (2001) examined this limitation stating that 'a complication arises in that sustainability incorporates many dimensions, including emotive and normative issues such as the "quality of life." Such issues cannot easily be encapsulated in simple indicators or prioritised in any objective sense of the word.' Consequently, this research will also allude to factors that cannot be quantified or measured in any definite way.

Energy Efficiency

From the Results section it has emerged that calculating a universal guideline regarding animal traction energy requirements is fraught with difficulties. The sustainability level of animal traction does appear to be favourable given that 12 out of the 13 interviewees produce most, if not all, the feed requirements of their horses. However, very few of the interviewees suggested the same designation of acreage or feed per horse. None of the respondents produced fuel for their tractors. Only Farmers C, D and H suggested the same estimate of 2.5 acres per horse. Furthermore, the disparity of estimates ranged from 1 acre to 4 acres per horse. Accordingly, it may follow that these results could be dismissed as inapplicable as they provide no real guide as to the amount of acreage or energy a working horse requires. However, the average acreage derived from these results is 2.42 acres. This amount complies with a range of literature regarding the care of horses. 'Most land used for horse and ponies is of relatively poor quality and will only support an average of one horse per 2.4 acres (one hectare).' (New Rider 2009). There are several factors that may account for the differences.

There are, however, some anomalies in the results. The interviewee who stated that he assigns 10 acres for his five horses was speaking of his own specific case. This interviewee's horses are of the Clydesdale breed. Most of the horses were of a general cob type averaging around 14 to 15 hands (around 4.5 – 5 feet tall). The Clydesdale breed of horse is one of, if not the, largest breed of horse in the world. Cindy Thomas (2009) describes the breed at being 'over 18 hands, about six-feet tall.... growing to over 2,000 pounds.' The average horse weighs in at around

‘1000 to 1200 pounds’ (Pavia and Posnikoff 2005, p.23). It follows, therefore, that this horse would require more feed and, inherently, more land to provide that feed or energy much in the same way that a tractor with a higher Horsepower will require more fuel. However, Farmer J maintains these exceptionally large horses on 2 acres each. It may be the case that the land is of higher quality and is sufficient to feed the horses.

An explanation for the 1 acre estimate, as per Farmer A, could be similar. This interviewee does not farm with his horses, and consequently, their energy requirement may not be as high as those horses that are worked every day. From the results, it can be seen that those interviewees who farm with horses assigned at least 2 acres per horse which may be a reflection of the higher energy requirements of a horse who is worked. Additionally, land quality will differ from farm to farm and it could be hypothesised that a horse may be supported on 1 acre if the land is of good quality. This does not contradict the New Rider (2009) suggestion that a horse requires ‘2.4 acres’ as this same estimate considered the general poor quality land that horses tend to be kept on.

Furthermore, since the horse is a living animal and each animal is different, it is impossible to arrive at an infallible feed requirement guide for horses. Farmer D made this observation. His pair of horses are of the same breed, sex and size yet one of the horses always needs a bit of extra feed to thrive in comparison to the other horse. This is a common phenomenon amongst horses.

It follows, therefore, that further research into the amount of land, based on the quality of land, required to sustain a horse in Ireland is desirable. Investigating this potential phenomenon, however, is beyond the scope of this study. However, a farmer (considering working with horses) could come to a general guideline of the

land amount that might be needed by comparison with nearby neighbours who might keep horses, although this would not be a definitive estimate, it could give an indicator of what the local land can support.

All the interviewees supplied their horses with hay in winter. However, the amount of land required to produce the hay was included in their land estimation per horse. Farmer M, who does not have a sufficient amount of land imports hay from off farm sources.

Another common thread amongst the findings was the need to feed additional hard feeds during winter. Not all interviewees fed hard feed; however, a significant proportion deemed it necessary. Farmer L, for instance, reasons that hard feed is necessary since during winter 'hay has lost nutritional value over time.' Eight out of the thirteen interviews fed supplementary cereal feeds such as oats, maize, corn or beet pulp. Again, cereal feeds were produced on most of the farms. Farmer J stated that he was completely 'self sufficient' when it came to feeding his horses.

The potential 'self sufficiency' of farmers powered by animal traction may be intrinsically linked to farm sizes. Those farms that claim to meet their energy needs from their working horses all fall under the category of a Teagasc 'small farm' Forristal (1999) being under 60 acres. 40 acres was the maximum sized farm which was farmed by horses in this study. Consequently, favourable results for animal traction in this study are all limited to small sized farms. However, it does not necessarily follow that the energy from animal traction is only sufficient for farms of this scale. Other factors may determine the size limit and will be considered in later sections.

It may be hard, consequently, not to make the assumption that horse traction is more sustainable in terms of energy than mechanised traction. Following

sustainability indicators, in an attempt to arrive at some comparable measure of sustainability between tractor traction and animal traction, may generate a different viewpoint. The indicators developed by Rigby *et al.* (2001) specifically to examine the sustainability of farming practices will be applied here.

Firstly, horse traction, specifically in relation to energy, may, at first, appear more sustainable since farming with horses succeeds in 'minimising off-farm inputs' (Rigby *et al.* 2001). Especially where the farmer produces the horses feed requirements on the farm. Horse traction energy also allows for 'minimising inputs from non-renewable sources' (Rigby *et al.* 2001). If hay, grass or oats, replace the non renewable oil required by tractors, then it may follow that horse traction meets this indicator of sustainability. Furthermore, horse traction may maximise the 'use of natural biological processes.' (Rigby *et al.* 2001). The energy cycle of the horse is a natural biological process - the feed grown on the farm powers the horse, the waste material produced from this process is also natural; all the interviewees used the waste (manure) to fertilise the soil, which again would contribute to the production of feed for the horses. Horse traction also meets another sustainability indicator as it 'increases farmers' self-reliance' (Rigby *et al.* 2001) in terms of energy production. Mechanised traction, or tractor traction, cannot meet these indicators of sustainability in terms of energy.

Given that these results were derived from qualitative research in the form of interviews, they are vulnerable to an element of bias both on the side of the researcher and/or the interviewee. It was found that interviewees tended to be either pro-animal traction on farms or decidedly against the idea of animal traction on farms. Consequently, some of the results on energy could potentially be exaggerated or under exaggerated but, given that the results of acreage estimation per horse are

not highly polarised, it seems unlikely that a high element of bias has compromised the results relating to energy. This concern will be addressed in each section, as some factors do seem to have generated more emotive views or results.

One potential advantage over tractor traction that does not seem to have been exploited on a wide scale by the interviews is the fact that horses themselves are renewable in their ability to reproduce. If this advantage were exploited by the interviewees it might farther reduce off farm inputs and contribute towards the self sufficiency of the farmers. Only 3 out of the 13 interviewees bred from their horses. A possible explanation for this will be discussed in the Cost Comparison Section on page 79.

