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Agrobiodiversity Products in Alternative Food System: Case of Finnish Native Cattle Breeds

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Abstract: Agrobiodiversity products i.e., products from native breeds and plant species can make a valuable contribution to a local food market while also maintaining and preserving ecological and cultural values. There have been attempts to create markets for these products, but they continue to be marginal across the world. Previous research revealed how various stakeholders perceive the native breeds and their products. This study applied a transdisciplinary, multi-actor co-production of knowledge approach that is often used in the food system research. The approach aims at improving the understanding of the ecological, regional and social embeddedness of a Finnish native breed, the Finncattle, and at co-creating feasible supply chains for Finncattle products. The study confirmed that the market does not work and the embeddedness may also constitute some challenges for the development of feasible product chains. The study suggested some practical solutions to overcome these challenges. Furthermore, the results revealed some weaknesses of the co-production of knowledge approach used and discussed possible reasons that can be further explored in future research.

Keywords: native breed; milk chain; meat chain; transdisciplinarity; co-production of knowledge

1. Introduction

The intensification of agriculture with internationally marketed breeds and varieties has led to significant changes in the number of local breeds maintained on farms. One-third of the world's farm animal breeds are endangered, with the proportion still increasing [1,2]. International conventions require the conservation, preservation, and sustainable use of these breeds as a part of biological diversity [3], which is considered important for several reasons: to provide insurance against future changes in production circumstances, to meet future market demands, to provide opportunities for research and rural development, and to preserve ecological, cultural, and historical values, e.g., [4,5]. Ex situ conservation can technically be organized in gene banks, but in situ conservation that takes place in the native territories of breeds, where they have adapted to the environment and where their development can continue, is preferred [5]. The problem is that native breeds are usually low yielding, and their production is consequently not profitable for farmers. In many countries, their production is supported by agri-environmental schemes. However, this is not an economically sustainable option in the long term [6]. The milk and meat product chains for native cattle breeds should therefore be developed as a profitable alternative under market rules.

Supplying products to local food markets is recognized in many countries as a potential means for keeping breeds in profitable production and thereby reducing the likelihood that they will fall out of use and face the risk of extinction [2]. Commoditization should be a deliberate option, as according to many previous studies, native breeds have numerous characteristics that constitute a basis for quality food products [6,7]. These products have many special qualities and Finnish and other European

breeds have been associated with various other values, such as historical, aesthetic, and landscape values [5,8–10]. This suggests the *embeddedness* of the agrobiodiversity products, emphasizing that the social context and environmental aspects of the products provide additional reasons for developing and marketing them as local or regional products [11].

There are already some examples of successful commoditization of local-breed products in different countries, for example Rare Breed Meat Company in the United Kingdom, Iberian Big in Spain, the Reggiana cattle in Italy, Pinzgau cattle meat and milk in Austria, to name a few. In Finland, the Eastern Finncattle meat and dairy products are processed and sold by a few farms or small enterprises and served in high-class restaurants. There also appears to be a consumer segment interested in these products, but general awareness among consumers is limited and not necessarily at all based on accurate information of the breeds and products [12]. Despite having assets for developing special products, some examples of successful commoditization and demand among consumers, the volume of production is not likely to be sufficient to guarantee the future of rare native breeds without subsidies. There is also the question on whether and how the embeddedness actually contributes to these systems, if there are "structural holes" [13] and how they could be better targeted.

Until now, the research has focused on agrobiodiversity products from the point of view of their ecological and socio-cultural value, conservation, or commoditization, for example in the SlowFood movement [7,14,15]. In this paper, we investigate the native breed products as a part of alternative food systems (AFS). We understand AFS as networks of producers, consumers and other actors that embody alternatives to the more standardized industrial mode of food supply [16]. Embeddedness is one of the key issues in AFS research. Yet, research on embeddedness of food chains has often focused on the differences in the role of embeddedness between alternative and conventional food systems, while less research emphasizes the role of the embeddedness within a certain system or chain [17]. Therefore, our first aim is to explore the role of embeddedness of agrobiodiversity products, in our case the Finncattle meat and milk, in alternative food systems. Secondly, based on the results of the situation analysis, we co-create milk and meat chains for these products with an aim to tackle the bottlenecks of the system. Food system research is increasingly based on multi-actor co-creation approaches, but there is limited research or critical assessments on how these processes work in practice. Therefore, our third aim is to assess the pros and cons of the co-creation process.

In the following section, we will introduce our theoretical approach for studying the native breed products in alternative food system framework and the concept of embeddedness as a tool to analyze the current situation and co-creating chains. We will then describe the research process and the results, comprising the problem analysis, and three alternative chains for the native breed products. Finally, we will discuss the results and the methodological implications.

2. Framework for Developing Chains for Finnish Local-Breed Products

2.1. Native Breed Products as Part of Alternative Local Food Systems

Native breed products constitute a natural part of the local food system in some developing countries [1,2,18]. In the western world, they can be seen as a part of the move towards alternative food networks that are considered to include a variety of distribution and/or production practices, such as farmers' markets, Community Supported Agriculture and farm shops, consumer food co-operatives, specialist food retailers, food with a geographical indication of origin. They are often connected to the agro-ecology movement and emerge as a response to globalized and industrialized food systems and chains [16,19–21].

