English

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Booklet #2

SUMMARY OF SOLUTIONS FOR AGRICULTURAL PRACTICES

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CEreal REnaissance in Rural Europe:
embedding diversity in organic and low input food systems

CERERE aims at sustaining and promoting innovative approaches emerging in Europe from a multitude of practices adopted to introduce and manage agrobiodiversity in cereal production.
These innovations are rooted in local traditions, knowledge and food culture.

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Increasing diversity in cereal cropping implies changes and fosters innovation in agronomy, processing and marketing and impacts on how cereals are produced and consumed. Many alternative cereals (such as ancient wheats) and genetic structures are well suited to low input environments. The species, strains and cultivars possess positive agronomic traits for organic and low-input production and thus can offer resilience for the system. There also is an increasing demand for healthy and environmentally-friendly food that offers opportunities to diversify supply chains. Growing alternative cereals therefore offers an opportunity for farmers seeking to build resilience through diversifying their farming system.

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1. The case for diversification in cereal cropping

Increasing the diversity of cereal cropping contributes to improving the resilience of farming in the face of climate change, pest and disease tolerance and weed competitiveness. Particularly in organic and low-input farming clear opportunities exist to diversify the cereal production at the level of crop species, the genetics of the cultivars grown and in diversifying supply chains and markets.

- To grow alternative species to modern wheat and barley that are better suited to low input farming, farmers will need to know how to adapt their agronomic practices to these alternative cereal species.
- Diversification can also utilise alternative genetic structures, such as landraces and populations with intra-varietal genetic diversity that offers resilience and local adaption to the environments in which they are grown. Farmers will need to know how to get seed and where in how to get these different varieties.
- In both cases, there is a need to get to know the crop in the farm environment and for the specific e end use for which it is intended. Here the most relevant questions can be summed up as, “Will it grow?”, “What yield range can I expect”. Here it is important that farmers work together with researchers in getting to know the crops that they grow. This can go further towards improving the crops through farmer-led breeding, and there is a need to provide a reservoir of genes to preserve cultivated genetic diversity in-situ and maintain the genetic diversity for further breeding and crop improvement.
- And finally, there is a need to find, develop or create a market or supply chain for the novel crops.

The CERERE project derived collected solutions relevant to farmers that demonstrate the potential of diversified cereal cropping systems and supply chains through farmer -led research and the close collaboration between researchers and farmers, encouraging more integrated approaches to innovation in cereal food systems. This booklet summarises some aspects of those solutions, particular aimed at producers.

2. Alternative cereal species to modern wheat and barley

The two most commonly cultivated species of cereal crop in Europe are wheat and barley, where organic and low-input farmers mostly rely on modern pure line varieties. These are genetically uniform and mostly have been selected under high input farming conditions, and therefore may not offer the most suitable option for organic or low input farming. This booklet seeks to offer guidance on the alternatives that exists for Organic and low-input farmers, in terms of both species, and genetic structure. For wheat, there are opportunities to explore different species within the wheat family including the hulled, or so called “Ancient” hulled wheat species of Einkorn, Emmer and Spelt, and naked alternatives like Rivet. Other alternative species include Rye and Oats, both with positive agronomic traits for Organic and low-input husbandry. It is important to understand that within each alternative species, different cultivars and genetic structures exist. There are breeding programmes in Europe for all these species and although dominated by conventional programmes, some organic breeding programmes do exist. Within these species there are also heritage varieties, generally defined as pre 1950’s bred prior to the Green Revolution with its associated “technological package” and high input approach. It is generally accepted that varieties selected under low input conditions will be better suited to low input farming systems.

General principles of organic and low input farming apply regardless of which alternative cereal crop is grown, such as the use of fertility building leys and the practice of stale seedbeds for weed control. Considering general principles of organic farming, cereal agronomy and end use/markets should enable a successful diversification of cereals on farm. Cereal crops like Rye and Oats are also well suited to low input/organic production with adaption to those environments and strong markets in place. Information how to grow them can be found in many text books. Pseudo cereals (because they are a different family to real cereals) like Buckwheat and Quinoa may also present opportunities though the former presents an issue at harvest as an indeterminant crop that does not reach maturity like a typical cereal and may require swathing or direct combining while shoots are still green.

