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linked to the 20th Organic World Congress of IFOAM 2021

Organic Animal Husbandry systems – Ways to improvement

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[1] CORE Organic Cofund is a collaboration between 26 partners in 19 countries/regions on initiating transnational research projects in the area of organic food and farming. CORE Organic Cofund has initiated 12 research projects. Read more at the CORE Organic Cofund website: http://projects.au.dk/coreorganiccofund/

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Introduction

Otto Schmid, IAHA Chair

It is a great honour to open this Pre-Conference on behalf of the IAHA, the IFOAM Animal Husbandry Alliance (IAHA), who is organising this conference in collaboration with FiBL Switzerland, ITAB France, INRA France, several EU Core Organic projects, GoodEarthGreatFood from New Zealand, IFOAM – Organics International and ICROFS in Denmark. This Pre-Conference is linked to IFOAM Organic World Congress (OWC) 2021.

The main theme of the conference is "Organic Animal Husbandry systems – Ways to improvement". The organizers have taken into account the diversity of organic and sustainable animal husbandry systems. Special sessions are offered about improving organic cattle systems; sustainable livestock rearing and breeding systems; product and process quality; animal health management and the use of bioactive medicinal plants; sustainable rearing and breeding systems for pigs; and finally the future of animal husbandry. In small thematic workshops recommendations for development and research are discussed and will be presented in a stakeholder session at the Organic World Congress.

The Pre-Conference has been organised with project coordinators of five European Union CORE ORGANIC livestock research projects and other EU funded organic projects. This conference offers a platform to present their preliminary research results.

Due to the Corona Situation, not all contributors can physically come to Rennes, therefore we organize the Pre-Conference in a hybrid form, which is a technical and organisational challenge.

The IFOAM Animal Husbandry Alliance is an informal network of individuals and organizations interested in strengthening the development of organic animal husbandry around the world. IAHA was founded during the 2nd IFOAM Animal Husbandry Conference, September 2012, in Hamburg. IAHA is supported by the IFOAM World Board and Secretariat in Bonn. In the past the main activity of IAHA was to organize a pre-conference linked to the IFOAM Organic World Congresses, in 2014 in Istanbul and in 2017 in India. In 2020 a physical pre-conference should have taken place in September 2020 in Rennes, but it was postponed by one year due to the Covid19 pandemic. However, IAHA conducted a video-conference on 21. and 22. September 2021, which was very successful. . The proceedings can be downloaded from organic e-prints or the IAHA Website.

This very rich and diverse programme was only possible thanks to a strong engagement of the organising committee (Otto Schmid, Marion Johnson, Mette Vaarst, Barbara Früh, Chris Atkinson, Muazzez Cömert Acar, Mahesh Chander and Antoine Roinsard) and the support of the IAHA Steering Group. We very much acknowledge the support by members of the Scientific Advisory Board, which helped to review the papers (see list of members on page 5).

A special thanks go to Jessica Gearing, who did the English language check at FiBL and Stefanie Leu from FiBL for the registration, Bettina Billmann for the IAHA newsletters and Alijca Klaus from IFOAM international office in Bonn for the website support, and Janne Krabsen from ICROFS for backup-help with the proceedings. A big thank you to all the presenters for providing interesting papers.

Furthermore, we want to thank the IFOAM – Organics International (Ececutive Director Louise Luttikholt, Thomas Cierpka) and FiBL in Switzerland (Directors: Knut Schmidtke, Marc Schärer und Lucius Tamm) for their support

Contributed papers

Session 3: Sustainable livestock rearing and breeding systems

Session 4: Animal health management and use of bioactive medicinal plants and other alternative therapeutics

Session 5: Sustainable livestock rearing and breeding systems for pigs

Options and challenges for certified organic milk production in east African mixed smallholder farms

Gidi Smolders[1], Mette Vaarst[2], Raphael Wahome[3], Charles Odhong[3], Muhammad Kiggundu[4], Fred Kabi[4], Sylvia Nalubwama[5], Niels Halberg[6,]

Keywords: Crop-animal integration, Organic, Smallholder, East Africa, Dairy cattle

Abstract

Many East African smallholder farms with certified organic crop production also keep animals, but there is often very little integration and synergy between the different crops and animals. Based on data from three studies of dairy production at Kenyan and Ugandan farms with certified organic cash crops and non-certified organic dairy cows, different development scenarios and farm models for organic milk production are presented, which answer the following questions:

1) *Can smallholder farmers benefit from keeping certified organic dairy cattle, and when can it be viable, given the current challenges?*
2) *How can the dairy production be integrated into the farm and create synergy with the different farm elements?*
3) *Which changes in feed and management would be required to certify their milk production?*

Results indicate that there are good possibilities for more local recirculation of feed and manure. However, benefits are limited when there are only a few animals with short lactations on the farm. Improved management, including animal feeding, could be profitable, although many identified challenges should be overcome. The involvement of local communities in feed production and grazing areas seems to be a good option for mutual benefit. If certified organic smallholder farms diversified their income by selling organic milk, they would need a secure market. Depending on the cost of certification, these farms will only benefit from the sale of organic milk if they can produce milk year-round at a scale that balances the efforts and changes they need to make to comply with organic standards. More robust breeds than Holstein Friesian types of cows are needed to allow animals to graze in some areas. In addition, many smallholders do not have sufficient land to permit grazing around their homesteads, where the animals live.

Organic standards regarding animals need improvement and to be made more precise, especially requirements for grazing areas and feed. Certification comprising whole farms, including the animals, and not only crops for export, will enhance crop-animal integration.

Introduction

East Africa organic farming focuses on plant production. Dairy animals have been ignored as a fundamental part of organic farming, concerning the potential synergies with plant production and the opportunity to sell certified organic animal products. Animals and plant production ‘co-exist’, but nutrient recycling is not developed. Farmers produce milk for the family and sell

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small amounts at local markets. This informal sector could be an opportunity for quality, certified organic milk. This article explores whether livestock integration into organic farming systems can create beneficial opportunities and synergies for farmers. Can by-products from crops be quality feed for the animals? Can cows be integrated with organic cash crops to enhance nutrient cycling within the farm and between marginal lands and homesteads? Can certified organic livestock products be marketed for a more diversified income generation?

Material and methods

This article is based on studies in the project 'Productivity and Growth in Organic Value-Chains' (ProGrOV) in Kenya and Uganda, which focused on certified organic cash crop farms with non-certified dairy cows. The studies are linked to farming systems and the value chain approach (Kiggundu & Kabi, 2019; Nalubwama et al., 2014; Odhong, 2014). Table 1 describes the current situations in the two farming systems, supplemented with other literature sources based on data from these studies.

Table 1. Information on two selected dairy farms from Kenya (Odhong, 2014) and Uganda (Kiggundu et al., 2014)

	Kenyan case (1 Euro=124 KES)	Uganda case (1 Euro=4396 Ush)
Location of study sites	Kajiado, Kiambu and Kikuyu); 55 farms with certified organic crop / vegetable prod. and commercial milk prod.	Luwero and Kayunga; 30 farms with certified organic pineapple prod. and cows, mainly for own milk consumption
Farming system	Zero-grazing with Holstein Friesian cattle (450 kg body weight); commercial milk markets	Zero-grazing with local short horn zebu or crossbred cows (350 kg body weight).
Land total	8.2 acres, of which 0.8 acres for compound and cow house	7.4 acres of which 1.2 for homestead and animals, 2.6 acres for pineapples.
Dairy cattle	Estimated 2 cows in milk + young stock*	
Av milk yield: kg/cow/day	7	5
Lactation length, days	240	150
Calving interval, days	420	420
Age at first calving, mos	33	33
Mortality till 1st calving, %	20	20
Hired labour, euro/mos	32	34
Veterinary costs, euro/mos	17	29
Breeding costs, euro/cow/y	10	11
Sold animals, euro/y	733**	190***
Estimate organic production	Bonus for milk certified organic: +25%	
	Extra feed cost for organic feed: +15%	

*) In the Kenyan case, 2 cows in milk at all times was realistic; at the Ugandan farms, the average number of cows was smaller, but we decided to carry through a case where there would always be milk available from the herd. **) Estimated 0.4 cow, 0.8 heifer calf, and 1.2 bull calf (assuming that all calves survive the milk period of 3 months. ***) Estimated 0.7 cow, 1.3 heifer calf and 1.9 bull calf per year from the herd, assuming that all calves survive the suckling period of 3 months.

The farming system models used here are based on the studies mentioned above, including cross-sectional questionnaires, semi-structured surveys of smallholder farms with animals and certified organic crop enterprises, and a longitudinal study of the dairy production on organic farms (Odhong, 2014). In addition, feeding trials with pineapple residuals as silage or fresh feed were performed on smallholder farms in Uganda (Kiggundu & Kabi 2019; Kiggundu et al., 2014). The cross-sectional studies (Odhong et al., 2015, Nalubwama et al., 2016) included 55 (Kenya) and 90 (Uganda) farms. Detailed longitudinal studies comprised 24 (33 cows, milk recordings 8 months) respectively 30 farms (44 cows, milk recorded 12 months, limited suckling of calves).

In the studied farming systems, both in Kenya and Uganda, nutrient cycling between plant and animals were lacking. In Kenya, more commercial dairy farms depend on animal feed on other farms, because they lack land to grow feed on the own farm. Farms have limited acreage compared to animal numbers and don't grow feed themselves. The majority of the cattle feed was purchased, and less than half of the farmers used manure on their fields. In Uganda, cattle were kept in a tethering system under a tree where it is impossible to collect urine and almost impossible to collect the manure. Another problem was that the organic pineapple plots were located far from the homestead where the animals were housed. Transport of manure to the pineapple fields was not available unless it was carried. The use of pineapple by-products on those farms met the same problem. The majority of the by-products of pineapple were not available on the farm but at the processing plant. The knowledge about the conservation of larger amounts of pineapple by-products starts being available and the required materials and recourses. Vaarst et al., 2019 provides an extended description of material and methods.

