CLIMATE ADAPTED PRACTICES

Briefing Paper on Arable Crops

Prepared for: Seeding Our Future

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Introduction

This briefing paper explores how arable farmers in South West England can adapt to climate change, especially by evolving cultivation methods and crop choices. It draws on material from a longer research report produced by Elise Wach entitled Growing Through Climate Change.

Both documents were commissioned by Seeding Our Future, a non-profit research and advocacy project based in Bridport. One of their main initiatives is to work with producers and consumers to strengthen local food security.

Contents

1. Headline Messages for Arable Growers

Consider expanding crop diversity - climate adapted crops (eg Buckwheat) and using green manures (eg White Clover);
Explore climate adapted growing such as rainwater harvesting, inter cropping and agroforestry;
Look to work collaboratively with other producers to add value through processing and marketing initiatives;
Expand direct sales to local consumers via box schemes, farm shops, Food Hubs and independent local stores;
Reduce or replace artificial nitrogen fertiliser application with green manure and explore agroforestry option to reduce P, N, K inputs and resultant GHG emissions;
Reduce GHG impacts of field practices by adopting No Till strategies;
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2. A Climate Challenged Future

Globally, it is clear from research undertaken by [The Economics of Ecology and Biodiversity (TEEB)] that there "*is increasing evidence that today's agriculture and food systems are broken: our diets have now become the main burden of disease, more than 815 million suffer from hunger, over 650 million suffer from obesity, and malnutrition affects over two billion*".

The Institute for Sustainable Development and International Relations report - Ten Years for Agroecology models a future where farming in Europe can respond to climate change, phase out pesticides and maintain vital biodiversity, whilst providing a sufficient and healthy diet for a growing population.

The UK's food system is failing, putting the health of the population, and of the planet, at risk. The report of the Committee on Food, Poverty, Health and the Environment, calls upon the Government to end years of inaction and ensure that a healthy, sustainable diet is accessible for everyone.

Climate change is already impacting food supplies, and is forecast to create much greater disruption in the years ahead. Arable crop production in South West England could be disrupted through warmer wetter winters, hotter drier summers, and more frequent extreme weather events such as heavy rainfalls and storms. Further, future climate scenarios are characterised by uncertainty, so there is a chance of any kind of weather at any time in the year. Climate changes are likely to bring changes to pests and diseases, some positive and others negative. The extent to which climate change negatively impacts on agriculture depends in part on the methods of farming and the ability of the agricultural sector to adapt.

In the Bridport Area, food security in the context of our changing climate is a growing concern. Arable crops grown within 30 miles of Bridport are primarily for animal rather than human consumption. A shift to climate adapted growing combined with short supply chains are crucial to our future food security.

3. Diversifying Crops

Increasing genetic diversity of crops is one of the best ways to reduce risk to climate shocks for arable growers. Higher levels of genetic diversity are linked to lower vulnerabilities to disease epidemics, pest, and to climate related changes:

Crop	Climate Change Impacts	Adaption Measures
Wheat	• Warmer drier summers could increase yields but extreme climate events (e.g. high temperatures, drought and overly wet weather) may threaten crops. • Wheat stem rust could increase, and only 20% of the wheat varieties commonly grown in the UK are resistant to this rust. • Modern varieties are dependent on the use of synthetic fertilisers and phosphates. However, nitrogenous fertilisers are based on fossil fuels and supplies of phosphates from Morocco could decrease.	• Orient production more towards human consumption and less towards animal consumption. • Increase the diversity of varieties produced, including via populations. • Improve farm drainage and water management. • Consider intercropping for better soil health. • Utilise green manures to reduce reliance on nitrogenous fertilisers.
Maize	• Warmer drier summers could support maize cultivation in southern England. • Wetter winters increase the risk of soil erosion and runoff.	• Same as for wheat (see above) • Only plant if under-cropped with a winter cover or green manure given high erosion risks.
Buckwheat	• Quick growing crop. • Does not require highly fertile soils but does benefit from moderate amount of nitrogen. • Can tolerate wet soils but does better with well drained soils. • Low susceptibility to pests and diseases.	• Use green manures to reduce nitrogenous fertiliser needs. • Consider intercropping.
Quinoa	• High in protein, not technically a grain. • Production is already increasing in England though not yet a major crop. • Grows best in well-drained loam but can be cultivated in other soils. • Leaves can also be eaten.	• Consider sowing an undercrop to prevent blackgrass or fat hen from taking over. • Use green manures to reduce nitrogenous fertiliser needs.

