The investment case for ecological farming

Paul McMahon

SLM Partners

White Paper

January 2016

Summary

This paper explains why ecological and regenerative farming systems provide an attractive investment opportunity. It is intended for institutional investors, family offices and investment managers with an interest in real assets and/or impact investing.

Farmland investing today

Farmland has emerged as a new asset class for investors over the past decade because of higher food prices. Historical returns have been good. However, commodity prices have dropped and farmland values are plateauing in many regions. In addition, most investment has gone into high-input, industrialised farming systems that are exposed to hidden risks. In future, investors will need to be smarter and more environmentally-aware to capture the opportunities.

The risks of industrial agriculture

The profitability and sustainability of industrial agriculture are exposed to five major risks, which are set to intensify in coming decades:

1. Exposure to **high and volatile input costs**
2. **Degrading natural assets** such as soils and water reserves
3. **Vulnerability to a changing climate**, especially extreme weather events
4. **Negative environmental externalities** that will be increasingly taxed or regulated
5. **Shifting consumer trends**, as people demand clean, green, healthy and tasty food

Ecological farming: an attractive alternative

There is an alternative way to manage land that can minimise these risks, while increasing profitability. Ecological farming seeks to build soil health, minimise external inputs, recycle nutrients and energy, embrace diversity of crops and animals, and produce high value food and commodities. It is not necessarily organic (although it often can be), it can be practised on a commercial scale, and it is firmly science-based.

We have identified a number of proven systems that have investment merit. They include:

- Holistic planned grazing for cattle and sheep
- No-till cropping with diverse cover crops
- Agroforestry systems
- Low input pasture-based dairy
- Certified organic farming in certain countries

Seven reasons to go ecological

There are a number of reasons why these types of systems can deliver superior risk-adjusted returns:

1. **Comparable or better yields** in most cases
2. **Lower operating costs** because of less reliance on external inputs
3. **Enhanced natural capital,** with the opportunity to increase asset values by regenerating degraded land
4. **Climatic resilience** because healthy soils cope better with droughts and floods
5. **Positive environmental externalities** and the chance to be paid for them, for example through carbon credits
6. The ability to sell to **higher value markets** such as organic or grass-fed
7. **Higher profitability** with less volatility

The recent Paris Agreement has refocused attention on climate change and the need to control greenhouse gas emissions. Ecological farming can play a role by absorbing carbon from the atmosphere and storing it in the soil.

Investing in ecological farming

Farmland-ownership strategies provide the most direct exposure to this theme, as they allow investors to benefit from the uplift in value caused by the regeneration of land. But ecological farming is knowledge-intensive. Investors will need to back skilled operating teams, or invest in partnerships with carefully-selected farmers on a profit-sharing basis.

In terms of geography, the best opportunities lie in developed countries where land prices are not distorted by factors external to agriculture.

We believe that ecological farming systems can deliver superior risk-adjusted returns, while generating positive environmental impacts. There are proven systems out there – the opportunity lies in scaling them up.

About SLM

SLM Partners is an asset manager that acquires and manages rural land on behalf of institutional investors. Its mission is to scale up regenerative, ecological farming systems that deliver financial returns and environmental benefits. Founded in 2009, SLM Partners has offices in London, New York and Australia.

SLM Partners has raised and now manages the SLM Australia Livestock Fund, which acquires and operates grazing land in Australia with a focus on grass-fed beef cattle production. Launched in 2012, the fund has raised AU$105 million in equity and debt and acquired more than 480,000 hectares of land. The fund is applying a sustainable grazing system – known as holistic planned grazing – that can restore degraded land, increase stocking rates and improve profitability.

SLM Partners is developing a new investment strategy in Chile using the same grazing system but with a focus on sheep production. SLM Partners is also developing a fund that will invest in Irish forestry, applying continuous cover forestry management. The firm will continue to partner with innovative local land managers to develop investment opportunities in farming and forestry.

This White Paper sets out the investment case for ecological farming systems that are both profitable and environmentally beneficial. It is intended for institutional investors, family offices and investment managers with an interest in real assets, especially farmland. It is also intended for 'impact investors' who wish to generate positive environmental change as well as financial return. In our view, there does not have to be a trade-off between these two goals; it is possible to produce *higher* risk-adjusted returns by working with nature rather than against it.

Paul McMahon *is a Partner and co-founder of SLM Partners. Previously he was Vice-President at Climate Change Capital Ltd and Engagement Manager at McKinsey & Company. He has published widely on the topics of food security, sustainable agriculture and forestry, including the book* Feeding Frenzy: The New Politics of Food*. He holds a BA from University College Dublin and an MPhil and PhD from Cambridge University.*

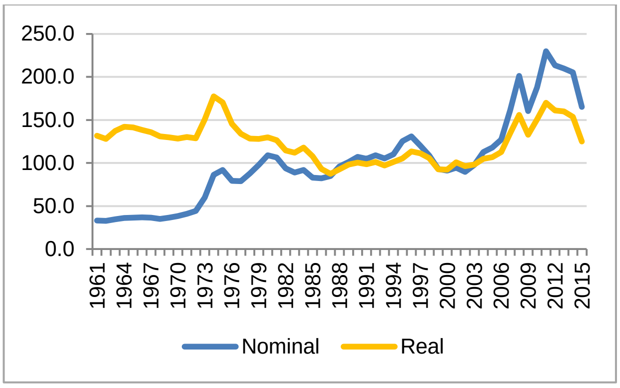
Farmland investing today

Farmland, a new asset class

Over the past decade, institutional investors have started to deploy real money into farmland. According to Preqin, 103 funds were closed between 2006 and 2015, raising $21.6 billion. Outside of funds, billions more have been invested through managed accounts or direct investments.[1] Most of these investments began after 2009.

There is one obvious reason for this investment splurge – the price of food. Between 1985 and 2005, there was little money to be made in farming. But this began to change in the mid-2000s. The prices of food commodities rose sharply. Between 2005 and 2014, the Food Price Index of the UN Food & Agriculture Organisation (FAO) was on average 41% higher in real terms than the previous decade (and 71% higher in nominal terms). This translated into higher farm incomes and higher returns to farmland ownership in most parts of the world.[2]

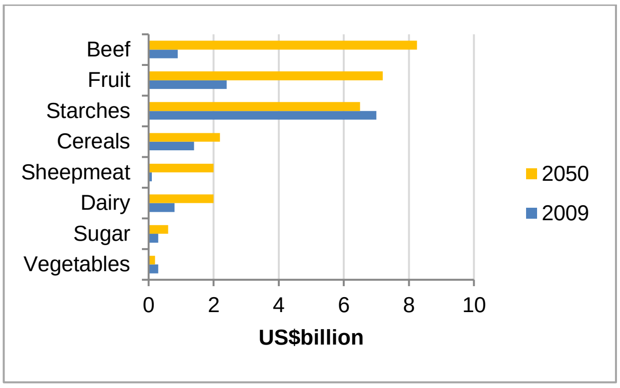
UN FAO Food Price Index (nominal and real)



Source: UN Food & Agriculture Organisation

There were a number of macro trends that caused the increase in food prices and that will continue to support farmland investing over the long-term. On the demand side, the world's population reached 7.1 billion in 2013 and is forecast to surpass 9.5 billion by 2050.[3] Rising incomes in the fast-growing Asian economies, especially China, are leading to dietary changes and greater demand for meat, dairy and protein.[4] Bioenergy has created a whole new market for agricultural commodities: for example, more than 30% of the current US maize (corn) harvest is turned into ethanol.

Estimated Chinese food imports, 2009 to 2050



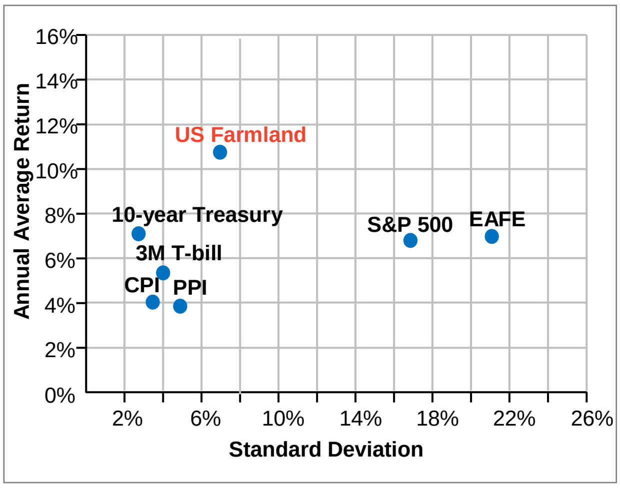
Source: ABARES

The UN Food & Agriculture Organisation estimates that food production will need to increase by 70% by 2050 to meet increasing demand.[5] But on the supply side, land and water resources are under pressure. The best, most accessible land is already being used, especially in the most heavily populated regions. Climate change, rising input costs and land degradation are all putting breaks on production. Yield growth has slowed since a burst of innovation in the 1960s and 1970s.

These macro tailwinds are propelling investor interest in agriculture. But there are also financial reasons why farmland is attractive to long-term investors. Land is a 'real asset'. It cannot be trucked away, or broken down and sold; it will always retain some value and therefore offers downside protection. It can generate income, either in the form of rents or profits from farm operations, thereby satisfying investors' hunger for yield – any yield – in the current environment. The returns from farmland are historically uncorrelated or negatively correlated with equity and bond markets, providing diversification. And these investments offer a natural hedge against inflation, as food prices and farmland prices go up during inflationary periods.

Last but not least, farmland can boast some impressive historical performance data. The NCREIF Farmland Index in the USA has outperformed stocks and bonds over the past ten, twenty, thirty and forty years, with lower volatility. Between 1970 and 2012 the index delivered an annualised return of 10.7%, with a Standard Deviation of just 6.5%. In the same period, the S&P 500 delivered an annualised return of 6.3%, with a Standard Deviation of 17.0%.[6] Farmland offers compelling financial returns at apparently low risk.

US Farmland returns vs other asset classes



Source: TIAA-CREF, *Investing in agriculture* (2013)

Challenges ahead

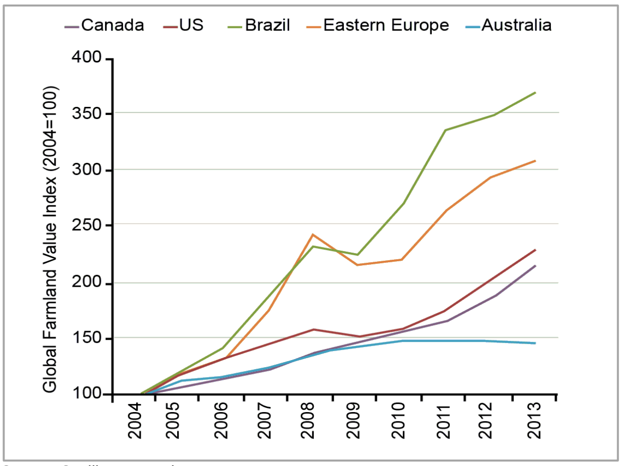
However, the days of easy money in farmland investing may be over. Food commodity prices have undergone a major correction over the last two years, especially for the staple crops that make up a large proportion of commercial farming output – maize (corn), wheat, soybeans and rice. Prices have dropped by 40-50% since their 2012 peaks. Food prices are still above the previous long-term average and for some products, such as red meat, prices remain high. But farmers are suffering after a few years of plenty. For example, data from the University of Illinois shows that crop farmers in that state who pay average cash rents for land will *lose* $41 per acre in 2015.[7]

Investors are also challenged by high farmland prices. Over the past decade many of the major agricultural producers have experienced rapid growth in assets values. According to Savills, farmland prices doubled in the USA and Canada and tripled in Brazil and Eastern Europe between 2004 and 2013.[8] This was a great investment in 2004 but there may not be much upside left in the near-term (with the exception of Australia).

Indeed, the recent fall in grains prices has led to the beginning of a correction in land markets in key producing areas. For example, at the heart of the US Cornbelt, the value of cropland in Iowa declined by 2% in 2013 and 7% in 2014, the first sustained fall since the mid-1980s.[9] Cash rents are down too. The idea that farmland is a one-way bet – that prices can only go up – is a fallacy.

There are still plenty of opportunities in farmland investing. But investors need to be smart with their money. They need to identify opportunities to use capital to improve the profitability of farm operations. This is possible because there are often large differences in performance between different farmers. The top quartile do very well, but the bottom quartile usually struggle to break even. In many cases, they only survive because of government subsidies or the hidden subsidies of unremunerated family labour. Rather than assuming that farmland prices or commodity prices can only go up, investors should focus on finding under-valued assets and backing operators that can improve the performance of these assets.

Farmland values in key markets



Source: Savills Research

Techno intensification

But how can you improve farm performance? If you attend one of the agriculture investing conferences that have sprung up in recent years, you will hear a typical narrative from fund managers and agribusiness executives. Their business plan is to take 'under-utilised' land and to introduce 'modern' technology and inputs – in the form of seeds, fertilisers, agro-chemicals, machines or irrigation – to produce a small number of commodities. Scale, specialisation, simplification and standardisation are the mantras. Mechanisation and chemicalisation the tools.

Or, they talk excitedly about 'AgTech'. There is a stream of start-up companies claiming to have discovered the solution to the food security challenge. Many of these new technologies support or intensify the high-input, industrial model of farming. For example, precision agriculture and 'Big Data' tools make the application of chemicals and fertilisers more efficient, but they lock farmers into the use of these inputs. Other companies seek to take food production off the land altogether, putting it in a warehouse under artificial lighting or keeping it in the laboratory (as in the case of lab-grown meat).

The ideal state is farm-as-factory, an industrial, linear process where inputs and outputs can be tightly controlled and the variability of nature tamed. This sort of attitude was taken to its extreme by an executive of one Brazilian farming company, who boldly stated that 'we are not farmers'. Instead, we are 'a large company that uses state-of-the-art technology to produce high-quality soybean'. 'The same way you have shoemakers and computer manufacturers, we produce agricultural commodities.'[10] Financial investors tend to 'get' these sorts of systems, as they look like the industrial businesses they more usually invest in.

Ecological alternatives

The irony is that this approach to agriculture is being challenged as never before. As this paper will explore, it can be expensive, risky, unsustainable and produce food of doubtful quality. Instead, farmers around the world are devising innovative alternatives that are more diverse, make better use of natural process, have less impact on the environment and are more profitable – all backed by a deeper understanding of biological and ecological science.

These systems tend to have a few principles in common. They:
- focus on soil health and soil biology as the foundation for all production;
- minimise use of external inputs, especially synthetic fertilisers and chemicals;
- recycle nutrients and energy – there is no such thing as 'waste';
- embrace diversity and exploit synergies between plants, animals and insects,;
- preserve and enhance natural resources (or 'natural capital'); and
- produce healthy, nutritious food that appeals to the consumer

It is about 'farming smarter, not harder'.[11]

SLM Partners believes that ecological farming represents a major investment opportunity. It not only deliver on sustainability metrics but can generate comparable, and often better, returns than industrial agriculture. This is 'impact investing' but without any financial trade-off. Indeed, in many cases deeper ecological understanding reduces risk and drives superior profitability. There are proven systems out there – the opportunity lies in providing the capital to scale them up.