Results and discussion

Different scenarios were developed for the Kenyan and Ugandan farming systems, where the dairy cows and milk production were integrated with the certified organic cash crop production. The scenarios for Kenyan herds included longer lactations, shorter calving intervals and improved feeding leading to higher milk yield. Table 2 presents the results for the scenarios developed for the Kenyan farm.

Table 2. Revenues for conventional and organic Kenyan herds, by changing lactations days, calving interval, number of cows and yield per day (through changed feed ration as explained in the footnote). Other variables as in Table 1.

Scenario	Lactation days	Calving interval, days	Yield kg/ day	No. of cows (milk)	Revenues, €	
					Conven-tional	Organic
1 Current status *	240	420	7	3.5 (2)	-1101	-879
2 Lactation days ↑ , Calving interval↓	300	365	7	2.4 (2)	-464	-210
3 Double no. of cows	240	420	7	7.7 (4)	-1943	-1449
4 Scenarios 2+3	300	365	12	4.9 (4)	-669	-110
5 Milk yield 12 kg/cow/day**)	240	420	12	3.5 (2)	-339	130
6 Scenarios 2+5	300	365	12	2.4 (2)	413	931
7 Scenarios 3+5	240	420	12	7.0 (4)	418	569
8 Scenarios 2+3+5	300	365	12	4.9 (4)	1086	2172

*) in Euro per year: feeding costs: lactating cows 1277, dry period and 479 and young stock 206: labour 441, interest on investment 565, veterinary costs 71 breeding costs 41, costs of land 50 and costs of buildings 36. Feeding costs organic 15% higher and bonus for organic milk 25%, other costs are kept fixed for the conventional and organic system. **) Feed ration changed to kg DM: Napier grass 8; green maize thinning 1; dry maize stover 1; grass 2.6 (cut or grazed, depending on conditions and possibilities); weeds 0.5; concentrate 1.7.

On many Ugandan farms, the certified organic pineapples were produced on fields more than 500 m away from the homestead, where the cattle was kept. That made crop rotation and integration of animals and crops difficult for farmers without means of transport. A large part of roughage and by-products had to be brought in from elsewhere (communal land, roadsides) in both countries. A consorted effort and local community involvement would be necessary to help solve the lack of organic feed and by-products. This would also create jobs and support income, e.g. for young people. Small parcels of owned land limit the possibilities of growing quality feed and converting to organic. The use of fresh or ensiled by-products of organic crops (pineapple) could help bridge the dry season feed shortage. Grazing to meet organic standards will be a huge challenge and might even lead to a change of breeds because of low resistance against tick-borne diseases of exotic cattle.

In the current situation in both countries, keeping dairy cows in conventional or organic systems is not economically viable: the total income from dairy cannot meet the total (calculated) costs. Due to short lactations and long calving intervals in Uganda, the feeding costs of non-lactating animals are 116% of those for lactating animals; in Kenya, with longer lactations, it is 54%. Non-financial reasons play an important role in keeping cattle, and costs may be calculated differently (feed, labour, return on investment). The non-financial reasons to have dairy cows or cattle are diverse: cattle is a kind of saving that can be sold when sudden expenses in the household occur, there is more food security when you have your own cows and milk and owning cattle gives the family a higher social status. Manure has a high value for subsistent farmers because they use it in vegetable gardens.

As shown in Table 2, prolonging lactation and shortening calving interval significantly adds to the economics of the farm with the chosen assumptions. The tipping point is a milk yield of 12 kg instead of 7 kg per cow per day and a short dry period. Markets demand a consistent supply of milk throughout the year, independent of season or availability of feed. In the Kenyan case, there could be a potential benefit in converting to organic in combination with better feed and management. In the Ugandan case, a complete system change with well-adapted breeds and manure processing is needed before conversion to organic milk production would add to the farm's income. Despite that, it could be beneficial for many other reasons to work according to organic principles and use existing knowledge of organic farming, e.g., improved soil management and recirculation of resources, even without being organically certified.

Conclusion and suggestions for research

Converting dairy cattle to certified organic on organic pineapple farms is viable when cattle are higher yielding, are more days in milk during lactation and a large part of the year milk can be sold at a higher price. Use of crossbreed dairy cattle and high energy and protein rations, including the use of feed resudials available on the farm or in the neighbourhood are essential to be profitable. For subsistence farmers, it could be profitable to adapt organic methods in the cattle management even without selling milk.

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Model of sustainable livestock systems in the rural Colombian Andean region through social appropriation processes

Fabián Cruz[1] , Gustavo Ruiz[1], Milena Uribe[1], Germán León[1]

Keywords: Silvopastoral systems, environmental protection, ecological livestock

Abstract

The articulation between farmers, universities, and a government agency generated a model that combines education and labour to build a solution that uses agroforestry systems as an alternative to change their reality and environment in Sucre (Cauca), a municipality located in southern Colombia. This region has a complex social problem caused by illicit crops that generated severe deforestation processes with consequences on the environment and effects on the availability of water resources and the region's biodiversity. The technological implementation included the following activities: the design and establishment of 50 hectares of silvopastoral systems (SPS) belonging to and in agreeance with 50 farmers, construction of two biological corridors and strategic reforestation (with 25,500 trees) around river basins and tributaries of the Mazamorras river, construction of a nursery for the production of plant material, sampling and bromatological analysis of local forages with potential for production and management in the agroforestry systems. For social appropriation and sustainability, dialogue and knowledge exchange between the communities and academic group, social mapping to identify critical areas for the community and a story of experiences were undertaken. The project was complemented with educational activities on silvopastoral systems and ecological livestock. Thus, through the project's development, the community contributed to improving and conserving their environment, balancing the problems detected in soils, water and biodiversity resources, and improving animal production (milk produced and daily gain weight) with direct consequences for the community. Furthermore, the social appropriation led to strengthened associations and extended the model to neighbouring communities in the region.

Introduction

Deforestation processes have generated an environmental problem around the Municipality of Sucre (Colombia), with severe effects on water resources and availability and a threat to the region's biodiversity. The Antonio Nariño University, together with the Sucre livestock farmer association, built a solution using the tree as the main element of the process. Thus, through the development and establishment of 50 hectares of silvopastoral systems (SPS) belonging to 50 farmers, using species for forage, honey or timber, through the construction of two biological corridors and strategic reforestation with 25,500 trees around river basins and tributaries of the Mazamorras river, the community contributed to the improvement and conservation of the environment, to balance the problems detected in soils, water and biodiversity resources, and improve the animal production, like milk production and daily weight gain, with direct consequences for the community.

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Material and methods

The project had two processes for its development over 18 months. One related to technological implementation and another for social appropriation. The technological implementation included the following activities:

- The design of the SPS in collaboration and agreeance with the producers
- The selection of areas for reforestation and implementation of two biological corridors
- Soil sampling for physicochemical and microbiological analysis from 50 farms, 18 in low altitude (<1000 metres above mean sea level (m.a.m.s.l.)), 20 in medium (1000-2000 m.a.m.s.l.) and 12 in high altitude (>2000 m.a.m.s.l.) were taken, and physicochemical parameters were analysed, such as texture, pH, total nitrogen (%), organic matter (% OM) and phosphorus (P ppm), among others.
- The construction of a nursery for the production of plant material
- Sampling and bromatological analysis of local forages with potential for production and management in the SPS
- The construction of a database with production and animal information
- The production of plant material
- The implementation of reforestation systems, corridors and systems
- Verification of results

For social appropriation and sustainability, dialogue and knowledge exchange between the communities and academic group, social mapping to identify critical areas for the community and a story of experiences were undertaken. Since its formulation, the project was complemented with educational activities on silvopastoral systems and ecological livestock systems.

Results

The **livestock production characteristics** of the 50 selected farmers in the project, before and after the 18 months of intervention, are described in Table 1:

Table 1. Productive characteristics of farmers

Description	Before the project	At the end of project	Difference
Number of farmers	50	50	0%
Average area per farms (ha)	7,2	7,2	0%
Number of cows in milking/farm	5,1	5,6	+9,9%
Milk produced per cow/day (L)	6,1	7,0	+15,4%
Daily gain weight (gr/day)	474,8	595,3	+25,4%
Area planted with SPS/farm (ha)	0,1	1,3	+1300%
Farms with artificial insemination pro-	1	8	+800%
Farms with mineralised salt supple-	21	50	+238%
Grassland with fertilisation, rotation and management - area/farm (ha)	0,2	5,8	+2900%

With the implementation of silvopastoral systems, the planting of complementary grass species was included. After six months of establishing the system, the **nutritional evaluation** of the species was carried out. The tree species described in Table 1, herbs (Thitonia diversifolia, Macroptilium sp.) and grasses (Pennisetum purpureum, Axonopus scoparius, Pennisetum thipoides, Pennisetum sp, Brachiaria decumbens, Brachiaria brizantha, Cynodon nlemfuensis, Hyparrenia rufa, Dichantium aristatum, Pennisetum clandestinum, Paspalum dilatatum, Brachiaria híbrida cv) used in the systems were evaluated with variables, like dry matter (DM%), crude protein (CP%), neutral detergent fibre (NDF%), acid detergent fibre (ADF%) and in vitro digestibility of dry matter (DMIVD%) (Figure 1). The enrichment of the grasslands with herbaceous and arboreal species has improved the nutritional conditions for the animals, reflected in the increased production of meat and milk.