In the following section we provide some guidance for the cultivation of ancient wheats as less well known cereal type to consider.

2.1 An agronomic guide to growing "hulled" wheats

Einkorn, Emmer and Spelt are the earliest domesticated wheats. They are referred to as "Hulled" or "Ancient" wheats due to the tough palea and spikelet glumes covering the grain. Common and Durum wheats are free-threshing crops, producing "naked" grain. The hulled nature of these crops has implications for their cultivation. They require processing in order to be milled and may lose up to 40% of the yield once de-hulled. The hull also increases volume and may slow down operations involving equipment such as seed drills that are designed for naked grains. However, the hull acts a protective covering, beneficial at planting and for storage, providing a physical barrier against pests and disease.

Under sub-optimal growing conditions some research suggests that these crops can outperform common wheat and better utilise nutrients to offer an alternative for marginal land, or lower fertility places in the rotation. They are prized for their nutritional qualities and health promoting properties. There is renewed interest in these crops due to these nutritional qualities, its adaptation to low-input agriculture and high level of resistance to pests and diseases that represent advantages for Organic farming.

2.1.1 Uses

The hulled wheats can be used as a substitute for common wheat flour and can be used in breads, cakes, biscuits, pasta and breakfast cereal and pearled (de-hulled) whole grain for soups and risottos e.g. emmer as farro. The grain can also be used in brewing and distilling and for feed with the hull fibre beneficial for ruminants, increasing he digestibility of feed. The grains are generally high in protein and low in energy levels. The high financial value of these crops means that using them for animal feed may not make sense in practice.

2.1.2 Variety or cultivar selection

Once the hulled species has been chosen, genetic class should be considered. There are modern commercial varieties (the result of modern breeding programmes) heritage alternatives, mixtures or populations/landraces with its genetic diversity. Being aware of the difference is important since any alternative cereal that does not possess genetic diversity will not be capable of adapting to the farm environment, and may not be as resilient as a population, but will still increase overall agrobiodiversity at the farm and landscape scale.

Most spelt grown is a modern hybrid that has been crossed with common wheat, although this spelt is well suited agronomically to low input farming, it is not a genetically true, pure spelt crop. It is also important to remember that the Ancient wheats have a winter and spring type and there is a suggestion that some may also be facultative meaning they can be sown in either Autumn or Spring. On farm screening of types/varieties may be needed to determine these and other traits.

2.1.3 Site and sowing

The ancient wheats can tolerate a wider range of soil types and perform relatively well on lighter soils that are generally lower in fertility. For this reason, they are also well suited to positions towards the end of an Organic rotation, when soil is less fertile. The husk requires estimates on planting rate, since seed numbers are difficult to work out. Seed rates for the ancient wheats (hulled) are usually of the order 150kg/ha, 170kg/ha and 190kg/ha for einkorn, emmer and spelt respectively. Planting the hulled grain makes more sense as it offers protection for the germinating seed and de-hulling adds unnecessary expense. If the grain has been de-hulled, this may make planting easier and seed rate can be calculated using the thousand grain weight (TGW) and the required plant number per m2. For instance, 400 seeds per m2 with a TGW of 40 would requires 16g/m2 or 160kg/ha. These seed rates can be adjusted to find the appropriate quantity for the farm and should be adjusted according to sowing conditions, soil type and sowing date. The ancient wheats will tolerate a range of sowing dates, with significant differences in phenology (late or early), photoperiod and vernalisation requirements among the varieties. As a general rule, sowing takes place in Europe between late September and early November for Winter types and late March and early May for Spring types, depending on conditions. Row spacing should also be considered too and may have a greater impact on growth and yield than seed number. The increased ability to tiller may favour wider row spacings but increased tillering could be at the expense of yield. Narrow row spacing will increase ground coverage and weed suppression and should be the preferred option under Organic and low input husbandry, particularly in high yield potential situations.

2.1.4 In crop management

As crops that are well suited to Organic and low-input production, they can be grown with very little in crop management. The agronomic traits they possess, as tall crops with the ability to scavenge nutrients make them well suited to these production systems. However, as with any cereal crop they, can be rolled or mechanically weeded to improve performance. For example, post-emergence harrowing of emerged weeds following crop establishment (2-3 leaf stage) can be very beneficial for crop establishment, controlling weeds and mineralising nutrients.