Alternative food systems (AFSs) are based on transparency and trust between the producers and the consumers founded in personal (face-to-face) encounters, and associated with nested markets, markets that emerge from processes of agricultural reterritorialization and from new forms of distribution, which aim not only to reconnect the actors (producers and consumers), but also to establish links between the rural and urban [22]. The reconnection of producers and consumers followed by direct

exchange and accompanied by shared goals and values are associated with the AFSs serving as an asset for products with small volumes [23]. The gastronomical and biodiversity values are combined with a broader selection of (intangible) quality arguments, such as farm and production system characteristics, local environmental, historical and cultural aspects, local distinctiveness, and use of arts and stories [24].

The concept of embeddedness has a role in understanding these AFSs. Embeddedness has been identified as an important element and widely used concept in AFS research for some time [13,17,25–27]. The concept was introduced by economic historian Karl Polanyi, who argued that the functioning of an economy could not be understood disassociated from the social world in which it was embedded and, therefore ultimately, the economy as a whole needs to be understood as parts of larger, historically derived, institutional, or social structures [28]. Thus, the concept of embeddedness helps to describe and explain how different surrounding institutions and contexts interact and may complement or conflict with each other.

In the AFS literature, embeddedness has received a number of different meanings. Yet, as Penker [17] suggests, embeddedness is most often used in food system studies as a concept for analyzing the social ties which modify and shape economic interactions. In principle, the embeddedness research can focus on the networks as a means of conceptualizing economic activity and/or identifying different degrees and qualities of embeddedness. Food-related embeddedness studies have often focused on alternative food chains, such as direct marketing, organic products, or farmers' markets. There, embeddedness is applied to illustrate the significance of trust and regard as well as moral and environmental considerations that go beyond the economic rationality.

Usually, embeddedness research integrates spatial, ecological, and social aspects [17]. Spatial refers to the (re)-localization of the production and products as a counterforce to the global food market or physical proximity of producers and consumers. However, it can also be related to the location-based identity of the products with the global market [29]. Ecological embeddedness in turn refers to re-establishing and highlighting biological processes within food chains. Social aspects are applied to illustrate the significance of trust and regard. These three aspects are only analytical as in real life they are overlapping, as for example a social aspect may concern also ecological aspects [11]. In addition to these dimensions, we also acknowledge the structural and relational aspects of the embeddedness introduced by Mark Granovetter [30] as important: Structural embeddedness covers all the actors involved in the chain, while the relational one informs the quality of these networks including the issues of trust and norms that shape these relations.

Based on previous literature, we argue that agrobiodiversity products integrate all of the three elements of embeddedness: Breeds are "place-based', as they are originally regionally rooted or even named after a region, although they might have later spread to other districts and become even 'national' as a distinction from imported breeds. They contribute directly to the preservation of genetic diversity of farm animals and plants, but also indirectly, for example through the maintenance of traditional pastures and meadows. In this way, they are also strongly ecologically embedded. Finally, due to many characteristics (low number, conservation status) and qualities (e.g., historical and aesthetic value), various values and meanings shape social interaction related to them. Therefore, we argue that the concept of embeddedness could be applied to explore how various stakeholders perceive the potential/current challenges and how the current problems in the food chain could be overcome by taking into account the different aspects of the embeddedness of the products.

2.2. Case of Finncattle in Alternative Food Network

In Finland, the populations of the three Finncattle breeds (Eastern, Western, and Northern Finncattle) comprise around 1% of the all mainstream dairy cattle breeds, and the total number of animals is only a little over 3000. The breeds no longer exist only in their traditional regions, but are distributed across the country. Most of the farms maintaining these breeds have less than five cows of the respective breeds [31], thus, the production is typically very small-scale. In Finland, as in

many other countries, the maintenance of these breeds is currently supported by agri-environmental schemes; farmers who have committed themselves to breeding Finncattle for 5 years receive €530 per livestock unit per year [31].

The milk production of Finncattle cows is low, often less than half of the average annual milk production of Ayrshire and Holstein cows. However, the fat (4.3%) and protein (3.4%) contents are at about the same level as those of other breeds, although Finncattle milk appears to have a higher content of unsaturated fatty acids and kappa casein type B [32]. The milk coagulation ability is also good, and the milk is therefore better for cheese-making than that of mainstream dairy breeds. However, as Finncattle cows are smaller than cows of the mainstream breeds, their meat production is considerably lower. The average live weight of the Finncattle cows is approximately 530 kg, while the Holstein and Ayrshire cows around weigh 100 kg more.

For example, in the case of Finnish native cattle breeds, there is evidence that the quality of milk for cheese-making is better than that of mainstream breeds (Holstein–Friesian, Ayrshire). The proportional yield of cheese and meat is higher than that of mainstream breeds [33], and there are also indications that the milk and meat include some constituents that are beneficial for health [34]. In addition to this evidence-based knowledge, there is also experiential knowledge of the quality traits of the milk and meat: chefs appreciate the taste and the quality of meat from native breeds in cooking. It has also been observed that many people who cannot drink processed milk are able to digest raw milk from local breeds.

