

A Central Region Farmers Trust Award

Sustainability in the organic and conventional farming sectors

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Executive Summary

The agricultural sector is fed up with organic and conventional farmers trying to score points over each other, especially when there is a food or environmental crisis. The reality is we need to work together to try to avoid problems occurring and develop the best, most sustainable farming system we can rather than worry about its terminology.

The paths of organic and conventional farms have diverged greatly over the last sixty years but both have achieved significant gains in productivity and environmental management over this time. With global food demand increasing the requirement for mineral resources, both for crop nutritional and petrochemical input, a method needs to be found to farm efficiently.

On my travels to China, Kenya, South Africa and Austria I saw many examples of highly refined agricultural businesses which offered both financial and environmental benefits over the common practice. These examples of good practice were on both organic and conventional farms and there were clear examples where diversifying into an organic market has led to a change in farming techniques for the conventional farmed area towards organic principles.

Household food security is an issue for over one third of the world's population and this issue is being made worse by soil erosion and degradation. The world population is increasing and there is no extra land available to grow crops on, therefore, food must be produced more efficiently from the land that is available and this land must be cared for to ensure that future generations have the same opportunities. Soil erosion is a very serious problem in most tropical countries but is becoming more of a problem in the UK. Farming systems must take account of avoiding high risk situations and adopt techniques to minimise erosion.

Organic farmers have often had to develop alternative production methods for weed and pest control to maintain satisfactory yields. Many of these techniques may become of greater interest to conventional farmers with rising energy costs impacting on the price of fertilizers and pesticides, together with increasing public and environmental pressures. Issues such as growing world population and less land availability to grow crops may require biotechnology as important part in food production. To find the best pathway the organic sector will need to engage with the conventional farming sector for a fruitful share of knowledge and allow further development. For agricultural systems to adapt they will need to take the best parts of all UK farming systems and use new technology to develop sustainable, efficient farming techniques.

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1.0 Introduction

1.1 Background

I grew up on a small beef and sheep farm in East Sussex. Much of the farm was marshland and thereby restricted farming options. From when my grandparents purchased the farm in 1970 through to the early 1990s my family took great pride in the 'taming' of the marshes which resulted in increased stocking rates and a longer grazing season. Now the objectives of this type of farming system have changed and all of this land is under environmental stewardship schemes. Part of the farm became a Ramsar site in 1992 and involved the management of wetland to try and rectify some of the damage caused by drainage and the intensification of agriculture. We considered ourselves traditional low input farmers and from an early age I developed an interest in appropriate agricultural management systems for the environment.

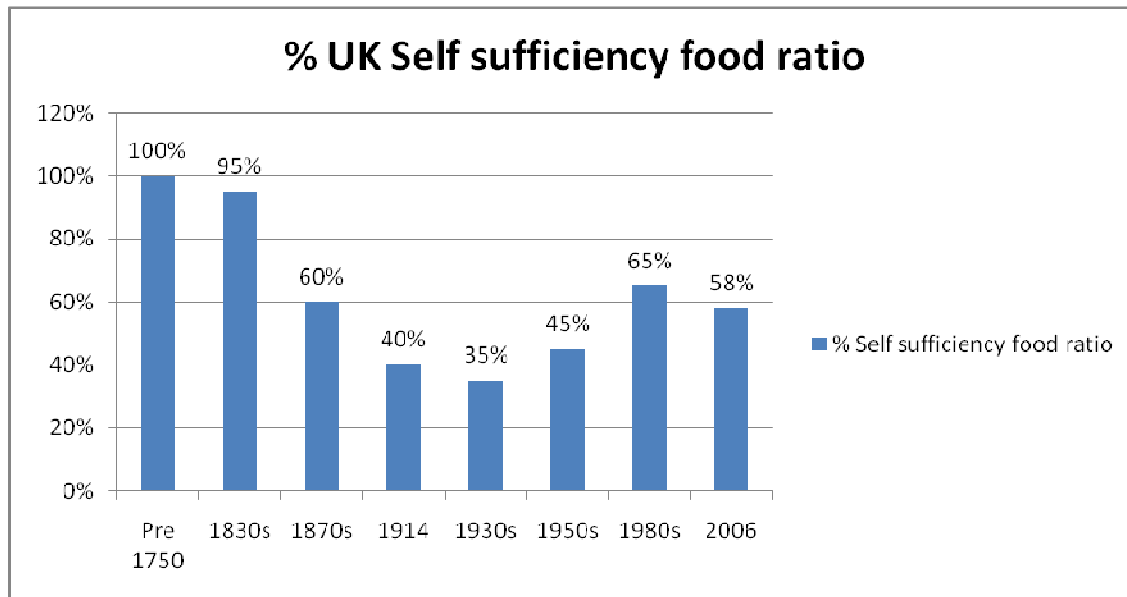
I obtained a degree in agriculture from Wye College and went on to gain a PhD from Reading University in "Genotype and systems interactions on grain yield and quality for organic wheat production". I then worked as a research officer for Silsoe College on a multidisciplinary funded precision farming project. Since this role I have worked as an organic adviser and eight years ago I established Nicola Cannon Organics from which I have operated in advice, training and consultancy. Currently I am a Lecturer in Crop Sciences at the Royal Agricultural College, Cirencester.

I am married to Adrian and we have three children Henry (8), Sally (6) and Alice (4) who have all greatly enjoyed the Nuffield experience. All three children have developed and been inspired far more than I ever imagined by joining me on part of my travels and following the rest back home.

1.2 Setting the Scene in the UK

Europe was designated a famine area in 1947 requiring substantial increases in food production. Grassland was ploughed-up and until 1966 the British Government subsidised fertilizer supply. A fast recovery was made and by the 1950s food was in adequate supply. The car industry and other industries started to expand rapidly, needing extra labour which came mostly from the agricultural workforce. The remaining people left working on the land therefore had to produce food more efficiently. This led from a shift from hoes to herbicide and from farm yard manure to chemical fertilizers, with machines rapidly replacing men. Farming soon became very efficient, profitable and attractive to investment from large institutions. This caused a rise in land prices and therefore a need for reliable good yields to repay investment.

The Common Agricultural Policy (CAP) of the European Communities was introduced in 1957 under the Treaty of Rome when Europe was still rebuilding after the war. The aims of the policy were to achieve self sufficiency, affordable food, acceptable income for producers and maintenance of employment in the agricultural sector. Average wheat yields in the UK rose from 2.72 t/ha in 1948-53 to 7.74 t/ha in 1998-2002. The UK changed from being a major importer of wheat of only around 24% self sufficiency pre- World War II, to a major exporter of 131% self sufficiency in 1987. Increased productivity was achieved through major advances in plant breeding, enabling greater fertilizer responses. The agrochemical industry evolved offering a wide range of herbicides, fungicides, insecticides and other products, which contributed to the high yields. However since the 1980s the UK has begun to decline in self sufficiency.



Even when non-native foods (foods we can never produce in the UK e.g. bananas) are excluded we only produce 71% of indigenous food types in the UK. There has been a drop in UK self-sufficiency of 15.6 percentage points since 1995.

1.3 A Change in Mindset

When the UK joined the EU in 1973 further subsidies became available to encourage self sufficiency in oil, milk and cereals. In the 1980s there were reports of “grain mountains” and “milk lakes” and the policies had to be changed as the public were no longer prepared to support the British farmer to produce unwanted products.

Other factors have also changed, in 1900 over 40% of the UK population was involved in farming, now it is less than one percent. People are far less in touch with how their food is produced and therefore do not fully appreciate factors of food supply. Many people do not consider fruit or vegetables to be seasonal products and understand little of the complex interactions between environment, food, energy supplies, greenhouse gas (GHG) emissions, the list could continue.

The UK is a rich country which is open to trade and is considered by Defra to be well placed to access sufficient foodstuffs through a sound functioning world market. The UK is able to trade internationally which allows for flexibility should a poor harvest or other problems occur with food supply. Our supermarkets access food from all over the world to meet our demand for year round varied fresh produce and they dominate the delivery of food to the point of sale to the public.

1.4 Concerns of Intensive Agriculture

With food in adequate supply, anxiety was expressed concerning the dependence of many farmers in controlling pests of agricultural crops with pesticides. Fears were raised due to possible adverse effects, such as the destruction of natural enemies of pests and other wildlife. There has also been concern that the use of such products could lead to undesirable levels of contamination in crops, soils and rivers. Fears have increased in recent years with greater awareness of global warming and it is widely stated that UK agriculture contributes more than its fair share of the GHG emissions. Defra has published fact sheets and is running workshops to help farmers understand the consequences of GHG emissions and to try and reduce the damaging effects of their businesses.

Nitrate Vulnerable Zones were first introduced in 1996 to try and reduce nitrate pollution in water by restricting the amount of fertilizer applied, both inorganic and organic forms and to ensure applications were only made at appropriate timings. Since this pilot scheme covering just eight percent of the country in 1996 it has expanded to cover fifty five percent by 2002 and is rising to seventy percent in 2008. Many more measures have also become statutory like the Code of Good Agricultural Practice as specified in the Water, Air and Soil codes. Money is also being channelled away from production support into environmental payments most notably with the Entry and Higher Level Schemes and Organic options. Anybody farming over the last ten years has to have become more environmentally aware and undoubtedly there is still far more to come. If we are going to produce sufficient food to feed not only ourselves but to try and feed the growing world population in an environmentally sensitive manner we need to draw on all the information available to ensure agriculture develops in a sustainable manner.