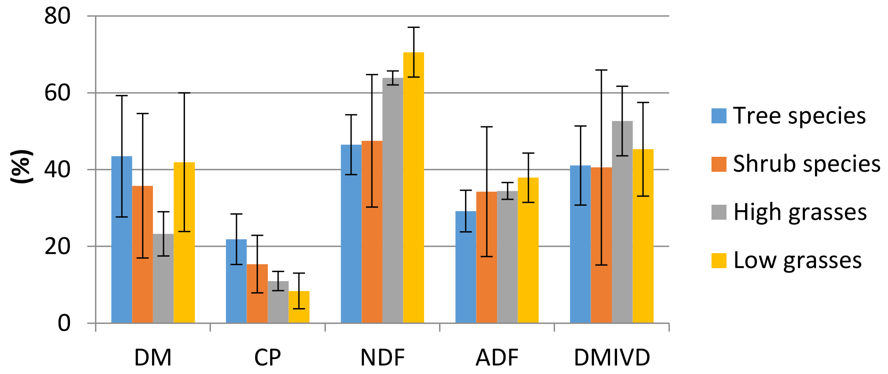

Figure 1. Nutritional value for species used in livestock production systems of Sucre (Cauca-Colombia)

Tree and shrub species with the potential to adequately perform the edaphological and climatic conditions of the region were selected for the **agroforestry systems**. This selection and evaluation were based on the soil analysis carried out, the characteristics of each property, and the knowledge that farmers in the region had (Table 2).

Based on the analysis of the environment (climate, soil, relief, production system) of the 50 properties selected for the establishment of SPS, a specific design for each farm was agreed with the producers (Type of arrangement, species to be used, density). On average, each property had one hectare, for which 750 trees were made available per producer. Thus, for the coverage of the designed silvopastoral systems, a total of 38,940 trees were produced in the nursery.

Two biological corridors were built using the community association methodology called “minga” on the margin of El Cajón Creek, where 4,000 trees and shrubs of native species were planted. For reforestation processes, the community prioritised areas with water sources that supply community aqueducts. In that sense, various species (hatchery, gold button, marathon, pink cedar, igua, etc.) were delivered to the communities, who in community activities (mingas), carried out the transport and planting processes in these areas. About 21,500 trees were planted utilising this process.

For the adequate establishment of the SPS in this project, the soil fertility was evaluated to generate recommendations for establishing species and soil management. Most of the soils have a pH that places them in the category of acidic to medium acids (5.1 - 5.3), with aluminium saturation between 8.8 - 11.8% with its consequences on toxicity for plants. For organic matter (OM), an average content of 2.75% for low altitude, 5.53% for medium and 9.76% for high altitude were found. Regarding the nitrogen content, the content was 0.14% at low altitude, 0.28% at mid-altitude, 0.49% at high altitude. In general, the OM content for the soils sampled in the municipality of Sucre was high (5.55%). The fertility potential found through the evaluation of the equivalent cation exchange capacity (CEC) for the soils of the municipality in the three climates (on average 5.69 meq / 100g) indicates a poor fertility potential. On the other hand, phosphorus (P) content also shows a low content in all the sampled soils (average of

5.69 ppm), a fact related to the acidity and the content of exchangeable aluminium found in these soils. In the microbiological results, average counts of 1.11x107 CFU gr-1 soil were found for bacteria, while for fungi, average counts of 1.81x103 spores gr-1 soil were made.

Table 2. Main forestry species selected and introduced in the livestock production systems.

Popular name	Scientific name	Altitude (m.a.m.s.l.)	Purpose
Abarco	*Cariniana pyriformis*	0 – 1000	Timber, shade.
Acacia mangium	*Acacia mangium*	0 – 1000	Silvopastoral, honey, shade.
Aliso	*Alnus acuminanta*	1700 – 3500	Silvopastoral, watershed protection, timber.
Gold button	*Tithonia diversifolia*	0 – 2500	Silvopastoral, ornamental, soil protection.
Cañafístula	*Cassia fistula*	0 – 1300	Silvopastoral, shade, posts, ornamental
Pink Cedro	*Cedrela odorata*	0 – 2000	Timber, basin protection, ornamental, posts
Cratylia	*Cartylia argentea*	0 – 1200	Silvopastoral, soil recovery, living fences.
Guadua	*Guadua angustifolia*	0 – 1800	Basin protection, ornamental, posts.
Yellow Guayacan	*Handroanthus chrysanthus*	0 – 1900	Timber, ornamental, honey, soil recovery.
Iguá	*Albizia guachapele*	0 - 1500	Silvopastoral, shade, fence posts, ornamental.
Leucaena	*Leucaena leucocephala*	0 – 1800	Silvopastoral, shade, honey, fence posts.
Matarratón	*Gliricidia sepium*	0 – 1600	Silvopastoral, honey, ornamental, posts
Nacedero	*Trichantera gigantea*	0 – 2000	Silvopastoral, shade, basin protection, honey
Nogal cafetero	*Cordia alliodora*	0 – 1900	Timber, honey, ornamental, soil recovery
Ocobo or purple flower	*Tabebuia rosea*	0 – 1900	Timber, ornamental, protection basins, honey

The holistic and systems concept were used throughout the project. The incorporation of trees in the meadows, and the increase in diversity, improved the availability and nutritional quality of the forages. In addition, the education and technical support provided for the producers allowed better management of pastures and reproductive information of the animals and initiated genetic selection by artificial insemination.

Conclusions

Technically, the project allowed the improvement of milk production of participating farmers by 15% and the weight gain of meat animals by 25%. Environmentally, small watersheds areas were protected by reforestation, and mobility and wildlife protection spaces were established. Socially, the project strengthened the farmers' association by introducing education processes, improving incomes (through the sale of fruit and timber tree seedlings, milk and meat), motivating participation and replicating the model in other neighbouring municipalities, and generating the search for differentiated markets (organic or environmentally friendly).

Suggestions for research and support policies to develop further organic animal husbandry

Small Latin American peasant producers have knowledge and experience of their environment, which deserve greater support from regional and national governments so that they achieve endogenous and sustainable development processes.

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Promoting organic livestock production: Supporting the growing number of start-ups

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Keywords: Organic, livestock, start-ups, capacity building

Abstract

India is one of the leading countries producing organic products. Recently, organic products of animal origin have triggered the interest of producers, entering into the market of certified animal products, including small exported quantity. Many start-ups, including farmers, have shown interest in organic animal production, processing and marketing. There is an emerging demand for information, knowledge and skills on organic animal husbandry. Youth, especially, have been looking for capacity building and hand-holding opportunities in this emerging market. The government of India has been supporting start-ups under different schemes, including those related to animal production. Organic animal husbandry is challenging in the sense that two systems of production, crop and livestock, are involved. Also, the export demand from importing countries is currently limited for organic livestock products from India, compared to cereals, nuts, fruits, spices, tea, coffee, herbs, cotton and other plant-based products. The recent export of certified ghee (clarified butter) from India to the UAE was an encouraging experience, motivating many to pay attention to this previously less developed area. The domestic market for organic livestock products is also slowly growing. Many start-ups find it an exciting opportunity to engage in organic livestock production, especially milk, meat, eggs, and value-added by-products from cow dung and cattle urine, etc. This paper presents start-ups working in organic livestock production needs to support their initiatives in India. Organic animal husbandry research and development activities are primarily concentrated in northern countries, the EU and other developed countries. Efforts are needed to encourage, support, and develop evidence-based organic animal husbandry in developing countries like India. The start-ups need information on organic animal standards, breeding, feeding, disease control, management and marketing of livestock products, potential markets, etc.

Introduction

India, with the largest number of organic producers (1.3 million in 2020) occupies fifth position in terms of area (2.3 Million hectare) under certified organic production (FiBL and IFOAM Year book, 2021). As of March 31st, 2020, the total area in the process of organic certification (registered under the National Programme for Organic Production) was 3.67 million hectares (2019-20).This includes 2.29 million ha cultivable area and another 1.37 million hectares for wild harvest. India produced around 2.75 million tonnes (2019-20) of certified organic products, including all varieties of food products. India currently exports a range of certified organic edibles & fiber to 58 countries across the globe. Organic food products exports grew by 51% to US$1040 million in 2020-21 compared to US $689Million in 2019-20, beating Covid-19 induced hiccups in the supply chain (PTI, 2021). The organic markets in domestic and exports are growing at a CAGR of 28% and 23.35% during last 5 years. The share of India's exports to total international trade stands at 0.82%. But, only a very little proportion of these impressive figures come from organic livestock products. However, the number of certified organic livestock units producing milk, meat and eggs are increasing in number in recent times. There are 52 certified organic dairy operators, 66 meat operators and 3 certified organic egg operators in India currently.

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The information on domestic sales of organic livestock products indicates the availability of certified organic milk and milk products in India (Table1). Also, India exported 2125 kg of certified organic *Ghee* (Clarified butter) to UAE during 2019-20 (Reeba Abraham, APEDA, Personal Communication, 2021).

Table 1. Production and sales of certified organic livestock products in India (2019-20)

Number	Item	Quantity (Tonnes)
1.	Milk	16050
2.	Ghee (clarified butter)	400
3.	Butter	9
4.	Milk Cream	390
5.	Skimmed Milk	320
6.	Skimmed milk powder	660

As quality conscious consumers are looking for organic animal products, domestic sales and exports begin to increase. This calls for efforts to promote organic animal husbandry and support the initiatives to meet the growing demand for organically produced animal products. There are dairy cooperatives in India engaged in the production and marketing of certified organic milk and various milk products.

Animals not only produce products for direct human consumption but also help produce organic by-products like cattle urine and cow dung used to enhance soil fertility. At ICAR-Indian Veterinary Research Institute and several other animal science research institutes and Veterinary Universities/colleges, initiatives are underway to promote organic animal husbandry. For instance, the Indian Council of Agricultural Research (ICAR) – National Research Centre on Meat certified its organic sheep unit having the know-how to handhold and guide the prospective farmers through all the processes involved in taking up organic sheep farming and certification. Under ICAR's Network Project on Organic Farming, it was observed that cow urine could increase the soil nutrient value and help manage insects, pests and diseases organically. As a result, ICAR scientists are exploring multiple usages of cow urine by conducting tests in the laboratory and applying them in the field. The research on the medicinal properties of cow urine is underway too. Cow urine has potential economically but must first be investigated for its medicinal properties. The start-ups see this as one big opportunity; once backed by evidence generated through research, they can develop products like bio-pesticides, bio-fertilisers and even cosmetics from cow dung and urine.