Ancient wheats area candidates for livestock grazing, particular those with more biomass, and may be grazed in late winter early spring. This may act as a way of controlling weeds, removing disease inoculum and promoting tillering, though little research exists on the impact of grazing on the crop or on livestock nutrition. This practice will provide additional fertilisation through animal manure. Sheep are the species most commonly used.

There is little that can be done under low input of Organic agriculture to control foliar disease in the crop with the genetics of the crop the most important factor in providing resistance. Both homogeneous and heterogenous varieties can offer resistance, the former through specific breeding of the trait, the latter through the natural selection and resistance from the genetic diversity and associated mechanisms. It is important to screen new varieites on farm to properly understand resistance and susceptibility to particular pathogens. Depending on local adaption to pathogens, some cultivars may exhibit high susceptibility to different strains/ races of pathogens e.g. yellow rust, and this should be tested on farm at a small scale before committing to larger areas of unknown cultivar or species adapted to some other geographical location.

2.1.5 Harvest

Harvesting Ancient wheats at the correct maturity is critical. The rachis (where the spikelets grow) can be very brittle at maturity and delays in harvesting can lead to head shattering and significant yield losses. There may be varietal differences for susceptibility to shattering.
Ideally, harvesting should be carried out when grain moisture content is 12% or less and at a slower speed and with a slower drum speed setting than for harvesting common wheat.
The ancient wheats are generally prone to lodging. If lodging does occur, avoid harvesting against the direction of the lodged spelt to prevent picking up mouldy grain.
A trial harvest run is recommended so that correct harvester settings can be determined.

2.1.6 Post-harvest

Storage should be at 12% or less moisture and, if hulled, with the hull retained. The grain is likely to need cleaning to remove impurities such as weed seeds, dirt and chaff and dried to the correct moisture to meet market requirements or for storage. The husk makes it more difficult to process than common wheat. Hulled wheats must be mechanically de-hulled just prior to milling, with this additional step making them more difficult and expensive to process than common wheat. Some farmers' value-add and process on farm. Small volume de-hullers are available. Oat de-hullers are also effective but generally will only handle small volumes. Most food-grade ancient wheat is grown under contract with a processing company.

3 Increasing the genetic diversity within the cereal crop

Diversifications can also take the form of higher diversity in the genetic structures of the crop, for example through populations with high genetic diversity or crop mixtures.
Within crop genetic diversity leads to improved resilience and adaption to the farming environment. Natural (and man-made) selection on the farm can provide an adapted crop suited to soil, climate and crop management.

- Heritage populations, in the form of landraces, are locally adapted to a particular place.
- Modern populations, such as composite cross populations are sometimes also referred as modern land races. Here several modern and/or heritage varieties are crossed to create a genetically diverse "variety" capable of local adaption to environment and climate.
- Varietal mixtures can offer some of the same benefits as more diversified genetic structures like populations. They are simple to create on farm by combining two or more varieties of the same species. The more varieties that are mixed, the greater the genetic diversity though it makes sense from an end use perspective to stick to the same species and grain qualities, since separation of grain may prove challenging.

In general terms, growing species populations of heterogeneous material will be almost identical to the practice of growing the pure line homogenous equivalents of the same species. The genetic diversity of such a crop provides more flexibility for crop management from site selection to harvest. For site selection, when growing populations, this may be less important as the crop will adapt over time to the specific environment and management.

3.1 Using of heritage cultivars populations

Heritage cultivars and species can represent an alternative to modern cereal varieties and increase access to and use of genetic diversity. Heritage varieties, those usually defined as bred before the green revolution under low input conditions, offer a good opportunity for low input production. Since these are bred pre-semi dwarfing, they are taller than modern varieties with a lower harvest index. This means grain yield will be lower than modern varieties and the risk of lodging is higher. Specific farm management should therefore take account of this thinking about suitability of soils, seed rates, drilling dates and place in the rotation. These heritage crops should generally be suited to lower fertility sites. Too much nitrogen will promote disease and cause lodging in these taller growing crop. Also, high seed rates are also likely to promote lodging. These crops have potential to be placed towards the end of rotations, rather than at the start immediately following a fertility building ley.