Crop	Climate Change Impacts	Adaption Measures
Rye	• Drought tolerant and relatively high resistance to diseases. • Benefits from warmer winters. • Majority of UK rye currently cultivated for biodigesters, livestock or unharvested cover crop.	• Same as for wheat (above) • Increase production to diversify grain base.
Peas & Beans	• Temperature changes increase risk of powdery mildew. Some risk of Bruchid pea beetle extending to England from France. • Negatively affected by drought.	• Increase / foster landscape diversity to protect from pests • Consider intercropping with grains, sunflowers, etc. Consider mulching for soil moisture conservation Use a diversity of varieties for resilience.

The main grain consumed in England at present is wheat. A total of 11-16 million tonnes of wheat is produced per year in Britain, most of which is winter wheat (sown in autumn). The UK is a net exporter of wheat, though also imports some varieties (15-20% of milling requirements) for their particular bread-making qualities.

About 40% of UK wheat is used for animal feed, and a significant amount of wheat is also used to produce glucose. Further, much more white bread (50g per person per day) is consumed than wholemeal bread (18g per person per day) in England. There is thus significant scope for optimising the nutritional outcomes of grain production and consumption (see Case Studies 6 and 7).

If wheat production were only oriented towards direct human consumption for a healthy diet, only about half as much wheat would be needed in the UK. Similarly, maize in the UK is grown primarily for biodigesters or animal feed, barley is produced primarily for animals and 1/3 of oats produced are for animal feed. Thus, there is scope for improving food security by reorienting grain production to human consumption. This requires producing different varieties in some instances, and improving drying, storing and processing facilities

4. Adaptive Practices

Potential adaptive practices which could enable farmers and growers in South West England to become more resilient to future climate scenarios include:

- Better on farm water management; from rainwater harvesting to the use of swales, furrows and/or vegetative strips to prevent water from simply running off the land.
- Intercropping; the cultivation of two or more different plants in the same space. Intercropping has been shown to help minimise pests and diseases and reduce weed problems while regenerating soils.
- Under-cropping with companion crops which are not necessarily harvested can reduce above ground competition (i.e. weeds), reduce pest problems and reduce or eliminate the need for fertilisers. The selection of the under-crop / companion crops depends on the soil and the main crop being sown. For cereals, clover, vetch and mustard are a few possible companion under-crops (see Case Study 2).

Soil health

Without stable soils, most food production becomes impossible; and due to increasing demand for food, agricultural land is being more intensely cultivated and farmed, resulting in unprecedented levels of soil degradation. A healthy well-managed soil will support productive and healthy crops and pasture, which in turn supports a profitable and resilient farming system. A soil that accumulates organic matter will sequester carbon, increase fertility and increase productivity - a win, win, win situation. Both reduced tillage methods and the addition of organic material have been seen to increase soil organic carbon (SOC) content in agricultural land as well as improve their fertility and soil health (see Case Studies 2,4 and 5).

Agroforestry

The term 'agroforestry' describes the inclusion and use of trees and shrubs as part of a wider agricultural system. Mosquera-Losada identifies five approaches within the system:

- Silvopastoral agroforestry: the combination of trees and livestock;
- Silvoarable agroforestry: the combination of trees and crops;
- Hedgerows, shelterbelts and riparian buffer strips;
- Forest farming: crop cultivation within a forest environment;
- Homegardens: combinations of trees and food production close to homes.

Silvopasture can lead to better livestock health, welfare, fertility and productivity as animals are protected from the elements. Soils also benefit from agroforestry, with the use of crop combinations that can support nitrogen fixing and other natural fertilisers, such as tree litter (leaves, deadwood, fruit and nuts), which nourishes soil and improves soil functions.

Tree-lined fields can also protect topsoil from wind and excessive water run-off, which also protects nearby waterways from algal blooms and silting. The productivity of one patch of land can also be extended throughout the year, since arable crops and tree crops (e.g. apples) will need harvesting in different seasons.