In 2006 Lord Stern published the review commissioned by the Chancellor of the Exchequer in July 2005 assessing the nature of the economic challenges of climate change and how they can be met, both in the UK and globally. This review received a great deal of media attention and seems to have been the trigger to change. Suddenly it seemed that most people are aware of the environmental issues facing us and many people in the UK have had their lives affected by flooding, rising fuel and food prices. Agriculture contributes about 7 percent of greenhouse gases and is the second largest source of UK GHG emissions. Of that:

- Only 1% is from CO₂ e.g. from the burning of fuels
- 36% of the UK's total methane emissions are derived from agriculture. Methane is 21 times more potent than CO₂ and is mainly emitted from livestock or livestock manures
- 67% of the UK's nitrous oxide (NO) emissions are derived from agriculture. This gas is 310 times more potent than CO₂ and is released mainly from artificial fertilizers but also livestock manures

Defra advice on agriculture and climate change recommends farmers to “maximise the efficient use of their inputs of fuels, feed and nitrogen as these minimise GHG emissions and reduce costs”. Many studies have been conducted which aim to calculate the carbon footprint of various agricultural systems and results seem to differ vastly. The CLA offer the CALM model to help UK farmers calculate their output.

There are many guides available for farmers in the UK to follow to protect the environment and procedures to prevent environmental pollution, many of which are legislated.

1.5 The Global Food Market

The UK is a classic example of developed countries increasing their reliance on imported food and energy. This situation has two main effects on food production elsewhere in the world:

1. More land in other parts of the world being used to supply UK food needs, which potentially reduces the amount of food available for that country's domestic consumption.
2. Increased food miles resulting in greater carbon emissions.

Demand for food products has also risen globally and consequently prices have also risen. The reasons include:

- Peak oil and the reduction in oil reserves is increasing the cost of energy along the food supply chain.
 - Fertilizers and pesticides require high oil inputs to manufacture so the costs of these products is rising in line with the oil price.
- Increased amounts of grain and biomass are being used for biodiesel, biomass and bio ethanol production reducing land area for food production.
- Poor harvests among key commodity exporters.
 - Water shortages are becoming an increasing issue in many food producing regions of the world.
- Urban spread increases competition for fertile land.
- In developed countries it is increasingly difficult to get labour prepared to work in manual agricultural/horticultural work.
- The increasing affluence of large population centres like China and India has led to a dietary change resulting in more meat and dairy products being eaten. This leads to increased competition for food.

All these factors and global insecurity regarding oil trading could potentially lead to food insecurity in the UK and globally. The UK therefore needs to be in a position to meet the food challenges it may face and know how to grow food in a less oil intensive manner.

Patrick Holden of the Soil Association states:

“With humankind and the planet facing the converging threats of climate change, natural resource depletion and ecosystem collapse, ensuring that global agricultural systems can feed our burgeoning population, are sustainable and can both endure and help mitigate these threats could not be more vital.”

With so many factors influencing UK agriculture I decided to study different areas around the world that are influenced by UK markets and also an emerging economy to gauge agricultural development. The focus of my study was to look at the sustainability of organic and conventional farming systems.

2.0 What is Agricultural Sustainability?

“Sustainability means living, working and behaving in a way that will sustain the integrity and biodiversity of the local, regional and planetary ecosystems on which all life depends. It means finding ways to achieve the quality that we seek in our own lives without sacrificing the quality that Earth's many and varied ecosystems need”.

Guy Dauncey

Agricultural sustainability means different things to different parties involved. Some consider that agricultural systems that are classified as ecoagriculture, permaculture, organic, ecological, low-input, biodynamic, environmentally sensitive, community based or extensive are sustainable by definition. However, this is debatable and for the purposes of this study I consider how more sustainable agricultural systems make best use of the surrounding environment whilst not damaging these assets. Some key principles to this are:

- Minimising the use of non-renewable resources/inputs which damage the environment or harm the health of farmers and consumers
- Make productive use of the knowledge and skills of farmers, thereby improving their self-reliance and substituting human capital for costly inputs
- Making productive use of individuals capabilities to co-operate together to solve agricultural and natural resource problems e.g. pest attacks, water management and management of non-farmed areas
- Integration of natural processes such as soil regeneration and preservation, nutrient management, nitrogen fixation and natural enemies of pests into food production processes

The consideration of these principles does not rule out technological development as long as it improves productivity for farmers and does not harm the environment. Many people believe that sustainable systems have to be extensive. For many parties agricultural intensification conjures up negative images resulting in systems which impose significant environmental costs. Intensification using the best technologies available e.g. suitable advanced genotypes and good ecological management often results in greatly improved agricultural systems.

Many times the question has been raised of “What is Sustainability?” and this is something I have found myself mulling over many times during my study. It is a very important question when looking for measures of sustainability whether organic vs. conventional, local vs. imported, sustainable livelihood, sustainable transport and energy, the list continues. My view on this has changed dramatically and the question no longer seems to be about organic vs. conventional as, like many studies have shown, this can be debated in either direction depending on which side of the fence you sit on, or, how accountable the energy use in a system is.

I have therefore viewed sustainability for this study in terms of agricultural systems which leave the land and water in a less degraded state and also have positive social implications in terms of poverty reduction. These are extremely difficult conditions to monitor and highly subjective, but, throughout my travels I have seen inspiring examples of pesticide reductions, soil fertility and structural improvements, effective water management, careful

and sensitive farm management which can act as models to any global business. These businesses were operating in both the conventional and organic sectors and often techniques which had been developed out of necessity under organic management have now been adopted into conventional practice as they are such effective methods helping production in many ways.

2.1 Motives for my study

Headline grabbing issues influence the market for agricultural products in the UK. These factors include issues such as food security, social correctness, concern or lack of concern for the less fortunate, heightened interest in local and organic food, rising fuel costs, increased food imports, changing weather patterns, high food wastage, fluctuating food prices, the list is endless. Each on their own are large topics to consider and in my Nuffield study I wanted to look at as many of these topics and see how other parts of the world are influenced in organic and conventional farming sectors.

2.2 Destinations

With so much talk of emerging nations and the influence these countries are having on food and energy, I was very keen to take the opportunity to join the Australian Nuffield Scholars on the southern China tour. After China I decided to visit Kenya due to its very diverse environment and its significance in terms of food imports to the UK. Kenya has received a great deal of criticism in recent years for the air freight export e.g. green beans and cut flowers with questions raised over the sustainability of such practices. South Africa was my next destination due to its well developed food economy which has both an important high value domestic food market and highly developed export markets. I then decided to look at the European perspective of sustainable farming systems and visited Austria for the harvest festival celebrations to see how fellow Europeans consider sustainable farming techniques.

3.0 China

For centuries China stood as a leading civilization, outpacing the rest of the world in the arts and sciences, but in the 19th and early 20th centuries, the country was beset by civil unrest, major famines, military defeats, and foreign occupation. After World War II, the Communists under Chairman Mao established a repressive socialist system that, while ensuring China's control, imposed strict rules over everyday life and cost the lives of tens of millions of people. After 1978, his successor Deng Xiaoping and other leaders focused on market-orientated economic development and by 2000 output had quadrupled. For much of the population, living standards have improved dramatically and the room for personal choice has expanded, yet political controls remain tight.

The rest of the world has gained a far greater knowledge of China over the last four years and much of the mystic of this huge country has been unravelled. China has undergone a humanitarian facelift in the last decade and its ability to host the Olympic Games as well as cope with natural disasters like the Sichuan earthquake has been widely reported in the media. Much of what we hear about China is regarding its rapid urbanisation.

China has experienced a colossal increase in demand for food due to increasing population, higher disposable incomes and increased demand for meat products. In response, farming in China seems to have jumped a developmental phase going straight from peasant farmer to very large scale industrialised farming. There are producers growing certified organic products on a large scale but these are mainly crops which store and transport for export relatively easily e.g. garlic. The big impact China makes on the UK and worldwide agriculture is not only on its demand for food and raw inputs but also the country's ability to produce agricultural inputs at a much lower cost of production.

Competition from China to produce agrochemical, drugs and other products in the agricultural supply chain have often led British or European manufacturers to be forced out of business due to intense price competition. After the competition has been forced out of business the Chinese production can gain a greater control of the market and force the world price to rise. China will therefore continue to put global pressure on the UK agricultural sector.

4.0 Kenya

Like many African countries, Kenya has a very young population with the average person being just 18 years old due to the high number of deaths from HIV/Aids, despite this, Kenya is still experiencing rapid population growth. Kenya has benefitted from a free education system since 2003 thereby enabling the younger generation of poor subsistence farmers, for the first time, to dream of a future away from the land for their children, although, like most of sub-Saharan Africa, many people still do not have any concept of education and children will leave school early to ensure that there is food for their family.

Many of the more fertile areas and land with desirable characteristics like good transport, water for irrigation, or desirable climatic conditions were colonised by the whites back in the colonial days. This has left some land distribution discrepancies which continue to plague the country. There are stark differences in production systems between industrialised agriculture and the traditional farming techniques. Products grown for export have increased dramatically over the last 15 years and this has been encouraged by a large reduction in export taxes imposed on these products.

4.1 Horticulture for Export in Kenya

In recent years the media has attacked the supermarkets for buying horticultural products which are out of season in the northern hemisphere, from the southern hemisphere to insure year round supply of perishable fruit, vegetables and flowers. Many supermarkets have now adopted a labelling system to inform the consumer that the produce they are buying has been air freighted. The message I feel implied to the consumer, is that of shame and guilt for their purchase. But, in my opinion this is a simplistic view which is easy for westerners to adopt who are not on the poverty line.

Under the Millennium Development Goals a report has been written 'Unleashing Kenya's potential for trade and growth'. The report highlights a recovery strategy for wealth and employment as well as implementing a National Export Strategy. In sub-Saharan Africa export horticulture has often been proposed as a pro-poor development strategy due to its intensive use of land and unskilled labour. The follow on benefits of export horticulture have been seen as a good source of foreign exchange currency, employment and results in an upgrading of agricultural production skills. The criticisms of export horticulture have been claimed as workers having to work very long hours in poor working conditions for low pay, however, it is now generally considered that the reduction in poverty resulting from this trade is far greater than the problems encountered.

