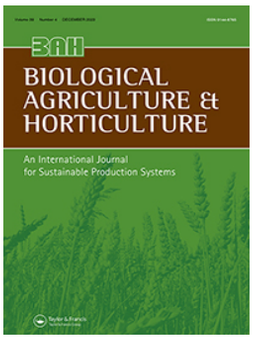

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Farmers' motivations for landrace cereal cultivation in Sweden

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ABSTRACT

The interest in landrace cereals, i.e. genetically diverse varieties with historical origin, has increased in recent decades. While several studies exist on farmer's motivations to grow landraces in a Global South context, investigations are much less common in the Global North. Through an interview study with 32 Swedish farmers that cultivate landrace cereals on a commercial scale, farmers' motivations to grow landrace cereals were explored. The farms in the study ranged from medium sized to large. The majority were located in areas with marginal agricultural land and less fertile soil. All farms sold the landrace cereals at advantageous prices as niche products and all except one were certified organic. The farmers' motivations for growing landraces were grouped around three themes: i) sustainable farming systems; ii) suitable agronomic traits; and iii) economic incentives. The first and overarching theme was that cultivation of landrace cereals fitted well with the farmers' ideals on sustainable farming, with for example less intensive weed control and novel intercropping systems, as well as enabling production of wheat with baking quality on marginal agricultural land. Cultivation of landrace cereals was framed in contrast not only to conventional farming, but also to 'conventionalised' high input organic farming. The farmers regarded producing and marketing landrace cereals as an important foundation for more sustainable and multifunctional farming and food systems. This reflected the farmers' perception of a lack of modern varieties suited for these systems as well as the ability of landraces to buffer risks of crop failure on marginal land.

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Agrobiodiversity; cereal production; farmer motivations; landraces; multifunctional agriculture

Introduction

For more than a century, agricultural systems have been developed to produce large amounts of food at low economic costs. Over the last 60 years, average farm size has increased in high- and medium-income countries (Lowder et al. 2016), and farmers have become increasingly efficient in meeting the demand for cheap and abundant food for an increasing population (Pretty et al. 2010). This development has been mirrored in plant breeding, resulting in high-yielding varieties dependent on high input levels (Newton et al. 2009). More recently it has become politically accepted that agriculture urgently needs to change in order to meet challenges such as climate change (IPCC 2014, 2021) and loss of biodiversity (IPBES 2019; Willett et al. 2019), while at the same time taking socioeconomic perspectives into account (Garibaldi et al. 2017). To meet these multiple challenges,

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farmers have been encouraged to grow more climate resilient crops (IPCC 2014) and to diversify their cropping systems (Zimmerer 2010). In this context, landraces – heritage varieties characterised by a high genetic diversity and a lack of formal plant breeding (Camacho Villa et al. 2005) - can contribute with valuable traits. Landrace cereals generally yield less than modern cereal varieties, but they have been shown to provide acceptable yields under marginal conditions, i.e. conditions characterised by low resource availability and low yields, and under extreme weather conditions (Newton et al. 2009; Yahiaoui et al. 2014). Crop robustness will be increasingly important in the light of climate change (IPCC 2014; Lopes et al. 2015; Migliorini et al. 2016), and maintaining crop genetic diversity has been pointed out as a key to future food security (Esquinas-Alcázar 2005; Swarup et al. 2021).

During the 20th century, landraces were increasingly abandoned in the Global North, including in Sweden, as the availability of external inputs, such as mineral fertilisers and pesticides, increased. Plant breeding was able to provide farmers with genetically homogenous cereal varieties that were well adapted to high levels of input, had high yield potential (Kingsbury 2009; Newton et al. 2009) and good pathogen resistance, for example against different rust diseases such as *Puccinia triticina* and *Puccinia striiformis* (Smale 1997). In the European Union, crop varieties were standardised and the exchange of heterogeneous seeds prohibited (Batur et al. 2021).

However, the last twenty years have seen a renewed interest in the cultivation of landrace cereals in Europe (Veteläinen et al. 2009), and the EU seed regulations have opened up for restricted landrace seed exchange on a limited scale (Batur et al. 2021). Landrace cereal products have also become increasingly popular among European consumers (Mahon et al. 2016; Wendin et al. 2020; Varia et al. 2021). They can be sold at higher prices than conventional cereal products in high and middle-income countries in the Global North (Brouwer et al. 2016; Nizam and Yenal 2020). Landrace cereals have been suggested as particularly suitable for organic farming (Wolfe et al. 2008) and for farming under low-input conditions (Bellon 2004; Van Bueren ET et al. 2011; Orsini et al. 2020). In field experiments, landrace cereals have been shown to have traits that make them better adapted to harsh environments and more extensive farm management practices than modern varieties (Newton et al. 2009; Yahiaoui et al. 2014; Ficiciyan et al. 2018). Landraces generally have large root systems making them good at acquiring soil resources (Bektas et al. 2016), and long straw making them competitive against weeds (Lazzaro et al. 2019).

In Sweden, landraces were only conserved by a few farmers and in gene banks (Leino 2017). In the 1990s, some organic farmers started using the historical landraces again, in search for varieties that suited organic farming systems (Allkorn 2023). They organised a participatory plant breeding project together with a professional plant breeder, which developed into the national seed swapping association Allkorn (Larsson 2020). In order to improve and adapt landraces to local conditions, the Allkorn farmers have recently started to use so called evolutionary mixtures in addition to the historical landraces. The mixtures are produced by combining many landraces of the same species and type, e.g. spring wheat (*Triticum aestivum* L.), which have been selected for desirable traits (ibid). After a few generations, the mixtures develop into a locally adapted population that is genetically diverse and resilient to biotic and abiotic stresses caused by adverse conditions, such as weeds, pests, diseases and drought (van Bueren ET and Myers 2012; Wolfe and Ceccarelli 2019).

What motivates farmers to cultivate landraces? There are relatively few studies describing farmers' experience of growing landrace cereals in the Global North (Raggi et al. 2021a). Landrace cultivation is still relatively common in developing countries in the Global South, despite continuous initiatives to replace landraces with modern varieties (Wattnem 2016; Fischer 2016; Atlin et al. 2017). Earlier studies from, for example, China (Li et al. 2012), Ethiopia (Abay et al. 2009; Hailu 2017), Mexico (Hellin et al. 2014), El-Salvador (Olson et al. 2012) and the Himalayan Highlands (Bisht et al. 2007) have suggested that yield and profit maximisation were not what primarily motivated farmers to cultivate landraces of cereals like tetraploid wheat (*Triticum spp.*), barley (*Hordeum vulgare* L.), sorghum (*Sorghum bicolour* L.), maize (*Zea mays* L.) and rice (*Oryza sativa* L.). Rather, the farmers appeared to cultivate

landraces to minimise risks associated with harsh environmental conditions, e.g. irregular rainfall in terms of amount, duration and timing, and droughts. Specific cultural features attributed to landraces, such as family traditions and cooking preferences (ibid; Xu et al. 2014; Monteros-Altamirano 2018) were also drivers for the cultivation. Moreover, it was mainly smallholder farmers using low input strategies that were inclined to grow landrace cereals (Bezançon et al. 2009; Bellon et al. 2017), partly due to a lack of alternatives and the costs of purchasing modern cultivars and associated inputs. Finally, experiences from the Global South have indicated that women were more engaged in landrace cultivation and conservation than men (Diop et al. 2018; Nchanji et al. 2021).