The Soil Association estimates that 10-14 tonnes of Carbon per HA could be sequestered in an agroforestry system.

Agri-ecological Farming

Nature friendly, agri-ecological farming includes many of the adaptive practices described in this briefing paper, such as:

- Longer crop rotations;
- Including cover crops like clover grown between crops so the soil isn't left bare and releasing carbon;
- Growing a more diverse range of crops instead of single crop monocultures, and
- Planting trees on farms.

Adopting agri-ecological methods can help to manage weeds, reduce erosion, provide for better soil fertility, improve carbon storage and even boost crop yields, reducing the need for harmful chemical inputs. For example, rotating cereal crops with grassland containing legumes like clover and sainfoin or growing crops such as pulses within the rotation will fix nitrogen into the soil. Including grass clover leys within the rotation, leaves the soil undisturbed for a period, and the legumes naturally pull nitrogen from the atmosphere into the soil. Allowing animals to graze these crops, provided they aren't overstocked, can bring additional benefits, like building organic matter into the soil and supporting biodiversity (see Case Study 3).

Mixed Farming

Mixed Farming has for centuries been the typical farm type in the Bridport Area. Since the 1980's farm sales and amalgamations have resulted in moves to larger, intensive production systems. Mixed farming is perhaps the most flexible and balanced farming system for the Bridport area, ensuring that all aspects of the growing process are working to their optimum.

A transition to agri-ecological farm system will need funding from government but in many areas around the UK local consumers are working with producers to lead the way to transition.

5. Processing and Storage

By selling direct via box schemes, farmers' markets and other short supply chains, food from small farms is fresher when it reaches the customer, as it has usually been picked within a day of delivery. The short time between harvest and delivery reduces waste and the need for refrigeration, while it is possible to sell produce of a greater variety of sizes and cosmetic appearances than supermarket buyers are willing to purchase. Packaging and transport costs are also reduced in comparison to centralised supermarket supply chains, as produce is collected from the farm or delivered within a limited radius of the farm, often using recyclable packaging. The short supply chains build trust and understanding between the farmers and their customers, strengthening community links around the farm.

Being able to add value to base arable crops though processing is often critical to the success of small farming operations. Arable crops for animal feed do not need to be as dry as that used for human consumption and thus many farms producing animal feed have not developed the capabilities for cleaning and drying grain to standards required for human use. Investing in processing capacity is a major step for many small producers and there is great scope for greater collaboration and co-operative solutions to build local processing facilities. (see Case Study 6).

With the prospect of greater climate impacts on crop production it would be wise for local communities to consider re-establishing systems for local food storage to help mitigate against crop failure and food distribution breakdowns. Food storage and distribution needs to be taken seriously as part of community emergency plans if continuity of basic food goods is to be assured in a climate challenged future.

In addition to buffering against shocks and losses, more local storage and processing facilities would help to de-centralise the food system.

Co-operative working[1] to pool resources, such as processing equipment, storage facilities and aggregating produce for wholesale are proving increasingly valuable for small scale producers. Adding value to crops, increasing the prices received and enabling access to infrastructure to grow businesses.

[1] Seeding Our Future is keen to work with local producers considering processing and storage issues. Help is available with funding and know-how as well as providing connections with consumers; contact - Email

6. Greenhouse Gas (GHG) Emissions

As well as having to adapt to a changing climate, another important response that arable farming can make is to reduce the greenhouse gas emissions that make climate change more severe. For arable cropping in general in the UK, the breakdown of GHG emissions is:

- 60 – 70% of all GHGs are related to synthetic nitrogen (fertilizer) production and application;
- 20% are related to fuel use and field operations;
- 10 – 15% from P and K fertilizers, organic manures and liming;
- 10% from sown seeds (emissions associated with its growing, processing etc);
- 1% from crop protection chemicals.

Artificial Nitrogen Fertilisers

The most significant source of GHG emissions from arable cropping in the UK are associated with the use of artificial nitrogen fertilisers. A number of studies have looked at the most nitrogen 'efficient' application rate for balancing the greatest yield of crop per gram of GHG emitted. For winter wheat this would be (depending on a host of normal farm variables such as soil type, previous cropping, winter rainfall and so on) around 150 kg N/ha which is well below the current commercially optimum rate of 190 - 210 kg N/ha that is the average over farms in the UK (see Case Studies 3,4, and 5).