This White Paper sets out the case for investing in ecological, regenerative agriculture. It consists of four parts:
- The risks of industrial agriculture
- An explanation of ecological farming (with case studies)
- The reasons why ecological farming can deliver better risk-adjusted returns
- How investors can take advantage of this opportunity

This paper presents data and case studies from developed regions that have commercial, large-scale farming operations. This includes North America, Western Europe, Australia, New Zealand and parts of South America. These are the regions of greatest interest to institutional investors seeking the security of real assets. Ecological farming also has great potential to improve food security, alleviate poverty and contribute to sustainable development in the poorest and least developed parts of the world. There is an extensive literature on this topic, especially on the role of agroecology in development, but it is not the focus of this paper.

The risks of industrial agriculture

Industrial agriculture is already beset by numerous risks to profitability. These are set to intensify in the coming decades because of economic, environmental and political change. These risks include:

- High and volatile input costs
- Degrading natural assets
- Vulnerability to a changing climate
- Negative environmental externalities
- Shifting consumer trends

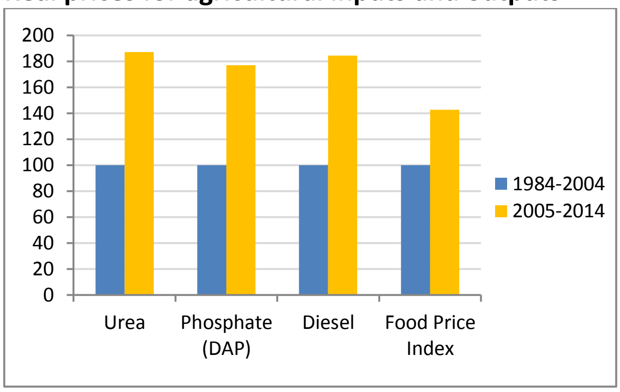
High and volatile input costs

Profitability in farming is driven not by high prices but good margins. Modern, industrial agriculture is heavily dependent on a range of inputs that can erode margins. These inputs include:

- Non-organic fertilisers (nitrogen in the form of urea and ammonia, phosphate, potassium)
- Pesticides (herbicides, insecticides, fungicides)
- Seeds (including expensive biotech seeds in some regions)
- Diesel fuel and electricity for machinery
- Animal feed, primarily cereals and soybeans

The problem is that although the price of commodities has risen over the past decade, the cost of inputs has risen even quicker. Globally, the average price of urea, phosphate and diesel in real terms was around 80% higher between 2005 and 2014 compared to the two decades between 1984 and 2004. The UN FAO Food Price Index was 43% higher in 2005-2014 compared to the previous two decades. Farmers' margins were squeezed even in a time of high output prices.

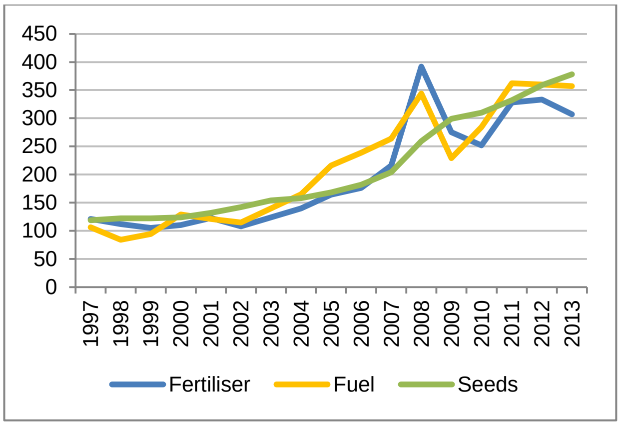
Real prices for agricultural inputs and outputs



Source: Indexmundi
Note: real prices indexed to 100 for 1984-2004 period

Figures from the USDA show how this played out for American farmers. In 1997 farm expenses absorbed 78 cents in every dollar of revenue. By 2012 that figure had climbed to 83 cents, i.e. margins had shrunk even though food prices were near record highs.[12] One of the major drivers was the rapid increase in the cost of fuel, fertiliser and seed, which tripled in the decade to 2012.

Index of prices paid by farmers in USA

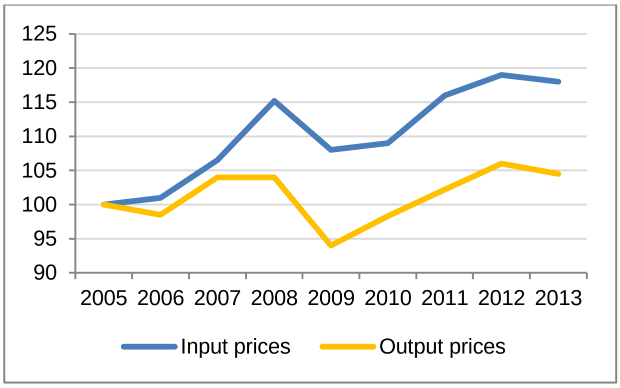


Source: USDA NASS. Base period = 1990-92

A similar pattern can be seen in the case of European agriculture. Figures from the European Commission show that input prices increased by 20% between 2005 and 2013 whereas output prices increased by only 5% (in real terms).

Intensive animal producers are most exposed to these trends as their inputs are often other farmers' outputs. Most poultry and pigs are raised indoor on a diet of grains or soybeans. There has been a trend towards fattening cattle in a similar way in feedlots. The biggest cost for these systems is animal feed, as it takes many kgs of feed to produce a single kg of meat. This multiplier effect concentrates the impact of higher raw commodity prices on intensive animal producers. Rising input costs force up the prices of grains and soybeans, which pushes up the costs for intensive animal producers even more. This is why conventional pig, poultry and cattle fattening enterprises have experienced a rollercoaster ride over the past decade. For example, the hog industry in the USA lost an estimated $3 billion in 2012 when drought forced up the price of crops.[13]

Agricultural input and output prices in EU



Source: Eurostat

There are many reasons for rising input costs. One is market structure. There are millions of farmers selling their products into increasingly globalised commodity markets. They are price takers. But inputs are controlled by a small number of large firms (Monsanto, Syngenta, John Deere, Yara, Bayer, and Dow, to name a few). This gives them more power to set prices. Farmers complain that the costs of inputs are 'sticky', rising quickly alongside food prices but then taking much longer to come down after food prices peak.[14] Corporations do their best to make sure that much of the economic surplus from rising food prices goes to them.

A fundamental driver of input prices is the cost of energy, especially fossil fuel energy. 80% of nitrogen fertilisers are synthesised from natural gas (and this activity accounts for 1.1% of global energy use)[15]. Most pesticides are derived from crude oil. Fuel from machines comes directly from crude oil. And energy is a major cost of extraction in the mining of phosphate and potash. Modern farming is energy-intensive. For example, energy-based inputs account for more than 30% of the production costs of maize (corn), rice and sorghum farmers in the USA.[16] Input costs are now coming down because of the recent fall in crude oil prices. But energy prices are inherently volatile.

Degrading natural assets

One of the reasons why farmers have to spend so much on inputs is that they are degrading the natural resources on which agriculture depends. These include soils, water reserves and ecosystems.

Land degradation can be physical, chemical, or biological. Physical degradation refers to soil erosion and changes in the soil's structure, such as compaction or waterlogging. Chemical degradation is caused by leaching, salinisation, acidification, nutrient imbalances and fertility depletion. Biological degradation refers to the loss of vegetation on rangelands, deforestation, and loss of biodiversity, which includes the loss of soil organic matter and soil microbes.

Agriculture is the prime culprit. Over-tilling and poor livestock management can destroy soil structure, strip the soil of vegetative cover and lead to water and wind erosion. Irrigation is a major cause of salinisation: salts are left behind as irrigation water evaporates. Use of chemical fertilisers and pesticides can kill the microorganisms that hold soil together, keep it aerated and make nutrients available to plants. Agriculture is also the main driver of deforestation in tropical countries.

Land degradation has been a factor in the decline of many civilisations in the past and is a worldwide problem today.[17] A major study in 2015 by the Intergovernmental Technical Panel on Soils found that 33% of land globally is moderately or highly degraded.[18] This leads to an estimated economic loss of $40 billion per year.[19] Each year about 12 million more hectares are degraded.[20] Recent research indicates that, under business as usual, the current soils in agricultural production will yield about 30% less than they would otherwise by 2050.[21]

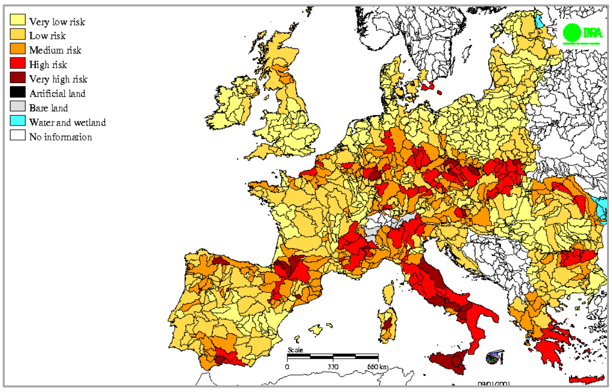
In China, a survey by the agricultural ministry found that over 40% of arable land had been severely degraded due to the overuse of chemical fertilisers. As a result, China was forced to convert more than 660,000 hectares of marginal farming land to forests in 2014.[22] In the European Union, about 117 million hectares, or about 22 % of the land area, is estimated to be degraded.[23] The rangelands of Australia have suffered decades of productivity decline because of poor grazing practices.[24] In tropical Brazil, the clearing and cultivation of native savannahs can reduce soil organic matter content from 5% to 0.5% after just 5 years of cropping.[25]

The value of soil erosion to the landowner (USDA)

"Soil for the land owner is a bit like the story of removing bricks from a wall: you can remove the bricks one at a time without any trouble until you remove one too many and the wall collapses. A land owner can tolerate soil erosion a little at a time, but at some point it is going to cost, and they won't know what they've got until its gone."[26]

Degradation is happening in some of the most 'advanced' farming areas. Iowa University found that soil was being washed away at a rate of 19 tonnes per hectare after heavy rains in 2013, thanks to intensive corn-soybean production that left the soil exposed.[27] Over the last 150 years, one-half of the fertile topsoil of Iowa has disappeared due to erosion.[28] This has a direct cost to farmers in terms of lost fertilisers and soil carbon. Iowan farmers are lucky that they are sitting on some of the deepest soils in the world. But other areas are not so fortunate. And even in Iowa, at these erosion rates, farmers will eventually hit bedrock.

Soil erosion risk in Europe

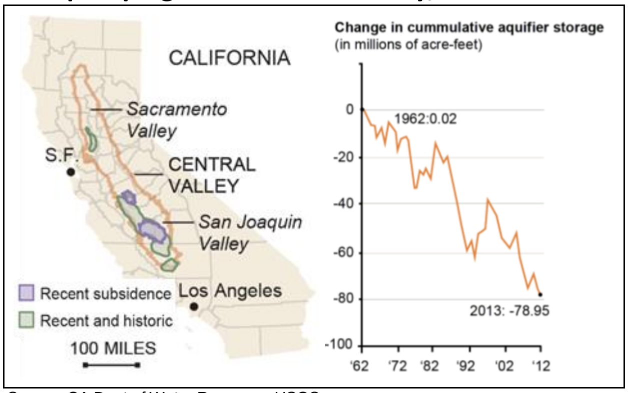


Source: European Soil Bureau

Agriculture also places a massive strain on scarce water resources. It is responsible for 70% of total water use now. Under business as usual, agriculture's demands are expected to almost double between now and 2030 – by which time many water basins will suffer huge deficits.

The risk is greatest for those producers that rely on groundwater. The water level of the Ogallala aquifer, which stretches under the Great Plains of the USA and provides about 30% of the irrigation water used on American farms, is falling at an alarming rate. Irrigated farms in California only escaped complete catastrophe in 2013 and 2014 by pumping massive amounts of groundwater at rates well above natural replenishment, leading to subsidence and water salinity. Water tables are dropping just as fast in the Indian Punjab and the North China Plains, where more than 300 million people depend on grains grown from over-pumping aquifers.[29]

Overpumping in the Central Valley, California



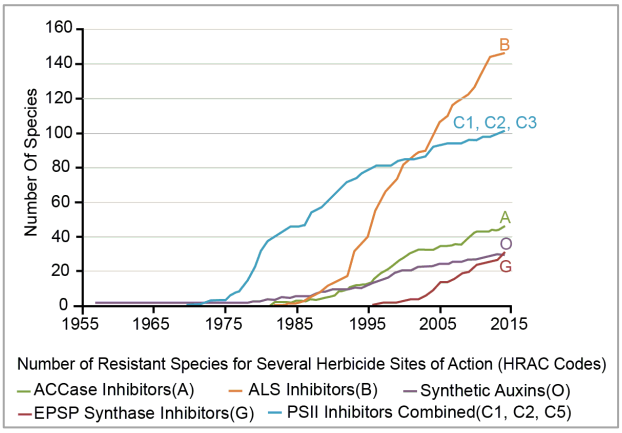
Source: CA Dept of Water Resource, USGS

A loss of ecosystem functionality and species diversity also creates risks for farmers. Much has been made of the recent decline of natural pollinators, especially bees, because of pesticide use and habitat change. About 40-50% of food comes from crops that rely on wild pollinators or domestic honey bees. The global value of their services has been estimated at €120 billion per year.[30] Technological alternatives to natural pollinators are expensive or simply don't work.

Widespread use of genetically-modified crops in simplified rotations has led to the evolution of resistant 'superweeds' and insects – entirely inevitable, as Charles Darwin could have pointed out. According to the USDA, 28 million hectares of American farmland had weeds resistant to glyphosate, the most commonly used herbicide, by 2013.[31] Farmers are now being told to use more powerful pesticides or to buy more expensive new GM seeds.[32] Globally, some 220 weed species have evolved herbicide resistance, and 600 cases of insecticide resistance have been recorded.[33]

By eroding their natural resource base, farmers increase their cost base. More fertilisers are needed to compensate for lifeless soils, more diesel or electricity is needed to pump groundwater from increasing depths, more pesticides or high-tech seeds are needed to keep nature in check. The input treadmill speeds up. But, in addition, the assets that farmers – or investors – have worked so hard to acquire are depreciating in value.