The Agricultural and Processed Food Products Export Development Authority (APEDA) implements India's National Programme on Organic Production (NPOP). Out of 32 accredited certification bodies (CBs) in India, 7 CBs are accredited by APEDA for certification of livestock and poultry. Also, it has taken initiatives to train certification bodies and evaluation committee to inspect and audit organic livestock operations. The APEDA has been organising capacity-building programmes for inspectors/auditors on organic livestock certification process towards developing organic animal husbandry in India. The start-ups wishing to convert to organic animal husbandry need to be aware of organic livestock production's conversion, production and certification procedures.

The Government of India is supporting several projects on organic agriculture that also include organic animal husbandry. The author is associated with Agribusiness Incubation Cell (ABI) at ICAR – Indian Veterinary Research Institute as a member of its Advisory Board. At this ABI cell, project proposals are invited for nurturing/incubating. The selected candidates are regularly mentored and financially supported to further develop the proposals having market potential. The selected start-ups are trained for two months on various aspects of agricultural production, processing and marketing under a newly launched start-up support programme (RKVY-RAFTAAR) of the Indian Ministry of Agriculture and Farmers' Welfare. They are trained on product development, branding, market assessment, launching in the market, winning consumers' confidence, product innovation, labelling, packaging, managemental aspects, record keeping, etc. All these trainees have been exposed to the prospects and opportunities for organic animal husbandry too. The trainees wishing to start organic livestock and poultry production are mentored through capacity building programmes. They are introduced to established certified organic farmers and export value-chains to create awareness, knowledge and opportunities in the sector including assisting in organic certification by accredited certification bodies eligible for livestock certification.

Once established, the newly certified farmers would act as role models for other farmers in the region since certified organic livestock production is still in infancy in India compared to the developments in production, processing and marketing of organic cereals, pulses, fruits, nuts, tea, coffee, fibre, oil and sugar production. The trainees are often very apprehensive of export markets for organic livestock products, which have serious challenges due to infectious diseases in India like Foot and Mouth Disease (FMD), which restricts export to FMD-free countries, mostly in developed northern countries.

Face to face training sessions, online lectures, radio talks and field visits towards capacity building of farmers on organic animal husbandry were undertaken. Many queries received via WhatsApp and mobile phone messages, telephone calls are being regularly addressed by Agricultural institutions. The Veterinary Officers of Sikkim state, which was declared a fully organic state in 2016 were trained at ICAR- Indian Veterinary Research Institute. Also, a document entitled “Roadmap to organic animal husbandry development in Sikkim”, was published together with Sikkim Organic Mission. The Animal Husbandry Officers, Dairy Development Officers, extension officers and farmers of various Indian states were oriented and trained on organic animal husbandry by the author under various government schemes . Organic animal husbandry happens to be a unique idea worth nurturing, given its growth potential for domestic and export markets.

Results

The capacity building initiatives on organic animal husbandry, including mentoring start-ups, have been helping farmers and entrepreneurs constructively engage in enterprises related to organic livestock production. The start-ups are making organic food more accessible and affordable to consumers while creating new opportunities for farmers by motivating them to adopt organic livestock farming practices. Not only organic foods but the start-ups are engaged in producing value-added products from animal by-products, which has an attractive market in India and has possibilities of exports. The author could convince the organic farmers to take up organic animal production by following organic livestock standards since they are already certified organic farmers mainly growing crops.

Discussion

Among different sectors of organic production, organic animal husbandry is a little less developed, especially in developing countries like India. Nevertheless, an interest in this area is growing, and farmers and qualified youths, in particular, are increasingly interested in organic animal production, processing and marketing. The growing need for information, knowledge, skills on organic animal husbandry needs to be effectively catered to. The author has attempted to meet this requirement by training the start-ups and farmers in conversion and by giving inputs to various committees in the Government of India on the development and promotion of organic animal husbandry. Besides capacity building measures, the start-ups and in-conversion farmers may require hand-holding, including financial support to take up organic animal production ventures.

Suggestions for research and support policies to develop further organic animal husbandry

Organic animal husbandry is an emerging sector in developing countries like India. The start-ups, including farmers engaged in organic farming and entrepreneurs, need support in terms of information, technical knowledge, finances, incubation and marketing of organic animal products. The extension and advisory services institutions have to provide prompt technical know-how and impart skills to field extension workers and farmers. For this, emphasis has to be given to start-up programmes that transform aspiring farmers into agripreneurs of organic animal husbandry.

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Organic Livestock Production in Turkey

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Keywords: Organic animal production, organic animal husbandry, ecological production, production capacity

Abstract

In parallel with worldwide development, organic production in Turkey shows rapid growth and increasing interest. Organic farming in Turkey was started in 1984, and by 2018 the organically cultivated area reached 365,889 hectares with 54,666 producers. The total amount of certified organic products is 1.7 million tons (TUIK, 2018). Organic farming is carried out on approximately 1.4% of the total agricultural land area.

Most organic products are exported to the EU, USA and Japan. Although, domestic organic product sales and organic product consumption have increased in recent years, organic livestock is still underdeveloped. Organic livestock production has been carried out on 148 farms in Turkey, consisting of 30 cattle farms (5,113 heads), 18 sheep farms (10,475 heads) and goat farms (10,685), 100 farms with broilers chicken (606,790 units) and layer (635,380 units) farms. In 2018, 12,884 tons of organic milk, 427 tons of organic red meat, 1,261 tons of organic chicken meat and 174 million organic eggs were produced in Turkey.

Organic chicken eggs (0.84%) and organic honey (0.46%) have the highest share of organic animal production. Turkey is a highly developed country in terms of organic beekeeping; 334 beekeepers produce 500 tons of organic honey annually from 51,742 hives. Most of the organic honey produced is exported. However, with regards to total agricultural production, organic meat and milk production ratio are very low, below 0.1%.

In Turkey, the development of organic farming is limited due to consumer awareness and low purchasing power. Furthermore, problems may arise in the export of organic animal products due to some animal diseases. In this review, animal production and consumption capacities in Turkey, the problems belonging to the current situation of organic farming and the solutions to these problems were evaluated.

Introduction

In line with worldwide development patterns, organic farming has seen significant developments in recent years in Turkey. Organic agriculture began in 1984 with the exportation of dried fig and raisin, which are among the traditional agricultural products in the country (Aksoy, 1999). This has followed by rapid development, and soon 300 different organic Turkish products were developed. The majority of these products have been exported to the developed countries such as the USA, EU countries and Japan. However, this situation has changed in recent years, and due to the increase in consumer awareness, some of the organic products have started to be consumed within Turkey (Ak, 2017).

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Currently, 1.7 million tons of organic products are produced in Turkey on 365,889 hectares with 54,666 producers. However, only1.4% of the total agricultural area is used for organic agriculture (Anonymous, 2019). In Turkey, organic agriculture is a sector based on vegetable production and subsequent exportable products. However, organic animal production has not developed due to low consumer awareness and purchasing power as well as export-related problems of animal products. Although the country has an important livestock, organic animal production and consumption is very low. However, there is a need for the consumption of chemical and residue-free organic animal products for healthy and balanced nutrition, especially for nutrition of pregnant women, infants and children (Evrensel 2001, Yurtagul, 2001).

General situation of animal husbandry in Turkey

Animal husbandry is an important sector economically, socially and nutritionally in Turkey. Animal husbandry contributes significantly to healthy and balanced diets, the country's economy, and it leads to increase employment capacity in the rural areas. There have been substantial changes in Turkey's livestock sector in recent years. While the number of small ruminants and buffaloes decreased significantly, the number of chickens increased significantly. The increase in the number of new developed breeds and hybrids in cattle breeding and improvements in the care and feeding increased the yield per unit animal. Although total milk yield has increased significantly, yield per animal is still insufficient. Therefore, the expected increase in production was not be achieved in other livestock sub-sectors, except for the poultry and feed sector.

According to the data recorded in 2018, there is 22.3 million ha of forests, 19.7 million hectares of agricultural production area and 14.6 million ha of grassland area in Turkey. The amount of rainfall is low due to climate and geographical conditions. On state-owned, low and medium quality pastures, the yield is very low due to early, heavy grazing. Inadequate quality roughage production is one of the main challenges for improving animal production. With the government's recent support for the sector, the share of forage crops in agricultural production has increased to 10% (Anonymous, 2019).

According to data from 2011, there were 3,076,650 agricultural enterprises in Turkey. The crop and animal production are often carried out together in those enterprises that their majority consists of small size family farms. According to 2018 data, the total number of livestock was 63,338,302 heads, of which 17,042,506 are cattle, 178,397 are buffalo, 35,194,972 are sheep and 10,922,427 heads are goats. Total cattle livestock is about 17 million heads that consist of 49.40% of new developed breeds, 41.25% of hybrids and 9.4% of domestic cattle breeds. The number of sheep is 38.2 million heads, with 85.6% domestic breeds, while the domestic goat breeds comprise most of the 10.9 million heads of goat. Red meat production is 1,118,293 tons, 90% of which are produced from cattle and 10% from small ruminants. However, red meat prices have increased very much in recent years because of the elevation of the purchasing power of the population and individuals. In the past, Turkey exported meat abroad, especially to the Arab countries. However, recently, meat and livestock from abroad have needed to be imported to meet demand. Milk production in the country has increased significantly in recent years. In 2018, 21.2 million tons of milk were produced, 91% obtained from cattle and 9% from small ruminants (Anonymous, 2019).

In 2018, 124 million layers and 233 million broilers were grown; 19 billion eggs and 2.1 million tons of chicken meat were produced. Turkey is among the top 10 countries in terms of world production of poultry meat and eggs. The ratios of eggs and chicken meat exported were 25% and 10%, respectively. On average, 240 eggs are consumed per person per year, and more than 50% of the meat consumption consists of chicken meat. The majority (99%) of the total poultry livestock is chicken; the remaining 1% consists of other poultry animals, such as turkey, goose and duck (Anonymous, 2019).