Potential GHG mitigation methods applicable to arable include:

- Modifying fertiliser systems; the method of manufacture, formulation, application and timing) with the aim of reducing GHG emissions per kg nutrient;
- Selection of different crop varieties that convert soil and synthetic nitrogen more efficiently into harvestable biomass; (see cropping alternatives);
- Managing crop residues.

Individually these approaches were estimated to have maximum mitigation potentials (on GHG intensities of crop produce) of -25%, -23%, -23% and approximately -16%. (credit: MIN-NO project 2009 - 2014)

Field Operations

Field operations are the next most significant source of GHG emissions in arable systems. This is both because of the effect of cultivations (frequency, intensity, and depth) and the effect that has on Soil Organic Matter and subsequent GHG emissions. There is a growing body of evidence that demonstrates the fewer the number of passes and the less the disturbance to the soil with each pass, the lower the GHG emissions are from the soil. This is principally as a result of the oxidation of the soil organic matter (SOM) by microbial activity that is stimulated by available oxygen following a mechanical cultivation (see Case Studies 1 and 4).

7. Bridport Local Food Initiatives

Bridport consumers have a long history of supporting local producers and sustainable farming. Through Bridport Local Food Group and others, the town is well placed to be part of a rapid transition to a citizen-driven eco-agri food system. Now is the ideal time to act to retain the upsurge in consumer interest in local food brought about in response to the Covid 19 Crisis. Since March 2020 Community Supported Agriculture veg boxes have seen a 111% increase in sales[2]. Consumers are increasingly conscious of the dis benefits of the current food system and are demanding fresh produce and local provenance.

Seeding the Future is working with a range of local food producers, local retail outlets and consumers to build a more resilience local food system around Bridport. Initiatives include:

- Developing a 'Dorset Diet' to demonstrate how unto 80% of foodstuff could be sourced from the local area;
- Exploring ways in which producers and consumers can work together to build greater resilience into the local food system; promoting box schemes, shared processing capacity and establishing a local Food hub; and supporting local producers;
- Promoting climate adapted growing by setting up a network of Allotment Ambassadors to share tips and guidance.

For more information about Seeding the Future's work in Bridport contact: Weblink

[2] Source Sustain 2020

8. ADAPTIVE CASE STUDIES

Case Study One

No Till Crop Establishment
South Dorset

Credit: Dorset FWAG, Dorset AONB

South Dorset Ridgeway farmer, Charlie Goldsack, had been interested in the no till drilling as a way of reducing costs of crop establishment. He purchased a second-hand 4m Kuhn DS4000 drill and started using it to establish cereals on his beef and arable farm in 2016. Charlie estimates that his costs (labour and machinery) of crop establishment are less than half of what they were before adopting the technology.

In using the system Charlies key observations about No Till were that:

- It worked well on the lighter soils over chalk with much reduced costs and no discernible yield penalty;
- Results on some of the heavier clay soil were mixed but there was evidence of improvements in soil characteristics;
- Slug damage has proved to be the major risk factor from using the technology.

As well as storing carbon in soils, reduced tillage has many benefits including the increase soil water infiltration rates and reduce water erosion, enhance soil water retention, and decrease production costs and fossil fuel (energy) consumption. However, zero tillage has also been shown to increase direct emissions of nitrous oxide (N_2O) compared with conventional tillage, due to an increase in topsoil wetness and/or reduced aeration as a result of less soil disturbance.

Case Study Two

Cover Cropping and Water Quality
Milbourne St Andrew

Credit - Farmers Guardian March 2019

Dorset grower John Martin, together with Kings Seeds, has designed his own cover crop mix, which provides the maximum benefit to his calcareous soils while also being cost-effective.
He was first encouraged to use cover crops on Deverel Farm, in Milborne St Andrew, in 2007 by Wessex Water to help reduce nitrates leaching into drinking water, as a borehole is located on the edge of the farm.