Development of weed resistance to herbicides



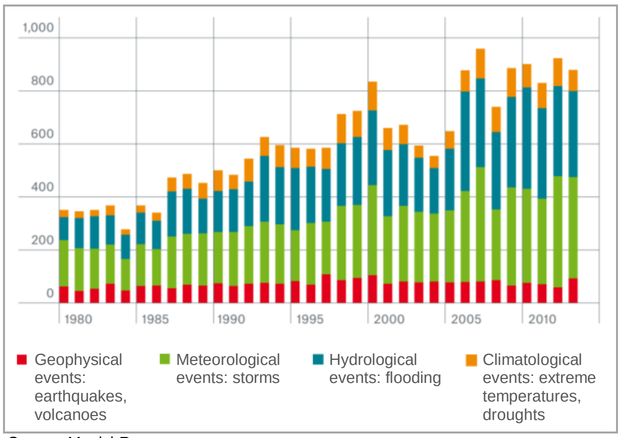
Source: Ian Heap, International Survey of Herbicide Resistant Weeds

Vulnerability to a changing climate

For as long as mankind has practiced agriculture, production has been at the mercy of the weather. Despite all the modern technology that is now available, this is still the case. Volatile weather has been one of the most obvious causes of supply shortfalls over the past decade. Australia experienced severe drought in 2002-03 and 2007-08, crippling its wheat harvest. A heatwave in Russia in 2010 caused its grain harvest to shrink from 100 million tonnes to 60 million tonnes. Heavier than usual monsoon rains flooded large areas of Pakistan in 2010 and Thailand in 2011. A 2012 drought in the USA devastated one-sixth of the country's maize crop and one-eighth of its soybeans – July 2012 was the hottest month ever recorded in the continental USA.[34] California's ongoing drought – which wiped $2.2 billion off its agricultural economy in 2014 – is the latest example.[35]

Are the frequency and intensity of extreme weather events on the increase? A natural catastrophe database maintained by the insurance group Munich Re indicates that the answer is yes. It shows that the number of extreme weather event has tripled since 1980.[36]

Number of natural catastrophes 1980-2013



Source: MunichRe

There is an obvious reason for this – climate change. The 2014 update by the Intergovernmental Panel on Climate Change (IPCC) made the strongest link yet between current weather extremes and long-term global warming. A Swiss-led study in 2015 found that global warming was to blame for most extremely hot days and almost a fifth of heavy downpours recorded globally.[37] And the intensity and frequency of these events is set to increase as the slow pace of action on reducing greenhouse gas emissions means it is almost certain that temperatures will rise by at least 2 degrees Celsius by the end of this century.[38]

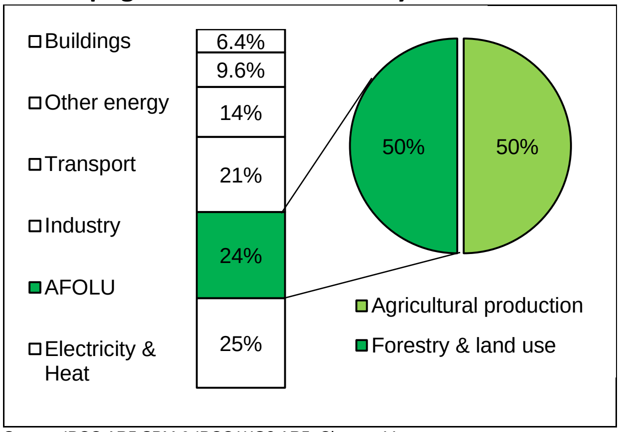
This poses a massive threat to food production in coming decades. Farms that lack resilience – because of bare soils, degraded soils, poor water cycles and lack of diversity – will suffer the most.

Negative environmental externalities

Although climate change is usually regarded as an external threat to food production, agriculture is a major culprit when it comes to greenhouse gas emissions. The latest report of the Inter-governmental Panel on Climate Change (IPCC) estimates that agricultural production is directly responsible for 12% of all man-made GHG emissions.[39] This chiefly comes from the breakdown of fertilisers in soils, methane production by animals, rice cultivation and manure management. The true figure is higher, as this estimate does not include indirect emissions from the production of fertilisers, agro-chemicals, machinery and other agricultural inputs, which can be very energy-intensive.

In addition, deforestation and peatland degradation account for another 12% of global man-made emissions. Agriculture is indirectly responsible for much of this, as it is a major driver of land use change in developing countries. In total, about 24% of man-made emissions come from the agriculture and forestry sectors, which is more than from industry or transport.[40]

Anthropogenic GHG emissions by sector



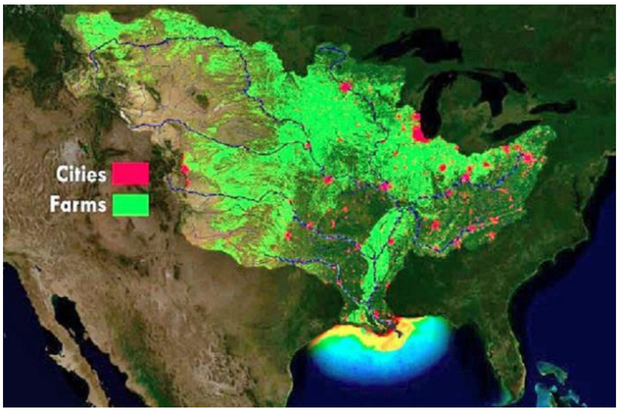
Source: IPCC AR5 SPM & IPCC WG3 AR5, Chapter 11
Note: AFOLU = Agriculture, Forestry and Other Land Use

This is just one of the negative impacts that modern agriculture has on human society – what economists call ‘externalities’. There are plenty more. Modern farming can be a dirty business.

Over-use of fertilisers can lead to run-off and leaching of nutrients, polluting watersheds. For example, in New Zealand the intensification of dairying over the past 20 years has led to a major increase in the amount of nitrates in waterways. In the Canterbury region, a government survey found that 11% of drinking water wells had levels that exceeded the maximum acceptable standard for nitrates.[41]

According to the US Environmental Protection Agency, about 68% of the USA’s lakes, reservoirs and ponds, and more than half its rivers and streams, are impaired, with the main culprit being agriculture.[42] Drinking water was suspended for two days in Toledo, Ohio in August 2014 because of algae blooms in Lake Erie linked to nutrient run-off from farms.[43] Nutrient overloading of the Mississippi River has led to a 6,000 square mile ‘dead zone’ in the Gulf of Mexico, with harmful effects on coastal fisheries, and similar impacts in the Chesapeake Bay. Farm-source pollution means that water companies and governments have to invest millions of dollars in water purification.

Sources of water pollution creating ‘Dead Zone’ in the Gulf of Mexico

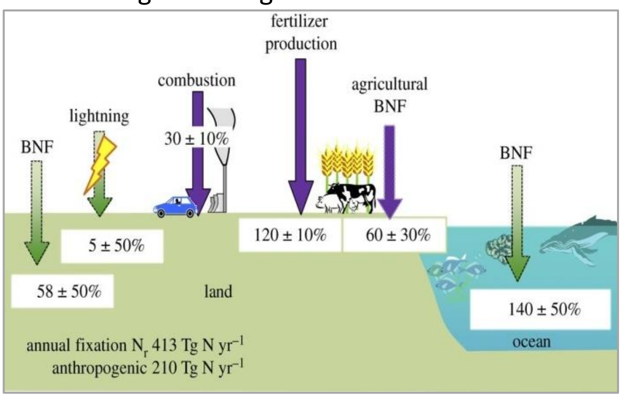


Source: National Oceanic and Atmospheric Administration

Nitrogen is the stuff of life, the building block for amino acids and proteins. But if ecosystems are over-loaded, nitrogen can be a water and air pollutant. The global cycling of nitrogen has doubled over the last century because of human activity. Fertiliser production alone is responsible for 29% of <u>all</u> nitrogen fixation, both natural and anthropogenic. But only 17% of the nitrogen used in agriculture ends up being consumed by humans in crops, dairy or meat products. The rest leaks to soils, freshwaters and atmosphere, where it affects human health, climate and biodiversity. It leaks especially quickly from soils made lifeless by chemicals, as healthy soil biology is needed to convert nitrogen into a plant-palatable form. Of all the biogeochemical cycles on which life depends, the nitrogen cycle is the one that has been most perturbed by human activity, with consequences we are only beginning to understand.[44]

Global nitrogen fixation

BNF = Biological Nitrogen Fixation



Source: Fowler et al, ‘The global nitrogen cycle in the twenty-first century’ (2013)

There are more powerful pollutants than nitrogen within modern agriculture. Toxic pesticides are a direct risk to the farmers and farmworkers who apply them. Occupational exposure to pesticides in the USA poisons as many as 20,000 farmworkers every year, according to estimates by the Environmental Protection Agency. The numbers are likely much higher due to under-reporting. Rural and agricultural communities have been found to experience higher rates of leukaemia, non-Hodgkin lymphoma, multiple myeloma, and soft tissue sarcoma, as well as cancers of the skin, lip, stomach, brain, and prostate. Farmworkers also bring home toxic chemicals on their clothes and body. As a result, pesticide exposure is attributed to higher rates of birth defects, developmental delays, leukemia, and brain cancer among farmworker children.[45]

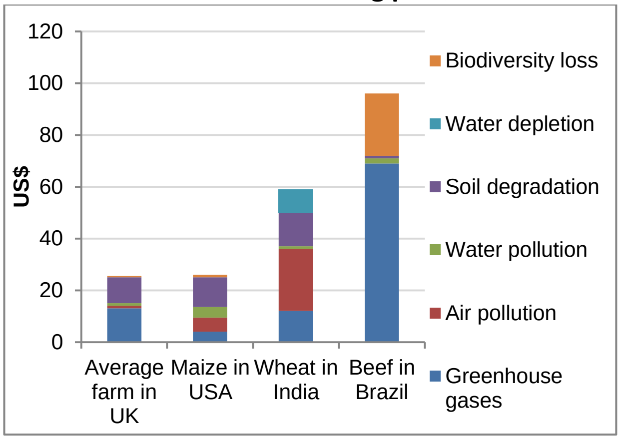
A potentially serious health risk to wider society is the over-use of antibiotics on animals. Intensive, grain-fed production systems are often unhealthy for animals. Huge doses of antibiotics are used to keep pigs, chickens and cattle alive and to promote growth. 70% of all the antibiotics used in the USA are given to animals. The majority are medically important to humans. Bacteria can evolve resistance to antibiotics, and there are many ways that these 'superbugs' can pass from animals to humans. For example, antibiotic-resistant bacteria have been found in dust in the air around cattle feedlots in Texas.

Because of increasing resistance, much of it linked to factory farming of animals, we are on the cusp of a 'post-antibiotic era' that 'could plunge medicine back into the dark ages'.[46] In the USA, 23,000 people already die from antibiotic-resistant infections each year.[47] According to a major study led by former-Goldman Sachs economist Jim O'Neill, drug resistant infections will kill an extra 10 million people a year worldwide by 2050, reducing world economic output by between 2% and 3.5%, unless action is taken to reduce antibiotic use.

Monocultures and the liberal use of pesticides also destroy biodiversity. In our human-dominated age – the Anthropecene – species are becoming extinct at an unprecedented rate. The expansion of agriculture, and in particular simplified, chemicalised agriculture, wipes out natural habitats and creates sterile farm habitats in their place. Biodiversity is essential to the healthy functioning of ecosystems. The loss of species can have unforeseen consequence and push systems off balance. It also erodes a genetic bank that scientists draw on for medicines and all kinds of innovations – including new crops – to the detriment of future generations.[48]

The charge sheet against modern agriculture is long. The food system has pushed costs onto society without having to internalise all the costs of production. The justification is that this allows for cheap food. But the 'true cost' of food, if all these externalities were priced, would look very different. For example, one study found that on an average UK farm the environmental cost to produce $100 of food was an extra $26. For Brazilian beef, which plays a large role in deforestation, the extra cost was estimated at $64-129. A hundred dollars of US maize (corn) may have environmental externalities worth $18-33.[49] In New Zealand, two researchers found that the annual economic cost of the environmental externalities associated with the dairy industry was higher than the total 2012 dairy export revenue of NZ$11.6 billion.[50]

Environmental costs of farming per $100 of food



Source: ISU, *What price resilience?* (2011)
Note: Based on 2002-2009 period. Midpoint taken where ranges used

But the non-pricing of externalities is starting to change. Governments are regulating more forcefully and penalising dirty production systems. To take a few examples:

- In New Zealand, restrictions on nitrogen fertiliser application are threatening the expansion of the intensive dairy model.

- In the USA, the Environmental Protection Agency is acting under presidential order to regulate farm-related pollution in the Chesapeake Bay. The private sector is also taking action via the courts: Iowa's largest water utility sued three counties in federal court in March 2015 to force them to clean up nitrate-laden water that drains from farms.[51]
- In Europe, the recent reform of the Common Agricultural Policy introduced 'greening' measures which require arable farmers to rotate crops, designate land as ecological focus areas and retain more permanent grassland.
- China is cracking down on polluters and promoting organic techniques in an attempt to improve food safety and salvage what is left of its environment.

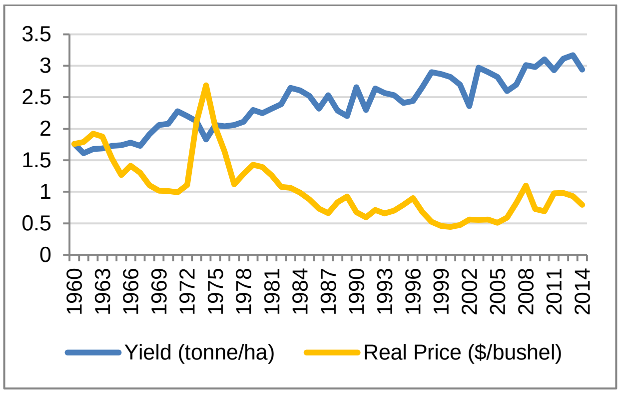
At some point, governments may put a price on carbon, which would change the equation of food production overnight.

Investing in farming systems that create negative externalities is risky, even if there is no cost now. The trend is inescapable. Pollution will increasingly be regulated and/or taxed. This is to say nothing of the reputational risks that are associated with investing in systems that leave the planet in a worse condition.

Shifting consumer trends

Over the past seventy years, the yields that farmers can achieve on their land have increased steadily. For example, the average US farmer now grows 3 tonnes of wheat per hectare, compared to 1.7 tonnes in 1960. But, at the same time, the cost of food in real terms (adjusted for inflation) has steadily declined. A kg of wheat is not worth as much compared to other goods or services. The terms of trade between the agricultural sector and the rest of the economy have turned against the farmer, which means that he or she has to grow more and more just to maintain income parity with everyone else.

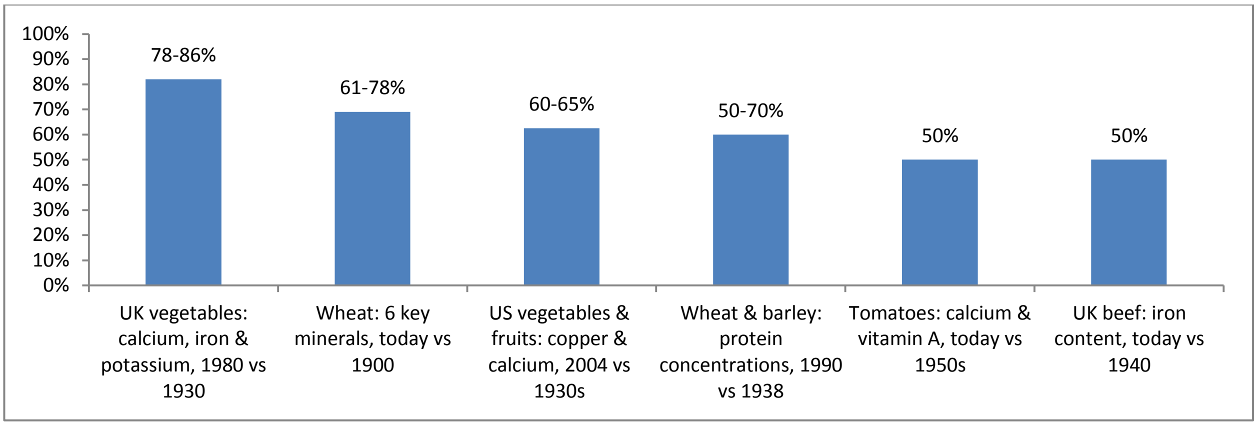
Yield and real price of wheat in USA



Source: USDA

What if this decline in value was partially linked to a decline in food quality? There is plenty of academic evidence that the nutritional content of our food has deteriorated over the past 50 to 70 years. Many vegetables have shown nutrient declines of anywhere from 5% to 40%. Researchers now refer to largescale "biomass dilution" – plants that have such low concentrations of certain nutrients that they do not adequately nourish the people who eat them.[52] You need to eat much more modern foods to get the same nutritional return.