Ecological animal husbandry in Turkey

Organic agriculture in Turkey has shown improvement based on vegetable production and exportation; however, Turkey has great potential for further development of organic animal husbandry. Animal production is carried out under extensive conditions in most livestock sectors, with the exception of poultry and part of the dairy cattle production. Since the use of inputs is very low in many livestock sectors, the yield per unit animal and the income level of the breeder are low. The rearing of small ruminants is mainly based on pasture. In most regions, especially in the Eastern Anatolia Region, 80-90% of animals' feed requirements are met from natural grazing areas such as meadows and pastures. Animal husbandry is generally conducted with low-yielded but disease-resistant domestic breeds (Pekel and Unalan, 1999). Thus, although organic livestock potential is high in the country, this potential is not utilised sufficiently.

The country's total meadow and pasture area is 14.6 million hectares; 35% is in the Eastern Anatolia Region. Therefore, this region has greater potential in terms of organic animal husbandry (Gokkus, 2013). However, the development of organic animal husbandry in Turkey faces some challenges; the export of animal products due to some animal diseases in the country, and the lack of demand in the domestic market, due to low consumer awareness and purchasing power. Therefore, although there has been an increase in the number of organic farms and production capacity in the country in recent years, there are very few organic animal husbandry farms. The number of certified farmers engaged in organic animal production, animal species, number of animals, amount of animal production and their shares in total animal production are given in Table 1 and 2.

Table 1. Organic animal husbandry and animal production data by years in Turkey

Year	Number of enterprises with animal husbandry	Number of animals	Meat production (tons)	Milk production (tons)	Egg production (number)	Cheese production (tons)
2004	7	20,182	450	154	92,500	48
2005	4	11,671	0	1,350	270,000	5
2006	6	14,407	12	2,875	241,940	0
2007	16	42,192	-	-	-	-
2008	31	38,972	554	8,711	4,424,000	-
2009	38	129,737	376	12,994	11,767,400	-
2010	105	387,984	6,803	11,605	17,889,808	-
2011	137	453,513	1,359	14,794	26,236,920	-
2012	151	253,783	480	17,627	36,105,556	-
2013	1,632	1,021,382	4,970	54,781	48,040,778	-
2014	216	1,121,159	2,107	15,510	64,898,912	-
2015	179	997,707	2,605	19,739	58,938,769	1
2016	173	1,215,632	1,609	21,431	147,600,367	375
2017	119	1,290,771	1,352	15,109	161,254,080	3
2018	148	1,268,443	1,688	12,884	174,675,362	15

As shown in Table 1, the number of enterprises and animals engaged in organic animal husbandry is increasing, from 7 in 2004 to 148 in 2018. Over the last 14 years, the total number of animals, which were 20,182, increased to 1,268,443. However, a limited amount of dairy has been produced as organic cheese, and the production of other organic dairy and meat products is meagre.

As seen in Table 2, the share of organic animal products in the country's total animal production is below 1%. On the world scale, production of bee and honey in Turkey is seen to be very important. However, only 0.46% of the total honey produced in the country is organic. Therefore, if the total number of animals in the country and animal production are taken into account, organic animal production is very low.

Table 2. Organic animal production and its share in total agricultural production in Turkey

Animal	Number of farmers	Number of animals	Milk production (tons)	Red meat production (tons)	Egg production (number)	Broiler meat production (tons)
Cattle	30	5,113	12,293	362	-	-
Sheep	18	10,475	48	50	-	-
Goat		10,685	543	15		
Laying Chicken	100	635,380	-	-	174,675,362	-
Broiler		606,790	-	-	-	133
Total	148	1,268,443	12,884	427	174,675,362	1,261
Share in total			0.06%	0.04%	0.89%	0.05%
Bees	334	Number of beehives			51,742	
		Honey production (tons)			500	
		Share in total honey production			0.46%	

Results

Turkey has substantial potential for organic agriculture. However, the production and consumption of organic animal products are very low due to the problems related to the export of animal products and the low consumer awareness and purchasing power in the domestic market. It is considered that the development and promotion of eco-agrotourism will positively affect the development of organic agriculture and animal husbandry. The use of domestic breeds should be supported to protect the domestic animal gene resources. In regions with higher organic livestock potential, such as Eastern Anatolia, Central Anatolia and the Mediterranean, sheep and goats should be preferred. Organic livestock breeding on a regional basis should be supported and carried out. Regarding the consumption of organic animal products, regular controls should be made to ensure consumer confidence, and unfair competition should not be allowed versus non-organic ones. Internal and external market investigations should be conducted for ecological animal products.

Discussion

Due to the barriers in the export of ecological organic animal products, the target for the country in the short term should focus on the domestic market. Organic production should be better supported to increase the production and consumption of organic animal products. To avoid problems in marketing, production capacity should be increased in parallel with consumption. Organic products must be used for the nutrition of children (0-6 years old) and social services, such as hospitals, by the legal regulation. Administrative and management concepts should be encouraged to develop for businesses dealing with organic livestock. Pastures should be preserved and improved, and the establishment of leys should be encouraged, as they are important in organic livestock. Producers and consumers should be informed about organic agriculture and animal husbandry through written sources and the media.

Suggestion for research to develop organic animal husbandry

The purpose of the health sector is to prevent the disease before it occurs. Therefore, society, especially infants, pregnant women and children, should consume healthier and safer organic foods. Improved nutrition conditions should be provided for healthier generations. Organic milk should be preferred in school milk programs to support production and consumption. When comparing the costs of conventional and ecological products, it should be considered that organic products are healthier, and the agricultural practices have a positive effect on ecological balance and contribute to the conservation of domestic gene resources. Also, it should not be forgotten that organic animal husbandry is an important and integral part of vegetative production. The development of organic agriculture in the country will help protect natural ecosystems, increase the income level of small-scale farmers, support agro-tourism and rural development, prevent migration from the village to the city, and provide healthier nutrition for society.

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Production of organic beef from male dairy calves – aiming at reduced carbon footprint

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Keywords: calf rearing, dairy farming, greenhouse gases, feeding strategies

Abstract

Beef is one of the foods that has the greatest climate impact. Furthermore, organic beef production has some challenges compared to conventional production. One of those challenges in Denmark is that male calves are typically raised as steers, which means a high feed consumption per kg live weight gain and thus a high climate impact per kg of meat. A system that raises organic young bulls could meet both consumer and political demands for organic foods with a lower climate impact per kg of meat. The project's purpose was to develop strategies for rearing organic young bulls, which consider feeding strategy, time of year for birth and slaughtering, focusing on achieving the lowest possible climate impact. Ten strategies for producing organic young bulls were established, combining the time of year when the calves are born, the slaughter age, etc. The aim was that these systems are less climate-damaging and, at the same time, profitable for the farmer. This was tested by scenario calculations. The rearing of organic male calves as young bulls decreases carbon footprint per kg carcass compared with organic steers. The carbon footprint per kg carcass, including soil carbon changes, was 18-32% lower for raising organic young bulls compared to organic steer rearing.

Introduction

Beef is one of the foods that has the most significant climate impact. Thus, there is a need to develop production strategies where beef has as low a climate impact as possible. Organic male calves from the dairy farm system can be raised as steers or in various calf and young bull fattening strategies. The question is: How will the choice of strategy affect the environmental impact of the beef produced? The purpose of this project was to develop strategies for rearing organic young bulls, taking into account feeding strategy, time of year of birth and slaughtering and focusing on achieving the lowest possible climate impact. Ten strategies for producing organic young bulls and one with organic steer production as a reference were set up and tested by scenario calculations using Life Cycle Assessment (LCA).

Material and methods

In this paper, LCA was used to test how different production strategies (time of year when the calves are born, the slaughter age, the feeding intensity and the amount of grazing involved) can affect the environmental impact. The main focus was on the carbon footprint per kg of meat produced. In Table 1, these strategies are defined, and the input and output of the strategies are described. Due to restrictions in the organic rules of production, limiting concentrates to constitute a maximum of 40% of the ration, the feeding intensity can never be as high as in

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conventional fattening strategies for young bulls. Thus, strategies 1A, 2A, 3A and 4A represent the most intensive strategies possible. The numbers and values presented in Table 1 are based on general knowledge from the conventional system for rearing young bulls (Mogensen et al., 2015) combined with new knowledge about strategies for rearing organic young bulls and data from rearing organic young bulls in a relatively small number of private farms related to the project (Vestergaard et al., 2020). The housing system was deep litter in all strategies.

Table 1: Definition of strategies and input-output per produced organic young bull and with steer production as a reference

Strategy	1A	1B	1C	2A	2B	3A	3B	4A	4B	4C	Steer
Month born	March			June		September		December			-
Feeding intensity	High	Low	High	High	Low	High	Low	High	Low	High	Low
Age, m[a]	13	17	17	13	17	13	17	13	17	17	26.5
Days at pasture [d]	62	170	169	0	184	75	183	183	183	183	336
Total kg DMI [b]	1931	2316	2964	1937	2309	1939	2317	1934	2312	2970	4102
kg DMI/ kg LWG[c]	4.9	5.8	5.7	4.9	5.8	4.9	5.8	4.9	5.8	5.8	7.4
Roughage %	65	86	68	63	87	74	87	73	86	70	88
Carcass, kg	231	227	301	232	227	231	228	232	227	301	303

[a] m: months at slaughter
[b] DMI: dry matter intake
[c] LWG: live weight gain
[d] Strategy 2A with zero grazing have access to an outdoor exercise area

The environmental impact of the ten strategies for the production of organic young bulls (‘1 kg carcass at the farm gate’) was estimated using LCA. The system covers the primary production at the farm where the animals are raised. Methane emissions were estimated using the equations for young (Nielsen et al., 2013), where methane is related to the proportion of concentrated feed in the feed ration and the daily gross energy intake. Details about the applied LCA method for estimating the environmental impact of beef can be found in Mogensen et al. (2015, 2016). The contribution from carbon (C) changes in soil was calculated using the method described by Petersen et al. (2013), where the type of crops grown affects whether C is sequestrated or released. Changes in the soil C pool were estimated based on one-year input of C from crop residues quantified by the Danish C-tool model (Taghizadeh-Toosi et al., 2014). The effect on biodiversity caused by feed production was estimated according to Knudsen et al. (2017). By this method, the number of vascular plants is used as a proxy for biodiversity due to the relation between the number of plant species and other organisms in the agricultural landscape. The carbon footprint of the applied organic feeds was calculated following the method from Mogensen et al. (2014). The starting point is average Danish conventional crop yields and the relationship between organic and conventional.