Since they are more prized for grain quality than for yield, prioritising their harvest will secure the highest quality.

Initiatives growing ancient cereals use them both to develop food products and to develop more locally adapted cultivars. Ancient and whole grains can be used to produce breads, pasta, baked goods and other novel products. One important activity of groups working in ancient cereals is to exchange seeds between the farmers, alongside developing food products. Seed quality and safety using appropriate methods must be ensured to avoid problems with seed-borne diseases. Many initiatives also refer to the better adaptation of such cultivars to organic or low-input farming and to local conditions. But there is a need to experiment with the performance of cultivars and species under the local soil and climatic conditions to reduce the risks of poor performance.

3.2 Sowing time

It is important to consider that almost all species of true cereal will have winter and spring types. In some cases, this is facultative, meaning they can be sown in either in the autumn or Spring. If winters are mild spring types are likely to be successfully grown as a winter crop. Winter types that don't have a strong vernalisation requirement they can be sown in early spring. It should be stressed that the crops are likely to be better suited to a particular sowing timing and that this should be considered as the optimum approach.
However, diversifying crops and adapting planting can provide greater flexibility for the farm. Populations may be better suited to a particularly sowing time but through continuous sowing at one timing or another can be selected for the alternative over time for example a population of winter wheat may be converted to a spring wheat if there are individual genotypes within that are suited to this sowing time and growing season, and the crops phenology (growth and development from germination to maturity) are appropriate.

3.3 Seed

Home saving seed is a key feature of using heterogeneous material (and non-commercial varieties) since the crop will adapt to the local environment over time. However, saving seed can lead to seed health and farm health issues through a build-up of seed borne disease with common bunt a particular issue. There are management options including cleaning through brushes, and chemical treatments, (both commercial; Tillecur, and homemade; mustard powder, vinegar).

4. Testing crops on farm through collaboration with research in multi-actor projects and operational groups

When diversifying with cereals the importance of testing the specific crop on farm cannot be overstated. When considering alternatives species and cultivars, comparing to current crops and adapting cropping practice and management accordingly through trial and error should form part of the process. While this booklet sets out some key principles and guides to the agronomy of different cereal crops there is no substitute for in-situ trials that will help inform the potential of cultivating different crops and the factors involved from sourcing seed to reaching markets.
Starting small to limit risk and building towards a new cereal enterprise is by far the best way to approach diversification by learning through doing. This may be particularly appropriate for heritage varieties like landraces. Although they are of the same species as crops that may already be grown on-farm, these cultivars may behave very differently and require a different agronomic approach in terms of site selection, place in rotation, seed rate, drilling date, spatial arrangement of seed at sowing etc.There is really no substitute to gain context specific knowledge by cultivating the alternative cereals on the farm to assess their performance and suitability for a particular climate, soil and farm management system. With all the different cereal crop types, crop management requirements will need to be considered though for some, it may not differ greatly from standard modern pure line varieties of typical crops like wheat and barley. If a farm can grow modern winter wheat, it is very likely to be capable of cultivating any cereal alternative.

There is lack of reliable evidence about the agronomic performance of alternative cereal crops under variable conditions, including yield, processing qualities, other product attributes and market demand for alternative cereals. Engaging with researchers and other stakeholders in multi-actor projects can help with the development of trials, with getting access to genetic resources (e.g. from genebanks and from other projects) and with expertise related to genetic and economic sustainability. Access to genetic material and results about site specific performance of cereals cultivars and species and access to findings from related projects. The multi-actor approach will foster the exchange of different types of knowledge between practitioners and researchers for mutual benefit. Multi-actor and farmer-led research approaches can be used in relation to participatory breeding and genetic resources. They can also be used to improve the understanding of processing qualities, of consumer attitudes, market demand and of rural development opportunities. Researcher involvement in trials about genetic resources can facilitate better communication between gene banks and farmers.