These results generally comply with the findings or hypotheses of research on animal traction as outlined in the Energy Section of the Literature Review. However, deviance from other research findings has occurred in regards to breeding from the horses. Previous energy comparisons relating to animal traction, or overall articles supporting the argument for animal traction over tractor traction, do account for the fact that horses can reproduce themselves while tractors cannot. This energy advantage did not emerge on a wide enough scale from the results of this study and may not be significant enough to count as an advantage in this case. An explanation for the minimal uptake of this advantage may be found in the section on page 79. Even so, this research has suggested that horses are a far more renewable source of traction than tractor traction in terms of energy.

The interesting story to emerge from these results is that the large majority of farmers who either work with horses on their farms/and or plough competitively provide the energy requirement via feed that is produced on the farm. As mentioned, this falls under indicators that suggest horse traction is sustainable. Nevertheless, it

does not necessarily follow that animal traction is sustainable. The following sections will examine other factors that may either detract or add to the argument that animal traction is more sustainable than tractor traction.

Cost Comparisons

Results relating to costs and the comparable forms of traction were variable. However, several patterns have emerged from the cost results. As previously stated, farmers who do not use their horses for farm work have not considered a cost comparison between tractor traction and animal traction. This omission may initially appear to be an absence of data, however, this researcher suggests that the limitation could be interpreted as evidence that conventional farmers, even though they keep horses, may not view their horses as serious sources of traction. Moreover, although the same farmers obviously keep horses, the cost of keeping them could be minimal given that the cost of the horses' upkeep does not seem to have made a significant impression in their opinions. Conversely, the same farmers purport that tractors are expensive with Farmer D estimating a cost of €50,000 for a new tractor. Additionally, the 4 of the 5 farmers who farm mechanically, and who disclosed the size of their farms, all fall into the Teagasc category of medium farms ranging from 150 acres to 250 acres. It could follow that the land required by their horses is almost insignificant and is easily absorbed into the general expenses of the farm. This study, furthermore, does not suggest that these farms switch to animal traction. Dick Courteau (2007) suggests that beyond 75 acres (30 hectares), a farm should be mechanised to be viable. Consequently, the fact that medium to large farms could easily carry the cost of animal traction may not account for much given that horse traction for them could be unfeasible. However, the cost of maintaining the work

horses on farms, where they are not used as sources of traction is considerably small, and, therefore, feasible for small farms. It could also be argued that small farms might find it too costly to support tractos. Since, as Farmer F noted 'tractors have put a lot of neighbours into debt,' an alternative source of traction could be worth examining for such farmers. As previously mentioned, Forristal (1999) suggested that large farms could carry the cost of tractors and machines more easily than small farms. Measuring sustainability must also involve cost considerations as a farmer must be able to sustain 'the viability/profitability of the farm.' (Ryberg *et al.* 1999)

Farmers who actively work with horses did have more fixed ideas as to the cost of animal traction on their farms. It could also be reasoned that this group of farmers had a more realistic idea of the cost of animal traction as their estimates are based on their real experiences of horse traction.

Generally, most of the farmers seemed to share similar estimates as to the cost of purchasing a horse suitable for farm work. Farmer L suggests a horse suitable for draught work could cost around €1500. Farmer M used to sell draught horse foals for €800-1000.

Horses, of the type suitable for draught labour, are also fairly common. One of the farmers works with the French Comtois breed of draught horse – this breed is bred for meat in France and, consequently, is not costly to purchase. Farmer F, J, and H all suggest that a specialised, and perhaps, costlier breed type is not required for draught work. Additionally, Farmer D suggests that smaller horses could be more suitable for draught work as they have a 'lower centre of gravity' and it is, therefore, easier for them to pull implements. The relative low cost of a working horse may also be a reason why so many of the interviewees do not breed from their horses. The cost of the horses is not prohibitively expensive; therefore, breeding from their

horses is not mandatory. The labour demands of horse traction may already consume too much time already and may make the idea of breeding, in addition to working with the horses unattractive.

The cost involved in maintaining a work horse, nonetheless, could negate any argument that horses are cheaper due to their initial purchase price. This researcher tried to ascertain the cost of keeping an active work horse. In addition to feed costs, horses require veterinary care as well as the services of a farrier (if the farmers cannot attend to the horses' hooves themselves). In Farmer M's case veterinary services have included 'vaccinations once a year. Other illnesses/check-ups approx. 3 times a year. About €90 per visit on average.' Farmer J, meanwhile states that a 'Farrier needed every 4 months, vet maybe every six months.' 4 of the 13 interviewees suggest that a farrier is needed around 3 times a year. Again, there is a wide variance in the results. This could be explained by the fact that the horse is a living system. It is impossible to predict the amount of veterinary visits an animal may require. However, tractors and machines also break down and require maintenance. The horse, however, is capable of healing while a tractor might require costly replacement parts etc. In spite of these factors, this researcher will attempt to surmise a potential cost by averaging out the number of times and costs of a farrier and vet. It is more expensive to have the horses shod as the cost of the shoes has to be added to the equation. Many of the interviewees do not have their horses shod and trim the feet themselves which removes this cost altogether. These results do suggest that a farrier could cost anywhere from €20 to €75 per horse per visit. This would work out at €60 if the horses only require a trim and €225 if the horses are shod. €20 seems to be a realistic estimation of a trim charge as it is similar to an estimation by Norman Storey (2004) of Teagasc who estimated a hoof trim for a

horse at being €18 per visit. Similarly, vaccinations are also necessary for horses. Storey (2004) lists that horses require a yearly vaccination. However, each vet charge seems to vary. It does follow, however, that a vet will be needed at least once a year. This may be over optimistic as it may be inevitable that a horse may require veterinary attention more than once a year. In Farmer M's case – the cost of three veterinary visits was €180 for the year. Farmer M, however, does not require a farrier. Nevertheless, if a farrier were required it would possibly cost €60, giving a figure of €240 per year. It should be noted, however, that this figure is hypothetical and is only suggested as a possible guideline for the cost of horse care. Furthermore, a horse that is shod would increase farrier costs to €300 bringing farrier and veterinary costs to a total of €480 per year. This figure is a generous estimate; however, this researcher wishes to be as realistic as possible. This amounts to €9.23 per week. Furthermore, if this cost is spread out per acre in each farm it may work out as follows:

		Size of Farm in Acres	Cost of care Per Acre (1 horse)	Cost of Care plus Purchasing Cost Per Acre (1 horse)	Cost per Acre if Following Horse Per Acreage Rule*
Sample	(i)	60 (24 ha)	€8.00	€9.25	€37
Sample	(ii)	98 (40 ha)	€4.89	€5.66	€62.29
Farmer	A.	80	€6.00	€6.90	€27.60
Farmer	B.	70	€6.80	€7.90	€31.60
Farmer	C.	150	€3.20	€3.77	€26.39
Farmer	D.	200	€2.40	€2.77	€24.93
Farmer	E.	200	€2.40	€2.77	€24.93
Farmer	F.	38	€12.63	€13.87	€41.61
Farmer	G.	27	€17.77	€20.55	€61.65
Farmer	H.	Not given	-	-	-
Farmer	I.	250	€1.92	€2.22	€24.42
Farmer	J.	40	€12.00	€13.87	€41.61
Farmer	K.	Not given	-	-	-
Farmer	L.	13	€36.92	€42.69	€85.38
Farmer	M.	8.5	€56.47	€65. 29	€130.58