Nutrient content of modern foods vs historical varieties



Source: D. Davis, 'Declining Fruit and Vegetable Nutrient Composition', *HortScience* (2009); *Scientific American*, 27 April 2011; M. Schatzker, *The Dorito effect* (2015)

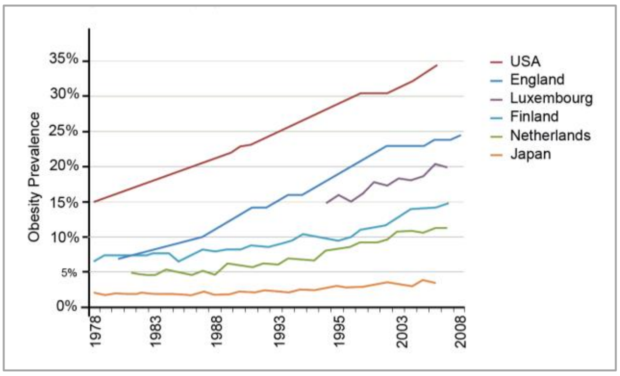
There are a few explanations for why this has happened. First, plant and animals breeders have selected for traits that produce bulk, without paying much attention to the minerals and vitamins that our bodies need. Nutritional quality has rarely been an objective. Second, these plants and animals are grown as quickly as possible in highly fertilised soils, which means they do not have the time or opportunity to absorb nutrients from biologically active soils. Third, the use of chemical pesticides means that plants do not have to invest much energy in their own defences. Surprisingly, it is often the plant's response to the stress of pest attack that produces healthy antioxidants beneficial to us.

Nutrition is linked to taste. Our bodies possess extraordinarily complex sensory instruments for distinguishing the content of food: our flavour-sensing genes take up more DNA than any other function of the body. As foods have lost nutritional value – especially micronutrients – they have become less tasty as well. To counteract this blandness, food manufacturers spend billions of dollars on inventing artificial flavours and adding them back in. Modern, processed food is usually composed of a few staple commodities – maize, wheat, rice, vegetable oils – combined in different ways and then loaded with sugar, salt, fat or flavours to trigger our tastebuds. So much of modern food is a nutritional con.[53]

The results are obvious – rampant obesity and nutrition-related poor health. According to the International Obesity Taskforce, almost 1.5 billion people are obese or overweight, which raises the risk of chronic diseases such as diabetes, heart disease and cancer. In the USA, the estimated cost of obesity-related illness is a staggering $190 billion each year, or nearly 21% of annual healthcare spending.[54]

Until recently obesity was most associated with rich, developed countries. But the trend is also appearing within middle income countries as their food systems copy the Western model. At the same time, about 1 billion people suffer from 'hidden hunger', lacking essential micronutrients such as vitamins and minerals. The proliferation of empty calories means that it is possible to be overweight and deficient in nutrients at the same time.

Percentage of adult population assessed as obese



Source: Public Health England

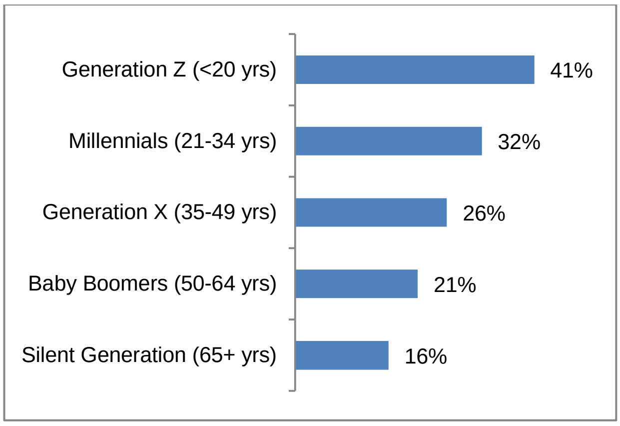
Over the past 100 years, farmers in advanced economies have focused on yield, volume, and standardised production of commodities that are easily traded and stored, but which have steadily declined in quality and value. An increasing share of the value has been taken by food manufacturers or restaurant chains that use cheap staples combined with artificial flavours to 'trick' the tastebuds of consumers. The easy availability of unhealthy, processed foods has had dire consequences for human health.

The failings of our food system are starting to be noticed. Consumers have woken up and are demanding something different. They are not only responding to a nutritional crisis but to the negative environmental impacts that are associated with modern agriculture. The wave of books, articles and TV shows on this subject is hard to miss. At first, this could be dismissed as an elite foodie fad. But this line is harder to maintain now. 'Fresh', 'healthy', 'natural' food is the fastest growing category in food retailing in Europe and North America. Niche markets such as organic and grass-fed milk and beef are growing at 10-20% per annum.

Mainstream consumers are concerned about issues such as the nutritional value of food, pesticide residues, the use of antibiotics and hormones in animal products, genetic modification and animal welfare. Whether grounded in evidence or not, the perception exists that modern, industrial agriculture is bad for people and the environment. And perception drives behaviour. This has led to increase demand for foods that are clean, green and healthy.

This trend is most obvious among younger generations. According to Nielsen's Global Health and Wellness Survey – a survey of 30,000 consumers in 60 countries – young people are much more interested in sustainably-sourced food and willing to pay a premium for it. Among consumers under age 20, 41% said they would willingly pay a premium for sustainable products, compared to 21% of Baby Boomers (aged 50 to mid-60s.)[55]

Willingness to pay premium for sustainable food



Source: Nielsen Global Health and Wellness Report (Jan 2015)

Corporate behaviour is changing as a result. The fastest growing supermarkets in the USA are Whole Foods and Trader Joe's, which focus on organic, natural foods. In food service, the fastest growing category is the 'fast casual' restaurant that places an emphasis on healthy food and sustainable sourcing. The best example is Chipotle, which has built a brand by shunning 'factory farming' and embracing farmers that practice higher animal welfare. Revenues at Chipotle have grown by 20% each year for the last 5 years.[56] In contrast, sales at McDonald's and other fast-food chains are stagnant.

As a result, food manufacturers and retailers are showing greater commitment to sustainable sourcing. In 2015 McDonald's pledged that it would phase out chicken that had been raised with antibiotics used to treat humans and only use verified 'sustainable beef' (although what this means is yet to be defined).[57] Perdue, Chick-fil-A, the Panera Bread Company and Chipotle have also committed to phase out the routine use of antibiotics in livestock.[58] Walmart, Unilever, Kellogg have all announced initiatives in the past two years to reduce the environmental impact of the foods they purchase. Companies are tripping over themselves to pledge that they will not use Genetically Modified Organisms (GMOs).

The risk for investors who back industrial farming systems that are perceived as polluting and unhealthy is that their products will be relegated to lower value commodity markets. They will be locked out of some of the fastest growing markets where price premiums are available for clean, green and healthy food.

Ecological farming: an attractive alternative

Are there alternative ways to manage land that can minimise these economic, environmental and reputational risks, while still producing food and other commodities in a profitable way at scale? We believe the answer is yes.

Definitions

Ecological farming is not a set of prescriptive rules, rather a set of principles that inform the design of a farming system. The emphasis is on farmers understanding their local environment – the interaction of soils, water, climate, vegetation, birds and insects that comprise an agro-ecosystem. These farmers seek to manage and mimic ecological processes, making the most of on-farm resources and minimising the use of off-farm inputs such as fertilisers and chemicals. A major focus is on improving the health of the soil by increasing organic matter and soil biotic activity. These systems tend to be diverse, incorporating crops, trees, animals in symbiotic ways. The waste from one part of the system becomes the nutrient for another. The interaction between different species reduces the threat from pests. By better understanding and manipulating ecological processes, clever farmers can produce extraordinary results.

There are a number of techniques or practices that are widely used in ecological farming systems:

- reduced or zero tillage;
- more complex crop rotations;
- use of cover crops to build fertility and protect soils;
- reliance on soil biology (e.g. microbes and earthworms) for soil structure and fertility;
- use of biologically active soil amendments (e.g. composts) to recycle nutrients and suppress soil-borne diseases;
- minimal use of agrochemicals because of their impact on soil biology and biodiversity;
- biological control of pests through species diversity ("integrated pest management");
- mixed crop and livestock systems;
- incorporation of fertility-building legume pastures within arable systems;
- effective utilisation of grassland by livestock species through controlled grazing;
- incorporation of trees and bushes within cropping and livestock systems (agroforestry);
- water conservation and harvesting through landscaping (e.g. keyline design).[59]

In many cases, multiple techniques are used together. Rather than simply increasing the efficiency of linear processes, ecological farming focuses on redesigning whole systems. The goal is to build a system that is more than the sum of its parts. The mental framework is 'farm as ecosystem' not 'farm as factory'.

There are lots of labels for this sort of farming and a number of variations: agro-ecology, eco-agriculture, organic, biodynamic, permaculture, conservation agriculture, regenerative agriculture, biological farming, low input sustainable farming. We use the term 'ecological farming'.

Avoiding misconceptions

There are also a few things that ecological farming is *not*. First, it is not necessarily 'organic'. Some farmers meet all the criteria of organic production without seeking organic certification because of the costs and administration involved – it is often a marketing decision. On the other hand, there may be times when it is sensible to step outside organic restrictions on synthetic inputs to achieve better outcomes. And it is possible for a farming system to meet the requirements of organic certification and still be destructive to the land. This is why some farmers strive to go 'beyond organic'. Organic certification can provide some very attractive marketing and pricing opportunities but these should be assessed on a case by case basis.

Second, ecological farming has often been associated with smallscale producers, either 'back to the land' hippy types in rich countries selling direct to consumers, or poor smallholders in developing countries. Indeed, much of the academic research on agro-ecology has focused on development projects in Africa, Latin America and Asia. But there is no reason why ecological farming cannot work on a large scale within a commercial environment – as the case studies in this paper illustrate.

The scale of operation is really a question of levels of social and economic development. In poor countries, where the majority of the population rely on the land for their livelihoods, it makes sense to design ecological farming systems for smallholders, who can use them as a way out of poverty. But in wealthy countries, where most people have already been drawn from the land to the cities, scale is important to deliver an acceptable income for farmers and farm workers. Machinery and technology will play an important role, alongside ecological knowledge.

Third, ecological farming is not 'anti-science'. In fact, it is deeply science-based and knowledge-intensive. The cutting edge science in agriculture today is not in chemistry but in biology. We are only beginning to understand soil microbiology, species interactions and ecosystem functioning. Professor Gordon Conway of Imperial College London, a former president of the Rockefeller Foundation, calls the emergence of ecology as a sophisticated discipline 'the second great revolution in modern biology' alongside genetics.[60]

For example, glomalin, a glycoprotein that plays a crucial role in binding soil particles together and creating soil fertility, was only discovered for the first time by an American scientist in 1996. Thanks to DNA sequencing, scientists have recently discovered the dizzying diversity of bacteria, viruses and fungi that live in and around plant roots in the soil. Studies show that 1 gram of healthy soil can contain up to 1 billion bacterial cells and 100,000 fungi. The important role of these microbes in agricultural production is now being teased out. [61]

Ecological farming is 'AgTech' but of a different kind. It is a return to the original definition of 'technology', which comes from two Greek words: *technis*, which means art, skill, craft or the way something is gained, and *logos*, which means word or thought. 'Technology' does not just mean physical objects such as new machines or seeds. It also refers to knowledge or mental objects. Knowledge-intensive ecological farming systems, therefore, are advanced forms of human technology.

The Royal Society on sustainable food systems

The Royal Society, in a major report called *Reaping the benefits: Science and the sustainable intensification of global agriculture*, state that sustainable food systems will have following attributes:

1. avoid the unnecessary use of external inputs;
2. harness agroecological processes such as nutrient cycling, biological nitrogen fixation, allelopathy, predation and parasitism;
3. minimise the use of technologies or practices that have adverse impacts on the environment and human health;
4. make productive use of human capital in the form of knowledge and capacity to adapt and innovate and social capital to resolve common landscape-scale problems
5. quantify and minimise the impacts of system management on externalities such as GHG emissions, clean water availability, carbon sequestration, conservation of biodiversity, and dispersal of pests, pathogens and weeds.[62]

A growing movement

Long the preserve of individual farmers working on the fringes, ecological farming is now going mainstream. The idea that ecology should be at the centre of agriculture has been endorsed by the two Rome-based UN food agencies (the Food and Agriculture Organization and the International Fund for Agricultural Development); the oldest scientific fellowship in the world (the Royal Society); an international study involving 900 experts from 110 countries (the International Assessment of Agricultural Knowledge, Science and Technology for Development, or IAASTD); and the French Agricultural Research Centre for International Development (CIRAD).

A big institutional change took place on 29 September 2014 in Rome, when the UN FAO Director-General José Graziano da Silva called for a 'paradigm shift' towards sustainable agriculture. 'We cannot rely on an input intensive model to increase production,' he said. 'The solutions of the past have shown their limits.'[63]

It is estimated that 200 million hectares of agricultural land are cultivated under some form of agro-ecological regime.[64] This figure is growing substantially each year.

A number of investment funds have also been created to invest in ecological and regenerative agriculture and food systems. Including SLM Partners, we have identified 7 investment managers pursuing these strategies. Together they manage more than $500 million in assets.

Managers investing in ecological agriculture	
SLM	Livestock strategies in Australia and Chile
Iroquois Valley Farms	Organic farmland in USA (Midwest & NE)
Farmland LP	Organic farmland in USA (West)
althelia ecosphere	Tropical commodities & forest carbon
moringa fund	Agroforestry in South America and Africa
AgrO-Ecological	Permanent crops & dairy in New Zealand
S2G Ventures	Growth equity along supply chain

Note: not exhaustive

Case studies

SLM Partners has spent many years studying ecological farming systems around the world. This section describes particular systems that we find attractive. They have been selected on the basis of the following criteria:

- Applicable at commercial scale
- Economic returns that are as good or better than industrial production models
- Proven environmental benefits, especially the ability to reduce greenhouse gas emissions
- Sufficient evidence in published studies to back up these claims

This selection is by no means exhaustive. Instead, it represents a shortlist of systems with attractive characteristics that have come to our attention. SLM Partners is investing in one of these systems and exploring others for potential investment opportunities.

Holistic planned grazing for beef cattle and sheep

Conventional management of livestock on extensive grasslands (which cover 3.5 billion hectares or 26% of the planet's ice-free landmass) consists of placing small numbers of animals in large areas for long periods of time. The result is over-grazing and land degradation, which limits stocking rates and erodes profitability.

There is an alternative form of management known as holistic planned grazing. (Other terms are 'mob grazing' and 'management-intensive rotational grazing'). This involves using fencing to divide the land into smaller paddocks, grouping animals in larger numbers, and moving them frequently according to a grazing plan. The goal is for the land to receive sufficient animal impact and then enough time to recover, mimicking the behaviour of grazing animals in the wild. Holistic planned grazing can regenerate pastures, increase grass production and increase stocking rates in commercial cattle and sheep operations.

Holistic planned grazing is being used on 40 million hectares worldwide, especially in regions of dry grassland or savannah.[65] There are well-documented case studies from the North America plains, Mexico, Australia, east Africa, and the Patagonian region of Argentina and Chile.[66] SLM Partners is implementing this grazing system for beef production on 480,000 hectares of land in Australia through its SLM Australia Livestock Fund. SLM Partners is also developing an investment strategy in Chile focused on sheep production using this grazing system.

Large cattle herd on SLM property in Australia

No-till cropping with diverse cover crops and mob grazing

'No till' farming, now applied on 35% of US cropland, has emerged as a better way to grow crops in areas of low rainfall and fragile soils. But it typically requires large amounts of pesticides to control weeds and other pests, and often employs simple crop rotations.