The integration of farmer knowledge and skills with different scientific disciplines and other sources of knowledge is important. Facilitation will improve the understanding between the different actors and types of knowledge. Collaboration with researcher might also provide access to funding, such as and findings from related projects elsewhere, experiences of practitioners are fed back to researchers to engage them as problem solvers. One opportunity for funding exists in the form of operational groups as part of EIP-AGRI. These offered in the rural Development Programs of many regions of the EU.

5. Developing alternative supply chains and market development

5.1 Diversifying in markets and supply chains

Cereal diversification is a means to develop alternatives to the commodity cereal markets and rediscover the traditional skills of baking, brewing and flaking, local and traditional products and culture, as well as the knowledge about crop adaptability to a changing environment. Also, reduced yields compared to modern pure line alternatives may necessitate developing a specialist markets or a different marketing approach to provide a premium to offset lower levels of production, with the value derived from the novelty and diversification itself. At harvest, such crops need to be given priority to maximise grain quality. As part of the supply chain development, storage and processing will also need to be considered.
Developing supply chain and markets for products from cereal diversity relies on the involvement of all the actors along the supply chain that appreciate the value of plant genetic diversity and bringing together different skills. The CERERE project looked at many examples of farmers collaborating with others in the supply chain to encourage more integrated approaches to innovation in cereal food systems.

5.2 Consumers as partners in the cereal renaissance

There is uncertainty about consumer demand for products from ancient grains and underutilised crops among many initiatives. Initiatives starting with developing local markets for products from underutilised grains through direct selling or community-based initiatives and work closely with local customers, for example, a movement from consumers interested in local

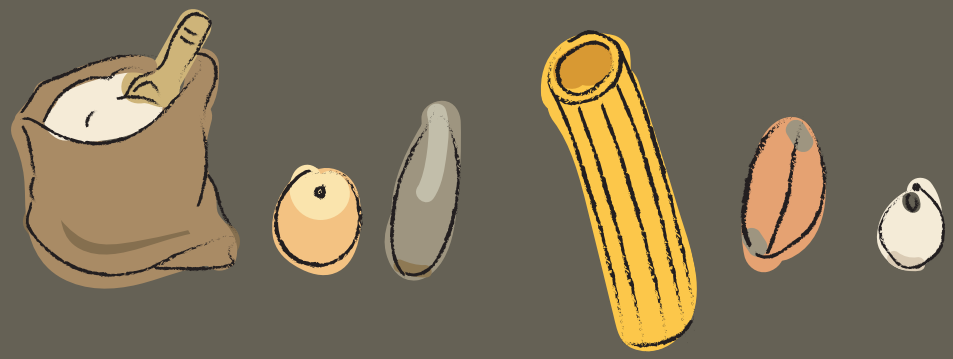
organic bread. Consumers wanting better control of their food choices are motivated by concerns for the environment and want to buy locally-grown food or other products with improved sustainability attributes. Importance is placed on communicating the story behind alternative cereal products to consumers. An integrated approach in relation to where to sell should be explored. Some consumers find it difficult to access local products and engage in alternative food networks and might prefer to buy such products in other outlets. Some of the initiatives of CERERE have also made good experience in finding consumers in cities and other locations by developing sales at national or international market through collaboration with existing processors and industry partners, whereas others are more reluctant to do so for fear of compromising their own values. Local cereal diversification initiatives can also be supported through education and direct involvement of consumers. This can build awareness and understanding and help develop the market in the long-term. Engaging with education activities also increases the social and potentially also economic sustainability of initiatives.

5.3 Support for networking and collaboration with industry partners

Many cereal-based initiatives originate from individual farmers or other businesses and evolve into broader networks, but the management of the network often becomes an obstacle. Working with processors that have identified a market niche or existing market opportunities for added value for alternative cereals offers a solution, involving professional facilitators of professional hubs to create spaces for linking farmers with advisors, researchers, breeders and retail. Involving existing processors can help consumers further afield (related to superfood, health food or traditional products). Support for the network helps facilitate the active involvement of farmers, bakers, millers and societies, communities and institutions. This will ensure that all nterests are respected and can help to match areas of interest to create new opportunities for more farmers to engage with growing alternative cereals crops. Facilitation can help create the space in which the different roles and interests can be explored and thus improve the collaboration. Collaboration can help identify practical or logistical issues in the processing or distribution of cereals and pool knowledge of specialist markets to identify and reduce a possible mismatch of needs and interests. This will encourage more producers to grow and engage with underutilized crops. Involvement of professional facilitators can help building network and links with industry and related sectors. This will help identifying and overcoming barriers to supply chain development. Small initiatives in particular to should clarify shared ethics and added value expectations in the early stages of negotiation with larger and more powerful industry partners.