*pair of horses for first 24 acres followed by one additional horse for every 24 acres thereafter

Shaded Area Denotes Interviewees who farm with horses

Figure 11 Estimates of Horse Care Costings

Dermot Forristal's (2009) estimates (listed on page 70) suggest that mechanised ploughing costs €67.55 per hectare (€27.34 per acre) for a small farm of 24 hectares (60 acres) This estimate is only a cost of ploughing for a farm of this size, however, it should give an indication as to the cost of running a machine. Charlie Pinney (2003) suggested that 'the generally-accepted horse-per-hectare ratio was around one pair per 10ha (24 acres) with that number increasing by one horse per each 10ha (24 acres) increment in farm size.' 24 hectares (60 acres) of farmland would therefore require 4 horses. The care cost of which would overall be €1920 (€480 x 4 horses) and divided per hectare would be €80 per hectare (€32 per acre). However, although this may seem higher in comparison to Dermot Forristal's estimates for tractor ploughing, this is the cost of horse traction overall. From the Results Section, estimates of the working life span of a horse range from 18-25 years. If 20 years is the assumed life span of the horse than we can also spread the initial purchasing cost of the horse over the 20 years - €1500 over 20 years works out at €75 per year. This would increase the hypothesised cost per year per horse from €480 to €555. For a 24 hectare (60 acre) farm with 4 horses, the care cost and the purchasing cost would rise to €2220 per year which would be €92.50 per hectare (€37 per acre). Figure 11 illustrates these results in Sample (i). This figure is above the cost of ploughing with machinery (estimated by Dermot Forristal 2009) at €67.55 per hectare. This does not prove that tractor traction is cheaper than horse traction – as it is not comparing like to like.

A more appropriate comparison could be drawn from Forristal's study (1999) as outlined on page 22. Forristal (1999) calculated the cost of running a second hand tractor on a 40 hectare farm at being IR£172.46 (€218.98) per hectare or IR£69.82 (€88.65) per acre. Sample (ii) in Figure 11 estimates the cost of horse traction as

derided from the results of this dissertation. Horse traction is considerably less at €62.29 per acre compared to Forristal's (1999) tractor traction estimate of €88.65 per acre.

However, the cost of additional labour is not inclusive in the horse traction estimates. The issue of labour will be discussed in more detail on page 91. It could be suggested, nevertheless, that small farms would not need to employ additional labour – this may not be the case where horse traction is concerned since horse traction requires additional labour, consequently, supplementary labour could be necessary as it may not be possible for the farmer to meet the additional labour needs.

Additionally the €62.29 per acre estimate does not include the feeding costs as feed costs are met by the land itself. Each farmer would have a different profit return per acre (different crop types etc.) and would have to calculate the loss of acre for each specific case. The cost of machinery for horse traction has not been factored into these estimates; most of the farmers interviewed for this study used old or antiquated machinery whose cost was nominal or impossible to guess at. Only Farmer L had imported modern machinery,

Furthermore, Dermot Forristal (2009), on page 70, states that 'Ownership of machinery on 12 acre (4.8 ha) or 40 acre (16 ha) would not be viable. Contracting in those operations would be the only option pursued on these units.' This could further jeopardise the sustainability of machinery on small farms as it would decrease rather than increase a farmer's self reliance, Rigby *et al.* (2001) suggest that sustainable farm practices should 'increase farmers' self-reliance.' Contracting farm operations would also maximise, rather than minimise 'off-farm inputs' (Rigby *et al.* 2001). Forristal (2009) also suggests that the cost of contracting could be around €70 to €80

per acre. This is above the cost of horse traction estimated for a 38 acre farm as listed in Figure 11. However, it is below the costing estimate for Farmer L and Farmer M. In these cases, contracting would be cheaper although, if mechanised contracting were utilised by Farmer L and M, it could follow that they would have to purchase fertilisers to replace the loss of horse manure. Their farms, consequently, could be deemed less sustainable if they switched to mechanised contracting. In Farmer L's case, the cost of contracting would be €5.38 cheaper per acre in comparison to horse traction, it could be reasoned that this amount could be consumed by the expense of fertilisers which would not be supplied by contracting mechanised traction.

The results of costs in this study differ from previous studies in the matter related to the disposal of the horse carcasses. In the Literature Review, on page 16, references were made to the fact that at the end of a horse's life the carcass can be recycled or even sold (Pinney 2003). However, in the Results Section on page 53, a potential profit from a carcass was refuted by the respondents. Farmer B suggested the opposite is the case stating 'it costs €60 euro to remove a dead horse now.' Farmer B would also never consider selling a carcass due to his attachment to his horse. Consequently, this study will not factor in the potential return that could be made on the sale of a horse at the end of its life. This issue also raised the matter of a farmer's attachment to a horse which will be examined again on page 90. A further economic benefit of the working horses may be that a farmer might enjoy more business due to the attraction people have towards crops produced by a horse powered farm. Farmer M potentially enjoys more business, as outlined in the Results Section on page 61, because of this factor. The fact that Farmer M transports his

crops to the market with his horses also draws more crowds to his stall. This collaborates with claims suggested in the Literature Review on page 23.

The economics of farming also has a role to play in measuring the sustainability of the farm. Rygby *et al.* (2001) list economic factors as requirements to meet their indicators of sustainability. In their list of indicators, a farming practice must sustain 'the viability/profitability of the farm.' This cost comparison section should illustrate that the cost of horse traction does not jeopardise the economic sustainability of the farms, furthermore, horse traction may be more economic than mechanised traction especially for smaller farms that may find it difficult to carry the cost of machinery. Although the section on energy and this section on costs, may both have found in favour of horse traction on small farm holdings in comparison to tractor or mechanised tractor in sustainability terms, it may not follow that horse traction will, overall, be found to be more sustainable. This could be an insurmountable problem especially if indicators are weighted – for example, if crop yields from horse traction are insufficient and yield indicators are given precedence, cost and energy factors may simply be rendered irrelevant. Rigby *et al.* (2001) refer to this 'problem of incommensurability between different facets or dimensions of sustainability, and a need to identify different indicators depending on the areas of decision-making with which one is concerned.' Rigby *et al.* (2001) referred to organic farms which may meet several sustainability indicators including non use of pesticides, which will meet indicators for biodiversity etc, however, the same farms may not produce high enough yields and, consequently, fail to meet sustainability indicators relating to quality of life for a farmer or crop yields. It is important, therefore, to look at more factors before any conclusion is arrived at.