I observed a huge divergence between local based organic products (mainly uncertified) and export organics. I felt that the overall benefits explained of export horticulture are the same for organic production. Initially I felt really disappointed by the local organic sector in Kenya and the vast differences I observed but, on reflection I fill that the production techniques which are being pioneered for organic farming are useful for helping most local agricultural systems in Kenya.

The Kenyan Agricultural Research Institute (a very large governmental body) seemed to have no knowledge of any work relating to organic techniques and many of the scientists were looking towards biotechnology for solutions to improve productivity. However, I visited the Kenyan Institute of Organic farming (KIOF) where I saw students and farmer groups being instructing in techniques such as composting, mulching, crop rotations, weed

management, integrating livestock, alternative crops and animals into the system. This information all seemed very basic but I feel that not only applies in Africa, we need to go back to the basic principles and consider working with nature to solve some of the problems we are facing in terms of energy in the developed world i.e. fertilizer production, pollution, poisoning from pesticides and affordable production techniques.

Kenya's organic export production seemed to produce very clean, highly productive crop rotations, often performing at a similar level to conventional crops. There was wide scale use of integrated pest management, composting and well designed crop rotations. Many of the producers had been persuaded to go organic due to pressures from their buyers but had gone on to develop very successful systems that were often pioneering new techniques which they then adopted in their conventional crops.



4.3 Examples of Good Practice seen in Kenya

Kenya's location on the equator makes it ideally suited to year round crop production. In some of the more fertile regions of Kenya which also have sufficient water for irrigation, the farming system allowed several salad crops a year to be produced from a single field, or roses to be continually picked for the European market. Careful crop rotations have been



designed to avoid the build up of insect pests and plant diseases. Crop hygiene is also very important to these progressive farmers with all crop residues being removed from the field to avoid the tissue acting as a host for disease. There are also several companies offering biological control agents which often substitute the need for pesticides e.g. *trichoderma*, *phytoseiulus* and *digoneutis*. The introduction of *phytoseiulus persimilis*, a predatory mite in glasshouses to control spider mite has demonstrated that *phytoseiulus* can eliminate mites from

greenhouses without the use of chemicals, resulting in a reduction in annual chemical applications of 40 - 65%. This has not only resulted in increased yields and stem length of roses, and improved quality but also makes a substantial financial saving every year on crop protection inputs. Worker's health and safety is also less at risk due to dramatically lower pesticide applications to crops. The reduction in chemical applications has a knock on benefit of leaving the plant with waxier leaves and therefore providing a better natural defence to diseases like mildew.



Integrated pest management (IPM) is also being used in salad and vegetable crops. *Digoneutis*, a parasitic wasp is now being used and multiplied up on site where fresh peas are grown. This has the distinct advantages over using normal insecticide applications with no harvest interval, no problems with resistance to insecticides and the main benefit is that aphids are not left dead in the crop, which consumers dislike, they simply disappear.

In a tropical climate like Kenya plant residues quickly breakdown, however, if this is not managed carefully the dead and decaying tissue can act as a source of disease inoculum for future crops. At the Kenya Institute for Organic Farming they were well aware of the benefits of composting for soil improvement but at a couple of other farms I saw large scale composting, vermicompost as



well as further experimentation with worm casts. The production of vermicomposts requires very little capital to set up, is easy to manage, is a good way to get rid of plant debris and then supplies a highly nutrient rich extract which can be fed back into the system, a residual compost, as well as extra worms which could be sold or passed on to get other people to establish such systems.

4.4 Poor land management and soil degradation

It is often viewed that leaving land to nature provides the best environment for wildlife. However, the increasing population in Kenya are attracted to these areas and see them as a



free source of fuel or free grazing. Nomadic herders are still commonplace in Kenya and these people have lost much of their traditional grazing areas due to urban pressure, increasing population, National Parks and land colonisation. To many of the tribes, especially the Masai, cattle are the most important thing in their lives. Many city dwelling Masai will still own a large herd of cattle back in his home area. The Masai use their cattle for blood and milk production for food as well as trading for brides and other possessions. The high demand for cattle results in high animal thefts as well as the need for good grazing. When grass is scarce due to drought the herdsmen/boys will travel long distances with their cattle to find grazing. Anybody farming land must be constantly on their guard against cattle grazing their property as this can result in

disease and pests in their stock and often human conflict.

However, an even greater problem than illegal grazing seems to be with the high fuel demands of the urban population. People do not have electric or gas and favour charcoal as their fuel source as it provides a flameless heat hence is cleaner to cook by and requires less space to store than traditional wood fires. Some people have sought to introduce kerosene stoves but these are expensive to run and result in many people, especially children becoming injured with burns.



So many people in Kenya are looking for a way to make money as unemployment runs at 40 percent. These people often find unfarmed land and cut down the wood to make charcoal. The lack of ground cover resulting from this practice often leads to large scale soil erosion. This problem not only affects the land which has been cleared but also those farming downstream who find their dams become useless as they are choked with run off sediment. This situation causes irreversible damage which could be avoided if land was managed correctly or alternative safe fuel sources could be supplied. One idea that seemed of great relevance is a solar powered cooker, if this technology was available it would save the cutting down of vegetation, would have no running costs once the equipment was purchased or provided, is safe to use and would save a great deal of deforestation/loss of vegetation.

“Our efforts to defeat poverty and pursue sustainable development will be in vain if environmental degradation and natural resource depletion continue unabated.”

Kofi Annan, 2005

4.5 Water Resources and Preservation

Like much of East Africa, Kenya is a water scarce country although it contains many rivers and large lakes acting as vital water storage. Many Kenyans live without clean water and have to walk many kilometres each day in the search it. Selling water has become a profitable business for those who can dig a sufficiently deep borehole, however, for many the cost of buying water is a more serious issue than lack of food and much of the water drunk is contaminated.



Another issue of major concern is the environmental management of the riparian zone between the land and the water. River and lake banks can be easily damaged by livestock. Animals frequently crossing rivers cause degradation of the river banks which results in poor water quality and ecological damage. Both of these issues are serious problems in Kenya and the Riparian Societies have pressed hard for the 2002 Water Act, but, this is still gazetted (that is not legislated against yet).

Tick borne diseases are a serious threat to livestock in East African and cattle require frequent dipping to prevent disease. This dipping often occurs in unsuitable environments and the cattle are often made to cross a river after being dipped resulting in water contamination. The nomadic herdsman also require their cattle to drink on a daily basis with the result on bank degradation and overgrazing near water creating further environmental problems.

Some of the large scale agricultural/horticultural operations adopted careful water management policies with the introduction of reed beds, rainfall collection systems, concreted dipping areas, use of mulches to reduce soil water loss and careful cultivation techniques.

At El Donio they use the neutron probes in cereal stubbles to monitor water movement within the soil profile. This practice enabled drilling to be strategically timed to provide enough water for germination but allowed the crop to be established before the rains. This technique was also being used to monitor the effect of cultivation systems on soil moisture loss. The farm that had adopted this technique of water monitoring was finding that crop establishment had been greatly improved and crop failures were becoming less common. Many farmers in the wheat growing area around Mount Kenya are plagued by poor establishment and their yields are far below the crop yields consistently reported by the more successful farmers in the area using water conservation tillage techniques.

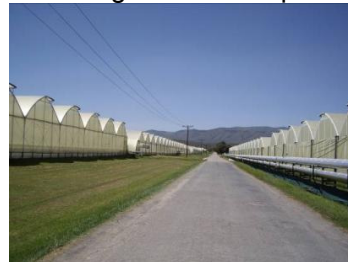


4.6 Sustainability of Air Freight Horticultrual Products

British consumers are often made to feel guilty by the media for purchasing air freighted produce from developing countries. Kenya is a prime example of a country where this type

of trade is very important to their agricultural/horticultural sector. Kenya's main export commodities include roses and other cut flowers, fine beans and salad leaves.

A consumer in the UK has three options when considering buying cut flowers, they can either buy them locally from a heated glasshouse (but probably from the Netherlands). Alternatively, they can buy flowers from Kenya which have been air freighted to Europe. A Dutch study in 2004 investigated the carbon emissions of these options and found that a European greenhouse contributed 670g of CO₂ per rose stem, but air-freighted Kenyan roses contributed half at 335g of CO₂ per rose stem. A more recent study by Cranfield University looked into the complete growing and transport chain for roses and found that a rose in Kenya produced 5.8 times less CO₂ than a rose produced in The Netherlands. The last alternative is the consumer can choose not to buy cut flowers.



Carbon emissions should not be the only factor to taken into consideration when deciding on the sustainability of flower growing. Crops that are grown in sunny environments e.g. Kenya are often situated in Developing Countries and therefore contribute significantly to the alleviation of poverty. In 2006 Kenya exported 18,650 tonnes of cut flowers to the EU and horticulture directly employed 135,000 people in a country where unemployment runs at over 50%. Studies have shown that an employed person in Kenya provides support for on average ten members of their extended family. That means that over one million people in Kenya are deriving benefit from the export of high value horticultural crops. These figures do not take into account people employed in allied service industries to this sector making the benefits even further reaching. When comparing this against the total aid budget for Africa, a 1% increase in Africa's share of global trade would deliver seven times more than the total aid budget.

To most Africans it seems highly hypercritical for a European person to advocate not purchasing Kenyan roses because of air freight as the amount of CO₂ that air freight contributes is as little as 0.1% of total UK carbon emissions. Also, the UK emits 9 tonnes of CO₂ per person per year, while the Kenya per capita emission is 30 times less at 0.3 tonnes of CO₂ per person per year. However, a debate on CO₂ emissions and food miles is an important part of the climate change debate, but, it is complex and difficult to quantify. Much of Kenya's horticultural exports are transported on scheduled passenger planes and removing the horticultural products from these flights will not stop these planes from flying.