Results

The environmental impact from primary production per produced male calf or steer is shown in Table 2. All strategies for raising organic young bulls resulted in a lower carbon footprint per kg carcass than the rearing of male calves as organic steers. The amount of kg carcass produced in the steer strategies is not higher than from 17 months at slaughter and a high feed intensity (C-strategies).

Table 2: Environmental impact from primary production per produced male calf or steer as a reference – effect on climate (kg CO_2-eq.), land use (m^2) and biodiversity loss (PDF index)

Strategy	1A	1B	1C	2A	2B	3A	3B	4A	4B	4C	Steer
GHG per animal, kg CO_2-eq.[a]											
Feed	1130	1206	1558	1127	1214	1129	1212	1134	1199	1537	1874
CH_4	891	1257	1419	880	1265	926	1266	965	1257	1448	2301
Manure	679	829	920	715	766	566	730	530	893	971	1364
total	2937	3532	4139	2964	3473	2846	3428	2834	3581	4204	5800
Soil C[e]	-62	-370	-141	-48	-364	-114	-365	-148	-377	-239	-662
GHG per kg carcass, kg CO_2-eq. [a]											
CF	12.7	15.5	13.7	12.8	15.3	12.3	15.1	12.2	15.8	14.0	19.1
CF soil C	12.5	13.9	13.3	12.6	13.7	11.8	13.5	11.6	14.1	13.2	17.0
m^2/kg carcass [b]	19.3	20.1	21.7	19.1	20.3	19.1	20.2	18.9	20.0	21.0	24.4
BD loss [c] PDF index/kg carcass	2.5	-0.4	2.1	2.9	-0.5	2.0	-0.5	1.1	-0.4	1.5	-0.7

[a] GHG: Green house gas emission
[b] Land use for feed production
[c] Effect on biodiversity loss (BD loss) in term of potential disappeared fraction (PDF)
[b]

The lowest land use per kg carcass was seen for the A-strategies. For the B-strategies, land use is only 4-5% higher even though the feed use is 18% higher. This is because more roughage is included in the ration with a higher crop yield per ha. The highest land use per kg carcass is seen for the C-strategies, with the same feed consumption as the B-strategies but more concentrated feed in the ration with the lower crop yield per ha.

Only when it comes to the effect on biodiversity, the B-strategies with the lowest feed intensity and a high proportion of feed from grass-clover in the ration (82-84%) are the most favourable strategies. Grass is the only feed crop grown with a positive effect on biodiversity compared to natural forest.

Discussion

The lowest carbon footprint (CF) per animal produced and per kg carcass was seen for A strategies. These strategies have a high feed intensity and a low slaughter age of 13 months. This low CF is due to the lowest feed consumption per kg live weight gain among the strategies and a high proportion of concentrated feed in the ration. Feed consumption per kg live weight gain affects all the major GHG contributions related to beef production; GHG from feed production, enteric methane emissions and GHG from manure management as more kg N is excreted with a higher feed consumption per kg LWG. However, there is a trade-off between the amount of roughage and concentrated feed in the ration. This is due to the fact that roughage is favourable concerning the lowest GHG from feed production but the highest GHG from enteric methane emission.

In the C strategies, with a higher slaughter age of 17 months and still a high feeding intensity, the carbon footprint per kg of carcass increases due to increased feed consumption. The B strategies with a low feeding intensity and slaughter age of 17 months have the highest carbon footprint per kg meat among the strategies with organic young bulls. Feed consumption per kg live weight gain is not higher than in the C strategies, but a greater proportion of roughage in the ration increases enteric methane production from the digestion of the feed. Rearing organic male calves as young bulls decreases the carbon footprint per kg carcass by 18-32% compared with organic steers.

Suggestions for research and support policies to develop further organic animal husbandry

As beef is one of the foods that has the greatest climate impact, there is a need to develop future production strategies where beef has as low a climate impact as possible. Raising organic male calves from the dairy farm system as organic young bulls instead of steers is one such mitigation strategy.

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Effect of calf rearing with mother contact compared to bucket feeding on health and welfare of calves

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Keywords: calf cow contact, social bonding, dam rearing, behavioural disorders

Extended Abstract

Introduction

Early separation of cow and calf is still common practice on dairy farms. In recent years, interest in mother-bonded calf rearing practices has increased. They are considered to be animal-friendly, labour-saving and health-promoting for the calf. However, these systems are challenging, e.g. regarding the cow's willingness to let down milk or the pain of separation after establishing a social bonding.

We tested the hypothesis that calves allowed dam suckling (DS) twice a day would benefit concerning weight gain, health-related traits and show fewer behavioural disorders (oral manipulations) compared to bucket fed (BF) group mates. Furthermore, we investigated the impact of cow-calf contact compared to bucket feeding on selected immune parameters in calf blood and cow milk.

Material and methods

We conducted two on-farm trials with local German Black Pied (DSN) (farm 1: n= 18 DS vs 17 BF) and Swiss Fleckvieh calves (farm 2: n= 12 DS vs 11 BF) until the age of four months between October 2018 and June 2020.

All calves were scored for health-indicating traits (weekly during their first month of life and monthly afterwards) and weighted weekly. Additionally, the farmers checked and documented the health status of the calves once per day and documented medical treatments. One treatment cycle was defined as a medical treatment of at least one day and a maximal of seven consecutive days for the same reason (i.e. 1 to 7 treatment days=1 cycle, 8-14 treatment days=2 cycles and so on). A subsequent treatment event was counted as a new treatment cycle if the treatment was interrupted for at least seven days. Behaviour (manipulation of objects or pen mates) was directly observed three hours (1.30 to 4.30 p.m.) weekly. Manipulations had to be executed for at least 5 seconds to be counted. After an interruption of 5 seconds, the execution of oral manipulation was counted as a new event. The avoidance distance of calves was measured as the distance between the animal's muzzle and the palm of the assessor's hand estimated in intervals of 10 cm. It was assessed by approaching calves from a distance of around three meters with the arm overhand at an angle of approx. 45 degrees in front of the body (Waiblinger et al., 2003), approaching the animals at a speed of one step of 50-60 cm per second until the animal either withdrew or tolerated being touched (Windschnurer et al., 2008).

Lactose content (mmol/L, norm reference <2.2 mmol/L, high values can indicate stress) of calf blood was determined weekly in the first month of life and monthly thereafter, using a handheld lactose analyser (Lactate Scout, EFK Diagnostics GmbH, Mannheim, Germany). Total protein content (g/L, norm reference: 50-70 g/L) in calf blood serum was determined with a

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portable refractometer (Euromex, Arnhem, The Netherlands) as an indicator for colostrum supplementation within 48 hours postpartum, as well as weekly in the first month of life and monthly thereafter. Packed cell volume (PCV in %, norm reference: 30-36%, low values can indicate iron deficiency anaemia) was measured in centrifugated EDTA conserved blood using a graphic reading device (Micro Haematocrit, Thermo Scientific™ 7600-0938) weekly in the first month of life and monthly after that.
Cow milk sampled according to the same time scheme as blood in calves was analysed for lactoferrin (mg/L) and immunoglobulin G content (mg/L).
The effect of feeding (DS versus BF) on all variables was analysed using generalised linear mixed models and mixed effects logistic regression models in R version 3.6.3 (2020-02-29, R Core Team 2020) on each farm separately. Apart from feeding, starting models contained lactation status of the mother (levels: primiparous or multiparous), sex of the calf (levels: male or female) as fixed factors, age of the calf in days as covariate and interactions between these variables. Animals were nested within the trial or treated as random effects for repeated measured data on farm 1 and farm 2, respectively. Treatment data (aggregated at animal level) was analysed using generalised linear models without random effect nor age of the calf. The difference between the least square means of the fixed effect feeding was assessed by Tukey tests using the «emmeans» package (version 1.4.5, Lenth, 2020) for the respective final model obtained after backward selection. The variable "feeding" was always retained in the final model during the selection process, regardless of its significance. Normal distribution of the residuals of final models was assessed by visual inspection of residual plots.
Statistical significance was assumed at $P<0.05$, with tendency between $P>0.05$ and $P<0.10$.

Results

On farm 1 average daily weight gain (g/d) did not significantly differ between feeding groups. By contrast, calves of primiparous cows on farm 2 benefited from mother-bonded rearing, but no statistical difference was found in calves of multiparous cows. Clinical findings regarding vitality, body condition traits, indicators for diarrhoea and respiratory disorders did not differ between feeding groups on either of the farms, but levels differed between farms. This was also true for number of medical treatment cycles.
Number of oral manipulations of pen mates was consistently higher in bucket fed calves across both farms, while objects were not manipulated with different frequencies between feeding groups.
Avoidance distance did not differ between feeding groups on neither of the farms, with average higher levels on farm 1 compared to farm 2. This difference was in accordance with higher lactate levels above the stress indicating threshold of 2.2 mmol/L found on farm 1, but did not differ between feeding groups.
Total protein content tended to be higher in DS calves compared to BF calves on farm 1 but did not statistically differ between feeding groups on farm 2. PCV differed significantly favouring DS calves on farm 1 and was below the critical threshold for BF calves, but the difference on farm 2 was not statistically significant.

The immunoglobulin G (mg/L) content in cows' milk with or without calf contact showed no statistically significant difference, and both were on similar levels. In week three, lactoferrin (mg/L) content tended to be higher in cow milk from cows with calf contact on farm 2, but apart from this, they did not differ.