Crop Yields

Unfortunately, this study did not generate strong responses or opinions relating to crop yields. Again, the lack of overall opinions on crop yield comparisons between horse and tractor traction could be indicative that interviewees have not noticed a pronounced disparity of yields between the two forms of traction. This could be too presumptuous and, consequently, this researcher suggests that studies, specifically related to crop yields and horse traction in Ireland would be valuable. There were a few notable results regarding crop yields. Farmer A claims that tractors give better yields. However, Farmer A was one of the few farmers under forty years old (meaning he would have no memory of farming prior to mechanisation). He has ploughed with horses for nine years for show only. He has not farmed with horses on a day to day basis and, therefore, he may not be speaking from his own experience. His opinion could be designated as conjecture.

Farmer G, meanwhile, asserts that using horses for 'scuffing, making drills is better with horses as they have no weight – better potato crop.' Farmer G's opinion might hold more credence given that he is over 40 and has farmed with horses for twenty years, which will mean that he has produced crop yields from horse traction. Farmer G also tried making drills with a tractor but preferred using horses. Farmer L also finds working with horses is particularly suited to organic farms as they help control weeds, which could indirectly influence crop yields on organic farms.

Due to the limitation of opinions on crop yields in this study, this researcher will neither assume that crop yields increase or decrease due to animal traction. It may be prudent to surmise that there is no real difference in a comparison as it could be argued that if there were significant decreases or increases in yields then the

interviewees/farmers would have been far more outspoken on yields than has proven to be the case. Nonetheless, there were more responses relating to soil compaction which could have an effect on crop yields, soil compaction will be dealt with in a separate section.

In relation to sustainability indicators, Rigby *et al.* (2001) include 'increased yields and reduced losses' as an indicator of sustainability. Horse traction, in this study, has not been proven to increase crop yields in comparison to tractor traction. In the case of crop yields, therefore, neither tractor traction nor horse traction has been shown to be more or less sustainable. This concurs with general completed studies on animal traction, as outlined in the Literature Review on page 57, which found neither in favour nor against increased crop yields from animal traction.

Labour

As previously mentioned, the FAO (1995) suggests that sustainable agriculture must 'Provide durable employment, sufficient income, and decent living and working conditions for all those engaged in agricultural production.' This section will examine the sustainability of labour for those who work with horse traction in Ireland. The researcher would like to note here, that the interviewees were generally very outspoken about matters relating to the labour involved in horse traction. Unlike energy, cost or labour comparisons, this section will include opinions regarding factors that cannot be easily compared in any fixed way. This study will include sustainability indicators such as 'emotive and normative issues such as the

"quality of life''' (Bell and Morse 2001). These issues, initially, emerged in the study without the particular intention of this researcher, however, through the course of the research it was acknowledged that these issues could be crucial in understanding the sustainability of animal traction in Ireland. Bell and Morse (2001) do warn that 'such issues cannot easily be encapsulated in simple indicators or prioritised in any objective sense of the word.'.

A common motif has emerged from the results relating to labour – that is, when it came to discussions on labour most of the interviewees gave an emotional response. Three main response types seemed to be revealed:

i. Farmers who had farmed with horses in the past and who expressed a certain measure of loss due to the switch to mechanisation
ii. Farmers who are vehemently against the idea of horse traction as the human labour involved would be unthinkable for them
iii. Farmers who actively farm with horses, enjoy the human labour involved in animal traction and believe it is better to farm with horses

The response to labour could be illustrative of the emotion involved in horse traction. Farmer K (Type (ii) response), for instance, would 'hate' to farm with horses while Farmer J (type iii) response, who farms with horses 'wouldn't farm any other way, horses make him love farming.' It could be said, therefore, that for Farmer K, horse traction would seriously threaten his quality of life while Farmer J's quality of life could seriously diminish in the absence of horse traction. Bell and Morse (2001, p.305) support the evaluating of peoples' emotions stating that 'what people 'feel' about something may not smack of good science to some, but does provide a finger on the pulse of the parameter as experienced in their lives.' Consequently, there could be an argument that horse traction could either increase or decrease quality of

life depending on the individual involved. Horse traction could be viewed as an indicator of sustainability depending on the emotional response of the farmer.

Farmers who gave a type (i) response also suggested that although the human labour involved was more time consuming, the necessity of the labour involved also contributed towards a stronger sense of community, Farmer B stated that 'Working with horses was great healthy work, kept farmers fit. The life was nice and relaxed. Would meet more people and talk.' This might suggest that horse traction meets another Rigby *et al.* (2001) sustainability indicator as horse traction 'improves equity "socially supportive"'. Although one farmer did state on return from time away from his farm, the first thing he does is'go to the stables to check and pet his horses' another farmer emphasized the benefit of tractors in that you can 'just put the key in ignition and you've started.' These results, it seems are all relative. Bell and Morse (2001, p.303) make the point that 'academics may run shy of words like 'beauty', 'goodness' and 'truth' but people everywhere understand them and value them and, whether we like it or not, they lie at the heart of sustainability.' With regards to animal traction, one farmer may find immeasurable value, or goodness, in his attachment to his horse while another farmer might consider the care of a horse to be a chore. Furthermore, although the emotional attachment of a farmer to his work horse may not be measurable, this researcher would like to cite Bell and Morse's (2001, p.304) observation that qualitative indicators, such as a farmer's quality of life, may resonate more with people than quantitative indicators since qualitative indicators often become the 'centre-point of vigorous and highly emotive debate.' Farmer M may have best succeeded in articulating feelings about the labour involved in animal traction, 'horses add to the contentment we get out of the work and adds to

the social aspects of working as a team, as they are living thinking creatures, co-operating with us to help us get the job done.'

In addition, the work involved in animal traction could be more beneficial to the farmer than the work involved with tractor traction. The comment offered by a ploughing competition supervisor, mentioned in the Results Section, on page 61, of ploughing competitions does imply that farmers who plough with horses seem to be calmer than their tractor ploughing counterparts. Could the possible contentment a farmer experiences at his work, overrule other indicators of sustainability? Or should it even be given serious consideration in the sustainability debate? Further research into this topic could be worthwhile, as this issue seems to be at the heart of the reasons why some farmers in Ireland might choose to work with horses over and above any consideration of sustainability.

However, an estimation of the amount of time involved in animal traction will now be attempted. In this case, there was a general consensus regarding the amount of daily care the work horse requires. Around 30 minutes a day was the suggested time required by each horse. This would involve mucking out stables, feeding and grooming. This rule does decrease if the horses are kept at grass (during summer months) in which case many of the interviewees suggested that five minutes was sufficient to water and check over each horse. Again, there were exceptions do this rule. Farmer J spends around 'Four hours a day' looking after his horses. It may be interesting for the reader to learn that Farmer J is considered, by the other ploughers, to be particularly 'gifted' with his horses, and this researcher witnessed the bond enjoyed between this interviewee and his horses. The four hours he spends caring for his horses may not be a necessity but more a reflection the enjoyment he experiences while with his horses, he did state that he viewed the time as 'quality

time.' In terms of sustainability, this time consumption may be acceptable on small farms where two or three horses are needed. However, on larger farms, this time cost would increase as horse numbers increase and could render animal traction unsustainable. A farmer would probably have to hire labour to attend to, as well as drive, the large number of horses necessary for a large farm (200 acres would require at least nine horses if the horse per acreage rule is followed) , this would dramatically increase costs to the point where horse traction could be rendered uneconomic as well as unsustainable. Again, therefore, the sustainability of animal traction is dependent on the size of the farms. However, as outlined in the Literature Review on page 9, the feasibility of small farms may be at risk with the high cost of machines per acre. It could be argued that for small farms, horse traction could prove to be more sustainable.