The Finnish farmers have a variety of reasons for keeping the local breeds. For many farmers, the motivations are related to traditions and to ethical or even aesthetic reasons [8,35]. Currently, most Finncattle cows are reared among other cow breeds and Finncattle milk is not therefore separated for processing. Only a few milk producers actively process milk products under their own Finncattle brand name. Some Finncattle cheeses are available from specialty stores, but Finncattle meat can very rarely be found in shops or retail stores.

Overall, the development of food chains for native breed products in Finland represents a complex challenge involving economic, social, and cultural aspects as well as a wide range of actors and institutions, such as farmers, consumers, the market, and the food industry, as well as laws and regulations similar to many local food systems [23,24]. Top-down and expert-driven approaches are not necessarily able to provide solutions and alternative approaches are needed.

3. Methods

In order to analyze the embeddedness of the Finncattle product chains, we applied transdisciplinary co-creation approach. It can be divided, in principle, into three distinct process phases [36,37]: (i) problem identification and structuring, (ii) the co-creation of solution-oriented and transferable knowledge, and (iii) integration and application i.e., the implementation of the results into social and scientific practice. The process is aimed to be a continuous exchange of knowledge among the participating researchers and together with the stakeholders. In this process, the role of the scientists is to apply appropriate interdisciplinary approaches in order to ensure the consistency of the research process across the participating stakeholder groups and viewpoints and also deal with questions of uncertainty in the results. Stakeholders may have very different roles in the process, ranging from one-way communication to consultation, collaboration and empowerment. The dialogue between stakeholders and scientists aims to ensure the exchange and interaction of their respective knowledge and, thereby, the societal relevance of the research [38].

Given the overall idea of embeddedness resulting from social ties, and regional and ecological aspects, it was necessary to work on regional cases. In order to select these cases, we mapped farms breeding native cattle, small cheese-making companies, slaughterhouses, small meat processing firms, and public farms, such as agricultural school farms or prison farms, that maintain larger numbers of Finncattle. These school farms act as in situ conservation farms for local breeds and often operate as local promotors of the Finncattle and have existing networks of local actors. Based on this

mapping, we identified Pirkanmaa and Kainuu regions as nodes for developing local breed markets. The regional workshops were complemented with consumer workshops in the Metropolitan region to engage those consumers who are the most potential users of the native breed products. Because restaurants were perceived as important end-users of Finncattle products in regional workshops but were underrepresented in these regions, the perceptions of the HoReCa (hotel, restaurant and café) sector were collected at a trade fair for the restaurant sector in a later phase. The process for the co-production of knowledge and data collected is presented in Table 1.

Table 1. Co-production of knowledge in workshops.

Workshop	Phase of Co-Production of Knowledge	Participants
Expert workshop (national level)	Problem identification and structuring on national level based on previous R&D projects	6 researchers and other experts
Pirkanmaa I (regional level)	Problem identification and structuring	26 participants: farmers, processors, advisory organization, school farm, consumers
Pirkanmaa II (regional level)	Solution development	14 participants: farmers, processors, and Internet retailer school farm
Kainuu (regional level)	Problem identification and structuring and solution development	7 participants: farming school, farmers, processor, breeding and advisory organizations
Consumers groups from I–XI (local level)	Problem identification and structuring and solution development	8–10 consumers in each group: ordinary consumers and consumers buying from farms, online grocery shops or via local purchase groups
HoReCa event (national level)	Problem identification and structuring and solution development	3 producers, approximately 100–200 representatives of HoReCa sector
Seminar for administration and participated actors (regional level)	Integration and application	20 participants
Final meeting (national level)	Integration and application:	9 participants from Ministry of Agriculture and Forestry and advisory and research organizations

3.1. Problem Identification and Structuring

For problem identification and structuring, we conducted an interdisciplinary situation analysis in a national-level expert workshop based on the results of various R&D projects dealing with native breeds from different perspectives, geographical regions, and societal contexts [10,12,39]. Research close to the topic of producing, processing, marketing, and consuming local and special food (organic milk and meadow meat) was complemented with the knowledge of local food systems, special products and consumer studies for identifying the problem content. Based on this knowledge, we defined situational descriptions for the different phases of the supply chains: Production, processing, trade/marketing, and consumption. This analysis operated as starting point in the workshops for building a shared perception of the current situation in the field.

In the first workshops in Pirkanmaa and in Kainuu, the problem analysis was discussed in small groups from the local perspective to explore the current situation and to identify the development needs for the product chain. The discussions were summarized by the researches by identifying the economic challenges of competing with the mainstream breeds. The further arguments to support the native breeds were organized by using the embeddedness, environmental, social, and regional dimensions. These arguments provided the foundation for searching the product chains that would solve the observed challenges.

3.2. From Problems To Searching For Solutions

In the second Pirkanmaa workshop and in the Kainuu workshop, the discussion continued towards solutions. The focus of the discussions was on illustrating milk and meat chains and identifying the links of the chain between farmers, processors, and consumers. The solutions for a functioning chain were sought. To activate possible ideas for the commoditization and further development of the chain, we provided some examples of solutions, such as enhancing hobby cattle, public cattle, and larger farms, direct sales, such as selling milk from vending machines on farms, selling products in online

shops, branding native cattle, and creating temporary pop-up restaurants. The discussion was led towards financial aspects: What were the references for defining the price of native cattle products, how much would a processor be willing to pay to farmers, and how much did farmers expect to receive for their products?