Conclusions

We conclude that restricted access to the mother alone only had a minimal effect on the traits investigated. Most parameters changed with age; however, the patterns varied considerably between farms, underlining the relevance of management, which is also reflected in different levels between the two farms. The only consistent difference between feeding groups we found was significantly fewer behavioural disorders in oral manipulations of pen mates in mother-bonded calves across both farms.

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'Whose views and ways are changing?'

Perspectives of change and transition related to cow-calf contact systems in European dairy farming

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Key words: Change pathways, systems changes, transition, fairness, natural needs, actor perceptions

Abstract

This presentation summarises some of the changing perspectives of and transitions to cow–calf contact systems, including identifying the challenges and benefits of the various types of systems, in particular dam-rearing and nurse-cow systems. No dairy system in the study countries was initially designed to enable cow–calf contact, but a multitude of systems allowing cow–calf contact have since been developed based on existing farm structures. Interviews and case studies show that the development requires significant changes in practices, attitudes and farm structures, all of which require a lot of investment. Research over the last two to three years in this area has considered several potential ways in which organic dairy systems could encompass forms of cow–calf contact. Whilst on the one hand these studies have acknowledged the 'naturalness' of cow and calf systems, including the motivation behind them and the need for the cow and calf to be together, 'unnatural elements' have also been highlighted, for example the high milk yields, deep udders and large herd sizes in today's dairy sector. Some issues remain unresolved and the future organic dairy sector will be required to find further solutions. One major issue is that of male calves, which are often removed from their dam early and in an abrupt way. This raises questions as to whether the current development of dam-rearing and other types of cow–calf contact systems can be seen as niche innovations, or as part of a larger change in the socio-technological landscape around dairy farming and calves. These changes are still ongoing in terms of organising new systems that are friendly and less restrictive for cows and calves, and could potentially be part of a larger transition at the systemic dairy farming level.

Introduction

Dam–calf contact systems can be seen to contribute significantly to the positive physiology and natural behaviour of calves and mother cows. In organic farming, as in conventional farming, the separation of calves and cows within days of the birth has generally been accepted. This practice is now being increasingly debated, because it does not meet the natural needs of the cows or calves. The CORE-Organic project GrazyDaiSy began in March 2018 with the aim of investigating the possibilities and sustainability of implementing dam-rearing systems in commercial dairy herds. A Danish project, KALVvedKO ('Cow'n'calf'), began in January 2019 with a focus on developing and testing housing systems for bonded cows and calves, and identifying critical issues regarding the implementation of these systems. Since the implementation of these two projects, we have observed a generally increasing interest in dam-rearing systems throughout Europe and the introduction of several projects targeting different aspects of cow–calf systems. These two projects have worked closely with environmental actors, and aim to investigate farmers' motivations and experiences, build on practical experience in the

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field, and investigate change processes related to establishing cow–calf contact systems. The aim of this presentation is to summarise some of the aspects of change and transition in the preliminary analysis of these systems, including the identified challenges and benefits of the various types of cow–calf contact systems.

Material and methods

This study was based on a joint analysis of semi-qualitative interviews (face-to-face and phone, recorded or with responses written down), conducted during the project period in Norway (5 case studies, 2018–2019), France (3 case studies, 2018–2019, and interviews and observations during a longitudinal study with 20 dairy farmers practising a certain type of nurse-cow system in 2019–2021) and Denmark (31 interviews with farmers, advisers and researchers, 2018–2019, and results from 2 years of stable schools, 2019–2020). The analysis of the case-study interviews, Danish actor interviews and interviews from 12 years of studies in the Netherlands on cow–calf systems were analysed and published in 2019 and 2020 (Vaarst et al. 2019 & 2020). In the present study, the focus of the analysis is on aspects of change and transition in cow-calf contact on dairy farms and within the dairy sector.

Results

The starting point: No dairy farm was designed to dam-rearing in the first place
Clearly, no dairy farming system in the countries where this research was conducted was designed to incorporate dam-rearing. Every farmer had started with an existing, more traditional dairy system and developed a dam-rearing system through various 'learning-by-doing' experiences. This may explain the very different systems emerging in the Netherlands, France, Norway and Denmark. Most of them were developed by innovative farmers, who for various reasons, took the initiative and made it possible to keep calves with their mothers for a period of between a few weeks and the entire suckling period, that is, a minimum of three months. Exchanges of experience had occurred to some degree and in some places. During the project period, educational material in terms of videos, articles in farming magazines and presentations enabled exchanges of inspiration. However, no dairy company had developed brands or labels for milk from farms that practised dam-rearing, and very few farmers in the study had received special recognition for or economic benefit because of their dam-rearing system.

Increasing interest in nurse cow systems
In Denmark, the discussion within and beyond farming turned increasingly to nurse-cow systems. One reason for this was that there seemed to be a general issue with reduced milk let-down in the milking parlour in the first few dam-rearing systems to be set up, which discouraged many farmers from trying these systems. Furthermore, the logistical challenges of having a relatively high number of calves in a traditionally designed dairy system seemed huge. Establishing a nurse-cow system was attractive because the nurse cows could be moved to another building or use land further away from the farm. In France, a nurse-cow system has been in development since 2010, and the GrazyDaiSy project followed farms where this system had been applied. In these systems, weaning and separation take place at the same time, when the calves are between four and ten months old. The French farmers seem very satisfied with this system, although it relies on the availability of summer grazing. Interestingly, the pattern of diffusion of the system could be described in a relatively detailed way, and study trips as well as mutual inspiration had played a big role in the system's dissemination. However, nurse cow systems often involves early separation between the dam and the calf, and does not meet the dam's need to nurse her calf, so the question is whether it fulfils the goal of more natural behaviour, as well as all the societal expectations.

Aspects of 'behavioural change' and personal motivation
If the transition to cow–calf contact systems is viewed through the lens of 'behavioural change', there is a focus on the farmer and his/her personal motivations and choices. There is a clear

assumption that 'establishing a cow–calf contact system' is an option open to everybody. However, since some consumers and retailers only recently have shown a readiness to pay a premium for cow–calf contact, this had obviously not been a motivation for farmers, which was also clear from the interviews. From the interviews it was clear that most farmers who had implemented dam-rearing systems were driven very much by the pleasure of seeing it work and seeing the interaction between calves and cows. They described how they were touched and impressed, for instance, by the mother's protection of her calf and their reaction to separation.

Situated social learning and resource investment required
As the projects developed, it became increasingly clear that cow–calf contact systems required significant investment of personal and often physical/technological resources. In other words: introducing a cow–calf system cannot happen without systemic change. In addition, considerable education was also required, for example, in terms of observing and supervising calves and cows in different ways. This suggests that support from colleagues, the dairy sector, industry and other actors could, in many cases, be a decisive factor for farmers in whether they dare to invest and learn. The interviews showed that farmers' priorities and views of the different qualities and aspects of the various cow–calf contact systems clearly influenced each individual farmer's choice and shaping of the system on his or her farm. For example, if a farmer prioritised allowing the mother cow to fulfil her natural role, dam-rearing was the preferred system, as well as letting bull calves stay with the mother. Many of the interviewed actors, however, placed major focus on the needs of the calf. This became an increasingly multifaceted debate for many actors, which raised awareness of the different interests and possibilities.

Cow-calf contact systems as part of bigger changes at farm level
Other innovative practices were combined with the cow–calf contact system. In the Netherlands, dam-rearing systems had originally started as part of the overall concept of 'family herds', in which all age groups were kept together. The French farms, with their nurse-cow systems, also introduced various combinations of cross-breeding, seasonal calving and milking only once per day. Furthermore, the brand 'La bille bleu' is an example of calves raised in CCC-systems, being slaughtered on the farm and sold at a premium price. In Norway and Denmark there were examples of farmers who introduced cow–calf systems alongside with other systemic changes, such as agroforestry.

Aspects of systemic change
While theories of trigger events, critical incidents and the diffusion of innovation can in part be used to analyse the implementation of cow–calf contact systems at the level of farms, farming systems and groups of farms, it is also relevant to look at conditions for fostering a more systemic change within the dairy sector. The initiation and funding of projects with this focus indicates the presence of a more collective and societal awareness of the issues connected with the early separation of the cow and her calf after birth. However, the question remains as to whether this is part of a larger transition which will requires multiple shifts and layers of change throughout the sector, as well as interplay between niche innovations and a partial reshaping of the landscape of organic dairy farming and potentially beyond. Such systemic change may require some sort of shock or destabilisation to create new windows of opportunity for larger changes. To some extent this shock may be present through some of the arguments around climate change (i.e. less, but more welfare-friendly animal farming), and some animal rights movements raising issues with industrial animal farming, including both the dairy industry and veal production. One of the dilemmas that was constantly raised throughout the period covered by the study is that of the difference between 'calves staying in the herd' and 'calves leaving the herd'.

Final discussion and future perspectives

At the farm level, major efforts are required to implement suitable calf- and cow-friendly dam-rearing systems. The farmer's perspective also has to change, both with regard to observing and understanding animal–animal and human–animal interactions, and to how the whole system works. This is in addition to the need to keep individual animals under close surveillance to monitor their health and welfare. Thus cow–calf systems require the same amount of time and effort as systems with separated calves and cows, but with a focus in different areas. Perceptions are also changing, and farmers need to trust in their animals' capabilities to a larger extent, which also partly breaks with some of the animal husbandry that is often considered important when taking care of cows and calves in a system with early separation, such as knowing exactly how much milk each calf is given. This shift from 'being completely in control' to 'trusting that the animals can manage' is identified as a key human learning in these systems as a component of the shift in focus to observing animals and spending time with cows and calves differently.