There are only a few examples of interview studies investigating the motivations of the farmers to use landrace cereals in a Global North context dominated by highly mechanised agriculture. Most of the present literature on landrace cereal cultivation from the Global North deals with farming under marginal conditions with relatively small farm units. Where Italian farmers managed marginal land, some tended to prefer landrace cereal and pulses instead of modern varieties, since they experienced that the landraces had a higher yield-stability than the modern varieties (Negri 2003; Varia et al. 2021; Leoni et al. 2021). Similar results were observed by landrace vegetable growers in Romania (Maxim et al. 2020) and small-scale farmers growing landrace oats (*Avena strigosa* Schreb) and Shetland cabbage (*Brassica oleracea* L .) in Scotland (Scholten 2012). Among farmers growing landrace barley Bere in Shetland and Orkney, UK, the main motivations were opportunities to sell the crop on niche markets, the cultural values of the landrace e.g. as part of traditional recipes, and that farmers perceived the crop suitable to grow in poor soils and with low inputs (Mahon et al. 2016). It has been observed that European farmers growing landraces of cereals and vegetables were elderly, and concern has been raised that landrace cultivation might not be handed down to the younger generations (Negri 2003; Veteläinen et al. 2009; Scholten 2012; Maxim et al. 2020; Raggi et al. 2021a).

The reasons why farmers grow a certain variety are complex, and may vary from the biophysical environment of the farm, the agronomic management system or the socio-economic conditions, including market opportunities (Desclaux et al. 2008). The farmers' identities and ideals may also play an important role in the choice to cultivate landraces (ibid). An interview study with eight farmers that grew landrace cereals and pulses in Sweden suggested that the motivation of farmers to grow landraces was strongly connected to their identity as organic farmers, and to their underpinning ideals of what sustainable farming should be like (Öhnfeldt 2019). How the farmers identified themselves has been shown to be key to decisions related to cultivation and other farming practices, indeed often overriding the basic economic and biophysical preconditions of the farm (Marquardt et al. 2022). The farmers' ideals related to farming have been suggested to range from 'productivist' to 'multifunctionalist' approaches to farming (Burton and Wilson 2006), where 'productivism' is often associated with bulk production of a few crops, while 'multi-functionalism' emphasises a more diversified farming approach (OECD 2001; Woods 2011; Roche and Argent 2015) that utilises, for example, regulating and supporting ecosystem services (Garland et al. 2021).

The study reported in this article explored farmers' motivations to grow landrace cereals in a highly mechanised agricultural context. In particular, four research questions were addressed:

(1) What are the characteristics of the farms where landrace cereals are grown?
(2) What are the farmers' motivations for cultivating landrace cereals?
(3) How are these motives connected to the farmers' ideals relating to the sustainability of their farming systems, and
(4) What is the role of landraces in their strategies to achieve these ideals?

Farmers' experiences of, and motivation for, growing landrace cereals in a Global North context were investigated by a qualitative interview study with farmers growing landrace cereals in Sweden.

Materials and methods

The basis for this article was an interview study with 32 Swedish farmers who cultivate landrace cereals on a commercial scale. An important entry point for finding farmers with experience of landrace cereal cultivation was through the Swedish national seed swapping association Allkorn (Allkorn 2023). In order to meet a broad range of farmers, the study was advertised at Allkorn meetings and at seminars focused on landrace cereals. Mills and bakeries that sell products from landrace cereals were contacted, as well as agricultural advisors, in order to find farmers that grew landrace cereals. Advertisements were also put in newsletters and on social media. The snowball method was then used (Noy 2008), i.e. asking the initial informants if they knew other farmers who were growing landrace cereals. Since landrace seeds are primarily spread by farmers' seed exchange, it was possible to find farmers also in the outskirts of the landrace cereal community, e.g. those who were newer to landrace cereal cultivation, or who were not active in Allkorn.

In total, 47 farmers were identified and briefly interviewed over the telephone about their experiences of landrace cereal cultivation. The study was limited to farmers who were growing landraces on a commercial scale, and who had at least two years' experience of landrace cereal cultivation, and 10 of the 47 farmers were excluded based on these criteria. Five farmers declined to be interviewed due to the COVID-19 pandemic. The remaining 32 farmers consented to be part of the study, and were interviewed using semi-structured interviews, which took one to two hours. The first part of the interview was structured with formal questions to gain detailed information on the general farm characteristics, while the rest of the interview was organised around themes (the interview guide used is shown in Supplemental Table S1). Most interviews were carried out at the farms, except three that were held by video or telephone. In order to reach an improved understanding of the farm and the farming system, farm-walks were conducted together with the farmers. These walks included visits to both the fields and essential buildings connected to the landrace cultivation, such as storage buildings, on-farm mills and farm shops. During the walk, farmers would often bring up matters that had not been mentioned in the interview, and themes from the interview were elaborated in more depth. The farm visits were documented in field notes and the interviews were recorded and later transcribed. Some of the farm interviews were carried out with several persons, for example spouses or grown-up children that also were active in the cultivation of landrace cereals. The interviewees were anonymised using letters, and in the cases where several persons were involved in the decision-making of the farm, numbers were used in combination with the letter, e.g. Farmer X2. An additional interview was also held with the plant breeder who had a key role in founding Allkorn. The interview study was further complemented by participant observation of meetings, field walks and seminars about landrace cereal cultivation arranged by, for example, Allkorn and Sweden's national centre for artisan food Eldrimner (Eldrimner 2016). Parallel with the interview study, an on-farm agronomic study of landrace rye (*Secale cereale* L.) was conducted. Many of the farmers (25 of 32) in the present interview study grew landrace rye and were thus part of both studies. This meant that these farms were visited 5–8 times during the growing season, giving many possibilities to ask additional questions. All interviews and farm visits were done by the lead author.

The material was thematised inductively (Bowen 2016) by first classifying farmers' motivations and experiences into subcategories, which were then grouped into three major themes. The quotes from the interviews that are included in this publication were translated from Swedish to English by the authors.

Results

These are varieties that suit the way I want to farm! (Farmer M).