After getting out of dairy in 2000, Mr Martin now grows 300ha of combinable crops on a rotation of winter wheat then spring barley, followed by alternate breakcrops of oilseed rape and large blue peas.

Mr Martin is happy to have about two-thirds of the farm in spring cropping if it means that the organic matter of the soil can be lifted. “There is no silver bullet to improving yields, it has got to come from the soil.

Conscious that the cover crops farmers in water catchment areas are being encouraged to grow also need to be cost-effective, Wessex Water has been running a trial of different mixes with varying costs on Mr Martin’s farm. Different combinations of oil radish, phacelia, linseed, lupin, buckwheat, vetch, burseem clover, red clover and spring oats were drilled at various seed rates to give a seed cost ranging £10-£30/ha, so that growers can compare effectiveness against cost.
Despite holding the trials for Wessex Water, Mr Martin is happy with the mix he has been growing for the past couple of years (see “Crop seed costings”, above), which includes buckwheat for phosphate, and sunflowers for biodiversity.

Whatever we grow as our main combinable crop is not necessarily good for the soil, so for six months I grow for the combine, and the other six months I grow something for the soil,” he says.
Soil bacteria have varying needs, so Mr Martin tries to grow as much of a mix as possible, but cost is an important factor.

About 80ha of cover is grown for the Countryside Stewardship’s mid-tier scheme, which pays £114/ha.
A further 40ha located close to the borehole is funded through Wessex Water to reduce nitrate leaching.

Case Study Three	
Mixed Farming Rotation **Tamarisk Farm** Credit Adam Simon	

The current farming operations at Tamarisk Farm have evolved along sustainability principles over the last 30 years. The Farm produce vegetables, meat, YQ wheat, barley and rye grain and flour. The Farm has recently purchased a small scale barley polisher to produce pot/ pearl barley. To increase digestibility they may invest in a roasting icing - so they could market Tsampa, which is not grown in UK, it would be the first English organic Tsampa.

No dig has been practiced for vegetable growing for over 30 years. Whilst the benefits of No Till Arable cropping are understood - reduced vulnerability to drought, reduced compaction, fewer vehicle passes, lower GHG emissions and improved soil structure - No Till is a challenge to achieve, especially on the heavier clay soils. Experience from other farms suggest many resort to periodic ploughing or use of herbicides to control weeds. These are key concerns for Tamarisk Farm as a certified organic producer. As a result *"Jury is still out on a move to No Till at Tamarisk Farm"*.

Tamarisk Is a great example of the benefits of a Mixed farming operation. Mixed farming offers the grower greater balance and flexibility. At Tamarisk a well established rotation system is used - Wheat (a hungry crop that takes much fro the soil) is followed by a second crop of Rye/ Barley or Oats which is less demanding followed by Green manure (recently Experimented with Clover) or A grass Ley. This approach works well with having animals available fo manuring. Tamarisk use animals on land un-suited to arable and where conservation grazing of permanent pasture is needed for biodiversity benefits.

Tamarisk work hard to make sure that crops like Barley/ Rye are not just fed to animals. A great deal of effort and carbon goes into producing arable crops and rightly they should feed humans not go for animal feed. animals eat grass! Flour sales work well for the far. During the Covid Lockdown sales of flour exceeded supply. Online sales have now reduced but the hope is raised intreats nada awareness in local produce won't dissipate.

Tamarisk is interested in other climate adapted practices including experimenting with with Ally cropping arable between fruit trees/black currants. Being a coastal farm full agroforestry establishment will be a challenge!

The idea of a Local Food Hub is also of interest to push local produce and make stronger connections between producers and customers. Tamarisk are looking to return to Bridport Market later this year - a way of connecting with customers and distributing online orders, mitigating customers having to individually drive out to West Beckington.

Case Study Four	
Organic Matter Application	

The recycling of organic matter (OM) to land provides a valuable source of nutrients, minerals and organic matter, and could potentially increase SOC levels. Currently, around 90 million tonnes of farm manures, 3-4 million tonnes of biosolids (treated sewage sludge) and 4 million tonnes of industrial ‘wastes’ are applied annually to agricultural land in the UK.