The next generation of no till is now being developed. This system combines no till cropping, diverse cocktails of cover crops and livestock grazing to produce crops and meat. Cash crops (such as wheat, oilseeds, cotton, pulses, hay or sorghum) are grown in extended rotations without tilling of the soil. Diverse cover crops 'cocktails' are planted to ensure 100% soil cover through the year and to provide fertility for the next harvest. Sheep or cattle are strip-grazed on the cover crops and residues, recycling nutrients and providing another revenue stream. Bale grazing is often used to carry animals through the winter outside.[67] The emphasis is on using plant diversity to feed the soil. This minimizes the use of chemicals and fertilisers, conserves soil moisture and boosts yields.

This system is most closely associated with a group of innovative farmers in the northern Great Plains of the USA, especially in the Dakotas, supported by the Natural Resources Conservation Service of the USDA. It is being applied on large, commercial farms of up to 2,000 hectares in size. There are also variations in Australia (for example, pasture cropping) and Brazil.

Cover crop diversity on Black Leg Ranch, North Dakota

Agroforestry

Agroforestry is the integration of trees with cropping or livestock systems. Trees can be grown for timber, fruit, nuts, forage or a combination of products. A variety of crops or grasses can be inter-planted in the alleys between trees, with enough space to allow conventional machines to operate. In livestock systems, the trees can also act as a source of forage for animals, enhance the productivity of the pastures and provide shade for animals. The most common livestock are cattle and sheep, although pigs and poultry can also thrive in woodlands. Systems can be dynamic, transitioning from crops/livestock to timber production as trees mature, or maintain a constant balance between crop/livestock and tree production.

A key objective in agroforestry is complementarity of resource capture. Tree roots extend deeper than crop or grass roots and are therefore able to access soil nutrients and water unavailable to crops or grasses. These nutrients are then recycled via leaf fall onto the soil surface. Trees also capture sunlight energy that may not be utilised by crops or pasture. This is true 'vertical farming', making full use of the 1 metre below the soil surface and the 2 metres above.

There are examples of successful agroforestry systems all over the world, in both temperate and tropical zones. Silvoarable examples include integration of wheat and walnut trees in France; soybeans, corn and pine in North Carolina, USA; wheat and apple trees in England; leguminous coppice trees and maize in Malawi; and palm oil with cassava, maize, legumes or fruit trees in Brazil. One of the most famous silvopastoral examples is the *Dehesa* system in Spain, which incorporates cropping, beef cattle and free-range Iberian pigs. Modern silvopastoral systems have been successfully developed in the southeast USA (mostly cattle and pine trees) and in Colombia.

Wheat and walnut agroforestry in France

Low input pasture-based dairy

Within the commercial dairy industry, there is a big divide between confinement systems that rely heavily on grains for feed and pasture-based systems that make use of grass. The latter have many economic and environmental advantages. Yet, even grass-based systems are often based on ryegrass monocultures and high use of nitrogen fertiliser, which can be expensive and environmentally damaging.

Farmers have developed more sustainable, lower input pasture-based systems that make use of more diverse swards (containing grasses, legumes and other broadleaves) and require less or no nitrogen fertiliser. Using holistic planned grazing (mob grazing), cattle are grazed in small paddocks for a short period of time before being moved. Plants are given time to recover and allowed to grow taller. The focus is on developing biologically active soils and healthy, diverse plants. There is also a strong focus on animal health. These systems incorporate smaller cattle breeds (e.g. Jersey-Holstein crossbreeds) that perform well on pasture, rather than Holsteins that have been bred for high yields on grains. They avoid growth hormones and minimise use of antibiotics.

Pasture-based dairy is common in high rainfall regions such as New Zealand, Ireland, and parts of Britain, France, the USA and Chile. Within each of these regions there are examples of farmers who have developed lower input, profitable systems that are less reliant on nitrogen fertilisers.

Healthy cows on diverse swards in New Zealand

Certified organic agriculture

Organic agriculture can incorporate many of the ecological farming practices outlined in this paper. Here we refer to 'Certified Organic' production systems. Organic certification prohibits the use of synthetic fertilisers, pesticides and genetically modified organisms. It focuses on building healthy soil and recycling nutrients. It also sets out higher standards for the treatment of livestock and poultry. Organic certification opens up marketing channels that deliver price premiums over conventional products for farmers. In the European Union, organic farmers can also benefit from higher subsidy payments.

By 2013, there were 43 million hectares of farmland worldwide certified as organic, around 1% of total farmland.[68] There are examples of successful, commercial organic farms in many regions. The attractiveness of particular organic markets can depend on local dynamics of supply and demand. We believe that organic production represents an attractive opportunity right now in North America – the returns are often more compelling than from conventional production. There are opportunities in organic grains; mixed organic farming systems that integrate crops and livestock; vegetables and livestock, organic permanent crops (fruit and nuts); and organic grass-based dairy. There are at least 2 investment funds with a combined $100m in assets focused on scaling up organic production in the USA: Farmland LP and Iroquois Valley Farms LLC.

Seven reasons to go ecological

Why should ecological farming systems be of interest to investors? There are a number of reasons why these types of systems can deliver superior risk-adjusted returns:

- Comparable or better yields
- Lower operating costs
- Enhanced natural capital
- Climatic resilience
- Positive externalities (with the chance to monetise them)
- Access to higher value markets
- Higher profitability

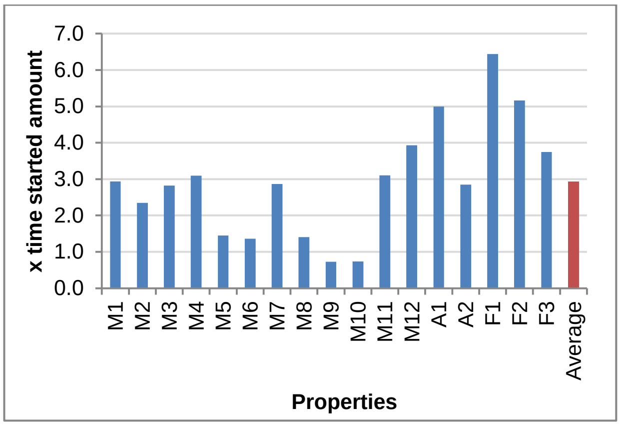
Comparable or better yields (in most cases)

The conventional argument against ecological farming is that it cannot feed the world. In particular, this is the criticism most frequently made of organic farming. But many ecological farming systems – which are not necessarily organic – can increase production. And the best organic farmers get close to conventional yields.

For example, holistic planned grazing usually allows stocking rates to be increased. Grassland benefits from high densities of cattle or sheep, so long as the animals are moved and grass plants have time to recover. Case studies from Australia (on "Duke's Plains", "Wirranda", "Bokhara Plains" and "Beetaloo Station") show producers were able to double or triple the number of cattle and the amount of beef produced after switching to holistic planned grazing.[69] On the "Rafter F Ranch" in New Mexico, USA, the stocking rate tripled.[70]

Similar results have been achieved in Patagonian Chile for sheep production. Data from 17 properties shows that, on average, the amount of grass increased by 2.9 times after introduction of holistic planned grazing.

Increase in grass production after implementation of holistic planned grazing in Chile and Falkland Islands



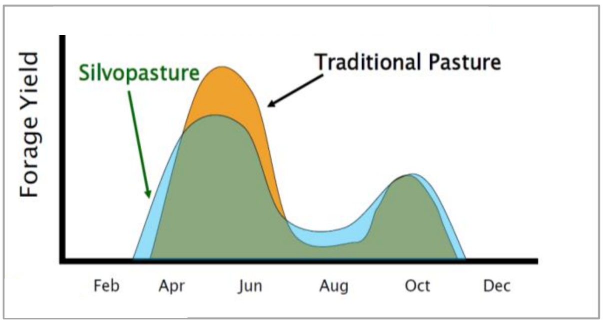
Source: Ovitec
Note: Data from 17 properties covering 288,000 hectares in total

The integration of cover crops and livestock into a no-till system can boost crop yields. The 5,400 acre Brown Ranch in North Dakota, achieves an average corn yield of 127 bushels per acres, compared to an average in that county of 100.[71] On the nearby Richter Farm, corn yields were 82 bushels per acre on fields that had cover crops compared to 73 bushels on conventionally managed fields.[72] Both farms also produced more forage for their cattle through this integrated system.

The central thesis of agroforestry is that productivity can be higher than in monocultures because of resource complementarity.[73] European research shows that agroforestry can boost output by up to 40%. 100 hectares of agroforestry can yield the same as 80 hectares of agriculture and 60 hectares of forestry separately, i.e. you get more from the same amount of land.[74]

In the southeast USA, the introduction of trees to pastures was found to improve weight gain of beef cattle. Animals performed better in very hot and cold weather because of the shelter provided by trees. In addition, grass grew earlier in the spring, stayed green for longer in the hot season, and grew for longer in the autumn, extending the grazing season.[75]

Silvopasture extended grazing season in USA trials

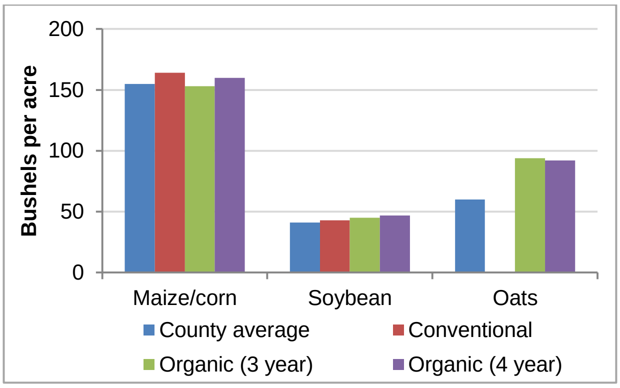


Source: D. Walter, 'Silvopasture: an agroforestry practice'

Studies of organic agriculture in advanced farming regions consistently show that crop yields are around 20% lower than conventional systems. These studies typically compare like with like, replacing chemical inputs with organic inputs and eliminating use of pesticides and herbicides. However, intelligent ecological farming does not simply try to replicate conventional monoculture, without the synthetic inputs. Instead, it uses diversity and synergy to produce a more varied array of food and other products from the same piece of land. The most comprehensive study of this subject, released in 2014 by scientists at Berkeley University, found that good organic practices that diversify crops in space and over time – utilising multi-cropping and crop rotation – reduced the yield gap to 8-9%. They also note that most comparisons of organic and conventional systems use seeds that have been bred to produce under high-input (conventional) systems. There may be room to close the gap further if the same amount of research and effort was put into breeding plants for organic systems. [76]

The ability of skilled management to replace synthetic chemicals is demonstrated by the Long-Term Agroecological Research (LTAR) Experiment at Iowa State University. This experiment has studied organic and conventional systems side by side using identical crop varieties since 1998. A conventional corn-soybean rotation is compared with more complex rotations involving corn, soybean, alfalfa, wheat and clover. The results show that organic yields have been equivalent to or greater than conventional counterparts.[77]

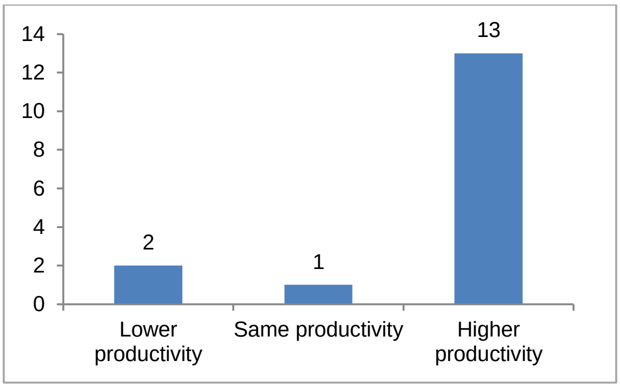
Average yields from organic and conventional systems in Iowa, 1998-2010



Source: Long-Term Agroecological Research (LTAR) Experiment at Iowa State University

The UK government's conservation, countryside and environment agencies commissioned a major report on the role of agroecology in sustainable intensification in 2015. The report looked at 15 agro-ecological practices. 12 were found to increase productivity, one was neutral and only two (organic farming and avoidance of agrochemicals) were deemed to reduce productivity. The report's conclusion was that "the productivity of integrated systems can be similar to that of conventional, intensive systems".[78]

Impact of 15 agro-ecological practices on productivity



Source: N. Lampkin et al, The role of agroecology in sustainable intensification (2015)

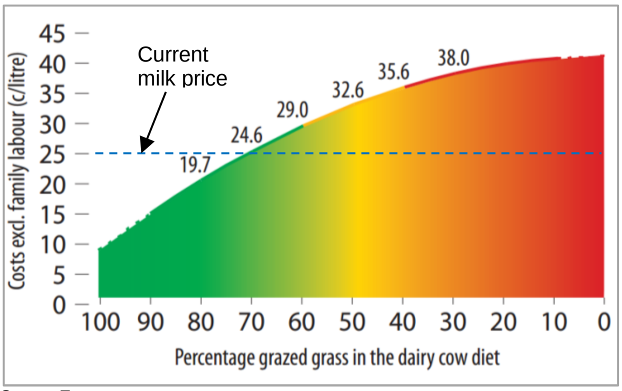
Lower operating costs

A key advantage of ecological farming systems is that they seek to minimise the use of external inputs such as fuel, fertilisers, pesticides and expensive seeds. Instead of buying in fertilisers, farmers look to replenish fertility by planting cover crops, rotating nitrogen-fixing crops, applying organic composts, and integrating livestock with cropping systems. Above all, they try to maximise the biological health of the soil, as it is the action of bacteria, fungi, worms and other insects that converts insoluble minerals into plant-available forms, thereby making the most of the soil's natural fertility. This can lead to impressive reductions in, or elimination of, synthetic fertilisers. They also rely on integrated pest management – combining crop rotations and ecosystem diversity – to control pests, weeds and diseases.

For example, in North Dakota, the Brown Ranch has almost eliminated the use of commercial fertiliser and most pesticides (although some herbicide is still used). Because of no tillage, tractor fuel use is half the county average. As a result, the direct cost of production per bushel of corn is $1.18 compared to a county average of about $2.60 per bushel.[79]

Livestock producers can minimise input costs by making the most of the grass that grows on their land. This applies most obviously to grazing ruminants such as cattle and sheep. For example, Ireland's agricultural research body has shown that the biggest driver of profitability for Irish dairy farmers is the proportion of grass in the cows' diet. Grazed grass is cheaper by a factor of 3 compared to concentrate feeds or grass silage. Only when cows get at least 80% of their nutrition from pasture are the costs of production kept low enough to generate profits across milk price cycles.[80]

Relationship between production costs and utilisation of grazed grass in Irish dairy



Source: Teagasc

If dairy farmers can reduce their reliance on nitrogen fertilisers by growing more diverse swards, they can achieve even more impressive cost reductions. For example, the Kruigers at Taranaki, New Zealand, run 635 cows on 236 hectares of land, producing 200,000 kgs of milk solids in an all-grass system, feeding only hay and silage produced on the property and using no nitrogen fertiliser. When benchmarked against 421 farms, their costs were $183 per cow, versus the group average of $671.[81]

Although ruminants such as cattle and sheep benefit most from a grass diet, there are also opportunities to raise pigs and poultry on pasture, which can reduce grain feed by up to 50%.

Enhanced natural capital

A core objective of ecological farming is to enhance the natural capital on which agriculture depends: soil, biodiversity, water and ecosystem functionality. This should be appealing to long-term investors looking to safeguard and grow the value of their farmland assets.