Farm characteristics

The farms represented in the interview study differed in terms of size and line of production but shared many other characteristics (Table 1). All farms except one were certified organic following the EU 2018/848 certification standard (European Commission 2018), the majority (22) were in addition certified with the Swedish KRAV certification (KRAV 2023), and one farmer was certified biodynamic (Demeter 2022). One of the farms was described by the farmer as 'virtually organic, but not certified'. More than half of the farmers (17) kept livestock. The landrace cereals grown by the farmers included wheat (*Triticum aestivum* L.), rye (*Secale cereale* L.), spelt (*T. spelta* L.), emmer (*T. dicoccum* Schrank ex Schübl.), einkorn (*T. monococcum* L.), barley (*Hordeum vulgare* L.), and oats (*Avena sativa* L.). In total, the farmers grew 44 different landraces of cereals (hereafter referred to as landrace cereals) on field scale. The farmers were using 2–14 different landrace cereals on a regular basis in their crop rotations. The mean number of landraces used by the farmers was four, and the most common were 'Dala' and 'Öland' spring wheat, 'Fulltofta' evolutionary winter rye and 'Svedjeråg' rye. All the farms were situated south of latitude 62 in Sweden (Figure 1), where the climate is more suitable for cereal cultivation than further north. Most of the farms (27) were located in mixed agriculture-forest landscapes, and only five were situated on the plains – the most productive agricultural areas in Sweden. Many farms (16) were located on what was described by the farmers themselves as marginal land for cereal production, e.g. with relatively poor soils. The majority of the interviewed farmers were men (34 out of 40) and the age-span of the farmers ranged from 30 to 73. The average age of the farmers was 54 years. The farm sizes varied from a few hectares to about 600 ha arable land with most farms between 30 and 80 ha. All farmers sold their landrace cereal products as niche products, either directly to consumers (20 farmers) through farm shops, farmers' markets, farmers' cooperatives focused on landrace products, or REKO-rings, or through small-scale millers that specialise in landrace cereal products (17). REKO-rings are a form of informal market place for direct sale organised by producers and consumers through social media (Daving Götberg 2018). The products were mostly sold locally, i.e. in the same county, but several farmers (10) also sold landrace cereal products outside their home county on a regular basis. Products were often sold to artisan bakers located in larger cities, or to larger mills for making special landrace cereal products. All farmers except two earned their main income from farming. Two of the participating farmers described themselves as hobby farmers, since they had retired and only cultivated small quantities of landrace cereals, but still on a commercial scale.

Motivations for landrace cereal cultivation

When analysing the farmers' motivations and experiences connected to landrace cereal cultivation, three main themes emerged; motives connected with: 1) ideals of sustainable farming; 2) agronomic properties of the landraces; and 3) economic incentives and markets for landrace cereal products (Table 2). The motivations for growing landrace cereals were often expressed as a combination of these themes, with the theme connected to 'ideals of sustainable farming' being the most prominent. This could be seen as an overarching theme. In the following sections, these three themes have been presented in more detail.

Ideals of sustainable farming

Vision of more sustainable farming systems. Many farmers, especially farmers with long experience of landrace cereal cultivation (10–30 years), described their motivations for using landrace cereals as part of their ideals about sustainable farming, often in similar ways to this farmer:

Table 1. Description of the informants and the farms in the study.

Alias	Gender	Age	Years with landrace cereals	Total farm size (ha)	Area arable land (ha)	Livestock	Main production	Channels for selling and processing of landrace cereal products
A	Woman & man	61 & 63	15	110	70	No	Cereals, apples	Farm shop, REKO (informal sale organised through social media), farmers' markets, local mill
B	Man	53	18	100	85	40 suckler cows	Cereals, beef cattle	Farm shop, REKO, Farmers' cooperative
C	Man	73	10	89	60	40–50 dairy cows	Cereals, dairy cows.	Farm shop, REKO, local grocery stores, directly to bakers. Own mill and bakery
D	Man	58	25	90	80	20 suckler cows, 4 sows	Cereals, beef cattle, pigs, potatoes, honey, rapeseed oil	Farm shop, REKO, directly to local bakers. Own mill.
E	Man & woman	40 & 40	5	150	70	50–60 dairy cows	Dairy cows, cereals	Local mill
F	Man	45	16	110	30	35 ewes	Sheep, cereals, eggs, honey	Farm shop, REKO, local mill, directly to bakers
G	Man	74	10	1,6	1,6	No	Hobby farmer, bakery	Own bakery
H	Man	61	4	80	50	130 ewes	Sheep, cereals	Local mill
I	Man	55	3	110	101	22 suckler cows, 200 ewes	Sheep, beef cattle, cereals	Farm shop and local mill.
J	Man	61	10	210	210	No	Cereals	Selling through farmers' cooperative
K	Father & daughter	67 & 40	30	80	60	No	Cereals	Farm shop, directly to bakers. Own mill.
L	Father & son	65 & 30	6	110	100	95 ewes, 20 beef cattle	Sheep, beef cattle, cereals, peas, lentils	Farm shop, local mills directly to retailers.
M	Man	42	10	1000	630	180 suckler cows	Cereals, beef cattle	Farmers' cooperative. Own mill.
N	Man	71	10	600	100	500 beef cattle	Beef cattle, cereals, cray fishing.	REKO, farm shop. Own mill and bakery.
O	Man	55	3	140	140	No	Cereals and herbs	Farm shop, local mill
P	Man & woman	43 and 43	3	140	110	35 dairy cows	Dairy, cereals	Local mill
Q	Man	39	10	260	260	Organic broiler production	Cereals, rapeseed, vegetables, off-farm work.	Local mill
R	Man	55	8	39	32	40 oxen	Beef cattle, cereals	Farm shop, directly to local bakers
S	Man	60	10	140	100	No	Cereals, vegetables, herbs, tourism, sheep	Farm shop, REKO
T	Woman	59	4	27	27	No	Cereals, vegetables, field mustard	Farm shop, REKO, directly to bakers
U	Man	70	5	8	8	No	Hobby farm	Local mill
V	Man	58	5	32	32	No	Cereals	Local mill
W	Man	58	20	370	270	No	Cereals, clover seed, peas, beans	Farm shop, REKO, farmers' cooperative. Own mill
X	Man & woman	65	30	106	70	120 ewes	Sheep, cereals	Farm shop, mills in other counties, directly to local bakers
Y	Man	59	20	95	10	35 ewes	Sheep, vegetables, cereals	Farm shop, local mill, directly to local bakers
Z	Father & son	67 & 27	10	100	100	No	Potatoes, cereals, white clover seeds	Local mills.

(*Continued*)

Table 1. (Continued).

Alias	Gender	Age	Years with landrace cereals	Total farm size (ha)	Area arable land (ha)	Livestock	Main production	Channels for selling and processing of landrace cereal products
AB	Father & son	59 & 30	3	180	120	15 suckler cows	Beef cattle, cereals	Local mill.
BB	Man	52	4	580	380	400 beef cattle	Beef cattle, cereals, off-farm work	Local mill
CB	Man	63	2	80	80	No	Cereals, off-farm work	Local mill
DB	Man	62	5	228	228	No	Cereals	Local mill
EB	Man	49	3	130	130	No	Cereals	Local mill
FB	Man	70	7	25	25	No	Cereals	Local crisp bread bakery