Additionally, horses require further human labour inputs for their training. Time estimates for training differed amongst the respondents. Farmer F,G and J estimated around six to eight weeks of training were necessary before a horse could be used in a team. Farmer M, who trains young horses for farm work each winter, suggests that is does take the winter to train the horses. Farmer M, believes that training is gradual and a horse should be well trained by six or seven years. A six to eight week time requirement for a new horse might be tenable for farmers, however, this is a guideline. Training a horse is dependent on several factors including the skill of the human trainer and the character or temperament of the horse. This constraint may have a bearing on the sustainability of horse traction, however, given the potential benefits of horse traction, this constraint may be acceptable if it does not cancel out the meeting of sustainability indicators.

Soil Compaction

As listed in the Results Section, on page 57, interviewees had more developed opinions relating to soil compaction. Twelve out of the thirteen respondents indicated that animal traction would reduce soil compaction. Farmer A was the exception to this response and maintained that tractors are 'better for the soil.' As mentioned in the section on Crop Yields, on page 87, the background of Farmer A could suggest that he is biased against horse traction and his opinions are not rooted in his experience but are more a reflection of his attitude. Furthermore, the issue of soil compaction also generated another issue that was not anticipated by the researcher. Farmer D offered his own opinion, based on his experiences. Farmer D has travelled to Amish counties in Ohio and made a number of observations on his visit. Amish farming, which is powered by horse traction and, consequently, has often been the subject of horse traction research (some of which has been referred to in this study) may not be universally relevant if Farmer D's account is acknowledged. Farmer D states that Amish farmers 'have the best sort of land with sandy soils that make it easier to plough with horses.' Farmer D believes Irish soils are heavy and, potentially, more difficult to farm with horses. Although Farmer D was not referring to soil compaction, this point could merit further research, unfortunately, research on the suitability of Irish soils for animal traction is beyond the limits of this study. If farther research proves that Irish soils are particularly ill suited to animal traction, then the sustainability of animal traction in Ireland could be jeopardised. Nevertheless, the possibility that the use of animal traction on Amish farms has maintained the 'sandy soils' would also need to be looked at.

Generally, the problem of soil compaction was expressed by most of the farmers. Farmer I, who is mechanised and farms 250 acres, has found that machinery really compacts his soils. A solution to the problem of soil compaction could be offered by horse traction, Farmer F was able to compare the change horse traction made on his soils which had been farmed by tractor traction, after the second year of horse traction the soil was 'not as compacted.' Mechanised farming, relating to soil compaction, may be deemed as unsustainable given 'that the regenerative capacity of renewable resources' (FAO 1995) is compromised by the heavy machinery.

Since most of the interviewees agree that horse traction reduces the problem of soil compaction, it may follow that horse traction meets sustainability indicators. Specifically, if horse traction could ensure that soils remain viable then it could be surmised that horse traction meets the Rigby *et al.* (2001) sustainability indicator which requires that a farming practice 'sustains the viability' of the farm. It could be argued that tractor traction, on the other hand, might threaten the viability of the farm if the soils become too compacted by the process of tractor traction. The problem of soil compaction was even noticed at the ploughing championships where Farmer I, and his farming companions, all observed that the land was very compacted by machinery and it was 'difficult to get below a 3 inch depth even though 6 inches was (depth) needed for competition.' Even if animal traction is not exploited on a wide scale, this researcher suggests that mechanised farmers could attempt to rectify serious soil compaction on their land by utilising horse traction for a few seasons. This is conjecture however, such a practice could be worthy of consideration especially if severe soil compaction puts the viability of farms at stake.

Modern Horse Traction Machinery in Ireland

Although there have been a few references to modern machinery for horse traction, as has been noted in the Literature Review, on page 12, for the most part the use of modern machinery was not strongly evident in the interviews. In fact, the use of modern horse traction machinery was only widely used by Farmer L. Although modern horse traction may increase the benefits (or simply decrease the disadvantages) of horse traction, in Ireland there has not been a strong uptake of modern machinery. The Results Section, on page 87, has highlighted the continued use of old machinery, some over a century old. This situation might deter those interested in horse traction from switching to horses. The age of the machinery, nonetheless, does suggest the durable nature of animal traction equipment as well as the fact that farmers are able to repair their own equipment which may meet the sustainability indicator that horse traction 'increases farmers' self-reliance.' (Rigby at al 2001). However, if the machinery used in Ireland by farmers who work with horses is antiquated, then this may suggest that Irish farmers who use horse traction may not be as productive as their overseas counterparts who utilise modern equipment and may enjoy higher productivity because of it. In other words, Ireland has yet to reach the full potential of horse traction. This could also weaken the argument that horse traction is more sustainable in Ireland if there is a serious limitation on the equipment available to horse traction farmers.

Farmer L's equipment, as pictured in the Results Section, on page 63, are evidence that modern horse machinery can be sourced and may help a farmer to farm with horses more conveniently. However, the machines still do not allow Farmer L to compete with mechanised traction in terms of speed. What they do allow, in the

case of the Round Bale of Hay carrier, is for Farmer L to integrate with mechanised farming practices – Farmer L is not limited by the fact that he uses horse traction. Farmer L has a machine for each farm task just as his mechanised counterparts would have. Farmer B suggested that 'to plough one acre involved a 12 mile walk,' Farmer L's plough allows the farmer to sit on the plough just as a mechanised farmer can do. Modern horse traction machinery, therefore, may contribute towards the sustainability of horse traction by increasing the farmer's quality of life (by making the work easier for the human labourer) as well as potentially (though not evidenced in this study) increasing productivity.

Conclusions

Since several factors relating to animal traction in comparison to tractor traction have been covered, sustainability indicators will now be used to compare the two forms, these indicators will incorporate the FAO (1995) indicators of sustainable agriculture as well as the indicators suggested by Rigby *et al.* (2001), however, since this was a qualitative study, it should be noted that these tables will only give a general idea of findings.