In the consumer group discussions, the solutions were outlined based on consumer interest, possible use situations, packaging, and expectations related to buying. The special characteristics of the Finncattle and possible marketing arguments were discussed as well as expectations regarding the Finncattle farms. The willingness to use alternative forms of purchase (directly from farms, REKO circles (*REjäl KOnsumption,* meaning *fair consumption)*, online shops) were discussed. The possible prices of the Finncattle products and willingness to pay were elicited with a mini survey. The suitability of the products for restaurants as well as willingness to buy them in their original regions were discussed.

3.3. Integration and Application

To evaluate the possibilities to implement the results into practice, the input from the local case groups and consumer focus groups as well as the experiences from meetings with the HoReCa sector were combined to create model chains for the Finncattle sector. Although Finncattle breeds have traditionally been breeds for milk production, many farms also specialize in meat production currently. For this reason, we identified possible chains for both milk and meat production, but also sought possible links between these two chains. These models, which collected information on the possible solutions and problems in the links between actors, were tested in a seminar gathering actors from both case regions and other parts of the country as well as from the administration and the advisory organizations. The alternative product chains were presented and further discussed, analyzed and developed together with the participants.

The final meeting, focusing on integration and application, was held to sum up the national perspective and to obtain feedback from national organizations. In this meeting, representatives of the Finnish Ministry of Agriculture, the farmers' association and the advisory organization were presented the problems in developing the chains, and possible governance solutions were deliberated.

In the following section, we will present the results from all three phases of the process.

4. Results

4.1. Problem Identification and Structuring

In the first phase of the co-creation of knowledge process, common understanding on the current situation in the native food chain, including production, processing, trading, and marketing phases, was created. The situation analysis revealed several economic constraints perceived by the actors in the chain. In the production phase, the low economic profitability of production due to the lower yield of the Finncattle was the key obstacle. The produced volumes were recognized as too small for processing products on farm or even on regional level. Moreover, the volumes tended to vary and be regionally varied. Partly due to low yields, the farms were not willing to grow their production. Some farmers aimed at solving the problem with alternative market channels, but the work load related to them was considered high. Part of the products faced low demand, for example male calves. Also for the processing phase, the critical aspect was the low scale of primary production and geographically scattered farms. This led e.g., to high milk transportation costs. In addition, uncertainty over the availability of milk was seen as a problem from the dairy perspective. Processors also perceived the financing for the development of new products being a challenge and observed difficulty in entering to the markets as trading companies do not buy directly from small entrepreneurs or slaughtering companies, partly due to low and insecure volumes.

Thus, there were several economic constrains for the market. The ecological, social, and regional embeddedness were used to analyze the arguments of different stakeholders in the chain. Besides these three dimensions of embeddedness, we also discerned institutional embeddedness that refers to

institutional and economic arrangements beyond open market around the current production systems. We classified the aspects of embeddedness based on them being perceived positive i.e., opportunities or being negative i.e., challenges (Table 2).

Table 2. Situation analysis for Finncattle product chain by experts and stakeholder workshops organized with dimensions of embeddedness.

	Ecological Dimensions	Social Dimensions	Local, Regional and National Dimensions	Institutional Dimensions
Positive aspects *From production* ↓ *to consumption*	Characteristics and versatility of animals Good grazing characteristics Possibility to distinguish from industrial products New knowledge of breeds and their qualities Consumers interested in health benefits and 'naturalness' of products Positive image of small-scale production Consumers interest in alternative forms of production	Producers' commitment Existing and increasing interest for collaboration and examples Direct selling as way to control market Informal channels in communication and marketing (social media, personal contacts) Pioneers in field spread knowledge New channels for marketing and delivery of products Positive image of breeds Existing consumer segment interested in products Knowledge increases willingness to pay Ethical aspects of consumption (animal welfare) Consumers interest in alternative forms of consumption	Foreign examples of regional products School and prison farms may serve as regional nodes for processing and marketing Cultural and historical values as means to increase awareness Considered as Finnish, pure and original, part of national identity Emotions and stories with regional focus as basis of marketing Consumers interest in local food Local restaurants are interested and some already use the products	Native breeds included in agri-environmental support
Negative aspects *From production* ↓ *to consumption*	Quality of milk and meat varies Multipurposeness of breeds: quality of meat is weaker compared to pure meat breeds Half of young ones are calves with low demand Processing industry does not always appreciate quality of milk and meat Restaurants interested in only some parts of animals Consumers' lack of awareness of breeds Research knowledge of product quality is lacking Concern for low number of animals How to differentiate from organic production	Producers' different aims, interests and values Lack of collaboration Product design and marketing takes time and money, cost sharing unclear Lack of knowledge in processing, marketing and of consumer expectations On-farm selling is time-consuming Lack of dedicated professionals in meat processing Products considered as elitist and expensive Consumers do not easily change their consumption behaviour Quality information is not sufficient for consumers	Scattered production Breeds have lost part of their regional image Due to low volumes, logistics is based only on frozen meat	Rigidity of agri-environmental support system Lack of models for agreements among producers and between producers and processing companies Hegemony of slaughtering sector: no demand for small animals or volumes Strict new regulation regarding processing, delivery and product information

In the ecological dimension, positive and negative arguments were rather balanced. The positive side related to the characteristics and versatility of breeds that enabled distinction from industrial products. Also, small scale production was perceived to provide a positive image. However, the same arguments could also be considered negative as the multi-purposeness and versatility of animals inside the breeds led to challenges in product quality. The quality arguments were not scientifically proven, which led to difficulties in differentiating the products from other specialty products, such as organic or local products.