5.4 Using organic farming and quality assurance schemes

The quality attribute of products from alternative cereals can be difficult to communicate to consumers. Many cereal initiatives use organic certification and/or other certification schemes, such as participatory guarantee system or geographical indications. Clear standards of organic and third party or participatory guarantee systems can provide additional quality assurances for consumers. Participatory schemes also contribute to an ongoing process of co-producing knowledge and learning from producers to improve their practices in a cost- effective way. All EU quality labelling schemes, such as organic certification, geographic indications (PDOs and PGIs) and traditional specialty guaranteed (TSG) can be useful for some cereal initiatives, but also collective marks developed by the initiatives themselves can be very useful and are less demanding then the EU quality labels. Most case study initiatives in the CERERE project work to organic standards and are certified. Organic standards are well developed, and the term organic is recognized by many consumers. Costs for certification or registration will occur in exchange for the permission to use a logo or recognized term, such as organic. Cereal initiatives should develop additional communication strategies and not rely only on organic or other certification to communicate the unique product qualities to consumers. There are a range of other opportunities to create trust and credibility, through personal contacts, farm and field visits and developing good relations along the supply chain. Farm visits can also be a good opportunity for peer-to-peers knowledge sharing to foster collective learning and improvements.



6. Conclusion

Cereal cropping systems are targets for diversification to improve sustainability, resilience and health in the field and on the farm. In the end, agronomy may not represent the greatest hurdle. Diversification at farm level is relevant and achievable with many options for cereals suited to a wide range of environments, with a general need to test and explore to better understand crop performance. The greatest challenge may well lie beyond the farm level where supply of diversified seeds and markets for diversified grains may hinder the farm level desire and attempts to increase diversity. By considering the collected solutions contained within, this may help farmers overcome the supply chain barriers in order to realise a true Cereal Renaissance in Europe.

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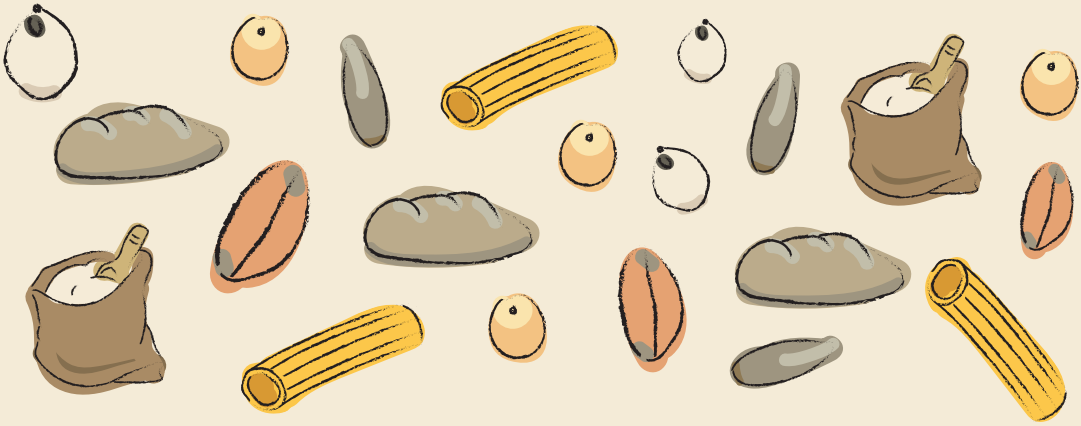

"CERERE is a thematic network that brings scientists and practitioners together. Its aims are to raise awareness about the value of good food, to identify cereal supply chains which use low inputs, to empower farmers and those actors who work with alternative food systems"

– CERERE consortium, Kick Off Meeting, University of Reading, November 2016

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This project received funding from the European Union's Horizon 2020 Research and Innovation program under Grant Agreement n° 727848.