4.6.1 Developments required to improve the sustainability of export crops

Research needs to be directed into improving the storage life of fresh produce so that they can be transported by sea, which still emits CO₂ but less CO₂ per Kg of product per mile than air freight. A greater understanding of post-harvest physiological process needs to be developed to extend the time the crop can remain in the transport chain. This could be undertaken by breeding and selecting varieties which are more suited to these circumstances. It could also be achieved by improving modified or controlled atmosphere shipping conditions. The most likely crops to change from air freight to shipping might include some vegetables and certain flowers such as carnations.

5.0 South Africa

South Africa is another country of extremes. There is a highly sophisticated food service sector meeting the needs of the corporate client and also a very exclusive tourist industry. In contrast between 40 and 50 percent of South Africa's population can be classified as living in poverty while 25 percent of the population can be categorised as ultra-poor. Although the country is self-sufficient in food production, about 14 million people are said to be vulnerable to food insecurity and 43 percent of households suffer from food poverty. South Africa is classified as an upper middle-income country with one of the most skewed distributions of income in the world.

5.1 Land Reform in South Africa

After the apartheid era the African National Congress (ANC) developed policies known as Black Economic Empowerment (BEE) to transform the economy to be representative of the demographic make-up of the country. The aim was to give previously disadvantaged groups (black Africans, Coloureds, Indians and Chinese who are SA citizens) economic opportunities previously not available to them. It includes measures such as Employment Equity, skills development, ownership, management, socio-economic development and preferential procurement.

In 1994 when the ANC came to power eighty seven percent of South Africa's land was owned by white people who accounted for less than ten percent of the population. The Land Reform Programme was then started to develop equitable and sustainable mechanisms of land distribution in rural areas. However, to date only four percent of land has been redistributed. The security of much land is threatening by land claims making an environment for business development difficult. Much of the land which has been redistributed is not now being farmed due to lack of knowledge, resources and security. The very poor landless people who were meant to benefit from this scheme remain largely unaffected and the South African Department of Agriculture is very eager to show models of success. The white farmers are also keen to get the situation resolved quickly so they can continue with their business. They are also afraid that this prolonged settlement of agreement could result in a land grab similar to the disastrous events in Zimbabwe.

5.2 Organics in South Africa

Organic produce in South Africa is sold predominately in Pick and Pay supermarkets or in the upper class supermarket Woolworths, this is the same as the Marks and Spencer's in the UK. Compared to the UK relatively limited ranges are available at quite a premium. The other place I came across selling organic vegetables, cosmetics, honey, clothes and even craft was a very upper class market in the most exclusive suburb of Johannesburg. The market traded as Bryanston Organic Market but the system of certification consisted of the market co-ordinator, a prominent figure in the South African organic sector, visiting people's farms/holding and a peer review to act as the organic guarantee, not an independent certification body. The market currently works to the International Federation of Organic Agriculture Movement (IFOAM) principles and guidelines. The market had conducted a survey of what their consumers considered as the most important factors when they bought food from this market and a summary of the results is:





- Food free from pesticides
- Organic certification is not important
- Not concerned about genetic modification (GM) or use of artificial fertilizers

The market sold very little 'organic' meat as the market group had a problem accepting the feeding and welfare standards that they saw in most animal systems. The only exception to this was venison but this was naturally reared on open veld.

Only seven per cent of the stallholders are certified organic and there is a

great deal of oppositions to tightening up on legislation. The people seem to view the food as ethical food and would prefer to change the name of the market rather than change the way it operates to make it organic.



South Africa had just put together a third draft of organic standards to the FAO for approval, the first and second drafts had been rejected. The country is hoping to gain an internationally recognised certification scheme. South Africa has been sponsored by a Swedish certification body and has used their standard as a foundation, i.e. the EU regulation. Currently most of the exported organic produce is certified by Ecocert, a French certification body and is grown in the Cape region. At present there are only about two hundred and fifty organic producers in South Africa representing about 0.1% of the land area.

5.3 Sustainability in South Africa

In section 2 of this report I stated that I viewed sustainability for this study as making the best use of the surrounding environment whilst not damaging these assets. However, for this part of my study I find I cannot even start to consider the agriculture I saw in terms of these criteria. Most of my time was spent in the Mpumalanga area which is also home of the world famous Kruger National Park. The opportunities to supply premium markets in this region are vast and the desire by smart tourist camps to procure from these areas is encouraging but under the current system of uncertainty of land ownership this market is not being met locally.

The issue regarding sustainability is disrupted to the core in local agricultural systems. In the Mpumalanga area unemployment is well over 60%, HIV incidence is at about its highest in South Africa, thought to be in the region of one third of the population and poverty and sanitation are still big issues. Soil erosion is commonplace but many still claim that it is not really a problem in that area. A community I visited bordering the Sabi Sands National Park have been given a farm but despite constant investment from the previous white owners the farm is hardly operational. The resources are all present; excellent fertile soils, irrigation and the potential market. The Government have money to help community farms like this to set up the infrastructure however despite wide spread reporting of under-spending on the Comprehensive Agricultural Support Programme (CASP) these types of farms seem unable



to succeed as they often cannot access these funds. Often the farms lack a coordinating figure to drive the community forward or it is very difficult to meet the deadline for application which are then followed by very long waiting periods until the money is paid. When the money is paid there are then often corruption issues with dissemination of the funds. These types of problems lead to unsustainable agricultural systems socially, environmentally, economically and politically.

5.4 Education in South Africa

The Department for International Development (DFID) has committed £8.4 billion on education in developing countries over the next ten years as it considers that greater investment is needed at all levels of education if we are to reach the Millennium Development Goals (MDGs). Fifteen million pounds of this will be spent on DeLPHE Development Partnerships in Higher Education program which aims to help reduce poverty, promote science and technology and meet the MDGs. In South Africa DeLPHE has a project running to identify the skills and education needed to support sustainable farming practices by building capacity, training, and develop a new curriculum for Sub Saharan African partners. I attended the DeLPHE conference at the University of Pretoria where I was shocked by the lack of educational capacity in South Africa. Household food security is a top priority for many South African citizens and this DeLPHE projects plans to get sustainability as a key element of education to emerging farmers.

5.4.1 Emerging farmers in South Africa

The South African president made a priority after majority rule that 10,000 black emerging farmers would have access to five million hectares by 2014. This programme has been happening since 1994 but when land is given to the people they have been found to not be making optimum use of the resource. The land has been found to be degrading quickly and rural populations are often frustrated. The challenge is to educate the people and provide post settlement support to allow successful sustainable farming. It is my opinion that government support should allow the educated man to manage and run these businesses and provide profit for himself on the provision that he is supplying infrastructure and employment locally. This would not be dissimilar to some of UK planning laws. Land in the hands on uneducated people deteriorates quickly and is unproductive. Over time the government could allow land transfer at a slow rate as skill base increases or aid sustainable farming on unutilised land.

6.0 Austria

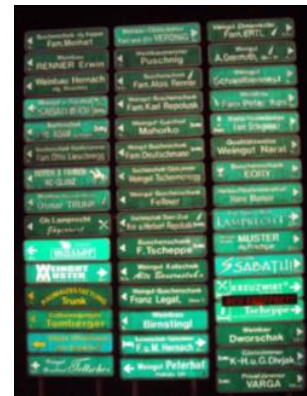
Austria was the ideal contrast from the other countries I visited for my study. There were some interesting similarities to the UK as a fellow member of the European Union but also big differences. I only visited Styria, a southern county bordering Slovenia. Styria mainly produces maize, pumpkin oil, cattle, forestry, apples and wine. I was invited to attend the seasonal harvest festivals and observe the passion for local production. My host was typical of many Austrian farmers in that his farm was the most important aspect of his lifestyle but he was not considered a farmer. Many Austrians still farm in a small way and the average farm size in this region is just 15ha. Apart from those nearing retirement most of these farmers also have other careers as well and I met train drivers, bankers, hoteliers and



foresters who all fell into this category. Even those who do spend all their time on the farm seem to derive their main income from a very popular form of local marketing known as a buschenschank. The definition of buschenschank seems to be food or wine produced on the holding and sold at the holding by the producer or their staff. This ranged from bread, cold meats, wine, chestnuts and apple

juice. The buschenschank is rather like the idea of a farmers market but the consumer comes to you and often eats some food in a restaurant/cafe setting and buys some to take home with them. Buschenschanks seem to appeal to all age groups and it is viewed in a similar manner as to how we view going to the pub for a meal. The food is almost exclusively traditional Austrian and quite simple menus.

Buschenschanks, especially at harvest time act as a major tourist attraction but for predominately Austrian and German tourists. In one region there were so many buschenschanks as seen in the photo I wondered if they could all be viable. However what seemed to occur was that the prevalence seemed to attract tourists to this area and promote them increasing the tourist income.



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7.1 Local Food

Austrian people seem to have immense pride in their local food and are clearly loyal to paying more for local produce than buying from the supermarket. In many towns they have a seasonal festival each year celebrating the harvest which involves a magnificent display of vintage tractor drawn arrangements celebrating their connection with agriculture and harvest. The people are still very proud to wear their traditional dress and to link the occasion with traditional music and the first wine press known as sturm. People are still connected with agriculture, probably due to the land ownership issues and this seems to lead to strong family and regional ties, although I would expect to see this dilute in the next few decades as the demand for wealth from the younger generation causes a migration to the cities.



Pumpkin oil is characteristic of the area and is a dark green nutty flavoured, high in polyunsaturated fats and omega 3 and omega 6 fatty acids. The oil is used to dress salads and some also believe it has medicinal properties. Pumpkin seed oil (Kernöl) is a culinary speciality of south eastern Austria (Styria), and is a European Union Protected Designation of Origin (PDO) product.