The social dimension of the embeddedness showed several opportunities. Although the number of the producers was relatively low, they were usually highly committed but also diverse: some of them were more interested in production and breeding, others in processing and marketing. There was already some collaboration between farmers and also between farmers and processing companies.

The increasing knowledge on the quality of milk and meat was considered as beneficial in the processing phase. The strong pioneers in the field were observed examples in informal networks. The wide range of consumers interested in alternative food chains was perceived to exist and it was therefore assumed that there exists a consumer segment interested in native breed products. Consumer interest in health-related and "natural and authentic" products were expected to support the demand for native breed products. The increasing information was foreseen to have a positive effect on the willingness of consumers to pay for the products.

The social dimension of embeddedness did not self-evidently contain only positive sides. The aims, interests, and values of the producers were found to differ leading to a lack of collaboration. This also related to the difficulty in sharing the costs of product design and marketing. Although alternative channels were seen as opportunities, on-farm selling was perceived as a binding and time-consuming activity. The main challenges in the retail trade were associated with the lack of awareness among consumers: As native breeds, their position and quality are not familiar to consumers, it takes time and effort to introduce them to the general public. Expectation was that in real life consumers do not easily change their food consumption behaviour and routines, and new information is not sufficient alone to raise their interest.

The regionality of the products provided mostly positive aspects for the chain development. School and prison farms, which are in situ gene banks, were seen to act as regional nodes for the production, processing, and selling of the products. The regional history of native breeds was perceived to offer a good basis for building stories around the products. Local food was expected to be a trend that is also strong in the restaurant sector.

Institutional dimensions were perceived more challenges than opportunities. Although agri-environmental support was considered as a possibility, it was considered insufficient, and the support system itself was seen as rigid and bureaucratic. For small producers, new demands in the regulations concerning product information was seen as restrictive.

4.2. Possible Solutions: Product Chains

In the second phase of the co-production process, food chains for milk, and meat products based on the situation analysis were constructed in the workshops together with the actors. Information from the consumer workshops and the HoReCa sector was integrated into these chains (Figure 1; Figure 2).

4.2.1. Milk Chain

In the regional workshops, four alternative supply chains for Finncattle milk and milk products were identified (Figure 1). The first identified option was to sell raw milk directly from the farm, e.g., by using a self-service milk vending machine. Other direct sales options were also discussed, but the producers pointed out that implementing these alternatives in the milk chain would require a change in food safety regulations, as currently it is not possible to transport unprocessed milk from a farm for sale. In the direct sales option, the consumer workshops pointed out that the characteristics of farms are important, as clients visit them. The key characteristics and expectations for Finncattle milk production should be taken into consideration in the primary production stage and marketing. For consumers, the production was expected to resemble organic production, including a high level of animal and producer welfare. Furthermore, the milk production was anticipated to maintain a traditional agricultural landscape.

The second option for a milk chain was that, instead of selling raw Finncattle milk to consumers, the producers could also create added value by processing the milk themselves. There are some examples of farms producing Finncattle cheese. However, the development of these small cheese-makers was considered a demanding process of trial and error. An easier option for on-farm processed products could be ice cream which is a less demanding way of starting on-farm processing.

The third proposed option to organize the chain was through close co-operation between a farmer and a local processor specialized in the processing of Finncattle milk products. The discussion also

led to an initiative from the farmers' side that focused on the co-operation of actors in the chain to form a co-operative. In the workshops, this idea of collaboration in milk collection from farms and optimizing milk deliveries was further processed and alternatives for ownership of the logistics chain were sought. The researchers helped in building the local networks by providing information on the possible milk providers and also the processors of milk in the area.

As identified in the workshops, the final end-users of local milk products can, in addition to consumers, be local restaurants. Direct sales to restaurants could provide an excellent strategy for developing seasonal Finncattle products. Participation in the Gastro Helsinki Fair raised promising expectations for producers for achieving and opening marketing channels directly to local restaurants. Increasing interest in the HoReCa sector was expressed in direct purchases of milk products from producers to restaurants.

Co-operation was also anticipated in marketing efforts that could be undertaken not only in collaboration with other Finncattle actors, but more broadly in collaboration with producers of other local or marginal products, such as lamb meat or other Nordic quality products. However, in marketing and branding, the need for well-established co-operation was recognized.

The fourth and final proposed option was the current practice of many farms: to mix the stream of Finncattle milk with the conventional milk supply chain. One very common belief among primary producers was that their cattle herd included rather few Finncattle cows, and it was not worth selling their milk separately. Furthermore, many regions lack a collector and processor of Finncattle milk. As the current conventional milk supply chain in Finland is highly concentrated with two of the milk processors collecting over 90% of milk offered for processing, it was considered too challenging to fight for new ways if no natural prerequisites exist.