FAO (1995) Sustainability Indicators for Agriculture	Tractor Traction	Animal Traction
• Ensures that the basic nutritional requirements of present and future generations, qualitatively and quantitatively, are met while providing a number of other agricultural products	Yes	Inconclusive
• Provides durable employment, sufficient income, and decent living and working conditions for all those engaged in agricultural production	Yes but may limit numbers employed in agricultural production	Yes
• Maintains and, where possible, enhances the productive capacity of the natural resource base as a whole, and the regenerative capacity of renewable resources, without disrupting the functioning of basic ecological cycles and natural balances, destroying the socio-cultural attributes of rural communities, or causing contamination of the environment.	No, tractor traction does not meet these indicators. It could be argued that tractor traction does not meet any of these indicators	Yes, horse traction can become part of the natural resort base, it is a renewable form of energy, it may enhance rural communities and it is less likely to cause contamination of the environment.
• Reduces the vulnerability of the agricultural sector to adverse natural and socio-economic factors and other risks, and strengthens self-reliance.	No, tractor traction is vulnerable to rising oil prices and reduces self reliance	Yes

Figure 12 Comparison with FAO (1995) sustainable agriculture indicators

Rigby *et al.* (2001) Sustainability Indicators for Agriculture	Tractor Traction	Animal Traction
•Improved farm-level social and economic sustainability	Decreases farm level social and economic sustainability	Increases farm level social and economic sustainability
• enhances farmers' quality of life	Dependent on individual farmer	Dependent on individual farmer
• increases farmers' self-reliance	Decreases farmers' self reliance	Increases farmers' self reliance
• sustains the viability/profitability of the farm	Dependent on too many variables To estimate here	Dependent on too many variables to estimate here
•Improved wider social and economic sustainability	Not included in this qualitative study	Not included in this qualitative study
• improves equity 'socially supportive'	Decreases social supports	Increases social supports
• meets society's needs for food and fibre	Yes	Inconclusive (animal traction not being practised on wide enough scale to measure)
•Increased yields and reduced losses	Minimal, if any, increase in yields or reduced losses	Minimal, if any, increase in yields or reduced losses
• minimising off-farm inputs	Maximises off farm inputs	Minimises off-farm inputs
• minimising inputs from non-renewable sources	Maximises inputs from non-renewable sources	Minimises inputs from now renewable sources
• maximising use of (knowledge of) natural biological processes	Minimises use of (knowledge of) natural biological processes	Maximises use of (knowledge of) natural biological processes
• promoting local biodiversity/'environmental quality''	Not included in this study (could be worthy of a dedicated study)	Not included in this study (could be worthy of a dedicated study)

Figure 13 Comparison with Rigby *et al.* (2001) sustainable agriculture indicators

It should be emphasised that these findings reflect the results of this study and it may not be appropriate to generalise these findings on to society at large. However, even though horse traction may meet more indicators of sustainability as highlighted above, this does not mean that animal traction is more sustainable than tractor traction. The weakness of this study emerged in the lack of responses or opinions relating to crop yields and animal traction. Tractor traction, at present, does meet 'society's needs for food and fibre' (Ribgy *et al.* 2001). The FAO (1995) requires that sustainable farming practice 'ensures that the basic nutritional requirements of present and future generations, qualitatively and quantitatively, are met while providing a number of other agricultural products.' Animal traction in Ireland does not occur on a wide enough scale, at present, to conclude that it can support our nutritional needs. It could be argued that in the 1950s, prior to the widespread uptake of mechanisation, Ireland relied on animal traction to provide our food requirements. The Central Statistics Office (CSO) (2009) records that in 1951 our population was 2,960,593 while in 2006 the population had risen to 4,239,848 - a population increase of 1,279,255. Furthermore, 'in 1841 Ireland supported a population of 8,175,124.' (Dublin University Magazine 1844). This is no way suggesting that Ireland could or should support a population of a similar size again, and it could be argued, that the country could not support this population in light of the Irish Famine, however, this could be over simplifying the causes and contributing factors of the Irish Famine. The problem of estimating crop yields, or whether horse traction could feed the population, could be compared to similar comparisons between organic and commercial farming where the ability of organic farms to meet society's nutritional needs has been called into question. D.J. Connor (2008) refers to this

debate and states that ‘an important issue to the acceptance of organic agriculture is found in the question of its productivity. Existing analyses have put the carrying capacity of organic agriculture at 3–4 billion, well below the present world population (6.2 billion) and that projected for 2050 (9 billion).’

It is also suggested that although animal traction does seem to meet many indicators of sustainability, it may follow that these indicators should be weighted. The problem of weighting indicators of sustainable development was also suggested by Ribgy *et al.* (2001) who state that ‘the units of measurement and the appropriate scales for measurement differ both within and across the commonly identified economic, biophysical and social dimensions of sustainability.’ In short, should one indicator take precedence over another indicator? For example, should a farmer’s quality of life or the self sufficiency of a farm be weighted? This researcher suggests that some indicators should be given precedence. The renowned, if not original definition of sustainable development, states that sustainable development is ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs.’(Brundltand Report 1987). If horse traction cannot meet ‘the needs of the present’ even though it may be a renewable source of traction energy that improves a farmer’s quality of life, then how can it be deemed sustainable? This study did not succeed in measuring whether horse traction could meet the needs of Irish society. Consequently, the answer to this problem may be discovered in further research. The absence of information on the issue of crop yields means that this study will be inconclusive regarding the question of sustainability between horse traction and tractor traction.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

This study has succeeded in showing that a small scale farm could be supported by animal traction which could make the farm more economically viable, improve the farmer's quality of life and self reliance, reduce external inputs and minimise the farm's dependence on non renewable sources of energy. Whilst animal traction may not be suitable for all farms, there is the economically viable option to use animal traction for those farmers whose quality of life or enjoyment of their work could be improved by working with horses.

Throughout this dissertation, the need for further research into certain areas has arisen. The issue of soil compaction and horse traction may merit a dedicated scientific study as suggested on page 32. The lack of opinions relating to crop yields and horse traction has been a problem throughout this study as mentioned on page 23 and which has been discussed on page 87. A project similar to the project in Hof Hollergraben, Germany (on page 26) should be conducted in an Irish setting to determine differences in crop yields. Additionally, the land required to support a working horse may also require a dedicated study as outlined on page 74. The suitability of Irish soils for horse traction was an issue that arose, as referred to on page 93, and may be worthy of more research. Perhaps the most significant idea to emerge relates to the potential improvement of a farmer's quality of life as a direct result of horse traction. In depth research regarding this potential issue could

generate interesting theories linked to sustainability, however, the issue could be more suited to psychological research due to the human intricacies involved and the possible therapeutic effect of working with horses. The lack of research into modern horse traction has been consistently referred to throughout this dissertation and, consequently, further research into this area is strongly recommended.

This study serves to illustrate that horse traction in Ireland has not been a subject of serious examination even though it could result in more sustainable small farms. Regardless of the outcome of horse traction research, any research that may uncover ways or practices that could be more sustainable should be endeavoured. Assumptions that horse traction is a thing of the past, or unworthy of serious examination, could lead to a missed opportunity as a consequence of an unwillingness to contemplate ideas that are outside the *status quo*. Achieving greater sustainability requires that we think beyond what is generally accepted. If new, old (as is the case for horse traction) or innovative practices fail, at least we may grow closer to achieving sustainability in our attempts, an attitude of 'nothing ventured, nothing gained' needs to be assumed.

REFERENCES:

Adams, P.W. 1998, 'Soil Compaction on Woodland Properties,' *The Woodland Workbook*, March 1998. Oregon State University, viewed 10th July 2009, http://extension.oregonstate.edu/catalog/pdf/ec/ec1109.pdf

Bell, Simon and Morse, Stephen, 2001, 'Breaking through the Glass Ceiling: who really cares about sustainability indicators?' *Local Environment*, Vol. 6, No. 3, 291–309.