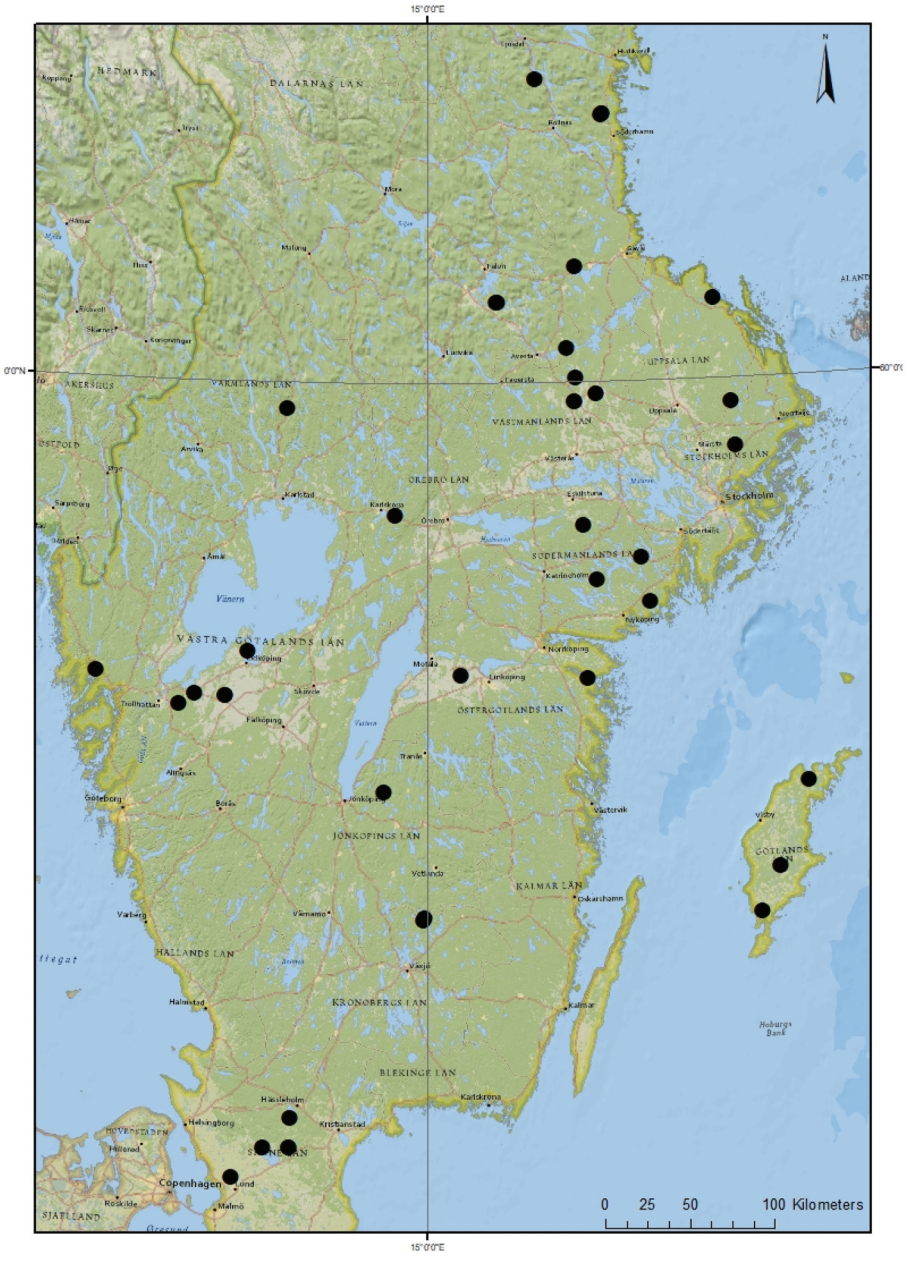

Figure 1. Approximate positions of the 32 farms in Sweden, where most of the interviews took place.

For me personally, one of the main drivers is to find a sustainable and resilient farming system (Farmer W).

Most of the interviewed farmers identified themselves as wanting to be at the forefront of developing sustainable farming systems – to be 'outstandingly organic' (in Swedish: 'Spjutspetsekologisk') was a common expression – and the cultivation of landraces was described as an important means to achieve such ambitions. All interviewed farmers stated that landrace cereal cultivation '*makes sense for organic or low-input farms*'. Many of the farmers with long experience (10–30 years) of landrace cereals had started to grow landraces when they transitioned to organic

Table 2. Three major themes for motivation and experiences of landrace cereal cultivation, with sub-categories (see text for motivations).

Ideals of sustainable farming
Vision of more sustainable farming systems
Networking
Upholding farming in marginal areas
Varieties adapted to organic practices
Conservation and development of landrace**s**
Agronomic properties of the landraces
Low demands on nutrient availability
Prone to lodging
Low harvest index and straw production
Weed competition
Diverse crop rotations and intercropping
Tolerance to pests and diseases
Tolerance to extreme weather events
Ability to adapt to local conditions
Economic incentives and markets for landrace cereals
An increasing market for landrace products
Short value chains
A nutritious product
Exploitation of niche markets

farming in the 1990s and early 2000s. For these farmers, landrace cereals were considered as an important cash crop, and they cultivated landraces as a way to achieve more sustainable cropping systems. In this group of farmers, it was for example common to experiment with innovative intercropping strategies involving landraces, as described below in section 'Agronomic properties of the landraces'.

When the farmers presented their motivations and reasons for growing landrace cereals, they used several arguments that were connected to an alternative vision for how agriculture and the entire food system should look in the future. They described visions of farming systems with diverse crop rotations using genetically diverse landraces. A common feature for the farmers was an accepting attitude towards weeds. Having a diverse ecosystem on the farm was regarded as more important than having a perfectly weed-free field:

> *I sort of have nothing against weeds, acceptance is more my line* (Farmer L).

The ideal farming system was depicted as circular and independent of agribusiness. Within this line of reasoning, farmers expressed ambitions to promote and act within a local food system with direct sale, with what was described by the farmers as healthy and nutritious landrace products. Farmers also often emphasised the importance of being '*a free farmer*', i.e. independent of large multinational companies. The farmers talked about growing landrace cereals as a means of reducing dependence on external inputs and developing a more circular system for nutrient supply. Such statements were often contrasted to more intensively managed organic farms, where large yields were stated to be achieved with the help of high levels of organically permitted external inputs such as pelleted meat and bone meal and chicken manure. Landrace cereal cultivation was thus mainly associated with organic and low-input agricultural systems, and the cultivation of landraces in conventional systems was described by the farmers as fundamentally wrong and in contrast to their ideals of what landrace cereal cultivation should be like.

> *I know that there used to be a farmer outside [a bigger town], he was completely conventional, sold it as landrace spelt wheat, that's just not right!* (Farmer Z1).

Networks. All farmers mentioned that growing landraces gave them networks with others who '*think along the same lines*' about sustainable farming, as one farmer stated when asked about why they started to cultivate landraces. These networks were often facilitated through Allkorn events or through regional networks for seed swapping, and by means of marketing landrace cereal products

through alternative food networks. Most importantly, the farmers described the networks as a way of meeting other farmers from all over the country who have a focus on sustainability, and who cultivate organically as conscientiously as possible, something that might not always be the case in their own local farming communities.

Upholding farming in marginal areas. The farmers that were new to landrace cereal cultivation, with only about 2–3 years of experience, did not always share the vision of being at the forefront of organic farming to the same extent as the farmers who had been growing landrace cereals for a longer period of time. Some of these newcomers emphasised landrace cereal production as a way to maintain cereal production in marginal agricultural areas and to maintain farming traditions. They typically described themselves as '*ordinary organic farmers*'. The agronomic traits of the landraces combined with the increased market interest and price premia made it possible for the farmers to grow cereals on marginal lands, e.g. in areas with much forest and less fertile soils, where the arable land would otherwise be turned into forest plantations or leys. One farmer, whose farm was in a region with a large proportion of forest area, and who had recently started to grow landrace rye and spring wheat, stated the following when asked about why he started to grow landraces:

> *Well, it is certainly much more fun to be able to grow cereals here than keeping the land in ley (. . .) and keep the land in the area cultivated and in use.* (Farmer FB).