Today the oil is an important export commodity of Austrian and Slovenian parts of Styria. It is made by pressing roasted, hulled pumpkin seeds (pepitas), from a local variety of pumpkin, the "Styrian oil pumpkin" (*Cucurbita pepo* var. *styriaca*, also known as var. *oleifera*). The pumpkins are grown often in alternating years with maize and many small local oil pressers exist to help keep the product truly local. The pumpkins are a low input crop which prefer to grow in manure enriched soils and are normally hand hoed. There is organic certified pumpkin oil but most is grown on small holdings that would not consider the financial benefits of organic certification worthwhile. Also, maize is grown as the alternative crop which is protected with the conventional growing methods. Most small farms co-operate or get a contractor in to do the mechanical work but still enjoy the manual work associated with pumpkins although the pumpkins are now mechanically harvested to remove the seeds.

Pumpkins seem to play an important role in diversifying the cropping and providing fair returns for a traditional product. Pumpkin seed is now being grown in China and is imported into Austria and the oil is sold at a cheaper price but generally people believe it is worth paying approximately €15/litre for this quality product of designated origin.

7.2 Organic farming in Austria

Austrian people generally seemed to be far more aware of their environment than we are in the UK. For at least the last five years most newly built houses in Austria have geothermal heating with a heavily insulated fire place for back up heat. Many rural households will still have connections with a small piece of land where they can obtain firewood and they fully appreciate the value of this fuel. The 'green movement' seems to be part of everyday life and nobody seems to stand out for their environmental stewardship.

My host ran a bed and breakfast which he had recently extended to include a buschenschank and saw his 30ha farm as a resource to supply the bed and breakfast. It soon became clear that he was following organic principles of production and then I found out by looking at his calendar that he actually worked to biodynamic principles. He thought there was nothing extraordinary about this. The farm was not certified organic or biodynamic and the tourists visited because they liked the environment it offered and the food they were served and the owner saw no reason to advertise or formalise this situation by becoming certified organic.



My host's neighbour, his brother also farmed and he had about 35ha of land which he had just finished converting to certified organic land. He was very happy with the organic option he had taken as it allowed him to claim further environmental grants and it hardly altered his farming system. His subsidy was in the order of €900/ha. His business was primarily single suckle



beef production and he was able to finish his stock organically on a purely grass based diet in seventeen months with a dead weight average of 220kg. The cows were continental breeds which seemed to respond well to the clover rich leys.

Austria has the highest proportion of its land under organic management of any of the EU countries. Austria has 360,969 ha of organic land in 2003 representing 10.8% of the utilizable agricultural area (Soil Association, 2007). Austria seems to have adopted organic farming on a larger scale sooner than other EU countries and starting supporting organic farmers in 1994.

7.0 The benefits of organic certification?

Organic farming is still seen by many African farmers as a viable option being reserved only for the very poor who cannot afford the high costs of agrochemicals and fertilizers. There is one specialist organic market held twice a week on the northern outskirts of Nairobi, however, not all the produce traded under this roof is certified organic which leads the consumer with little assurance to the production methods of the food they buy.

Farmers and growers throughout the world normally choose to become certified organic growers for one or several of the following reasons:

- To receive a price premium for their products
- To access new markets
- To maintain/increase market share
- Pressure from existing buyers
- To gain financial support e.g. organic entry level scheme
- To promote an image
- Because they believe it is right

I still believe that when a business converts to organic production most consumers believe that the company is better in some way e.g. ethical trading, workers rights, better management of the environment. Many businesses/individuals try and use this image to their advantage either through marketing campaigns but unfortunately also to gain points over the conventional sector. This practice is not only destructive for the conventional sector as it sends out confused messages to a group of people that are already disconnected and ill informed of the agricultural sector but also discredits the organic sector which can sometimes look petty and self righteous.

For food to be sold as organic in the UK or Europe it must comply with the EU Regulation on organic standards (No 2092/91). However, when it comes to sustainability this regulation is extremely weak. If the requirements for sustainability are insufficiently rigorous, then the use of organic labelling might actually increase unsustainable practices, because many consumers are likely to have the impression that organic labelling indicates environmental responsibility in general. There is nothing to stop a business from being both organic and Fairtrade. Currently Fairtrade is mainly associated with handicraft, chocolate, coffee, tea, fruits, nuts and other plant products. From my travels I visited several different businesses which were Fairtrade certified. These businesses all seemed to offer not only good working conditions, sometimes innovative trading schemes with small farmers but also social benefits beyond the workplace e.g. education for children, healthcare and often worker housing. These businesses were normally certified to several assurance schemes and seemed to not only have good welfare schemes but also good environmental management. The Soil Association who also certify many farms in both Kenya and South Africa have introduced an Ethical Trading Standard, but, this standard is not compulsory.

7.1 Fairtrade Businesses with enhanced environmental stewardship:

Williamson Tea have a corporate vision "To be a First Class global tea producer that meets the diverse tastes of all the ever increasing and changing spectrum of tea consumers" and their mission is "To grow and produce the best quality tea with the best sustainable agricultural

practices". They state that they are committed to the fundamentals of sustainable tea production namely:

1. Conservation of soil fertility and nutrients
2. Conservation of biodiversity
3. Sustainable energy use
4. Corporate social responsibility
5. Product value addition
6. Promotion of local and global economy.

Throughout my time at Williamson Tea it so genuinely seemed that these principles were at the heart of the business. The company were very interested in organic production but having tried it on one of their estates previously they were aware of the challenges mainly with crop nutrition that this system imposed. I am now left very curious to understand how organic tea estates do get fertility into the system without seriously reducing yield and quality. It is not possible to apply the normal principles of organic crop production to this crop as it is so densely planted and is non-rotational. Tea is normally grown in very specific regions due to climatic advantages (altitude for cool nights and good day time growing conditions but the sites must be frost free and have the appropriate rainfall). Where these conditions apply tea estates tend to dominate the landscape until climatic conditions change. Therefore it would not be viable to import composts/manures from other holdings as there would probably be a long distance and the tea estates by definition of the harvesting processes do not have sufficient crop residues to make enough compost to drive the system.



The Primary School and Workers houses at Williamson Tea, Changoi Estate,



8.0 The Role of agriculture in Sustainability

During the World Summit on Sustainable Development (WSSD) in Johannesburg the world development goals were set. Previously the United Nations Conference on Environmental Development (UNCED) in Rio de Janeiro in 1992 set up the three 'pillars' of sustainable development focussing on economic, social and environmental actions. Some improvements were seen through this policy and the number of people living on less than \$1/day dropped from 29.6% in 1990 to 23.2% in 1999. Much of this improvement was achieved in China.

The Millennium Development Goals

- | |
|--|
| 1. Eradicate extreme poverty and hunger |
| 2. Achieve universal primary education |
| 3. Promote gender equality and empower women |
| 4. Reduce child mortality |
| 5. Improve maternal health |
| 6. Combat HIV/AIDS, malaria and other diseases |
| 7. Ensure environmental stability |
| 8. Develop a global partnership for development |

Source: United Nations Development Programme (UNDP)

In 1991 over two thirds of people from mainland China and about forty percent of people from Sub-Saharan Africa were living on \$1/day or less. In 2004 a similar survey was conducted and found that only one in ten Chinese lived in poverty of the same standard while the percentage had not changed for Sub-Saharan Africa. The question was then asked why China had achieved such success while Sub-Saharan Africa stayed static. The World Bank came up with the following conclusions that policies must avoid doing harm to poor people, macroeconomic stability is crucial, internal market integration should not be neglected and most interestingly for this study is that the agricultural sector should be given high priority.

China's high economic growth in the agricultural sector in the 1980s was partly due to decollectivization of farms. Unskilled labour was quickly utilized by small farms creating employment and income streams. Africa has a relatively abundant supply of unutilized land that is suitable for agriculture. The current high food prices are a major threat to low income families and therefore the ability to grow food allows protection and potential income from the high food bill (World Development Report 2008).

But, can Africa learn from the lessons of China to help reduce poverty. Some sceptics would conclude that inequality is an inevitable outcome of higher growth and less poverty, but, the lessons from China show that the relaxing of constraints on the poor increased access to markets which has helped counter inequality. However,:

“We must not forget that Africa is 48 countries, not one” concluded Ravallion, “There is no African central government to transmit policy lessons from one place to another, and this is where the international community, including China, can help”.

The ‘Green Revolution’ of the 1960s when the production of food met and then surpassed the needs of the global population for the first time, largely bypassed Africa. Generally in the world today each person has twenty five per cent more food on average than they did in 1960, in Africa they have ten per cent less. African governments have often tried to adopt modern, mechanised agriculture as the salvation but these efforts have made little impact on food poverty and often lead to unsustainable approaches leading to severe land degradation.

A recent UN FAO study has found that that organic practices outperformed traditional methods and chemical-intensive farming techniques. The benefits they perceived are from improved soil fertility, better water retention and better resistance to drought. However, many are predicting a technological fix probably in the form of Genetic Modification (GM) as the salvation of the 21st century but to many the amount of cash required to buy patented seeds and herbicides will be restrictive. The reality probably is that agriculture will have to adopt ‘good practice’ globally to meet the challenges that lie ahead. These techniques are likely to involve a combination of GM and organic.

The role of organic agriculture in terms of its impact to improve global sustainability is likely to become apparent in the coming years. With increased energy prices farmers need to learn to farm in a more energy efficient way and adapt their farming systems accordingly. For many farmers in developing countries the choice will be made for them as they simply will not be able to afford fertilizers and agrochemicals. However, in the absence of these products farmers will need advice and guidance on how to adjust their growing techniques if they can no longer afford these products, otherwise there will be a further increase in poverty.

In September 2008, Sir David King, the UKs former Chief Scientist said:

“The problem is that the Western world’s move towards organic farming – a lifestyle choice for a community with surplus food – and against agricultural technology in general and GM in particular, has been adopted across the whole of Africa, with the exception of South Africa, with devastating consequences.”

8.1 Agricultural Soils

Erosion is widespread across much of the tropics and it is estimated that three quarters of African farmland is degrading by wind and soil erosion. In sub-Saharan Africa farmers traditionally cleared land to grow crops and then left it fallow to regain fertility. However, increasing population pressures has resulted in farmers continually farming the same land but not adjusting their production system to account for long term sustainability. Many African farmers are therefore suffering reduced yields, resulting in greater poverty and malnutrition.