Because ecological farmers rely less on external inputs, they have no choice but to make their land as productive as possible. They seek to build soil health and fertility from the microbes up, increasing nutrient recycling, improving soil structure and preventing soil erosion. To take one example, research in Europe on cover crops shows that their inclusion in sustainable integrated rotations can prevent soil erosion, increase available nitrogen to the following main crop, improve soil structure by remediating compaction, reduce weed burdens and increase yields.

Ecological farmers maintain greater biodiversity and landscape complexity, which reduces pest pressures by increasing natural pest enemies. There is evidence that crops grown in soils with high organic matter content and active microorganism communities have greater resistance to diseases. Organic soil amendments such as compost can also enhance soil pathogen suppression [82]

As well as improving soil quality, ecological farming can actually *create* new soil. For example, Joel Salatin on Polyface Farms in Virginia, USA has used high-density planned grazing to create 8 inches of new soil in 10 years on formerly bare shale rock. He has been described by *Time* magazine as 'the most famous farmer in the world'.[83] Other farmers

Restoration of Loess Plateau, China

Before: September 1995 **After: September 2009**

Source: J. Liu, *Hope in a changing climate* (2009)

have achieved impressive soil building rates through crop rotations, compost application and planting of cover crops. This is the equivalent of a real estate investor adding new floors to a building.

There is a massive opportunity to use regenerative agriculture to restore some of the 33% of the world's land that is currently degraded. The economics are compelling. Degraded land is often abandoned, under-utilised and/or cheaply priced. The investment needed to restore land has a direct payback in the form of increased productivity and higher asset values. Building natural capital leads to greater financial capital. We call this an 'ecological turnaround' strategy.

The *Economics of Land Degradation* initiative has assessed the costs and benefits of land restoration. They estimate that the adoption of sustainable land management could deliver up to $1.4 trillion in increased crop production[84]. They also catalogue multiple case studies with compelling investment returns. For example, studies show that planting palm oil on degraded, deforested land in Indonesia (rather than clearing virgin forest) can generate an internal rate of return of 14-16%.[85] SLM Partners is acquiring degraded grazing land in Australia and Patagonian Chile with the goal of doubling production by introducing better grazing practices.

Climatic resilience

Individual investors and farmers may not be able to do much to control the weather but management decisions can affect the vulnerability or resilience of land to extreme events. Soils that lack organic matter, microbial life and proper structure cannot absorb and retain moisture – they dry out quicker in the heat and are more likely to flood after rain. Pastures that have been stripped of vegetation by poor grazing management, with a high proportion of bare soil, collapse at the outset of a drought. Unhealthy plants and animals are more susceptible to climate-related disease. The stressed agro-ecosystems that characterise many farming operations will be tested like never before as extreme weather becomes more common.

Ecological farming systems are more resilient to these weather extremes. They tend to embrace a wider range of crops and livestock, providing diversification. Moreover, they rely on healthy soils and ecosystem functionality to absorb the shocks.

If there is one indicator of resilience it is soil organic matter (SOM). Soil organic matter – which gives good soil its dark, earthy colour – is composed of stable organic material known as humus, plant and animal residues in various stages of decomposition, and the biomass of living organisms. It has extraordinary properties, cycling nutrients, improving soil structure, buffering acidity, retaining water, absorbing pollutants and storing carbon. Its effect on the water cycle is probably the most important contributor to climatic resilience. Soil organic matter retains water, keeping soils moist during dry periods. At the same time, soil organic matter creates porous soils that allow rapid infiltration during periods of heavy rain, preventing flooding. Ecological farming systems that maintain high levels of soil organic matter suffer less from droughts and deluges.

Evidence for this comes from the 30-year farming systems trial carried out by the Rodale Institute in Pennsylvania, USA. It showed that yields were up

2012 drought comparison: 2 soybean fields side-by-side in Indiana, USA

Conventional minimum till

No till plus 5 years of cover crops

Source: USDA National Resources Conservation Service

to 30% higher in the organic system compared to the conventional system during periods of severe climatic disruption (droughts and floods).[86] This result was confirmed by a UN FAO meta-study of 50 studies of organic versus conventional profitability, which found that organic crop yields were higher in cases of bio-physical stress such as drought.[87]

The farmers using crop rotations and diverse cover crops in a no-till system in the northern Great Plains have had similar experiences. When rainfall was 60% below normal in 2012 they still achieved 80% of normal yields, while many neighbours had no harvest at all.[88] These farms also responded better to floods. For example, the water infiltration rate on the Brown Ranch has increased from ½ inch per hour to 8 inches per hour since the change in farming system. During a 2010 rainstorm 13.6 inches of rain fell in 22 hours on the Brown Ranch. The first 8 inches of rain infiltrated into the soil before surface-flow began. There was no erosion. On neighbouring fields, there was both major erosion and standing water.[89]

The link between soil organic matter and water use has also been studied by the Institute of Sustainable Agricultural Research at New Mexico State University. Its research indicates that soil organic matter promoted plant growth, improved soil water-holding capacity, increased nutrient availability, and reduced land preparation and cultivation costs. "Soils with higher carbon content and larger fungal populations enabled us to double the production in the soil with the same amount of water," scientist David C. Johnson reported.[90] He pointed out that soil organic matter was a farmer's best protection against drought.

Integrating trees into farm landscapes can have a similar impact. Trees regulate temperature, smoothing out extremes of hot and cold, with benefits for the plants and animals below.[91] They also help water to infiltrate into the soil and protect against flooding and erosion. For example, research from France shows that access to land for agricultural purposes after flooding events can be 7-14 days sooner under agroforestry than for land cropped as a monoculture. In Wales, pastures planted with broadleaf trees had water infiltration rates 13 times and 67 times greater than in the treeless ungrazed and grazed plots respectively.[92]

Positive externalities – and the chance to get paid for them

Improved water infiltration has benefits downstream, far away from the farm. One of the reasons for intense flooding in the UK in recent years is the poor state of agricultural soils. The benefits of ecological management in terms of water protection have led to water companies in several countries paying farmers in catchment areas to transition to organic farming systems.[93]

This is one example of how ecological farming can generate positive externalities beyond the farm gate, rather than pushing environmental damage onto the rest of society. As well as controlling water flows, these farming systems can also improve water quality. Biologically active soils require less synthetic fertilisers and there are ways to minimise nutrient run-off. For example, the USDA has found that using cover crops in between corn and soybean production in the Midwest could reduce nitrate run-off by 43%.[94] Several studies show that nitrate leaching can be reduced by 40–64 % through organic farming. Planting trees along boundaries and rivers in an agroforestry system can intercept 60-98% of nitrogen, phosphorus and sediment escaping from crop fields.[95]

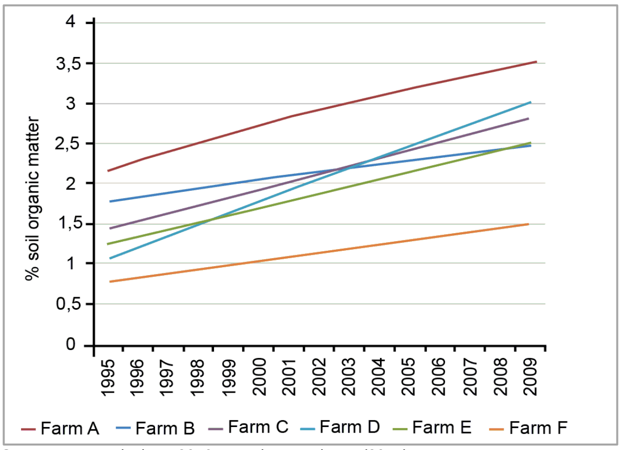
Reduced nitrate leaching is one of the great attractions of lower input grass-based dairy systems. For example, more diverse swards were introduced on one of the largest dairy operations in New Zealand, Cloverdale Dairies in Canterbury, which milks 3,000 cows across 1,300 hectares of land. This enabled the business to reduce nitrogen use from 300kg per hectare to 90kg per hectare, while maintaining high levels of production. The operation won a national award in 2012 for the farm with the lowest environmental footprint.[96]

There are many other ways that ecological farming avoids negative externalities. Organic systems and lower input grass-based systems are usually healthier for animals and do not rely on prophylactic use of antibiotics – posing less of a threat to human medicine. A diverse, biological agro-ecosystem will support much more biodiversity than a simple crop or animal monoculture, preserving the genetic bank for future generations. For example, the most up-to-date review of 94 studies comparing organic versus conventional farming found that, on average, organic farming increased species richness by about 30%.[97]

Perhaps most important, ecological farming can help tackle climate change by putting carbon back in the soil. There are an estimated 1,500 Gigatonnes of organic carbon in the world's soils. This is *three times* more carbon than contained in the atmosphere. It is also much less than there used to be. Soils have lost an estimated 456 Gigatonnes of carbon over the last 10,000 years because of land clearance and cultivation. Of this, 136 Gigatonnes have been lost since the industrial revolution.[98] Could we put some of this carbon back in the soil?

There are examples of ecological farming systems that do just that. For example, a study of beef cattle production on American rangelands found that shifting from continuous grazing to multi-paddock grazing (or holistic planned grazing) sequestered 5-12 tonnes of CO_2 per hectare per year – which was more than enough to offset any methane emissions from the animals.[99] An organic corn-vegetable-wheat rotation in the USA, which used composted manure and legume cover crops, sequestered 8 tonnes of CO_2 per hectare per year.[100] French research between 1995 and 2009 showed that switching to no or minimum tillage, with continuous crop cover and biomass recycling, sequestered up to 7.4 tonnes of CO2 per hectare each year.[101]

Increase in soil organic matter after switch to no tillage or minimum tillage in France

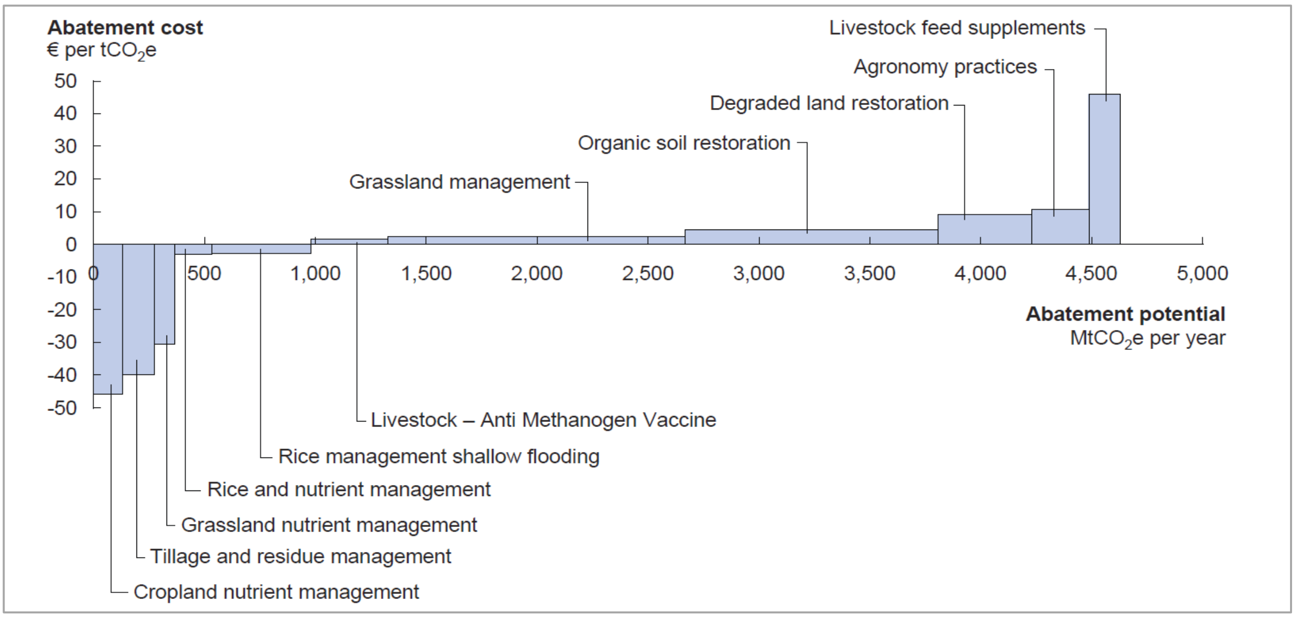


Source: IAD, Agriculture 2050 starts here and now (2011)

The challenge is scaling these sorts of approaches up to the 1.6 billion hectares of cropland and 3.5 billion hectares of grassland across the world. But achieving even small changes in soil carbon can make a big contribution. This argument has been pushed strongly by the French Government, which launched a '4 per 1000' initiative in December 2015, calling for a worldwide effort to increase soil organic carbon. It pointed out that increasing the amount of soil organic carbon by just 0.4% per year would be enough to offset all man-made CO_2 emissions.

More conservatively, in their famous greenhouse gas abatement cost curve, McKinsey & Company estimate that agriculture could deliver 4.6 Gigatonnes of CO2e abatement per year by 2030. This represents 12% of the total abatement needed to put the world on a pathway towards climate stability. Most of the abatement measures in agriculture come at a neutral cost, or are profitable and require no substantial capital investment. The technical term for this is 'no-brainer'.[102]

McKinsey greenhouse gas abatement cost curve for the agriculture sector



Source: McKinsey & Co, Global GHG Abatement Cost Curve v2.0

Could farmers get paid for creating positive externalities such as carbon sequestration? Some nascent markets have emerged, although not without teething difficulties. The Chicago Climate Exchange created protocols for 'carbon farming' that paid out $7.4 million to American farmers between 2006 and 2010. Farmers received credits for shifting to no-till cropping practices, converting cropland to grassland, implementing sustainable rotational grazing, or planting trees. The scheme ended when it became clear that greenhouse gas emissions would not be federally regulated and demand for voluntary credits dried up.[103] But new protocols for agriculture are now being agreed as part of California's official cap and trade programme. The Californian market is currently paying $12 per tonne of CO2e for offset credits.[104]

The Australian government's Carbon Farming Initiative also allows farmers and land managers to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land. An Emissions Reduction Fund, funded with AU$2.55 billion by the government, has been established to purchase credits. In November 2015 some of the properties that SLM Partners manages in Australia successfully bid to supply in excess of 2 million tonnes of CO2 credits to this fund over the next 10 years. This will generate significant extra revenue for these properties.[105]

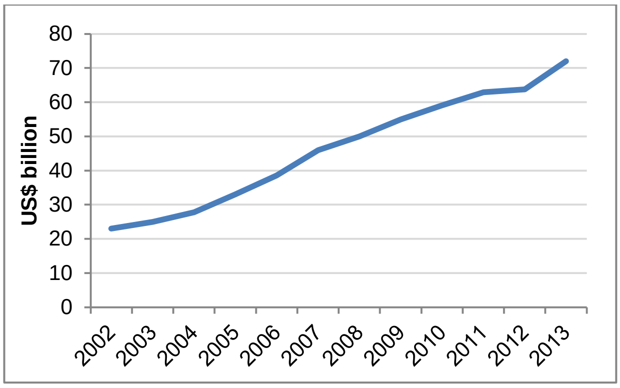
The recent Paris Agreement on climate change, negotiated in December 2015, placed a greater emphasis on the importance of carbon sinks to offset man-made emissions. As international efforts to tackle climate change intensify, the probability increases that more farmers and landowners will get paid for generating positive environmental impacts. At SLM Partners, we tend not to assume any such revenues when analysing investment opportunities. Instead, it represents an additional upside, one that comes at no cost when managing land ecologically (as we have already discovered in Australia). It is also a question of risk mitigation, as we do not want to be on the wrong side of environmental taxes or regulation.