Varieties adapted to organic practices. Closely connected with the farmer's ideals of growing landraces as part of an organic and sustainable cultivation system, were arguments about the need to develop varieties adapted to organic farming practices. A common narrative from the farmers was that seed production and supply of seeds have become global assets in the hands of a few powerful multinational companies and actors, and that growing landrace cereals is a way to take back the right to cultivate one's own seeds. One direct effect of centralised plant breeding for the farmers is the lack of locally adapted varieties, and a lack of varieties adapted to organic farming conditions. The farmers explained that they propagate their own landraces, since regional and national plant breeding centres either have shut down or are focused on conventional and intensive cultivation.

> *These varieties had been mothballed for a long time, but when organic cultivation was increasing and we tried to find varieties that suited better in organic cultivation, they [landraces] became interesting again!* (Farmer X1).

Landrace propagation is in the above quote presented as a consequence of the lack of plant breeding for low-input organic systems. In a similar vein another farmer argued '*We have to take matters into our own hands and do it ourselves*'. Several farmers expressed a desire that landraces should be freely distributed and in the hands of the farmers or local organic plant breeders. The majority of the farmers (21) were engaged in participatory plant breeding through the Allkorn community gene bank (*Bruksgenbanken* in Swedish), exchanging seeds and propagating landraces together.

Conservation and development of landraces. Farmers described their perspectives on growing landrace cereals as different from the official views of the Swedish public authorities, such as gene banks and actors from governmental boards, which they claimed had a too strong conservation-oriented perspective. The farmers often described the motives of these public authority actors as focused on conserving landraces for cultural heritage, a security for the future, and as a resource to supply breeding material suited for high input conventional farming. In contrast, the farmers described themselves as active users and developers of their own landrace plant material. The farmers were not mainly interested in conserving the landraces *'just for the sake of conserving them'* (Farmer M) or '*conserving for the sake of conserving*' (Farmer B), as two farmers stated when asked why they cultivate landrace cereals. The farmers described the goal of their landrace conservation as to enable the use of the landraces in organic or low-input farming. The agronomic properties were an important motivation for growing landraces. One farmer who has grown landraces for a long time and who has propagated several landraces stated the following:

> *Conservation? No, I leave that to the state. If anyone wants me to do any conservation work, they would have to pay me. We just want to use them [landrace cereals] because they have properties that I need to farm my land in an organic way.* (Farmer A1).

A farmer who has long experience of growing many different landrace cereals and who has been involved with propagating landraces stated:

> *We are not so idealistic that we just grow them [landrace cereals] only for the sake of growing them, we want to get a living from it!* (Farmer Z2).

Agronomic properties of the landraces: experiences of agronomic traits and management

Landraces were argued by the farmers to be suitable for organic farming systems and in agreement with their ideals about sustainable farming systems, because of their agronomic traits, which were described as lacking in modern varieties. The farmers often emphasised that they were unsure whether their experiences of agronomic properties were connected only to the actual traits of the landraces, or if it was also related to how these traits interacted with how they managed their crops and the local environmental conditions on the farm. In either case, the combined effect of variety, management and environment suited their farming systems. A farmer with long experience of landrace cereal cultivation stated the following when asked about his motivations for growing landraces:

> *The most important reason for me is that the modern varieties are not adapted to the way that I want to farm, the way I want to grow crops. (. . .) I think that plant breeding has drifted away from my needs, from what I want from the crop. And that is the most important reason for me – that these [landraces] are really good for me! (*Farmer M).

Furthermore, landraces were also described as having agronomic properties particularly suitable for organic farming on marginal lands, e.g. with less fertile soil. More than half of the farms were located outside the major cereal production areas, in regions where large areas of agricultural land have been replanted with forest. They typically described their soils as not being optimal for cereal production, for example like this:

> *We don't have the land with the best growing conditions, so the landraces suit well. They are not so demanding, but still give stable yields.* (Farmer L).

The agronomic traits associated with landrace cereal cultivation were thematised under eight subcategories (Table 2), which have been further elaborated in detail below.

Low demands on nutrient availability. All farmers in the study stated that landrace cereals require less nitrogen than modern varieties, or rather that the landraces cannot take advantage of high doses of nitrogen as well as modern varieties. Most of the farmers generally applied less fertilisers to landrace cereals than to modern varieties. This enabled them to save on fertiliser costs compared to more modern conventional varieties and was especially valuable for farmers who do not have access to manure from livestock, and therefore are dependent on bought fertilisers. In the farmers' experience, using landraces is a way of growing a crop with sufficient protein levels for baking, but with less input of fertilisers. One farmer with over 20 years' experience of growing landrace wheat stated:

> *We always have a shortage of fertilisers in organic farming, and if you then can get bread wheat quality at 80–120 kg nitrogen [per hectare] it is certainly interesting, especially if you can sell it at higher prices.* (Farmer M).

Prone to lodging. The farmers described lodging as a problem when growing landraces but argued that it can be handled through appropriate management. One farmer related:

> *If we fertilise too much, well, they just lodge then – they always do that in the end, but if we fertilise less they lodge later in the season, and then it is alright, because then we can harvest and get a good yield anyway.* (Farmer L).

Many farmers described how landraces tend to bend and form 'vaults' rather than lodging flat with the straw breaking close to the soil surface, as modern varieties do. Since lodging is relatively common, many farmers have developed techniques for harvesting lodged landrace crops, for example, adapting combine settings.

Low harvest index and straw production. Most farmers had experienced lower grain yields from landrace cereals than from modern varieties. The farmers often attributed this to morphological traits of the landraces, e.g. longer straw and smaller ears and kernels of the landraces. The smaller size of the kernels was argued to be problematic, since small kernels can make the milling process difficult. Regarding the longer straw of landraces, the majority of the farmers regarded this as an advantage:

> *A wheat with longer straw is easier to raise protein levels on, in my experience. When a longer straw starts to ripen it has more to send up to the kernels.* (Farmer M).

> *I much rather want a longer and strong straw with a smaller ear than these short worthless ones with large ears.* (Farmer D).

The experience of the farmers was that well-established landrace cereals produce more straw than modern shorter varieties. The farmers whose main income came from livestock production stated that it is critical for them to have straw for bedding and fodder. Buying straw in an area with few cereal producers can be both expensive and a logistical problem. Growing landrace cereals that give high straw yield is therefore seen as advantageous, and was by some farmers described as the main motivation for growing landrace cereals:

> *The reason that I grow this [landrace cereals]) is the straw, straw is difficult to get here and expensive . . . there are crazy amounts of straw [from landrace cereals]! If I were to grow more, I would maybe even be able to be self-sufficient on straw!* (Farmer I).

Farmers without livestock also regarded the high straw-production as positive, even though it was not a direct economic benefit to them unlike the livestock producers. The long straw can be used for mulching and fits in with the ideal described by the farmers of not taking too much from the soil and taking care of the system in a circular way. A farmer that specialises in cereal production stated:

> *We want the straw back in the ground, we want to give back as much material as possible, so we mulch down the straw, making it circular. But for us it is not a direct economic advantage to get a higher straw yield, because we don't have livestock.* (Farmer K2).