4.2.2. Meat Chain

The elicited pathways for Finncattle meat based on the problem analysis in the co-production process are presented in Figure 2. The discussion concerning the operation of farms in meat production raised some solvable issues. Many farms producing Finncattle meat operate as independent units focused on breeding their own cattle. In milk production, male calves form a challenge as a side product of milk production, and co-operation between these two production lines could thus benefit the sector. However, established modes of co-operation, such as a calf market for native breeds, do not exist. Although some farms have utilized the young bulls of other large milk production farms, such as school farms, in the case areas, more established relationships for co-operation could benefit both farm types.

In the discussions with consumer groups, expectations regarding the farms were expressed. Similar to the milk chain, the production of Finncattle meat was typically expected to be organic, and animal welfare issues were expected to be in focus on the farms. Free pasturage of cattle was anticipated. If the products were sold from the farm, other activities and services, such as an attractive landscape and opportunities to see the animals, were also expected. The co-production process emphasized the importance of defining the focus of production on farms and developing the farm as a tool for consumer marketing.

The main challenge in the me at production chain from the producers' perspective appeared to be the scarcity of slaughter services. In many cases, slaughterhouses specializing in native breeds were not available. The regulations for the slaughtering process prevent the slaughter of animals on farms if the meat is intended to be sold out. Thus, many producers were forced to send their animals for slaughter over long distances, which affects the meat quality, a key issue in producing Finncattle meat. The process of co-production also encouraged the producers to initiate co-operation to find solutions for the slaughtering problem. In the process, links were also established between farmers and small meat processors.

From the producers' perspective, reaching consumers directly without shops, as an intermediary that would take part of the price premium, was considered very important. Some farms sold their meat

products directly from the farm but, from the consumers' perspective, this was only considered to be feasible close to city centres or main roads. The co-production process brought out the possibilities of close-food circles where orders are initially made to farmers online and purchases are completed in face-to-face contact (REKO). Some of the farmers had positive experiences of using the REKO circles and recounted them in the co-production process.

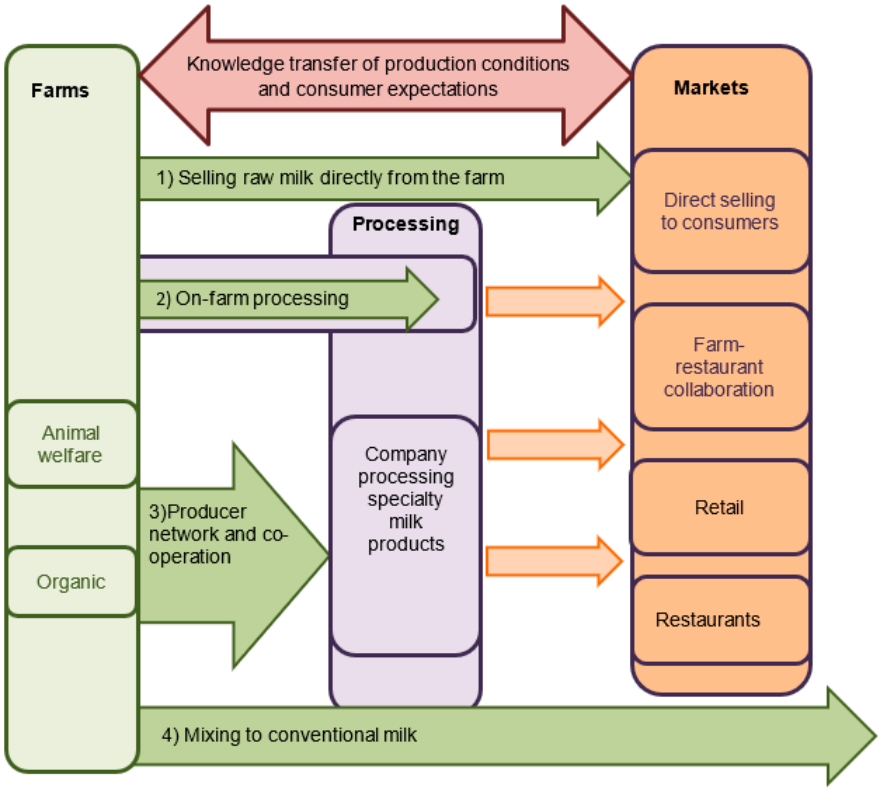

Figure 1. Identified milk chains.