Higher value markets

A further advantage of ecological farming is that it allows investors to tap into higher value markets and, in some cases, achieve premium pricing for their products.

The most obvious market is for organic food, which is growing strongly. The value of the global organic market rose from $15 billion in 2000 to $72 billion in 2013. Organics already account for 4% of all food sales in the USA and a slightly lower proportion in Western Europe.[106] According to Grand View Research, the global organic market is expected to reach $211 billion by 2020.

Global sales of organic products, 2002-13



Source: FiBL

Although organic food is usually associated with wealthier consumers in advanced economies, the fastest growth in the coming decade is expected in Asia and particularly in China, where there are major concerns about food safety. For example, US dairy company Organic Valley, which entered the market in 2000, has seen sales double every year and now sells millions of cartons of organic milk in China per year.[107] "This is the first market I've worked in where food safety is a more important consideration than price," Rob Chester, chief compliance officer at Wal-Mart in China, said in an interview.[108]

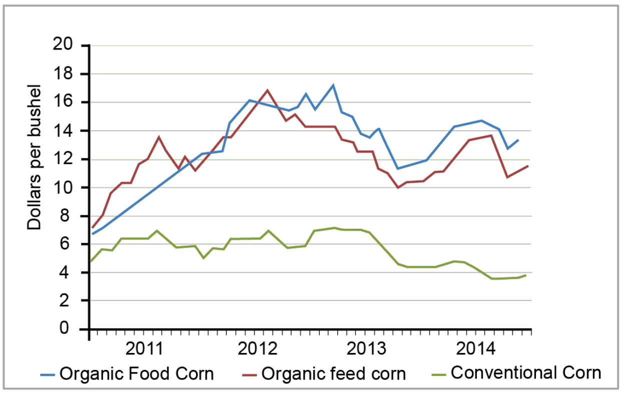
The great attraction of the organic market is the price premium available to farmers. This varies between products and countries. In the case of organic grains in the USA, a substantial premium has opened up between organic and conventional because of high demand and limited supply. For example, organic maize (corn) sold at 3 times the price of conventional maize in 2014. There are also substantial premiums for organic dairy and meat. Organic prices also tend to be more stable, buffering producers against the volatility of commodity markets. In addition, organic food companies are offering long-term off-take agreements to growers in order to boost supply, which can further reduce pricing volatility.

'Organic' is just one category that consumers use to differentiate their food. There are a number of other certification schemes that try to reassure consumers about the provenance of their food. For example, a market is opening up for 'grass-fed' or 'pasture-raised' beef and dairy. The US grass-fed beef industry has grown 25% annually in the last 10 years and now represents 3-5% of the total retail beef market.[109] According to the USDA, wholesalers paid a 16-37% premium for grassfed cattle in April 2015.[110] In Australia, the cattle industry recently launched a Pasturefed Cattle Assurance System (PCAS). Processers are paying 5-10% price premiums for animals with this certification.[111]

Another market segment is 'antibiotic-free' meat. Currently, antibiotic-free beef, pork and chicken account for only 5% of meat sold in the US, but their share is quickly growing. Sales of such chicken at US retailers rose by 34% in value last year. And prices for these products are higher.[112]

Whether organic foods are more nutritious or safe than non-organic foods is a hotly debated topic. The evidence is equivocal.[113] Interestingly, there is a stronger scientific consensus that pasture-raised meat and milk is healthier than grain-fed products. Yet, to a large extent the science is irrelevant. Consumer perception is what matters, as this drives buying behaviour. There is certainly a widespread perception among consumers that organic food is healthier and worth paying more for.

Organic corn prices vs conventional corn in USA



Source: USDA Economic Research Service

Finally, we should not forget about that much neglected criteria – *taste*. Chefs have been at the forefront of changes in popular food culture. They usually come down in favour of more ecological farming systems on the basis that food grown in this way simply tastes better. One of the most active proponents of the farm-to-table movements in the USA is Dan Barber, who runs the Michelin-starred restaurant Stone Barns. He writes that "when we taste something truly delicious, something that is *persistent*, it most likely originated from well-mineralized, biologically rich soils".[114]

Ecological farmers have the opportunity to tell a differentiated story to consumers and consumer-facing companies. They can escape the downward spiral towards commodification and instead produce food of the highest nutrition and sustainability, with the reward in the form of stable and higher prices.

The health benefits of organic vs conventional vs grassfed

Are organic foods healthier than non-organic foods? It is a hotly debated topic. A 2014 study by scientists at Newcastle University came to this conclusion, citing higher levels of antioxidants and lower pesticide residues, based on a meta-analysis of 343 peer-reviewed publications. But three other meta-analyses since 2009 have reached the opposite conclusion, stating there is no measurable difference in nutrition or safety.[115]

Interestingly, there is stronger scientific consensus on the health benefits of meat and dairy from grass-fed animals kept on pastures compared to grain-fed animals kept in confinement. Grass-fed meat and dairy were found to have higher levels of beneficial Omega-3 fatty acids, conjugated linoleic acid and antioxidant vitamins. This was regardless of whether the production systems were organic or not (although organic systems tended to be more grass-fed).[116]

More profitable systems

Ultimately, the investment case for ecological farming comes down to economics. We have collected dozens of case studies of farmers who have transformed their profitability – and easily surpassed local norms – after switching to ecological systems. As a result, they have achieved a much higher return on their land and their capital.

In a number of Australian case studies, holistic planned grazing for beef cattle allowed farmers to achieve a cost of production of between AU$0.40 and AU$0.75 per kg of beef. The average price received was AU$1.48 per kg. In contrast, the average cost of production for conventional graziers in Australia was $1.43 per kg. Therefore, conventional cattle producers had margins of 3% whereas those using holistic planned grazing enjoyed margins of 50-73%.[117]

In Patagonian Chile, the introduction of holistic planned grazing and improved sheep breeding allowed sheep properties to grow their profits by 2-3 times within 5-7 years. These producers were able to achieve gross margins of 60-85% by increasing sheep numbers, improving the quality of meat and wool, and keeping operating costs low.[118]

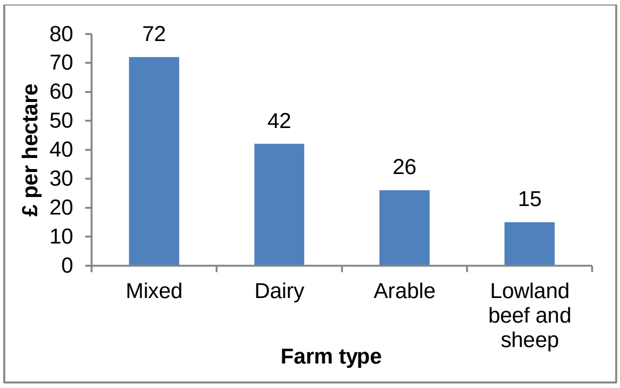
In North Dakota, USA, the Richter farm increased its profit by $135 per acre after introducing cover crops in 2007. This came from reduced herbicide costs, increased yields, and extra forage for beef cattle.[119]

There is a large body of published research showing that agroforestry can produce superior economic returns over the long-term. Data is available for silvopasture systems in the southeast USA and New Zealand, and a range of silvoarable and silvopasture systems in Europe. Agroforestry is usually more profitable than growing crops or pasture on their own, or timber on its own. Profits are also less volatile because of diversified revenue streams.[120]

There is a consistent stream of research from the USA and Europe showing that organic farming is more profitable than conventional methods. This is because of lower costs, higher prices, and, in the case of Europe, higher subsidies. In the UK, for example, data from the Farm Business Survey for the period 2007-2012 shows that organic farms had annual income that was higher by £15-72 per hectare, depending on the farm type.[121]

Higher profitability of organic farms in UK, 2007-12

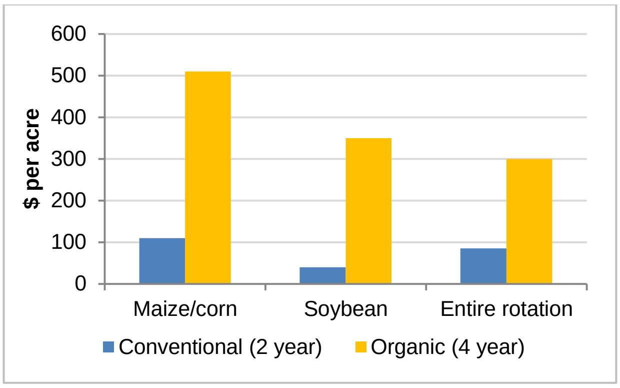
Extra £ per hectare per year compared to conventional



Source: Soil Association, Organic farming: how it stacks up (2014)

In the USA, the Long-Term Agroecological Research (LTAR) Experiment at Iowa State University found that the return to management (after labour, land and production costs) was $300 per acre for the organic system compared to $100 per acre for the conventional system.[122]

Average economic returns from organic vs conventional farming in Iowa, 2006-2010



Source: Long-Term Agroecological Research Experiment at Iowa State University

The low cost advantages of grass-fed dairy systems using management intensive rotational grazing have already been mentioned. But low-input systems with diverse swards can perform even better. For example, "Paeroa", a 88-hectare dairy and deer farm in the Waikato region of New Zealand, is stocked at 2.8 cows per hectare and has a milk yield comparable with conventional farms nearby. But the farm has much lower costs because it does not apply nitrogen fertiliser, rarely reseeds pastures, does not use grain feed, and has minimal animal health costs and high herd fertility. According to Dairy Insight Profit Watch, the profitability of "Paeroa" is nearly double the Waikato average.[123]

We believe that ecological farming systems can generate higher profits for farmers and for those investing in farmers and the land. As a result, it is possible to achieve internal rates of return of >10% on investments, even in developed economies. To put this in context, rates of return for investments in industrial agriculture are more likely to be in the single digits.

Investing in ecological farming

The previous sections described the risks of industrial agriculture and the benefits of ecological alternatives, with reference to a number of case studies. There are many examples of ecological farming systems that generate good profits as well as positive environmental impacts. But how can institutional investors deploy capital in this space? This requires a closer look at the what, where, who and how of farmland investing.

What to invest in

Transitioning towards, or scaling up, ecological farming requires capital. There a number of different points along the food supply chain that investors can invest in.

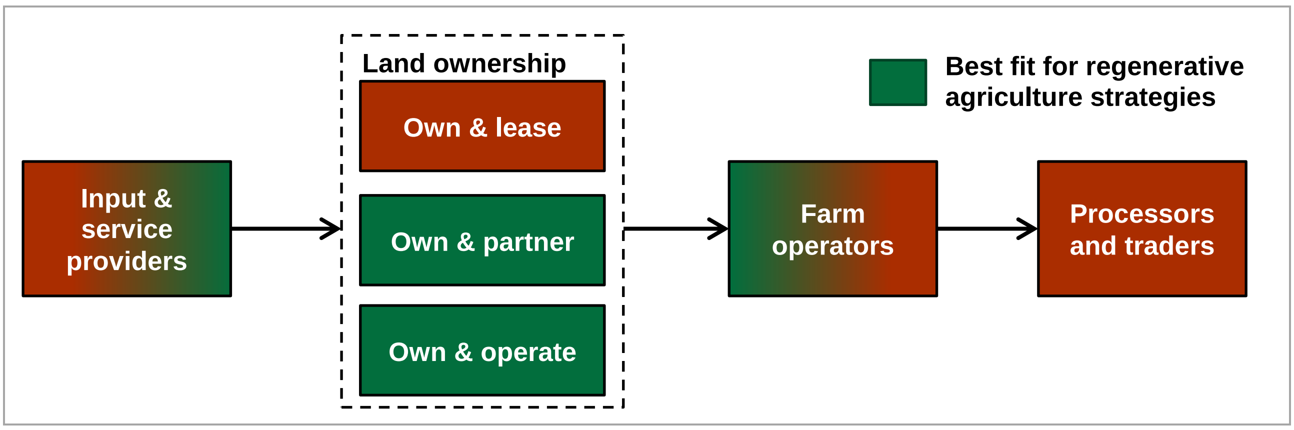
Much traditional private equity investment has gone to agribusinesses that supply inputs or services to farmers – seed companies, tractor manufacturers, fertiliser companies. Ecological farming systems aim to use fewer external inputs, so this limits the opportunity to invest in this part of the supply chain. However, there are a few companies that have emerged to serve the needs of ecological farmers. For example, Midwest BioAg is an American company that provides soil analysis and soil amendments to biological farmers – it has received investment from a private equity fund, S2G Ventures.

For investors seeking the comfort of real assets, land ownership is an obvious strategy. But there is the question of who will operate this land. A common approach, especially backed by large investors in the USA, has been to buy land and lease it to third party farmers. It would be difficult to ensure the use of ecological farming in these situations. There is also the risk of misaligned incentives. The lessee farmer may be focused on extracting the maximum return from the land during the lease period, not building natural capital over the long-term.

A more fruitful way to invest in ecological farming is to acquire land and then partner with carefully-selected farmers who have shared goals. A partnership agreement will specify the desired land management system, include provisions for monitoring of environmental impacts, and allow for profit-sharing between investor and farmer. It may also include a right for the farmer to buy the land after a certain period, at a pre-defined price. This model gives the investor the security of land ownership, access to operational partners with shared goals, and a possible exit mechanism (through the farmer's right to buy). It gives energetic farmers access to land (which is increasingly out of reach to young farmers) and a platform to grow their farming enterprise.

Another option is to invest in teams that acquire land and operate it, taking care of all aspects of the farming enterprise. This can be achieved through traditional fund structures or direct investment in corporate vehicles. It gives the investor the security of land ownership, but also maximum control over how the land is managed and full equity exposure to the returns from farming. It

Investing along the food supply chain



requires integrated management teams that possess a range of skills from investment to farming. This is the model SLM Partners uses in its Australian beef cattle fund, which has acquired and operates 480,000 hectares of land.

It may also be possible to use debt, equity or hybrid instruments to invest in farm operating businesses that implement ecological systems. This would include capital-light enterprises that lease land rather than purchasing it but require working capital or capital for plant and equipment. Livestock operations can be especially suitable as they may have a substantial amount of capital tied up in their animals.

However, these operating companies are unlikely to benefit from the full uplift in value created by regenerative agricultural systems that improve the quality of the land. One exception may be in developing countries where farming companies operate on the basis of long-term leases (more than 40 years), as this can encourage investment in the development of the land.

Investors could also back processors and traders that specialise in the products grown on ecological farms. This is likely to include consumer brands that target higher value markets such as organic, grass-fed, biodynamic, or high animal welfare. These companies can send a powerful signal back to farmers and stimulate the scale-up of ecological farming systems. They can also directly benefit from shifting consumer tastes and price premiums. However, they do not offer the security of land ownership and do not benefit from the higher margins of ecological farming systems. These are not 'real asset' strategies.

We believe that the most compelling investment opportunities are 'own and operate' and 'own and partner' strategies within the land ownership segment. Ownership of a real asset provides downside protection. Investors also benefit from the full value of the improvement to the land caused by ecological farming systems, as well as any sector-wide appreciation in land values caused by other factors. At the same time, these strategies provide control over the type of land management, either by bringing it in-house or by forming risk-sharing partnerships with carefully selected operators. There may also be an opportunity to invest down the supply chain, from this land base, if the potential for value-add is compelling.

Where to invest

A land ownership strategy precludes investment in many developing countries where foreign investors are not allowed to own land. This has long been the case in African and Asian countries, where long-term leases are the preferred model. In recent years, Brazil, Argentina and Ukraine have introduced restrictions on foreign ownership of farmland, often requiring majority local partners. The prairie states of Canada also prohibit outside financial investors from holding farmland.