Three of the farmers in the study also used the straw in alternative ways, for example selling to artists working with handicraft, or for thatching, where the length and strength of the landrace straw is considered as an advantage.

> *The goal for us is to get straw for thatching (. . .) Rye straw is the best (. . .) it must be strong and long, preferably 1.5–1.6 metres.* (Farmer D).

Weed competition. All farmers mentioned that landrace cereals compete better against weeds than modern varieties. Farmers generally attributed this to the longer straw of the landraces that shades out the weeds. To illustrate the competitive advantage of landrace cereals compared to modern varieties one farmer paraphrased his neighbour:

> *The neighbours say about our spelt fields that 'You are out spraying the fields during night-time, you don't fool us, no one can have so weed free organic fields!'* (Farmer Z1).

Along the same line, a couple running a dairy farm in a region dominated by forest described why they chose to grow the landrace 'Dala' spring wheat and not modern spring wheat:

> *No, it would not be an option to grow modern spring wheat, we have tried that and it is too . . . weak. It hasn't got enough competitiveness against the weeds.* (Farmer P1).

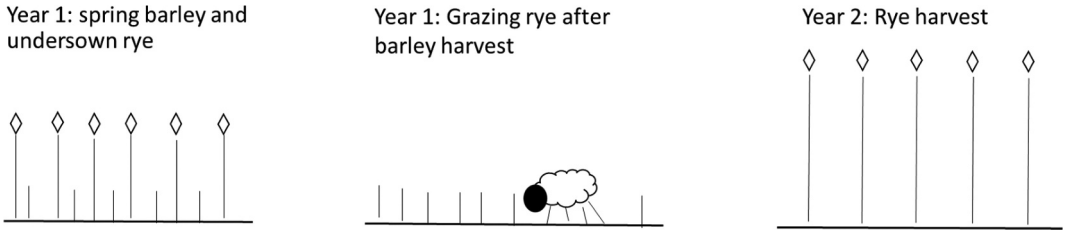

Figure 2. An example of an intercropping system with the 'Svedjeråg' rye landrace (described further in text).

Some farmers used landrace cereals as a '*weed cleaning crop*', because of their high ability to compete for sunlight, water and nutrients. The most commonly used crop for weed cleaning was landrace rye, but sometimes landraces of spring wheat and other species were also mentioned as weed cleaning crops. Some farmers also ascribed allelopathic abilities to the landraces:

> *I took over a few fields on the other side of the road that had lots of thistles, and after a few years I broke the ley and sowed Dala spring wheat – and the thistles didn't have a chance! There were a few wretches, but they kept a low profile – proper ashamed of themselves. I guess that it is like with rye, that it is something about the roots* [*of the landraces*] *that senses the weeds and make sure that the weeds don't make any mischief.* (Farmer C).

Many of the farmers experienced that the competitiveness of the landraces made it possible for them to have less intensive weeding strategies, enabling fewer mechanical weed treatments, such as weed harrowing, row hoeing or stubble cultivation between crops, than with modern varieties.

Diverse crop rotations and intercropping with landraces. A common experience was that landrace cereals provide farmers with more crop alternatives, enabling more diversified crop rotations. Having access to several landrace alternatives has encouraged farmers to experiment, both with longer and more complex crop rotations, and with intercropping. Intercropping landrace rye ('Svedjeråg') with undersown clover or ryegrass (*Lolium* spp) is a good example of an alternative management practice that is becoming popular (Figure 2). The landrace rye is commonly sown by the end of June together with the undersown crop, thus allowing an early season fallow to control weeds, but it can also be sown earlier or later – the sowing date is flexible. The rye grains are then harvested the year after sowing. According to the farmers, the rye should be grazed or cut several times during the first autumn to facilitate winter survival. The farmers that keep animals recounted that this late autumn grazing provides valuable late season livestock feed. When the rye is harvested in year 2, the forage crops remain as a well-established grass-clover ley. Some farmers have also tested the relay intercropping of 'Svedjeråg' rye with a spring sown crop, e.g. barley, spring wheat, peas (*Pisum sativum* L.) or faba bean (*Vicia faba* L.). The two crops are sown in spring and the companion crop is harvested in year 1, while the rye is harvested in year 2. These tests, inspired by traditional ways of growing 'Svedjeråg' rye, have created interest among other farmers, especially since it means '*two crops but with only one ploughing*' (Farmer D). Several of the farmers that are more specialised landrace cereal producers have also grown pulses for direct human consumption in intercropping systems, where different landraces of pulses are grown together with landrace cereals, e.g. lentils (*Lens culinaris* Medik.) with spring emmer. The landrace cereals were described as providing a higher yield than modern varieties in their intercropping system, being able to 'hold their own ground' against the pulses. However, some farmers reported that the long thin straw sometimes causes problems when intercropping with climbing species, e.g. lentils, and increases the risk for lodging of the cereal.

Tolerance to pests and diseases. The majority of the farmers in the study described landrace cereals as generally more tolerant to pests and diseases, something that the farmers attributed to the genetic diversity of the landraces. For example, one farmer with long experience of landrace cereal cultivation explained how pest and disease control worked in a landrace field:

> *Well, if you take a modern field, then it is all homogeneous. And if you then take a field with landrace cereal – they are different all of them, every grain is different, they are different individuals all of them. And if there is an intruder, some pest, aphids or whatever, then the plants cooperate, it becomes harder for the pests to find (. . .) all the kernels, and before that happened the ladybirds and others have already had time to get there, and that is how the balance works . . .* (Farmer X2).

In this quote, the farmer attributed the genetic diversity of the landraces as a way to delay pest invasions, which in combination with natural enemies in the field acts as a safeguard against serious damage. This was often contrasted against a field with modern varieties.

Sometimes other traits were described as making landrace cereals in general more tolerant to diseases. Several farmers mentioned how the long distance between the flag leaf and the ear in the landraces makes landrace cereals more tolerant to leaf spot diseases spread by spores, since the spores are less likely to reach the ear. Farmers often contrasted the tolerance of landraces towards pathogens to the more uniform modern varieties:

> *These new varieties that are developed are like clones, they all have the same genetic set up and they all have the same protection against diseases – and the same weakness.* (Farmer Z1).

Although the landraces were described as generally tolerant to pests and diseases in theory, the farmers still struggled with keeping their crops healthy. The main disease issue cited by the farmers in relation to landraces were connected to seed and soil borne diseases. Some landraces of wheat were described as impossible to grow, since they are subject to so much common bunt or dwarf bunt (*Tilletia* spp.). Farmers with long experience of landrace cereal production were worried about the spread of common bunt and other seed-borne diseases through seed exchange and pointed out seed health and seed cleaning as major challenges for landrace cereal cultivation.

Tolerance to extreme weather events. A common experience among the farmers was that landrace cereals were noted to be more tolerant to extreme weather than modern varieties. Landraces were described as hardier, and better at maintaining yield under variable conditions, than modern varieties. The farmers attributed this to traits such as deep roots, high tillering ability and most of all to the genetic diversity within the landrace. Farmers also brought up the issue of landraces being more tolerant to droughts. A common narrative was that the landraces gave normal or next to normal yields even under dry conditions, while modern cereal varieties tend to fail, as illustrated by the quotes below.