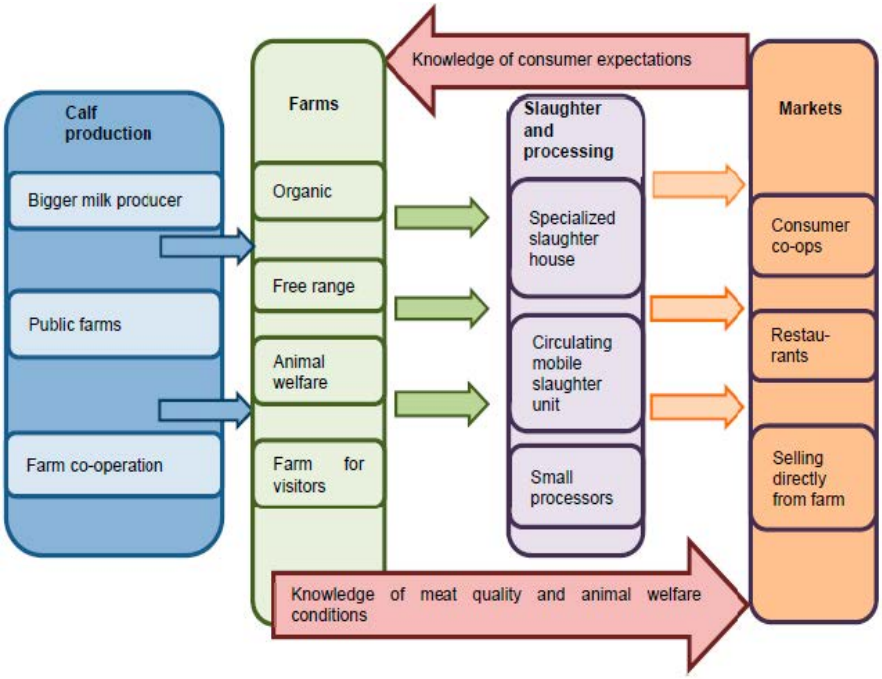

Figure 2. The identified meat chains.

The process also encouraged meat producers to directly contact fine-dining restaurants to offer their meat. Especially those restaurants focusing on Finnish cuisine were considered promising. However, a clear indication from the restaurants was that the price also needs to be competitive and the quality consistently high.

In the focus group discussions, the appropriate price of Finncattle meat was discussed and reference levels for the price were sought. The producers considered the appropriate price that would cover the expenses to be close to the price of organic products. From the consumer perspective, 98% of the consumers participating in the workshops were willing to buy these products. Of those, 81% were willing to buy in average 30% more. Yet, the focus group discussions clearly indicated that, for consumers, the endangered status of the breed was not a sufficient reason for buying a Finncattle product, rather the opposite: Some consumers thought that the breeds were too rare to be consumed [40].

4.2.3. Integration and Application — Bringing Results into Social and Scientific Practice

In the national seminar and group of national experts, the findings from local workshops, consumer focus groups, and HoReCa interaction were introduced in the form of two models designed and presented above. The seminar confirmed many of the findings: The consumer side of the chain was not seen as a problem, as there appears to be a segment willing to buy native cattle breed products, even though it was acknowledged that consumers need more information about the Finncattle. Information campaigns that highlight the multiple qualities of the products could be used to promote the logic of eating endangered animals to guarantee their conservation.

The main challenges seem to be in the production and delivery of the products. The importance of co-operation between producers in all phases of the food chain was emphasized. It was perceived especially crucial in organizing milk collection from small farms that are scattered around the country. The small proportion of the Finncattle among the livestock on farms was also seen as a factor increasing the costs of production and ultimately the price of products. Here, the key question that emerged in the discussion during the second phase of the project was the ownership of the co-operation: Who should take the lead? There is already an association related to the Finncattle, but it focuses more on breeding issues than on products and marketing. There are also other examples of co-operation between special meat producers (Highland cattle, Angus beef, Finnsheep), but so far the Finncattle farmers seem to have worked rather independently.

The national seminar also confirmed that, in the meat chain, open, trustworthy, and ethical meat production is especially important. The comments from the other Finnish areas brought out some examples of small slaughterhouses that emphasize the animal welfare and thus good meat quality, encouraging the co-operation of producers to organize the slaughtering process. The possibility of mobile slaughter units was considered as promising, as a producer of the equipment exists in Finland and examples of its use in reindeer slaughter are available. However, it was seen that new technical solutions are needed to organize the monitoring of slaughtering in such a way that unnecessary bureaucracy is avoided.

5. Discussion

5.1. Multiple Faces of Embeddedness in Developing Agrobiodiversity Food Systems

Embeddedness has been considered a key element in the development of alternative, bottom-up food systems. Locality, face-to-face encountering between producers and consumers leading to trust and regard and environmental values as elements of embeddedness are often perceived as a resource. We assumed that embeddedness could explain the current situation of the native breed markets and provide support for the evolution of these food chains. Our analysis on Finncattle revealed that embeddedness really matters: We found that there are number of spatial, social, ecological, and also institutional aspects that create a potential. In particular, consumers and restaurants were interested in

products produced at small scale, close to nature, reflecting the regional characteristics and history, mostly to be used as special products. Short supply chains or alternatively place-based stories linked to the product and producers would build trust and regard among the consumers.

Yet, the analyses of embeddedness of the system also revealed that there were some constrains and characteristics of the current situation, implying that the market does not function well. As for the scale and volume of production, the most critical point in dairy production was the small volume of milk produced combined with the geographically scattered production leading to special challenges in the collection of raw milk. These challenges could be solved by short chains and a low level of processing (e.g., ice cream). Products with a higher level of processing (e.g., cheese) require bigger volumes and, consequently, either larger production units or collaboration with milk producers and dairies.

In meat production, the major opportunities were linked to possibilities for direct sales from breeders to consumers or from farms to restaurants. Fueled by the research process, one proposed solution was setting up a new form of a short supply chain, i.e., an interlinked producer-slaughterhouse-restaurant chain. A solution could be co-operation in organizing small-scale slaughtering and enabling mobile small-scale slaughterhouses to reduce the length of animal transportation and to improve the quality of meat. The prerequisite is that food safety regulations should allow these types of developments in slaughtering.