Soil degradation is not a problem limited to developing or tropical countries. It is commonplace in the UK to see rivers running brown after heavy rainfall. Some farmers still do not seem to value the true asset of their soil and consider it as a medium for supporting plants during growth rather than an integral part of a biological cycle. Soil degradation involves both the physical loss (erosion) and the reduction in quality in top soil resulting in nutrient decline. This influences future agricultural productivity and has implications by way of pollution and flooding on the urban environment. It is estimated that about 2.2 million

tonnes of topsoil is eroded annually in the UK and over 17% of arable soils show signs of erosion.

Eroded soils are often deposited on roads and other environments where they cause inconvenience and damage resulting in large clean up costs. In the UK soil silts up reservoirs, contaminates water supplies resulting in estimated clean up costs of £264 million a year and with additional costs where water is contaminated from agricultural pollutants costing a further £203 million a year. However, these costs could be substantially reduced if farmers adopted many of the recommended strategies to conserve soils and prevent erosion.

Methods farmers can adopt to mitigate soil degradation

- ✓ Reduce mechanical operations on wet ground
- ✓ Plant crops early in the autumn with coarse seedbeds
- ✓ Working across the slope of the hill where safe to do so
- ✓ Using low ground pressure set-ups on machinery to avoid compaction
- ✓ Careful livestock management to avoid overgrazing and poaching
- ✓ Planting/maintaining hedges, grass margins, shelter belts to reduce water and wind erosion
- ✓ Avoid low ground covering crops on erosion susceptible sites
- ✓ Adopt minimum tillage techniques
- ✓ Use buffering areas by watercourses
- ✓ Using attenuation areas

Many of these factors will create a more efficient agricultural system with less erosion thereby resulting in greater long term sustainability especially if they are combined with taking measures to protect and enhance soil organic matter. The use of the following techniques will help to protect soil organic matter:

- ✓ Returning straw and other crop residues after harvest
- ✓ Applying animals manures, composts or sewage sludge
- ✓ Increasing grasses (and legumes) within the crop rotations
- ✓ Using catch crops or green manures
- ✓ Adopting appropriate minimum tillage techniques

High levels of organic matter in soils helps improve the physical structure of the soil, increases water filtration, decreases erosion, improves workability and holds plant nutrients. There are no negative impacts of increasing soil organic matter in mineral soils. An audit of arable topsoil in the UK was taken in 1980 and 1995. It was found that around 18% of organic matter had been lost during this period. Losses in organic matter can lead to a greater risk of soil erosion, decreased buffering from drought or heavy rainfall, more energy required to cultivate soils and poorer nutrient retention.

All UK farmers are now required to fill in a Soil Protection Review annually as part of Cross Compliance, NVZ have a high undertaking through the requirement of a Soil Management

Plan. The review is aimed to make farmers examine their farming methods, appreciate causes of soil degradation and then implement techniques to reduce risks to soils. Unfortunately many farmers in the UK see this Soil Protection Review as just another form to fill in to achieve their Single Payment Scheme rather than a useful working document.

8.2 Organic Farmers and Soil Management

A sweeping generalisation is that organic farmers have a much greater understanding of soil biology than conventional farmers in the UK. They appreciate the role of earthworms, bacteria and fungi in the process of breaking down crop residues and manure application and understand the importance of soil organic matter for nutrient retention. Organic farmers design their crop rotations around natural nutrient cycling and include grass clover leys to build up nitrogen within the system as well as the positive impact this has on soil organic matter. It is a complete paradigm shift from that of a conventional farming system and requires a totally new method of thinking. It is not simply elimination of the inputs from a conventional system.

As external synthetic fertilizer inputs are banned the rotation is adapted to crops which respond positively to lower fertility situations. Crops such as triticale, oats and rye are all regularly grown on many organic farms. Buyers of organic feed have had to adapt their rations to cope with these crops. Many of these relatively rarely grown crops in conventional situations have other advantages apart the ability to grow in low fertility situations e.g. alleopathic effects and high ground cover to suppress weeds. But, weeds continue to be a major challenge to organic growers and the farming system is often based around techniques to avoid weed competition and growth. Some of these effects are positive for the environment such as a greater reliance on spring cropping but other techniques could be viewed as negative to the environment.

Most organic farmers in the UK are still operating a plough based tillage system resulting in fine seedbed which are at greater risk of soil erosion especially where overwintered ploughing is practiced. To avoid weed competition from many of the highly competitive autumn germinating weeds e.g. blackgrass, winter crops are sown often as late as November. Later sowing results in smaller plants, reduced crop rooting and therefore lower soil stability. This technique coupled with a plough based system makes organic farmers at serious risk of soil erosion and greater loss of soil organic matter.

8.3 How can organic farmers adopt more sustainable soil management techniques?

Many organic farmers feel they cannot even contemplate the adoption of minimum tillage techniques as they fear serious weed competition without the burial action of the plough to take many of the viable seeds out of the growing range. There are a very few organic farmers adopting non-plough systems and the Institute of Organic Trainers and Adviser (IOTA) have recently undertaken a couple of study tours to the Netherlands and Germany to look at minimum tillage organic systems.

A minority of conventional farmers are experimenting with sowing crops directly into a cover crop to avoid cultivations, minimise risk of soil erosion and to help to build up soil organic matter. These techniques could be ideally suited to organic farming to move away from plough-based systems, but currently many of them are reliant on glyphosate to kill off the cover crop soon after drilling. Glyphosate is prohibited under organic standards and therefore this technique cannot be adopted. Experimentation is required to adapt this

system for organic management e.g. cutting at a strategic time of an appropriate cover crop to kill the cover crops, cover crop suitability to the system, the impact of cover cropping on crop rotations.

Organic farming is often claimed to deliver environmental benefit in terms of increased biodiversity and although many consumers purchase organic food for perceived health benefits many also state that their choice of buying organic food is for environmental reasons. The organic industry has had difficulty in wide scale scientifically proving the health benefits of organic food. Of 76 studies reviewed measuring biodiversity impacts of organic agriculture in groups of organisms ranging from bacteria and plants to earthworms, beetles, mammals and birds of 99 separate comparisons of groups of organisms,

- 66 found that organic farming benefited wildlife
- 8 concluded it was detrimental
- 25 produced mixed results or suggested no difference between the farming methods

8.4 Stability of the organic market

The organic sector globally has grown year on year for at least the last decade. However, the credit crunch has very quickly shown that some of those who were considered 'loyal' to the organic sector can soon deviate when conditions are tough. It is therefore important that the messages in term of agricultural sustainability are quickly adopted as good practice by the conventional sector to insure that environmental sustainability is not totally compromised by economic instability i.e. the benefits of organic production are wider reaching than just certified organic produce.

9.0 Actions farmers should take to work towards sustainable farming techniques

As discussed earlier in this report, both conventional and organic farmers throughout the world are often taking many measures in varying forms to try and improve the sustainability of their farming practices. In the UK we have excellent guidelines to help farmers in this direction. LEAF (Linking Environment and Farming) was set up in 1991 to help bridge the growing gap between producers and consumers. LEAF puts farmers, environmentalists, food and agricultural organisations, consumers, government and academics together to consider the sustainability of the farming industry. LEAF promotes Integrated Farm Management (IFM) and operates with this policy "A whole farm policy providing the basis for efficient and profitable production which is economically viable and environmentally responsible. IFM integrates beneficial natural processes into modern farming practices using advanced technology. It aims to minimise environmental risks while conserving, enhancing and recreating that which is of environmental importance." LEAF goes about implementing this policy with the following principles:

- a commitment to good husbandry and animal welfare
- efficient soil management and appropriate cultivation techniques
- the use of crop rotations
- minimum reliance on crop protection chemicals and fertilisers
- careful choice of seed varieties
- maintenance of the landscape and rural communities
- enhancement of wildlife habitats
- a commitment to team spirit based on communication, training and involvement

Farmers and growers belonging to LEAF complete a LEAF audit. This has been adapted further into a quality assurance scheme known as LEAF Marque certification and is a commitment to consumers and the food industry regarding standards, traceability and sustainability. This mark can demand a premium and is a far greater commitment to sustainable agriculture than simply an organic certification symbol.

The agricultural industry has responded very positively to LEAF and there are few people who criticise the philosophy. However, some farmers feel that paying between £150-£300/year to LEAF will not provide any return for their product and therefore are hesitant to join. Others may not be convinced of the benefits of such schemes. Auditing a business is an important way to benchmark the businesses success. All farms in the UK are required for tax purposes to provide accounts for financial performance and many farmers will use this information to help restructure their business through benchmarking costs and this process can identify unprofitable enterprises. But, financial performance is not the only indicator of business success and more farmers are becoming aware of sustainability issues.

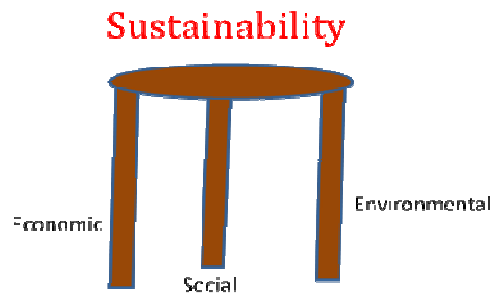
In 2001 the Government accepted proposals from the farming and crop protection industries to minimise the environmental impacts from the pesticides. The programme was developed as an alternative to a pesticide tax which had been under consideration by the Government. Targets were set for co-operation from the industry in the form of Crop Protection Management Plans (CPMP), National Sprayer Testing Scheme (NSTS) and National Register of Sprayer Operators (NRoSO). Farmers were encouraged to join and support the Voluntary Initiative (VI) by taking part in all three elements.