The application of OM to agricultural soils can help to maintain (and enhance) existing SOC levels, as well as help to improve soil structure/ stability. This often results in an increase in soil water retention and water infiltration rates (thereby reducing the risks of soil erosion), improves plant nutrient uptake and acts as an organic fertiliser. This provides both cost and energy (fossil fuel) savings involved in manufacturing inorganic fertilisers.

There is clearly scope for additional soil carbon storage/ accumulation from zero/reduced tillage practices and organic material applications, however, some changes may be limited or minimal. There are issues with SOC accumulation being finite and reversible, meaning SOC levels will only remain elevated if the practice is continued indefinitely.

Table 1. Potential increases in SOC following the application of a range of organic materials at 250 kg/ha total N

Organic material	Application rate	Potential increase in SOC		% of SOC stocks
	(t/ha dry solids-ds)	(kg/ha/yr/t ds)	(kg/ha/yr)	in England & Wales[c]
Farm manures	10.5	60	630	0.69
Digested biosolids	8.3	180	1500	1.64
Green compost	23	60	1400	1.54
Paper crumble	30[a]	60[d]	1800[c]	1.98
Cereal straw	7.5[b]	50[b]	370	0.41

[a] Typical application rate of primary or secondary chemical/physically treated paper crumble = 75 t/ha fresh weight, supplying 150 kg/ha total N. [b] fresh weight of straw. [c] Assuming 28 g/kg SOC in the top 25 cm & a bulk density of 1.3 g/cm^3 (91tC/ha). [d] Average SOC increase per tonne dry solids applied assumed to be the same as for farm manures (which have a similar composition of carbon compounds).

Case Study Five	
Organic Soil Fertility Chapel Farm - Arable with livestock Credit: Soil Association	

Faced with a bad blackgrass problem, Worcestershire farmer Adrian Steele converted to organic to reduce his weed problem and improve soil health.

Chapel Farm, near Pershore, Worcestershire is a 360-hectare arable farm with a further 140-hectares share farmed. It has a diverse mix of arable crops plus a dairy heifer rearing system and has been certified by the Soil Association for 30 years. The farm was in an impossible blackgrass situation after his father, Richard Steele, grew continuous wheat during the 1970s. Having a heavy clay soil meant the option of growing more spring crops, wasn't a viable, so Adrian decided to convert to organic and hasn't looked back since.

Fertility building is critical to successful organic management. "Building soil fertility without artificial fertiliser requires a change of thinking. Instead of single annual cropping you need to think ahead and plan a balanced, mixed rotation to build soil fertility over the long term. It might feel daunting at first, but that initial investment of time pays off in long-term gains. Adrian recommends devoting time to building fertility within your rotation through no-till periods and leguminous grass leys to fix nitrogen through root nodules. Also, compost, green waste, digestate and farmyard manure applications will all encourage the complex soil food web to develop.

Controlling pests and disease - Adrian's key controls are balanced rotation, later drilling and selecting strong varieties. Variable-rate drilling is implemented according to soil type on the farm, with seed rates increased on heavy land and during late autumn drillings. This helps maximise crop establishment and reduces weed emergence. He adds: "Using nature to fight nature by using methods like companion cropping (growing two crops side by side) and encouraging beneficial insects through beetle banks can help to fight pests."

Looking back over 30 years, Adrian says his soils are now in excellent health with increased soil carbon, root mass and workability, all of which are essential for profitable and sustainable farming. Biodiversity on the farm is much improved, especially insects which help to reduce pest issues and numbers of the Red Listed corn bunting have risen.

Case Study Six

Grown in Totnes - Oat Project
Local Grain Storage and Processing

Credit: Elise Walsh

As part of the Transition Town movement in Totnes, a local group of citizens got together to try to localise grain production for human consumption. All the farmers in the area were producing grain for animal consumption and recalled that their parents had done the same. As there was no infrastructure in place for the storage, processing and milling of local grains, the group organised to provide this. With £100k funding from Esmée Fairbairn to cover salaries and equipment, they rented a small industrial unit and purchased a dryer and a mill. Their learning curve was steep, and they are writing up a guide to the process now (to be available on Grain Lab). Challenges they faced included the following:

- **Different standards**: Standards for 'clean and dry' grain are lower for animal consumption than human consumption. Farmers in the Southwest tend to lack facilities to dry and clean grain to the level required for human consumption.