Even where restrictions are not in place, or long-term leases provide a viable alternative, it should be carefully considered whether land investment is compatible with social welfare and development in developing countries. In many cases, this type of investment displaces local communities who rely on the land for their livelihoods. Foreign 'land grabs' are, rightly, an emotive issue. Many ambitious schemes have collapsed over the last ten years because of a failure to secure local support. It is possible to develop effective strategies in developing countries, with positive social impact, but it requires a lot of time and effort, and the political and social risks remain high.

Turning to developed countries, many do not possess attractive land markets. This could be because of fragmentation – usually the result of historical subsidy (e.g. western Europe) or land restitution (e.g. eastern Europe) policies. It is hard to develop an institutional-scale strategy in these countries, as the transactions costs are high. Or farmland prices can be distorted by factors that have nothing to do with agricultural potential, such as lifestyle buyers, ecotourism or residential development. In the UK, for example, prices are inflated because of inheritance tax rules which allow people to pass land to their heirs without being subject to inheritance taxes. This drives down the potential yield of all farming systems.

SLM Partners focuses its attentions on developed countries (such as Australia, Chile, New Zealand, the USA and Canada) where land is available at scale and prices are not distorted by factors external to agriculture. This lowers political risk, increases potential yields and ensures that the quality of farm management remains the primary driver of returns.

Who to invest with

One strong theme in this paper is that ecological farming systems are knowledge-intensive. They require highly-skilled managers who can observe the land and continually adapt to changing circumstances. This is the opposite of 'farming by numbers'. It is one of the major barriers to more widespread adoption of these farming approaches.

Farming is also intensely local. Every district has a particular combination of soils, climate, terrain and biodiversity – its ecological context. It also has a specific social context, which must be understood to build harmonious working teams and external relationships. The business environment often varies too, such that only people with local knowledge will get the best value when selling crops or animals, or buying inputs or services. There are many ways for outsiders to trip up.

SLM Partners seeks out operational partners with track records of implementing ecological land management system. We tap into networks of ecological farmers that are emerging around the world. We believe that strategies must be built from the ground up, with teams who understand the local context. Finding the right people is usually harder than finding the right land.

How to invest

After deciding on a strategy, geography and team, there is still the question of how to structure an investment and what terms to use to ensure alignment of interest between investors and manager. When farmland investing began to emerge as an asset class in the mid-2000s, most promoters took the traditional private equity term sheet off the shelf: investments were structured as closed-end funds, with 10-year terms and '2 and 20' management fees. However, there is a growing realisation that these terms may not be suitable for farmland investing. Farmland is a long-term asset that produces income yield. The requirement to exit can destroy value. Performance fees should be tied to both income yield and capital growth to properly align incentives.

As a result, many different models are being used for farmland investment. They include:

- Direct investment in evergreen corporate structures
- Long-term funds that mirror infrastructure or real estate terms
- Traditional private equity funds
- Managed accounts

We believe that a variety of structures and terms can be used for farmland investing, depending on the requirements of the investors. Two principles should be in place. Performance targets and fees should be linked to income yield as well as capital appreciation. Investors should have some control over the timing and nature of exits.

Conclusions

Farmland investing has many attractions for institutional investors. But investors need to be smart to avoid falling on the wrong side of commodity cycles and to avoid backing the wrong type of farming systems.

We believe that investing in industrial agriculture comes with many risks: high and volatile input costs, degrading natural assets, vulnerability to a changing climate, environmental risks, and shifting consumer trends.

Ecological farming offers a genuine alternative. It can produce higher or similar yields, while making the most of what nature provides for free. It can enhance the soils, water and ecosystems on which agriculture depends, while increasing resilience to extreme weather. It can minimise negative externalities and even produce positive impacts on the environment, in particular through putting carbon in the ground. Ecological farmers can also tap into more valuable, growing markets. This is one reason why they are often more profitable.

We have seen a number of revolutions in agriculture over the past 200 years. First was the mechanical revolution, when harvesters, threshers and tractors allowed farmers to manage larger areas. Then came the chemical revolution, when pesticides, synthetic fertilisers and new seeds delivered higher yields. Now we are on the brink of a biological and ecological revolution, as we harness our new understanding of natural processes to design a food system fit for the twenty-first century. Investors can accelerate this transition, and profit from it, by investing in land and partnering with innovative, ecological farmers.

References

[1] Preqin *Special report: natural resources* (Nov 2015)
[2] http://www.fao.org/worldfoodsituation/foodpricesindex/en/
[3] UN Population Division, *World Population 2012*
[4] ABARES
[5] FAO, *The state of the world's land and water resources*
[6] TIAA-CREF Center for Farmland Research, *Farmland markets: valuation, investment performance and issues for the future* (2013)
[7] G. Schnitkey, 'Projected 2015 net income on a 1,500 acre grain farm', *Farmdoc daily* (5):127 (2015)
[8] Savills, *International farmland focus 2014*
[9] US Federal Reserve of Chicago
[10] SLC Agrícola executive quoted in *The Guardian*, 13 Mar 2008
[11] CPD, *Farming smarter, not harder: securing our agricultural economy* (2012)
[12] http://ageconomists.com/2014/10/27/8-trends-shaping-the-future-of-agriculture-the-census-of-ag-facts-everyone-should-know/
[13] http://www.reuters.com/article/2013/08/12/usa-hogs-profit-idUSL2N0GD1LY20130812
[14] *DTN The Progressive Farmer*, 10 Oct 2014
[15] UK Government Foresight, *The future of food and farming* (2011)
[16] USDA, *Agriculture's supply and demand for energy and energy* products (2013)
[17] See J. Diamond, *Collapse: how societies choose to fail or succeed* (2005) and D. Montgomery, *Dirt: the erosion of civilizations* (2007)
[18] ITPS, *Status of the world's soil resources: technical summary* (2015)
[19] Economics of Land Degradation Initiative (2013)
[20] UNCCD
[21] *Reuters*, '"Peak Soil" Threatens Future Global Food Security', 17 Jul 2015
[22] *Queensland Country Life*, 9 Mar 2015
[23] ELD Business Brief, June 2013
[24] Centre for Policy Development, *Farming smarter, not harder* (Nov 2012)
[25] D. Walston, *Above and below ground* (Nuffield Scholarship report, 2015)
[26] https://www.extension.iastate.edu/AGDM/crops/pdf/a1-75.pdf
[27] Environmental Working Group, *Washout* (2013)
[28] D. Pimentel, 'Soil Erosion Threatens Food Production', *Agriculture,* 2013, 3
[29] L. Brown, *World on the Edge* (2011)
[30] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[31] *Reuters*, 23 Jul 2014
[32] *New York Times*, 11 Aug 2014
[33] J. Pretty & Z. Bharucha, 'Sustainable intensification in agricultural systems', *Annals of Botany*, 114 (2014)
[34] P. McMahon, *Feeding frenzy: the new politics of food* (2013)
[35] *The Wall Street Journal*,27 Feb 2015
[36] Munich Re, *Natural catastrophes 2013: analyses, assessments, positions* (2014)
[37] *Reuters*, "Torrential rains increasing in warming world", 8 Jul 2015
[38] IPCC WGIAR5 Ch 7. The IPCC report references IPCC 2012 – the report I have on climate extremes
[39] IPCC WG3 AR5, Chapter 11
[40] IPCC AR5 SPM & IPCC WG3 AR5, Chapter 11
[41] *Radio New Zealand*, 27 Aug 2014
[42] *US News & World Report,* 16 Feb 2015
[43] *The Wall Street Journal*, 5 Aug 2014
[44] D. Fowler et al. 'The global nitrogen cycle in the twenty-first century', *Phil Trans R Soc B 368* (2013)
[45] Farmworker Justice, *Exposed and ignored: how pesticides are endangering our nation's farmworkers*
[46] BBC, 19 Nov 2015
[47] *New York Times*, 16 Sept 2013; Texas Tech University press release, 22 Jan 2015
[48] Millennium Ecosystem Assessment (2005)

[49] The Prince's Charities' International Sustainability Unit, *What price resilience?* (March 2011). For a similar estimate see New Economics Foundation, *Urgent recall: our food system under review* (2014). It estimates the cost environmental externalities from UK agriculture at £274–361 per hectare.
[50] http://ageconsearch.umn.edu/bitstream/187496/2/FooteJoy_2014.pdf
[51] *The Wall Street Journal* (8 Jan 2015)
[52] D. Barber, *The third plate* (2014)
[53] M. Schatker, *The Dorito effect: the surprising new truth about food & flavor* (2015).
[54] J. Cawley & C. Meyerhoefer, 'The medical care costs of obesity: an instrumental variables approach', *Journal of Health Economics*, 31(1) (2012)
[55] *USA Today*, 9 Jan 2015
[56] http://www.forbes.com/sites/greatspeculations/2014/06/23/how-the-fast-casual-segment-is-gaining-market-share-in-the-restaurant-industry/
[57] *New York Times*, 4 Mar 2015
[58] *Wall Street Journal*, 3 Nov 2014
[59] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[60] G. Conway, *The doubly green revolution: food for all in the twenty-first century* (1999)
[61] *Science*, 14 Aug 2015
[62] Royal Society, *Reaping the benefits: science and the sustainable intensification of global agriculture* (2009)
[63] http://www.fao.org/news/story/en/item/250148/icode/
[64] J. Pretty & Z. Bharucha, 'Sustainable intensification in agricultural systems', *Annals of Botany* 114 (2014)
[65] J. Pretty & Z. Bharucha, 'Sustainable intensification in agricultural systems', *Annals of Botany* 114 (2014)
[66] See the Savory Institute website: http://savory.global/
[67] http://www.farmandranchguide.com/news/crop/menoken-farm-uses-crop-livestock-diversity-to-improve-soil-health/article_9cd7c95a-6c77-11e1-832f-001871e3ce6c.html
[68] FiBL & IFOAM, *The world of organic agriculture* (2015)
[69] S. Joyce, 'Change the management and what happens – a producer's perspective' & R. Sparke, 'Cell grazing – a producer's perspective', in *Tropical Grasslands*, 34 (2000); Soils for Life, 'Beetaloo Station' and 'Bokhara Plains' case studies; *Queensland Country Life*, 12 Dec 2013
[70] 'Profile of good stewardship: the Rafter F Cattle Company', in *The Quivira Coalition*, 4, 2 (Mar 2001)
[71] Abe Collins, http://www.nodpa.com/production_soil_cover-crop-cocktails-073013.shtml
[72] National Wildlife Federation, *Future friendly farming* (2011)
[73] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[74] World Agroforestry Centre
[75] USDA, *Inside Agroforestry*, 20, 2; L. Godsey, 'Silvopasture economics: three case studies'; D. Walter presentation, 'Silvopasture: an agroforestry practice' [available online]
[76] L Ponisio et al, 'Diversification practices reduce organic to conventional yield gap', *Proceedings of Royal Society B* (2015). This meta-analysis looked at 3 times more studies than previous analyses.
[77] Iowa State University, *The Long-Term Agroecological Research (LTAR) Experiment* (2011)
[78] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[79] Abe Collins, http://www.nodpa.com/production_soil_cover-crop-cocktails-073013.shtml
[80] http://www.agriculture.gov.ie/media/migration/agri-foodindustry/2025agri-foodstategy/publicconsultationsubmissions/representativebodies/DairyIndustryReportConHurleysub260115.pdf
[81] R. Williams, *Wealth Creation in dairy farming* (Nuffield Scholar report, July 2011). See also D. Musgrave, 'Non-ryegrass pastures - the science and farmer practice', *Pasture Persistence – Grassland Research and Practice Series 15* (2011)
[82] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[83] Sacks et al, *Restoring atmospheric carbon dioxide to pre-industrial levels*
[84] ELD Initiative, *The rewards of investing in sustainable land management* (2013)
[85] ELD Business Brief, *Opportunity lost* (2013)
[86] Rodale Institute, *The Farming Systems Trial - celebrating 30 years* (2011)
[87] N. Nemes, *Comparative analysis of organic and non-organic farming systems: a critical assessment of farm profitability* (2009)
[88] L. Carlisle, 'Diversity, flexibility, and the resilience effect: lessons from a social-ecological case study of diversified farming in the northern Great Plains, USA', *Ecology and Society*, 19(3) (2014)
[89] Abe Collins, http://www.nodpa.com/production_soil_cover-crop-cocktails-073013.shtml
[90] New Mexico State University press release, 8 Jul 2014

[91] USDA, *Inside Agroforestry*, 20(2)
[92] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[93] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[94] USDA Agricultural Research Service (4 Feb 2015)
[95] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[96] R. Thornhill, *Forage and grazing techniques* (Nuffield Scholar Report, July 2014)
[97] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015)
[98] R Lal, 'Soil carbon sequestration to mitigate climate change', *Geoderma*, 123 (2004)
[99] T. Wong, R. Teague et al, 'GHG mitigation and profitability potential of different grazing strategies in the southern Great Plains', *Sustainability*, 7(10) (2015)
[100] Rodale Institute, *Regenerative organic agriculture and climate change*
[101] IAD, *Agriculture 2050 starts here and now* (2011)
[102] McKinsey & Co, *Pathways to a low-carbon economy* (2010). The latest IPCC also states that up to 4.6 $GTCO_2e$ of mitigation potential could be available in agriculture in 2030. See IPCC WG3 AR5, Chapter 11
[103] http://www.wfo-oma.com/media/k2/attachments/WFO_Farmletter_12_2014_ENG.pdf
[104] http://calcarbondash.org/
[105] http://www.environment.gov.au/climate-change/emissions-reduction-fund/cfi/about
[106] OTA 2012
[107] http://www.businessweek.com/articles/2014-07-31/tonys-farm-organic-food-provider-to-chinas-elite
[108] http://www.bloomberg.com/news/2014-03-13/chinese-pay-double-for-organic-kale-after-food-scandals.html
[109] iGrow, 'Bright future for grassfed beef' (20 Sep 2013)
[110] USDA market reports
[111] http://beefcentral.generatorjsa.net/trade/article/4640
[112] *Wall Street Journal*, 3 Nov 2014
[113] National Academy of Sciences, *Toward sustainable agricultural systems in the 21st Century* (2010)
[114] Dan Barber, *The third plate* (2014)
[115] For the debate, see Genetic Literacy Project. https://www.geneticliteracyproject.org/
[116] *Agri-Pulse*, 22 Aug 2014
[117] Case studies: "Bokhara Plains", "Duke's Plain", "Wirranda", "Tarabah", "Beetaloo". Benchmarking data for 1998 to 2011 from Holmes Sackett database
[118] Ovitec
[119] National Wildlife Federation, *Future friendly farming* (2011)
[120] N. Lampkin et al, *The role of agroecology in sustainable intensification* (2015). See also S. Grado & A. Husak, 'Economic analyses of a sustainable agroforestry system in the southeastern United States', *Valuing Agroforestry Systems* (2005)
[121] Soil Association, *Organic farming: how it stacks up* (2014)
[122] Iowa State University, *The Long-Term Agroecological Research (LTAR) Experiment* (2011). The superior profitability of organic farming has been confirmed by the USDA and National Academy of Sciences. USDA, *The profit potential of certified organic field crop production* (2015); National Academy of Sciences, *Toward Sustainable Agricultural Systems in the 21st Century* (2010)
[123] R. Thornhill, *Forage and grazing techniques* (Nuffield Scholar Report, July 2014); http://www.grassland.org.nz/publications/nzgrassland_publication_2249.pdf