The success of the Voluntary Initiative is commendable and hopefully it has made more farmers think about the implications of their actions. The VI allowed LEAF audited farmers to count in their target of land covered by CPMPs. This example shows how voluntary schemes can end up playing an important part in future legislation. Although the legislation in itself has not been altered, which is what many farmers fear by adopting and proving the worth of more audited schemes, it has prevented the proposed pesticide tax.

Uptake of schemes like the CPMP and also the Soil Protection Review and Soil Management Plans have enticed farmers into co-operation by linkage to revenue received through agri-environment schemes like the Entry Level Scheme. The public may be surprised that farmers need paying to get them to appreciate further the stewardship role they play in the management of their land, but in terms of overall sustainability this is a positive step. In the United Kingdom and European Union we also have much legislation which has to be complied with to avoid prosecution like the Nitrate Vulnerable Zones and pesticide regulations. The sooner farmers can adopt sustainable farming practices the better adapted they will find themselves to the inevitable increase in environmental protection legislation the industry will soon need to comply with.

9.1 The Fragility of Agricultural Sustainability

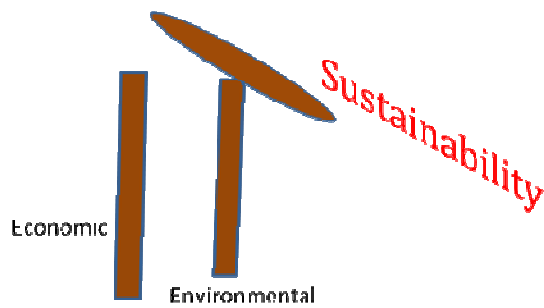
Sustainability is often referred to as comprising of economic social and environmental factors. This can be considered the 'stool' of sustainability.



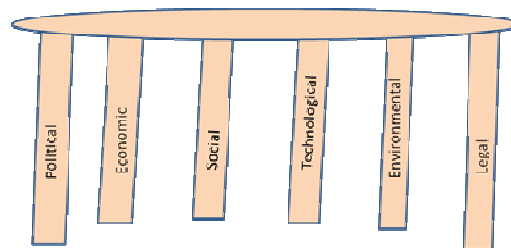
The stability of this stool is essential to support sustainability. If one leg of the stool becomes unstable it often leads to the collapse of the whole system. This fragility was clearly demonstrated to me during my trip to Kenya when the Government elections were held.

Many people were forced to flee their homes either because their homes were destroyed in rioting or because they felt unsafe there. Kenya's horticultural industry draws people from all over the country and uses the tribal system to its benefit. Tribalism creates loyalties and competition; therefore many companies would make sure they had a different tribe person on the gate to the employees working inside so no alliances were formed to allow goods to be illegally taken from the company. Suddenly these people were afraid to go to work because of these tribal reasons; their colleagues had become arch enemies. Flowers remained uncut, vegetables unpicked, transport impossible to organise. Many roads were dangerous to travel and hijacking of vehicles was a serious risk as the police and army were busy deployed keeping the peace; thereby allowing opportunist criminals to seize this opportunity.

In a matter of one week the stool of agricultural sustainability had been destabilised and the system no longer was sustainable, in this case due to social reasons.



A situation like this clearly demonstrated that this 3 legged stool of sustainability is slightly too simplistic and it seems more appropriate to adopt the PESTEL (Political, Environmental, Social, Technological, Economic and Legal) model for sustainability. This model which is normally applied to business strategy seems to better describe the issues relating to agricultural sustainability.



This model also directly relates to UK agricultural situations and some of the risks which could be listed under each of the legs are represented in the following table.

Political	Economic	Social	Technological	Environmental	Legal
Elections and change of Government	The credit crunch	Unavailable labour	Equipment failure	Loss of irrigation by pollution	Withdrawal of pesticides
Connected representation in Brussels	Interest rates	Opposition from surrounding community to agricultural practice	Insufficient mineral reserves e.g. phosphates	Soil erosion preventing economic returns	Over bearing regulation
CAP reform	Poor commodity prices		Limited management capability	Spray drift ruining adjoining crops	

9.2 Lessons for UK Agriculture

There are many voluntary schemes (either paid or unpaid) which encourage more sustainable farming techniques within the UK. Organics is often viewed as the premier environmental scheme however, EU organic regulations do not cover areas of sustainability so although these farms may take more consideration of their impact on the environment, it is not a requirement. By adopted an organic farming technique the grower may be taking some of the high environmental risks out of the production system e.g. application of

insecticides and other pesticides or fertilizers, but there are still many risks for environmental pollution and soil degradation e.g. use of farm yard manures and plough based cultivation techniques. If the organic industry want to lay claim to environmental benefit then it will require global agreement to implement e.g. through the International Federation Organic Agriculture Movement (IFOAM) and for the UK through the European legislation. The EU regulation is just about to be updated to 834/2007 and does not go much further than the existing EU regulation 2092/91. Although amendments can be made to the regulation it is unlikely to bring in such a key concept as a sustainability amendment and it is unlikely for another EU regulation on Organic production to be replacing 834/2007 in the foreseeable future.

The certification bodies in the UK have the right to add standards over and above the EU regulation but this can lead to confusion to the consumer. Some people call this 'gold-plating' of the organic standard, however, as seen in the example of LEAF, farm audits pioneering higher standards can result in a positive environmental lead for voluntary uptake and help the industry.

Farmers in the UK are quick to mention that their industry is over regulated and simplification of support and regulation is required to function efficiently. Normally new environmental legislation is a logical progression and is only implemented to prevent pollution or bad practice. Farmers need to keep abreast of proposed legislation and be prepared to contribute to the consultation process if they feel the legislation will have a negative impact on their business.

Organic farmers need to look to the conventional sector to ensure they are adopting best practice for sustainability. Technology continues to play an increasing role in refining agricultural systems and organic farmers need to make an informed decision about the uptake of such advances. Some of these developments may initially be prohibited under organic standards e.g. the use of genetically modified organisms, but in the future may play a vital role.

Conventional farmers need to look to the organic sector and consider adopting some of the techniques that organic farmers have developed/refined to suit farming in the absence of artificial pesticides and fertilizers. The rise in fertilizer prices and the threat of the loss of many pesticide products will force some farmers to adopt more sustainable practices. Their improved soil biological awareness is also something conventional farming can learn from the organic sector.

It is important to remember that sustainability is a complex subject and can be disrupted by a multitude of factors including political, social, technological, environmental and legal (PESTEL). The complexity of sustainability makes it important for farmers to engage at all levels to enable their business to prosper on all the PESTEL factors. Farmers need to be well educated and co-operate with one another to give the industry a cohesive opinion and this then needs to be well represented in a timely and appropriate forum.

British farmers also need to be aware that Africa can offer serious competition for growing many horticultural crops. Media coverage often leads the British public to believe that Africa is simply a struggling continent with inadequate food supply and prone to famines and droughts. There is a great deal of underutilized land throughout Africa and companies/growers who are ready to meet the challenge of new markets and adapting/take on new land accordingly. Many of these farms are keen to experiment to improve production techniques and will jump through the hoops required to meet the market requirement.

The UK is currently facing difficult economic times. It is already reported that sales of organic produce have slowed with the media citing price and suggesting that the consumer has switched to local or fairtrade produce. Conventional farmers need to take care in priding

themselves if there is a fall in the organic sector as it probably means that other high value or premium lines are also likely to suffer a downturn.

9.3 Lessons from organic production

When agriculture became industrialised in the UK most of the research spend was directed at chemical based systems. Organic research and even low-input or less petrochemical based systems have only really had a research spend in the last fifteen years and then this has been reducing from the public sector further in the last three years. However, the development or continuance of organic systems now provides a vital tool to analyse to help us how to farm with rising energy prices and problems in supply of fertilizers. Without the organic sector there would probably have been little or no interest in leguminous crops apart from feed value which would have led to a reduction in the knowledge base on green manuring being diminished if not non-existent. Both of these aspects of organic systems are highly likely to become of far greater interest to conventional farmers.

Organic farmers however do need to be aware of the limitations of their system. I perceive these limitations to be:

- Lower yields
- Restricted uptake of agricultural developments
- Reliance on fuel demanding, soil degenerating plough based systems for weed control
- Market vulnerability from global economic crisis or other future threats

The organic sector needs to appraise these risks and limitations and consider progress to make the sector sustainable and develop.

10.0 Conclusions

Sustainable agriculture and sustainable development can be two very different things and result in different outcomes. The poorest people have been some of the first to be effected by climate change even though it is the richest countries which have caused the problem. Therefore to make agriculture more sustainable reliable carbon credit systems must soon become commonplace to reward good sustainable farming practices.

In sub-Saharan Africa only 4% of public spending and 4% of foreign aid goes towards agriculture. The World Bank states that growth in the agricultural sector has a four times greater effect on poverty reduction than any other sector. Therefore, far more effective aid must be given to sub-Saharan African farming to enable it to undergo a sustainable 'Green Revolution' like that which has occurred over much of Asia.

Governance and policy remain vital tools in creating sustainable agriculture systems. I was in Kenya during the 2007 elections and it was devastating to see a country jump backwards so quickly when the trouble erupted. Although most of the trade with Kenya has now resumed, a great deal of damage has been done both in terms of buyer's confidence and in workplace harmony. Leadership in Africa has obviously hit our headlines many times in 2008 already and targeting aid to improve sustainability for any agricultural sector is a challenge to guarantee that the results benefit those for whom it is intended.

Globally we have woken up to the some of the challenges that our planet is facing in the form of climate change, limitations of natural resources (fuels, fertilizers and land) and the impact this has on both the rich and the poor. Sustainable agricultural systems can play a vital role in helping to alleviate poverty, prevent future poverty and make the most efficient and appropriate use of the land resources available. Education is essential to ensure that people understand this message. Education takes many forms from making sure that we understand how food is produced and therefore how our purchasing decision influences food product in social, in environmental and economic terms but also for policy makers and those implementing policy i.e. farmers to appreciate their role in sustainability. I believe there is a wide scale lack of awareness of good soil management and the implications this can have on crop growth and yield and also the long term productivity of that land. Some of these factors are being addressed by the new Soil Framework Directive (2006/232) which is currently blocked in the EU by the UK and a couple of other countries as well as the change of the Common Agricultural Policy from a production based payment to environmental based payments.