- **Transport costs**: Transport costs of grains are very high. Given that grains are very cheap in the market, it was not economically viable to send them further afield and they therefore had to sell their flour very locally.

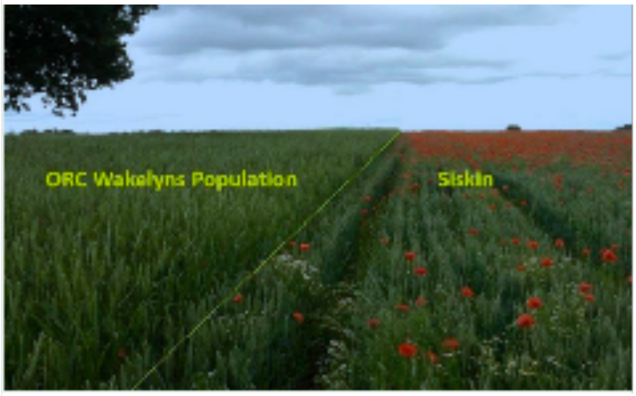
- **Steaming vs. drying**: Rolled oats (and other rolled grains) are normally steamed upon rolling in order to prevent them from going rancid once their oils are exposed to the air. As the group did not have the facilities to both dry and steam grains (you can't do both in the same place!), they did not steam them. To maintain freshness, Schumacher college, who had purchased some of the oats, kept them in the freezer.

- **Sorting grains:** They encouraged their farmers to intercrop wheat and peas, which gives a better yield. However, the farmer did not separate the crops post-harvest. The group tackled this labour-intensive job by throwing a party and enlisting community support to separate the grains.

- **Baking needs**: Bakers need time to adapt their recipes and baking processes to different grains. This was a barrier for a local baker who in principle wanted to try the new grains but did not find the time to trial them.

- **Contractor constraints:** Keeping the grains free of pesticide (and gluten in the case of oats) posed challenges for harvesting and seed cleaning, as equipment is owned and managed by contractors who service all the grain farmers in the area. Combined with their small amount of land, this meant the group was on the bottom of the priority list and some of their oats were not harvested in time.

As words of advice, one member of the organising group stated, 'It's all about relationships - for example, plants and the soil, one place and another. Whichever relationship it is, it needs to be looked at and understood. Anywhere that money is involved there probably needs to be a contract of some description.' Charlotte believes that local grain projects like this are feasible (and hopes to prevent other groups from repeating their errors) but they do need extra funds to get up and going.

Case Study Seven	
Increasing Adaptability through Genetic Diversity in Wheat **Wakelyns Farm, Suffolk** Credit: Elise Walsh	

Normally, in a conventional farm, only one or possibly two varieties of wheat are sown at a given time. In contrast, some agroecological farmers in the UK have been cultivating ‘populations’ of wheat.

The late Professor Martin Wolfe selected 21 wheat varieties that were important either for high yield or good qualities (e.g. resistance to drought or rust). He then crossed these for all possible combinations, resulting in about 200 different varieties, which as a population is referred to as ‘YQ’ or ‘yield quality.’ All of these varieties were sown and allowed to grow. In other words, they were not selected or reduced down by the farmer from this stage; any selection was done by ‘nature in the field.’

In 2017, a comparison was conducted between the population wheat field and three monoculture fields of modern varieties. The modern varieties did not last through the difficult drilling season, but the population field was thriving. This video explains the Organic Research Centre (ORC) trial: Wheat Populations at Wakelyns Agroforestry Farm. The YQ wheat has been considered a success for baking, and also has above average mineral contents. Its flour is sold via Hodmedod’s amongst other outlets.

While until recently, seed regulations required that varieties be registered individually and that they could be proven to be uniform and stable, the population varieties are anything but uniform, and their ability to evolve, rather than remain stable, is likely to support farming adaptations to climate change. The EU recently adjusted its regulations for organic seed to allow for the sale and distribution of ‘heterogenous material’ such as population varieties. With the exit of the UK from the EU, there will be a need to ensure that UK seed laws also allow for heterogenous materials to be sold and distributed.