Bender, M. H., 2000, An economic comparison of traditional and conventional agricultural systems at a county level, The Land Institute, *American Journal of Alternative Agriculture,* volume 16, Number 1, pp. 2-15.

Bender, M. H., 2002, 'Energy in Agriculture: Lessons from the Sunshine Farm Project,' paper presented at *the Third Biennial International Workshop, Advances in Energy Studies: Reconsidering the Importance of Energy*, Porto Venere, Italy, 24-28th September 2002 (proceedings in press).

Bolduc, Arthur, 2009, 'A Horse-Powered Produce Farm,' *The Draft Horse Journal*, Summer 2009. Viewed 2nd August 2009,

http://www.drafthorsejournal.com/summer2009/feature.htm

Bolgiano, Chris, 2009, 'A Tradition Born Anew - horse logging,' *American Forests*, volume 106, winter 2001, viewed 10th Aug, 2009,

http://findarticles.com/p/articles/mi_m1016/is_4_106/ai_67547039/

Broom, Alex, 2000, 'Using qualitative interviews in CAM research: A guide to study design, data collection and data analysis,' *Complementary Therapies in Medicine*, volume 13, Issue No. 1, March 2005, pages 65-73.

Bruntland, G. (ed.), 1987, '*Our common future: The World Commission on Environment and Development*,' Oxford, Oxford University Press, viewed 8th August 2008, http://www.un.org/documents/ga/res/42/ares42-187.htm

Central Statistics Office, 2009, '*Population 1901-2006,*' Central Statistics Office, Cork. Viewed 20th October 2009,
http://www.cso.ie/statistics/Population1901-2006.htm

Connor, D.J., 2008, 'Organic Agriculture Cannot Feed the World,' Field Crops Research
Volume 106, Issue 2, 5th March 2008, pages 187-190,
viewed 12th October 2009,
http://0www.sciencedirect.com.ditlib.dit.ie/science?_ob=ArticleURL&_udi=B6T6M-4RKDPM4-1&_user=2322584&_coverDate=03/05/2008&_alid=1056731262&_rdoc=1&_fmt=full&_orig=search&_cdi=5034&_sort=r&_docanchor=&view=c&_ct=5115&_acct=C000056897&_version=1&_urlVersion=0&_userid=2322584&md5=2cd0757654cfdded7ef796213c3e1d58#secx5

Cornelissen, A.M.G, J.,Van den Berg, W.J. Koops, M. Grossman and H.M.J. Udo, 2001, 'Assessment of the contribution of sustainability indicators to sustainable development: a novel approach using fuzzy set theory,' *Agriculture, Ecosystems & Environment*, volume 86, Issue 2, August 2001, pages 173-185.

Courteau, Dick, 2007, 'Horse Power: A practical suggestion that could transform the way we live,' *Orion Magazine*, September/October 2007, viewed 15th January 2009,
http://www.orionmagazine.org/index.php/articles/article/343/

De Beyer, Don. 2001, 'Draft Horses,' *Suite 101*, 1st December 2001, viewed 5th May 2001, http://www.suite101.com/article.cfm/farming/53483/2

De Decker, Kris, 2008, 'Bring Back the Horses,' *Low Tech Magazine*,' 18th April 2008, Ed. Vincent Grosjean, Barcelona, Spain, viewed 3rd August 2008,
http://www.lowtechmagazine.com/2008/04/horses-agricult.html

Denscombe, M, 2007, *The Good Research Guide: For Small-scale Social Research* Buckingham: Open University Press, pages 174-204.

Dublin University Magazine, 1844, 'Census of Ireland 1821, 1831, and 1841 compared,' *Dublin University Magazine*, volume 23, number 137, May, 1844, viewed 20th November 2009,
http://www.libraryireland.com/articles/CensusIrelandDUM23-137/index.php

Dunkle, Guy. 2008, 'Horse Logging an Old New Standard,' *Farming Magazine*, Fall 2008, Ohio, viewed 30th August 2009,
http://www.farmingmagazine.net/Articles/Horse%20Logging.pdf

Fall, Alioune and Adama Faye, 1999, 'Minimum tillage for soil and water management with animal traction in the West-African region,' in P.G Kaumbutho and T.E. Simalenga (eds) *Conservation Tillage with Animal Traction. A resource book of Animal Traction Network for Eastern and*

Southern Africa (ATNESA), Harare, Zimbabwe, viewed 13th August 2009, http://www.fao.org/ag/ags/agse/agse_s/3ero/namibia1/c18.htm

Food and Agricultural Organisation, 1995, 'Sustainability issues in agricultural and rural development policies,' FAO Trainer's Manual, volume 1, viewed 10th September 2009,

http://www.fao.org/wssd/sard/index-en.htm

Food and Agricultural Organisation, 2009, '*Draught Animal Power*,' Agriculture Engineering Branch, FAO, Rome, viewed 15th December 2008, http://www.fao.org/ag/ags/agse/chapterps1/chapterps1-e.htm

Forristal, Dermot, 1999, 'Machinery Costs On Tillage Farms And The Development Of Decision Support Systems For Machinery Investment/use On Farms,' *Teagasc,* Crops Research Centre, Carlow, viewed 7th July 2009,

http://www.teagasc.ie/research/reports/crops/4156/eopr-4156.asp

Forristal, Dermot, 2009, Personal Communication.

Friedmann, Erika, 1997, 'The Human Companion Bond: How Humans Benefit,' *Alternative Therapies in Health and Medicine*, volume 3, Issue 4, July 1997, Pages 8-16.

Ganzel, Bill, 2009, 'Horses Finally Lose Their Jobs,*' Living History Farm*, New York, viewed 29th August 2009,

http://www.livinghistoryfarm.org/farminginthe40s/machines_13.html

Glaser, B. and A. Strauss, 1967, 'The discovery of grounded theory,' Aldine, Chicago, in Walsh, Denis, 2006, 'Appraising the Quality of Qualitative Research,' *Midwifery,* volume 22, Issue 2, June 2006, pages 108-119.

The International Center for Technology Assessment, 1998, '*The Real Price of Gasoline*.' International Center for Technology Assessment Washington, D.C, November 1998, viewed 9th August 2009, http://www.icta.org/doc/Real%20Price%20of%20Gasoline.pdf

Jackson, W & M. Bender, 1982, 'Horses or Horsepower?' *Soft Energy*, July/August 1982, pp. 70-87.