In some respects the organic sector has confronted some of the challenges facing agriculture by moving away from a petrochemical based system to enhancing biological systems for food production. Many of these techniques are going to help farmers overcome the limited resources that they have previously relied upon and help maintain food production which is vital with increasing world population.

There are alternative production methods available which often require a greater understanding of the biological system but which can often improve control over the pesticide alternative. Education is required for successful adoption of these techniques to make sure growers appreciate the way in which they work. Biological control may initially seem more difficult but the benefits can soon become very attractive with no problems of harvest interval, pesticide residues or operator safety. Many of these biological control agents have only been developed to enable growers to meet organic market demands, however growers soon realise the benefits extend way beyond the organic system and adopt them for their conventional production.

Local food also has an important role to play in helping the non-agricultural public appreciate the importance of food for the rural environment. Local food can also in some cases reduce the environmental impact of supply chain by reduced transport but in some cases it can be less efficient than imported produce.

Food security plays an important role in stabilising societies. The food riots of 2008 showed how hungry people feel forced to act. Uprising like this can destabilise governments and political instability can result in agricultural instability as observed in Kenya. Social factors are also important in political stability and Fairtrade often allows smaller producers to have a share of a market which would otherwise be unavailable to them and for workers to lead a higher standard of living, medical provisions and an education for their children. If we do not adopt more sustainable farming techniques globally we will see far more food related problems due to increasing populations and increased demand for food by developing nations e.g. China and India, less land available to grow crops due to soil degradation, unreliable climatic conditions and global warming.

| Soils in the UK are often more tolerant to soil erosion and degradation than tropical soils but these issues are still of great concern. Adopting techniques that help reduce environmental degradation will result in a more sustainable future. LEAF and the Voluntary Initiative both have useful audits to help farmers identify areas they can improve in their systems.

11.0 Recommendations for UK Agriculture

- Develop a greater awareness of soil and promote farming methods which reduce soil erosion and degradation.
- Increase soil organic matter by the addition of manures, composts and crop residues to help in water retention, soil stability and nutrient holding capacity.
- Increase educational awareness of sustainable agriculture techniques.
- Recognise other countries/regions may be better at growing certain crops and avoid protectionism of British crops but concentrate on crops that can be produced efficiently in the UK.
- Accept that trade of agricultural products can help alleviate poverty in developing countries and acknowledge that trade is better than aid.
- Develop a constructive dialogue between the organic and conventional farming sectors to ensure that ALL our agricultural systems are as sustainable as possible.
- Develop a hybrid of organic and conventional production systems which takes the best elements of each to make a system that is more efficient, sustainable and capable of supplying an acceptable quantity of an acceptable quality.
- Agriculture is a major contributor to greenhouse gases and ALL farming systems throughout the world must strive to adopt systems which reward good farming practice.
- Collective action must be taken on a global scale to ensure that all farmers are given a fair chance to develop sustainable agricultural systems and to minimise food shortages especially in relation to rising global food demands.

12.0 Postscript

To help to implement these recommendations I am:

- Developing research projects to try and link the best aspects of organic farming into conventional production.
- Working on developing the Highgrove Summer School on sustainability (Prince Charles invitation only workshop on sustainability for industry leaders).
- Including sustainability as an integral part of my lecturing at the Royal Agricultural College from Foundation Degree through to Masters teaching.
- I have been working on the DeLPHE project in South Africa in disadvantaged rural communities (many Mozambique refugees, high unemployment) to set up a pilot project. Initially the work has involved linking a land claim farm, identifying the beneficiaries, finding a primary market at local clinic and funding to pay for food and now to develop a high value market for the game reserves lodges.
- I plan to take any opportunities that I can to use the uncertainty over external inputs in agriculture to get people to consider alternative production techniques which are hopefully more sustainable.
- To try and assist in meaningful dialogue between the organic and conventional farming sectors.

13.0 References

- Environment Agency (2004) The State of Soils in England and Wales.
- Parliamentary Office of Science and Technology (2006) UK Soil Degradation.
- Soil Association (2007). Organic Market Report 2007.
- Wainwright, H. (2008). Food miles and horticultural trade. *The Journal of Horticultural Science and Biotechnology*.
- World Development Report 2008: Agriculture and Development.

14.0 Appendices

14.1 People visited during my travels

14.1.1 Kenya

Mick Wilson-Smith, Williamson Tea Head Office: Meeting regarding current issues in Kenyan agriculture. The role of large export businesses in the rural economy and actions to promote sustainability.

David Stanely N.Sch, Farmer: Land ownership in Kenya, current issues within the livestock sector

Dr Wamae, Dr Joseph Gichane Mureithi and George Karanja, Kenya Agriculture Research Institute (KARI), Kaptaget Road, Loresho, Nairobi: Agricultural research priorities in Kenya, use of field stations, challenges faced by diverse environments of Kenya, agricultural education, varietal improvements and technology in Kenyan agriculture.

Professor Henry Wainwright and Louise Labuschagne, Real IPM, Kichozi Farm, Near Giogio Estate, Thika: The practice and use of integrated pest management, production of beneficial insects, social responsibility from the employer, development of organic techniques, vermicomposting, food miles and horticultural trade.

John Njoroge, Kenya Institute of Organic Farming, Juja Town, Ndarugu: Development of organic standards in East Africa, local and national organic food marketing, agricultural education, agricultural extension work, chemical safety and operator safety.

Joseph Ngugi Mutura, Sustainable Agriculture Community Development Education Programme (SACDEP), Thika: Appropriate development, challenges of agricultural education in rural communities, inspirational thinking regarding local food security, empowering local communities.

Dr Nikolai van Beek, Kenya Biologics Ltd., Macadamia Centre, KARI, Thika: An integrated pest management company looking at baculoviruses for insect control in vegetables resulting in no harvest interval or toxic residues and a more sustainable production method.

Zachary M Makanya, Participatory Ecological Land Use Management Association (PELM): Farmer led development, problem oriented agricultural development.

Paul and Maria Epsom, Kakuzi Ltd, Makuyu Estate, Thika: Boran cattle, on-farm slaughter house, quality meat marketing with a premium, blue gum plantations and processing, charcoal making, Del Monte pineapple subcontracting and environmental management on 20,000 acres.

Jane, John and Jackie Kenyon, Mogwooni Farm, Nanyuki: Stud Boran cattle, Dorper sheep, dairy cross Boran cows for milking, camels, Galla goats, sustainable charcoal production.

Johnny Harris, below Pride Rock (as in the Lion King) Nanyuki: Organic dried herb production, sustainable livelihoods in remote locations, air freighting of perishable products, water, fuel and labour issues.

Brynn Llewelyn, Florence and Delulu, Ol Donyo Farm, Nanyuki: Sophisticated cereal growing using precision farming, careful water management and adapted varieties.

Nick Emson, Agrifresh Ltd. Lolomark, Nanyuki: 325Ha's Organic and conventional salad crops for the air freighted export market to the UK. Crop rotations, biological pest control, composting and experimentation with compost teas.

Alasdair Keith, Oserian, Naivasha: Growing 200Ha's of flowers (roses and carnations mainly) with 27,000Ha's of game reserve. Worker welfare, technology in growing, electricity and heat generation from geothermal energy, air freighting of flowers and sustainability.

Sarah Higgins, Lake Naivasha Raparian Society, Naivasha: Sustainable water use, the impact of the flower industry on the lake, pressures influencing sustainable agriculture.

Samuel and Grace Thumbi, Williamson Tea, Changoi Estate, Kericho: Tea production and challenges regarding sustainability, worker welfare, wildlife conservation and fair trade.

David Mbage, Kakamega Environmental Educational Programme (KEEP), Kakamega, Nt Eldorat: Rainforest preservations, pressures from agriculture, community education programmes and school access projects.

Peter Mankinta, Gede Butterfly Project, Gede, Watamu: Butterfly farming to prevent deforestation, project successes and failures.

Mohammed Maliq, Mida Creek Community Project, Watamu: Mangrove preservation, diversification into sustainable tourism, snake farming and preserving rural communities.

14.1.2 South Africa

Konrad Hauptfleisch, Bryanston Organic Market, Johannesburg: Organic certification, marketing and sales in South Africa, consumer interest and sales of non-certified products.

Mackenzie family, Alice Cot, Sabi Sabi, Mpumalanga: Community farming projects, game conservations.

Jackson Mdluli, Myath Caiphys, Aaron Mambane, Jane Zimmerman, Hlulani Farm, Mpumalanga: Community development agricultural projects, educational challenges, linking with tourist trade – possibilities and challenges.

Fanie Terblanche, DeLPHE Project, University of Pretoria: Challenges of agricultural education and development in South Africa.

Chris Stimie, Systems for Sustainable Development, Totiusdal: Water management, Black Economic Empowerment and community development.

Mokutule Kgobokoe, Jacky Smit & Lebo Botsheleng, Department of Agriculture, Pretoria: Agricultural challenges facing South Africa especially in relation to land reform.

14.1.3 Austria

Gerhard Hartlieb, Hartlieb Olmuhle, Heimschuh: Local specialist oils for predominantly local markets, diverse small-scale oil crushing, geographically defined region marketing both organic and conventional product lines.

Walter Skoff, Eckberg, Styria: Quality wines, co-operative growing and direct marketing.

Roland and Andrea Striber, Eckberg, Styria: Small scale vineyards, high quality production, challenges in small scale farming.

Frans Tertinek, Oberhaag, Styria: Organic beef producer