Our conclusion is that the embeddedness is certainly an important factor in building alternative food networks, but a special attention needs also to be paid to the constrains that may relate e.g., to the localization, "structural holes" in the chains, such as organizing the gathering and processing, and small volumes that in our cases showed to be bottlenecks in developing processed products, or environmental aspects, such as rarity of the breed that may prevent consumers from eating its meat. In the social side, collaboration among Finncattle breeders is low which may result from the long geographical distances between farms and the small numbers of Finncattle. It appeared that many farmers identified themselves as sole producers with no experiences of working with other farmers or actors of the food chain. This may additionally be due to differences in breeding motivations and practices (see also [38]); some of the farmers had adopted a business-oriented attitude and were interested in networking and commoditization, and some had chosen to adopt conventional production excluding any commercial activities, some of the farmers are winding down their farm business or keeping the animals only as a hobby. It was also unclear who should take the lead in the co-operation and who should be responsible for enhancing it. Following Granovetter [29], we suggest that both structural and relational embeddedness play a role.

The results confirmed the previous knowledge that consumers have no or at least a very limited knowledge of Finncattle and their special characteristics. The results also demonstrated that consumers understand and accept the higher price of these products and link the price to the small populations of Finncattle. The consumers showed willingness to keep these products as luxury goods and tended to attach various meanings and stories to the products and to favour purchasing them in special places. A more comprehensive marketing strategy needs to be built for local-breed products that would take into account all of the aspects of marketing as well as consumer expectations. This, again, requires collaboration between the farmers and other actors in the chain to promote these efforts.

5.2. Co- Production as Means to Understand and Develop Feasible Food Chains

Despite the increasing popularity of the transdisciplinary co-production approach in solution-oriented sustainability research, many studies have also reported numerous challenges related to it [36]. In our case, we also experienced some of these. First, there was the challenge related to the commitment of the stakeholders in the process, particularly the consumers. The workshops were originally planned to be truly multi-stakeholder and we invited participants from all stakeholder groups. Overall, we observed difficulties in finding stakeholders to participate in the workshops and follow the process throughout the project. The farmers and the developing organizations were the most strongly represented, while we lacked consumers' participation. Later on, the workshops

exclusively involving consumers revealed very low awareness of native cattle and their products, which might also explain the lack of commitment to the topic. Considering the whole production chain, some of the participants might have been interested in or felt ownership in some of the phases, but were not interested in developing the entire chain. Referring to the feeling of ownership and lack of collaboration between the producers, we also felt that considerable expectations were addressed to the researchers as coordinators of the project: The researchers were expected to take the lead in organizing the collaboration. Perhaps this was a result of the mixed roles of the researchers as "reflective observers, knowledge brokers, facilitators, and change makers" [41].

Secondly, from the project management and co-ordination point of view, the challenge was also related to time constrains. The project lasted only for one year. It became evident that researchers and practitioners would have needed more time and resources to become rooted in the research area, to get to know the actors and discuss with them, and to build trust. We would have organized more workshops but, realizing the difficulties in getting enough stakeholders to participate in them, we did not find this feasible. Here, alternative forms and forums, such as social media, could have been used as arenas for co-producing knowledge of the situation and solutions.

Thirdly, there were also challenges related to the application and implementation of the results. On one hand, the results confirmed many of the same observations that also concern other local or high value products, such as the problems of small volumes, special qualities, and high costs. Also, as there were no owners of the issue, there is a danger that the results of the projects will not be utilized by the stakeholders, but may remain the property of the financer (the Finnish Ministry of Agriculture) and the research community. In other words, the social impact might not reach the extent that was expected.

On the other hand, the project acted as a platform for creating new relationships and learning, which may lead to local activities in the long term. Even during the project's life-span, some of the participants gathered together independently in order to enhance collaboration. The farmers also suggested a new form of producer and marketing co-operation for developing production and marketing the final products to the end-users. Nonetheless, despite the many challenges, we felt that the idea of transdisciplinarity, bringing different disciplines and social knowledge together in order to solve a practical problem, was fruitful. We could argue that none of the disciplines involved, nor the researchers alone, could have developed such a multifaceted understanding of the phenomena.

6. Conclusions

Diverse information exists from the previous research on the perceptions of actors in native breed production chains, but previous scientific knowledge and policy have not been able to stop the decline of the breeds and promote the trade's growth. This study applied a co-production of knowledge approach aimed at solving the conservation of native Finncattle breeds by developing feasible chains for the supply of products from native breeds to nested markets. Like many previous studies, this study identified the diversity of characteristics of native breeds that constitute a basis for special food products. Furthermore, in the transdisciplinary process, we succeeded, together with the actors of the chain, in developing model chains for meat and milk products. Although the chains developed included some conventional alternatives, they displayed many new options to deliver the products more directly from producers to consumers. In these direct chains, information on the special characteristics of the products could be conveyed from producers to consumers and the information needs of consumers could also be brought to producers.

The co-production of knowledge succeeded in creating a consensus on the current situation, in delivering ideas and also in creating new contacts between the actors. Despite the active participation of stakeholders in the process, taking an active role in building the co-operation was not easy for participants. This shows the lack of social capital in the field, but it also challenges the methods of co-production of knowledge and suggests even tighter and publicly resourced support for the field. All in all, the steps towards self-sustainability of native breeds presented in this study are necessary to enable conservation through the active use of the native breeds.

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