Kendell, Chet 2005, 'Economics of Horse Farming,' *Rural Heritage*, Spring 2005, pp 71-80, viewed 2nd February 2009, http://www.ruralheritage.com/back_forty/economics.htm

Kolstrung, Ryszard, 2007, 'Renaissance of working horses: Benefits of using horses in farming and forestry,' *Proceedings at the International Coalition to Protect the Polish Countryside,* Museum of Ethnography, Krakow, 6th November 2007, viewed 2nd July 2009, http://www.icppc.pl/eng/index.php?id=278

Larkin, Michael, 2004, '*Quantitative and qualitative approaches to research*,' De Montfort University, Leicester, UK, official website, viewed 28th August 2009, http://www.psy.dmu.ac.uk/michael/qual_aims.htm

Logsdon, Gene, 2009, 'Did the Amish get it right after all?' *Organic To Be*, 13th February 2009. viewed 3rd April 2009, http://energybulletin.net/node/47713

Morris, Siobhán and Martino Newcombe, 2008, 'Horses for courses**,'** *Organic Matters*, Sept/Oct 2008 Issue, Longford, viewed 2nd September, 2008, http://www.organicmattersmag.com/features/1-features/205-horses-for-courses

Myers, Michael D. and Michael Newman, 2007, 'The qualitative interview in IS research: Examining the craft,' *Information and Organization,* volume 17, Issue 1, 2007, pages 2-26.

McQuail, Tony, 1993, 'Farming with Work Horses**,'** *Ecological Farmers Association of Ontario***,** McGill University (Macdonald Campus), Ste-Anne-de-Bellevue, Canada, viewed 12th May 2009,
http://eap.mcgill.ca/MagRack/EFA/EF_93_E_1.htm

Morris, Siobhán and Martino Newcombe, 2008, 'Horses for courses**,'** *Organic Matters*, Sept/Oct 2008 Issue, Longford, viewed 2nd September, 2008,
http://www.organicmattersmag.com/features/1-features/205-horses-for-courses

New Rider, 2009. 'How Much Land per Horse?' New Rider, Worcester, official website. viewed 24th September 2009,
http://www.newrider.com/Library/Misc_Tips/land_horse.html

Panin, Anthony, 1995, 'Empirical evidence of mechanization effects on smallholder crop production systems in Botswana,' Elsevier Science Limited, *Agricultural Systems*, *Volume 47, Issue 2*, *1995*, *Pages 199-210.*

Pavia, Audrey and Janice M. Posnikoff, 2005, 'Horses for Dummies,' Wiley, John & Sons Ltd., viewed 24th September 2009,
http://books.google.ie/books?id=lBNPjojOho8C&pg=PA22&lpg=PA22&dq=average+horse+weight&source=bl&ots=akGmTxLJ6Z&sig=W-czB_mgighqGjqOrF_XiJzajm8&hl=en&ei=EzTWSvXHI4uH4Qbq8uzeDA&sa=X&oi=book_result&ct=result&resnum=5&ved=0CBUQ6AEwBDgK#v=onepage&q=average%20horse%20weight&f=false

Pimentel, David, 2009, Reducing Energy Inputs in the Agricultural Productive Systems, *Monthly Review*, July-August 2009, viewed 19th July 2009,

http://www.monthlyreview.org/090803pimentel.php#pimentel

Pinnney, Charlie. 2003. 'The case for returning to real live horse power,' in Douthwaite, R. J (ed.), *Before the Wells Run Dry Ireland's Transition to Renewable Energy*, Greenbooks, Dublin, viewed 10th November 2008,

http://www.feasta.org/documents/wells/contents.html?sitemap.html

Rigby, Dan, Woodhouse, Phil., Young, Trevor and Burton, Michael, 2001, 'Constructing a farm level indicator of sustainable agricultural practice,' *Ecological Economics*, volume 39, issue 3, December 2001, pages 463-478.

Rose, Julian, 2007, 'Renaissance of working horses: Benefits of using horses in farming and forestry,' paper presented at the *International Coalition to Protect the Polish Countryside Conference* Museum of Ethnography, Krakow, 6th November 2007, viewed 02/07/09.

http://www.icppc.pl/eng/index.php?id=278

Rydberg, T. and Jansén, J., 2002, 'Comparison of horse and tractor traction using emergy analysis,' *Ecological Engineering,* volume 19, pages 13-28.

Sandelowski, M. and J. Barroso, 2002, 'Reading qualitative studies,' International Journal of Qualitative Methods 1, pp. 1–47, in Walsh, Denis, 2006, 'Appraising the Quality of Qualitative Research, *Midwifery*, volume 22, Issue 2, June 2006, Pages 108-119.

Schmid, Sandra, 2000, 'The Fall and Rise of the Work Horse,' *Sustainbility Magazine*, No. 3.

Sparks, Jim, 1988, 'Horse-drawn ploughs unearth pleasures of past,' *The Spokesman-Review*, April 25th 1998, viewed 1st September 2009,

http://news.google.com/newspapers?nid=1314&dat=19880425&id=3DcSAAAAIBAJ&sjid=ne8DAAAAIBAJ&pg=3236,6529879

Starkey, Paul H., 2000, 'Rapid appraisal methodologies for animal traction,' in Kaumbutho PG, Pearson R.A. and Simalenga TE, (eds), *Empowering Farmers with Animal Traction: proceedings of the workshop of the Animal Traction Network for Eastern and Southern Africa (ATNESA)*, 20-24 September 1999, Mpumalanga, South Africa.

Storey, Norman, 2004, 'Cost of Producing a Weanling Foal,' *Teagasc,* ,Kildalton College, Piltown, Co. Kilkenny, viewed 4th October 2009,

http://www.teagasc.ie/ruraldev/docs/programmemes/equine/Cost_of_production.pdf

Strüber, Klaus, 2004, 'Arbeitspferde im biologisch-dynamischen Gemüseanbau. Zusammenfassung iner Projektarbeit,' *Starke Pferde*, volume 29, January 2004, viewed 15th August 2009,

http://orgprints.org/9425/1/SP_29.pdf

Strüber, Klaus, 2005, 'Arbeitspferde im biologisch-dynamischen Gemüsebau. Zusammenfassung des Berichtes,' *Starke Pferde,* volume 33, January 2005, viewed 15th August 2009,

http://orgprints.org/10121/1/SP_33.pdf

Thomas, Cindy, 2009, 'Clydesdale Working Horse Breed Description & Equine History,' Horses and Horse Information, official website, viewed 1st October 2009,

http://www.horses-and-horse-information.com/articles/clydesdale-horses.shtml

UN Department of Economic and Social Affairs, 2009, 'Agriculture,' Division for Sustainable Development, United Nations Official Website, viewed 15th May 2009,

http://www.un.org/esa/dsd/susdevtopics/sdt_agriculture.shtml

Verma, S.R, 2008, 'Impact of Agricultural Mechanization on Production, Productivity, Cropping Intensity Income Generation and Employment of Labour.' *Department of Agriculture and Cooperatives, Ludhiana*, viewed 5th September 2009,
http://agricoop.nic.in/Farm%20Mech.%20PDF/05024-08.pdf

Walsh, Denis., 2006, 'Appraising the Quality of Qualitative Research,' *Midwifery,* volume 22, Issue 2, June 2006, pages 108-119.

Warren, Lori K., 2002, 'Feeding Working and Performance Horses,' *Alberta Agriculture, Food and Rural Development*, Canada, viewed 20th August 2009,
http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex5409