> *In 2018 yields were a bit lower – it rained almost nothing after we sowed that year, it was like a desert. Many [other farmers] didn't get a yield at all, but we had a decent yield – but it [the crop] germinated less [fewer plants emerged due to dry conditions during establishment], of course.* (Farmer BD).

> *No one got any yields to speak of 2018, and then I got 3,5 tonnes* [*landrace rye*] *without fertilising! Perfect! It is probably because – taller variety, deeper roots that can reach the water.* (Farmer I).

> *The thing is that it* [*landrace cereals*] *is possible to grow . . . we have seen that, during the last three dry years, that we still get a yield of cereal.* (Farmer X2)

> *It was very dry, and then we saw a difference between the landrace cereals and the other varieties (. . .) It [the modern varieties] grew dreadfully bad because of the drought. The landraces were relatively good.* (Farmer E1).

Local adaption and genetic diversity. The farmers commonly described genetic diversity within the landraces as an important positive trait. Many suggested that the genetic diversity enables the landraces to adapt to local conditions, which was regarded as advantageous. As a way to enhance genetic diversity, many farmers have started using evolutionary mixtures. The most widespread evolutionary mixture was autumn and spring sown rye, but in some cases, farmers have developed their own mixtures of spring wheat, emmer wheat or oats. Farmers stated that it takes three to four years for a local adaptation effect to be noticeable in the mixes. A period of three years was considered as an informal limit in the Allkorn association for when an evolutionary mix can be considered as locally adapted and can be renamed after the farm. Genetic diversity is, however,

associated with challenges. The present regulations for seed exchange make it mandatory to register landraces as conservation varieties if farmers want to sell their seeds on a commercial scale. To register landraces as a conservation variety requires among other things that the varieties are uniform, which excludes most landraces from being registered. Several of the farmers regarded the new EU regulations (EU 2021/1189) that will open up for sale of organic heterogeneous material (European Commission 2021) as a positive development.

Economic incentives and markets for landrace cereals

Farmers' motivations to grow landrace cereals were also related to economic incentives. Although the agronomic properties enabled the farmers to increase the sustainability of their farming systems in line with their ideals, economic incentives and the market opportunities were described as prerequisites for farmers to start growing landrace cereals or scaling up the production.

An increasing market for landrace cereal products. The farmers in the study reported an increasing demand for landrace cereal products and many of the farmers that had recently started growing landrace cereals explained how they were motivated by the demand from consumers. Experienced growers of landrace cereal cultivation described how the interest from consumers had increased gradually over the last 20 years and how they themselves had taken an active role in creating a demand for landrace cereals among consumers and bakers, by informing them about the qualities of landrace cereals. Consumer interest in landrace cereals seemed to have begun with the cultivation of spelt:

> *It was that [the spelt] that started it all. And then came a sudden boom for 'Ölandsvete'.* (Farmer M).

The spring wheat landrace 'Ölandsvete' was described as the starting point for the landrace cereal trend among consumers, a trend that has been increasing since around 2005:

> *Suddenly we started to receive a totally different kind of feedback from the customers in the farm shop. That's when the 'Ölandsvete' hype really got started . . . the customers were mad for it . . . and since the mid '00s it's just gone upwards!* (Farmer K).

Short value chains. More than half of the farmers reported that they sold landrace products directly to consumers (Table 1), either as whole kernels, flour, flakes or as processed food such as bread, cakes, granola, or as vegetarian meat substitutes. The motivations for direct sale were described as economic, but also as a pride in producing a unique and premium product. Many farmers narrated how they used different marketing techniques to increase the demand for their landrace products. Selling landrace cereal products directly to consumers or to small-scale mills thus constituted an important business model for the farmers. Many farmers specialised in crop production mainly sold their landrace products directly to consumers. The specialised cereal producers had in many cases invested in drying and storage facilities at the farm, while farmers specialised in livestock production were more inclined to sell their produce directly to small agrifood businesses such as local mills. The farmers described selling to larger retailers or cooperatives as futile. Selling landrace cereal produce directly to consumers through short food chains was described as important for the farmers, and a way of motivating consumers to pay premium prices for landrace products. A couple with long experience of selling their products directly to consumers stated:

> *We have seen in the supermarkets that there is no point in trying to sell it [landrace cereal products] there, not unless the staff is very knowledgeable (. . .) there is an ongoing battle in the supermarkets about the space (. . .) if it just stands on the shelf and does not sell enough you are soon out (. . .) and there is no point in selling through Lantmännen (large farmer's cooperative) either.* (Farmer X1).

Another farmer described:

> *Well, you need to sell it* [*landrace cereal products*] *directly to the customers to get paid enough . . . so that's why we invested in the mill in the first place.* (Farmer C)

A nutritious product. Landrace cereals were often depicted by the farmers as being nutrient dense, in contrast to modern varieties:

> *These [landraces] are filled with healthy stuff, not like those conventional varieties!* (Farmer B).

Most farmers, especially farmers with relatively long experience of growing landrace cereals, were convinced that landrace cereal products are healthier and have a better and richer taste than modern varieties. In the experience of many of the farmers, the landrace cereals are also well suited for artisan sourdough baking, and for traditional recipes. Several farmers stated that consumers had reported health benefits from consuming their landrace cereal products. Most of these experiences are related to consumption of emmer, einkorn or spelt wheat. Other related narratives among the farmers were that products made from landrace cereals makes you '*feel more full*' (Farmer X2) and that the products are '*more nutritious, containing more micro-nutrients*' (Farmer W). This belief was often expressed in stories that mentioned a historical decline in nutrient content in modern cereals:

> *Until the 70s the modern cereals were completely OK with regard to minerals, but nowadays you need to eat the double amount of modern wheat to get enough minerals (. . .) we really ought to get paid for nutrition content, if you get full at half the amount [from landrace cereal products], then you don't need so high yields. (*Farmer X2).

Many farmers said that they felt that they have a lack of knowledge about what causes the positive health experiences that their customers had told them about. They often expressed a wish that this should be investigated further in research, since scientific findings on nutritional benefits would be an advantage in communications with customers and strengthen the position of landrace cereal producers.

Exploitation of niche markets. Marketing landrace cereals as a unique niche product was important for many farmers, and some have built their entire business by portraying landrace cereal production as associated with healthy products, authenticity and being at the forefront of organic farming, i.e. communicating their ideals related to farming and food production. This positioning of landrace cereals as a unique product becomes prominent in the way some of the farmers reasoned about the size and value of their yields. Producing for a niche market makes large yields less important:

> *I don't want to maximise the yield (. . .) I don't need 8 t, 2 t can be enough. It is important to keep track of the market, and not dump the prices, not like those big growers . . . [mentions a large organic farm]. We must keep the prices up, and make sure to tell the customers what they are paying for.* (Farmer S).

Especially the more specialised landrace cereal producers ascribed quality traits to the landraces. They argued that the landraces were healthier, as opposed to 'mass produced' cereals. In their opinion, landrace products should be sold more or less directly to the consumers as a niche product, in contrast to bulk cereal production. Farmers often positioned their products in opposition to conventional farming. They criticised conventional farming as being associated with low prices, unethical and unhealthy products, and focused on producing:

> *. . . as many tonnes of carbohydrates as possible (. . .) we want to produce high quality tasty products instead.* (Farmer W).

However, the rising demand for landrace cereals has meant that more farmers have become interested in trying out landraces. Especially the farmers that were newer to landrace cereal cultivation (2–3 years-experience) stated that they do not have time or equipment to process the cereal on the farm and sell directly to customers, nor do they have the interest to propagate new landraces from small seed samples. Instead, being able to buy larger quantities of seeds, and to sell the grains to larger companies, for example to large crisp bread bakeries, was described as a desirable scenario by some of these farmers.

Discussion

What characterises farms that cultivate landrace cereals in the highly mechanised agricultural context of Sweden? The farms in the study were mainly located in what the farmers themselves described as areas marginal for cereal production, similar to other studies of landrace cultivation in Europe (Negri 2003; Scholten 2012; Peratoner et al. 2015; Maxim et al. 2020). However, the farmers were primarily not smallholders, which is frequently the case in the literature from the Global South (Altieri and Merrick 1987; Bellon et al. 2017) and also in some instances from the Global North (Scholten 2012; Mahon et al. 2016; Leoni et al. 2021). They were, with some exceptions, farmers with medium to relatively large sized farms, and all the farms except one were organic without this being a selection criterion. Unlike other studies from a Global North context (Negri 2003; Maxim et al. 2020; Raggi et al. 2021b), findings of this study suggested that landrace cultivation in Sweden is not primarily carried out by elderly farmers, but by farmers in all stages of their farming career (Table 2). The mean age was five years lower than the Swedish average age for farmers (Swedish board of Agriculture 2021), indicating a resurgence of a new generation of farmers who are interested in cultivating landrace cereals. The gender distribution, with a majority of male farmers, followed the pattern of Swedish cereal cultivation in general (Andersson 2014). Similar to Veteläinen et al. (2009), it was mainly organic farmers that use landrace cereals in Sweden. These farmers were not newcomers to farming as in e.g. Leoni et al. (2021), but represented a wide range of commercial organic farmers.

The farmers' motivations for cultivating landraces were shown to be closely connected to certain ideals of what sustainable farming is or should be. These ideals could be seen as the underlying and overarching motivation to grow landrace cereals. A common feature among the farmers was a vision of developing sustainable farming systems and identifying themselves as being – or at least wanting to be – at the forefront of organic farming. The farmers wanted to produce sustainable, nutritious food while at the same time provide other ecosystem services than just provisioning, ideals that have been described as typical for multifunctional farmers (see Burton and Wilson 2006). In order to attain this ideal, the farmers utilise landrace cereals in designing their farming systems, a phenomena that has been previously described in a meta-study of multifunctionality of landraces by Ficiciyan et al. (2018). The agronomic properties of the landraces were an important motivation for the farmers, forming the basis of the farmer's sustainability claims with regard to landrace cultivation. The farmers ascribed certain traits to the landrace cereals and explained how these agronomic properties provided many different and important ecosystem services to the farms. Examples of these were regulating services such as controlling weeds by competition for resources, and cultural services less commonly discussed in the literature, like flour for sourdough baking and long straw for crafts and thatching. Several of the farmers' experiences of agronomic traits of landrace cereals were in line with other experimental results, such as weed suppression (Murphy et al. 2008; Lazzaro et al. 2017), larger root biomass and water retaining ability (Bektas et al. 2016), as well as yield characteristics (Murphy et al. 2008; Konvalina et al. 2010; Diederichsen et al. 2012), while other experiences are yet to be investigated. Landrace cereal cultivation was considered as a way for farmers to develop varieties with agronomic properties suited for their way of farming. Producing varieties adapted for organic systems has long been overlooked in formal plant breeding (Wolfe et al. 2008; van Bueren ET and Myers 2012; Osman et al. 2016). In this light, the farmers in this study regarded landrace cereal cultivation as an alternative, a way for them to take control of the plant breeding and develop locally adapted landrace plants that suited their farming systems.

An important economic motivation was the opportunity for farmers to sell their cereal products through local niche markets for landrace cereal products, where landraces could be sold at advantageous prices. The farmers in the study described the market for landrace cereals as increasing, and several of them had developed business models based on landrace production, similar to what has been observed by farmers keeping native breeds of cattle (Soini et al. 2012; Ovaska and Soini 2017).

Interestingly, when farmers described their motivations for growing landrace cereals, the ideal of developing 'outstandingly organic' and multifunctional farming systems was not just contrasted against conventional agriculture, but also against the so-called 'conventionalised organic farming' (Darnhofer et al. 2009). In such descriptions of the conventionalised versus non-conventionalised organic farming, the properties of the landraces were presented by the farmers as being a more sustainable alternative than the modern varieties that are available for organic farmers. Landrace cereal cultivation was described as more in line with the IFOAM principles, i.e. the principles of Health, Ecology, Fairness and Care (De Wit and Verhoog 2007; IFOAM 2008). In contrast, the farmers positioned organic cereal production with a high reliance on bought nutrients, as conventionalised organic farming (see Darnhofer et al. 2009). Landrace cereal cultivation can in this light be regarded as a counter practice against both conventional or conventionalised farming practises (see Coolsaet 2016). The results of this study indicated that farmers wished to restrict the cultivation of landraces to low-input organic farmers, partly in order to protect their niche market.

These results contributed with perspectives on what motivates farmers in a northern European context to use landrace cereals. The crop characteristics and management practices described by the farmers can be of particular importance when developing plant material and farming systems to meet challenges such as climate change, biodiversity loss, loss of arable land, and reduced availability of effective pesticides. The study showed how different agronomic properties of landrace cereals enabled multifunctional farming practices such as novel intercropping systems, and less intensive weed management, which enabled farmers to cultivate cereals on marginal land. The agronomic properties in combination with increasing market opportunities for landrace cereal products, means that landrace cereal production can potentially generate livelihood opportunities in rural areas with marginal agricultural land, where cereals for human consumption would otherwise not be grown. In addition, utilising marginal land for food production by using crops adapted to these challenging growing conditions can considerably contribute to increased global food security.

Conclusions

This study showed how landrace cereal cultivation in a developed country like Sweden was closely associated with organic farming, and that characteristics for farms using landraces ranged from large to medium sized, and from specialised cereal producers to mixed and livestock-based farms. The farmers' motivation to grow landrace cereals was mainly based on the need for suitable varieties for multifunctional organic farming systems, which was closely interlinked with the farmers' ideals of sustainable farming. Landraces were described by the farmers as having agronomic traits that suit these systems well, although the bulk yields were generally somewhat lower than for modern varieties. The products were sold on an emerging niche market, which provided an important economic motivation. The interest in cultivating landraces can be regarded as a consequence of the lack of modern varieties adapted for low-input organic farming. The experiences of the Swedish farmers in this study illustrated how landrace crops – long believed to be outdated and obsolete – can in fact play an important role in an agroecological approach towards development of more sustainable farming and food systems.

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