Whilst the focus of these projects has been quite centered around farmer decisions and farming systems' development, the transition to mother-bonded rearing or any other form of cow–calf contact system on a larger scale still requires considerable changes on multiple levels, both sectoral and societal. Many actors see cow–calf contact systems as a part of a larger systems change towards agriculture with fewer animals, which are kept more in harmony with the area and landscape (from a systems point of view) and which are more animal friendly because they meet animals' needs to a higher degree. On the other hand, some actors argue that cow–calf contact systems are less resource efficient and thereby less climate efficient, because calves drink more milk when with cows than they are offered under traditional systems. This illustrates how many challenges remain in terms of implementing cow–calf contact systems more widely. Another issue is the current pricing system, which still focuses almost solely on volume of milk production, leading to negative economic consequences for those farmers who keep calves with cows. In terms of potential future transition pathways, we may witness the emergence of cow–calf contact systems which offer alternative and interesting niche products, those which are more widely accepted as a 'new normal' way of dairy farming or a combination thereof.

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Mother-bonded calf rearing in organic milk production: Lessons from pioneer farmers in northern Europe

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Keywords: calf rearing, dairy farming, mother-bonded, practice

Abstract
Pioneer farmers in northern Europe have developed a multitude of different ways of keeping cow and calf together for longer after calving. The practice, timing, and period around both separation and weaning are the most difficult to manage for the nine surveyed farmers. Future research should focus on positive and negative consequences of length, type of contact and methods of separating and weaning.

Introduction
Organic dairy farmers in northern Europe commonly separate calves from their dam around 24 hours after birth. The main reasons for the early separation are: 1) ability to harvest and sell more milk and gain a higher profit, 2) artificial feeding allows closer monitoring, 3) separation is thought to facilitate milk-let-down in the parlour and 4) early separation is thought to minimise separation stress response (Meagher et al., 2019). However, consumers increasingly question this practice (e.g. Weary & von Keyserlingk, 2017). Several dairy farmers throughout northern Europe have developed systems for keeping dam and calf together, and the EU CORE Organic project GrazyDaisy aims to develop systems that allow for increased contact between cow and calf. That includes building on practical experiences and lessons of pioneer farmers, who have developed systems for mother-bonded or dam-rearing calves, terms used to denote the rearing of a calf by its own mother. This short paper briefly presents selected case farms that practise different forms of mother-bonded rearing.

Material and methods
Farms selected as cases had to have a system implemented for mother-bonded calf rearing in the period right after calving. The length of the period with mother-bonded rearing could vary from a few weeks to the whole milk-feeding period. This study excludes farms with a hybrid of mother-bonded and foster rearing as well as exclusive foster systems. Two or more researchers from the GrazyDaisy project visited each selected case farm to collect data and other information.

Results
Nine case farms surveyed so far represent nine different approaches to mother-bonded calf rearing (Table 1) from Scotland, the Netherlands and Germany. Overall, cow and calf are together either the full day or half day, and most surveyed farms practice a combination with full time right after calving followed by half time. Farmers separate cow and calf either abruptly or gradually where calves for the latter have more restricted access to their dam by either limited time together or limited contact through a barrier. Typically, the restricted access through a barrier is achieved by moving calves to a separate pen adjacent to the cow area where cows can reach through or over to the calves while preventing suckling. All farms practice either abrupt weaning or gradual weaning through either limited contact or the use of a nose flap. Farm 5 uses a milking robot to control access between the cow and calf.

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Table 1. Characteristics of system for mother-bonded rearing on case farms*

Farm:	Age of calf in wks. at:		Method:
	Separation	Weaning	Separation
Scotland			
1	22	22	Abrupt
2	26	25	Gradual
the Netherlands			
3	4	12	Abrupt
4	10	10	Abrupt
5	17	19	Gradual
6	16	10	Gradual
7	10	12	Gradual
Germany			
8	14	13	Abrupt
9	15	15	Abrupt

*Average for heifer calves given when different from bull calves.
**Gradual decline controlled by a milking robot.

Discussion

The nine farms surveyed here reflect a complexity of mother-bonded calf rearing systems that the individual farmer has made work in their particular setting. This complicates deriving concrete advice for other farmers and possibly reflects why science is not clear on many of the issues surrounding these systems (Meagher et al., 2019). Furthermore, the practice, timing, and period around both separation and weaning are the most difficult to manage for the nine farmers, and their current practices have evolved over the years. Finally, there appears to be a compromise between the desire to allow cows and calves more time together whilst ensuring sufficient saleable milk and having calves gain more but not too much weight per day. If milk is to meet the entire energy need of growth, then calves need to daily consume an average of 7.1 kg ECM to grow 700 g or 13.8 kg ECM to grow 1,400 g per day over three months (Based on NRC, 2001).

Your suggestions for research and support policies to develop further organic animal husbandry

Research should focus on elucidating the positive and negative consequences of short or long periods with mother-bonded rearing, half time or full time contact, abrupt or gradual separation and weaning as well as different stable systems. This is crucial to ensure the development of beneficial systems for both farmers, cows and calves.

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General conditions of organic cattle farms in Turkey

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Keywords: Organic cattle breeding, organic milk, organic milk quality, CLA, Omega-3

Abstract

This research includes the data of a face-to-face survey study conducted to determine the general conditions of organic dairy farms in different regions of Turkey and the analysis results of feed with milk samples collected from these dairy farms. The survey was conducted in 10 dairy cattle farms in the country. Samples for feed and milk analysis were collected from 5 farms representing different regions of the country. According to the research results, in the dairy farms, especially between the western and eastern regions of the country, there are significant differences regarding business and land size, the utilisation rate of pasture, species of cattle breeds, milk yield and quality.

Introduction

Organic production in Turkey was first started in 1984 with the export of raisins and dried figs, which are traditional export products, due to the demand from abroad (Aksoy, 1999). In Turkey, organic agriculture first showed intensive development in crop production, while organic livestock farming has not developed much due to export-related problems seen in animal production (Ak, 2015, Turhan et al., 2017). The first organic livestock production in Turkey began in 2006. In the following years, the number of breeders, animals and the number of products increased slightly. However, the share of organic animal products in total animal production was very low. Organic animal husbandry is carried out in a total of 148 farms in Turkey. These farms organically produced 12,884 tons of milk, 427 tons of red meat, 175 million eggs, 133 tons of chicken meat and 500 tons of honey. Almost all of the products are consumed in the domestic market. Approximately 1% of the total egg production in the country, 0.5% of the total honey production and 0.1% of the total meat (red or white meat) production consist of organic products (GTHB, 2019). For this reason, organic animal production and consumption levels in Turkey are very low compared to plant production.

Material and methods

In this study, the overall condition of Turkey's organic dairy farms, feed and milk characteristics were investigated. For this purpose, 10 dairy farms were visited to make face-to-face surveys. Moreover, feed and milk samples were taken from 4 different farms located in 4 geographical

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regions each season in a year to determine feed and milk quality. Raw nutrients in concentrated and roughage feed samples, raw nutrients, and silage quality parameters in silage were determined. Vitamin E, CLA, and omega-3 were determined in milk samples as well as the basic nutrients.

Results

The survey data regarding the organic dairy cattle farms in Turkey was given in Table 1. According to the survey, land and pasture areas of organic dairy farms are on average 353 ha and 1.835 ha, respectively. The average number of dairy cattle is 212 per farm. Daily milk production is 19.5 l/head. The insemination number per pregnancy is 1.7. The number of lactation is 3.3. Fat and protein contents of milk are 3.8 and 3.2%, respectively. The death ratio of calves up to weaning is 4.4%. The ratio of mastitis is 11.8%. The artificial insemination ratio is 60%. The silage usage ratio is 80%. The grazing period is 5.8 months. The first insemination age and service period are 18.9 months and 62 days, respectively. The lactation period is 288 days. According to the milk and feed samples taken from 5 organic cattle farms, the quality of corn silage used is high and contains 30.5% total solid content. The contents of total dry matter, fat, protein, lactose, CLA, omega-3 fatty acid, Vitamin E, total bacterial count and somatic cell count are 11.7%, 3.6%, 3.0%, 4.7%, 0.36%, 0.32%, 0.41 mg/lt, 154.000 and 280.000 in raw milk.

Table 1: Survey data of the organic dairy cattle farms

Data regarding farms and production	Number of farms	Min.	Max.	Mean
Land area (Decars)	7	98	20.000	4.169
Pasture area (Dekar)	6	40	70.000	21.137
Pasture period (month)	4	5	8	6.5
Silage usage	5	n/a	n/a	71.4
Number of milking cow (head)	7	127	10	317
First insemination age	7	13	36	20.8
Artificial insemination rate (%)	3	n/a	n/a	42.9
Insemination number per pregnancy	6	1	2	1.6
First calving age (month)	7	22	48	30.3
Service period (day)	7	45	90	65
Lactation period (month)	6	200	305	261.7
Period between pregnancies (day)	7	365	450	405
Lactation number	6	3	4	3.25
Daily milk yield as mean (l/head)	7	13	28	15.5
Fat content of milk (%)	4	3.6	4.4	3.94
Protein content of milk (%)	4	2.8	3.5	3.25
Somatic cell count (SCC)	2	25.000	200.000	112.500
The death ratio of calves up to weaning (%)	6	2	10	3.78
Mastitis rate (%)	6	0	30	11.87

Discussion

Regionally, significant differences have been determined among the farms relating to production and feeding conditions, animal capacities, production technologies, milk yield and quality. The number of organic livestock farms has been decreasing due to insufficient support. According to the results of this research, more support is needed to develop organic animal production, organic dairy cattle breeding and increase the consumption of organic milk and dairy products in Turkey.

It is necessary to sufficiently inform producers to increase milk yield and quality and raise consumer awareness to increase consumption. Since approximately 1/3 of the total pasture areas in the country are located in the Eastern Anatolia region, it is recommended to primarily support organic animal husbandry in this region and basin basis.

Suggestions for research and support policies to develop further organic animal husbandry

Providing government support to organic animal production and raising consumers' awareness of the health benefits of organic animal food through the media will help strengthen organic animal production.

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Antihyperlipidemic and antioxidant properties of CLA of grass-fed milk & meat

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Keywords: CLA, animal feed, antioxidant, metabolic diseases

Abstract

In a meta-study, the role of conjugated linoleic acid (CLA) were analysed. CLA is available in meat and dairy products such as butter, milk, beef, and lamb. The total amount of CLA in foods varies greatly depending on animal feeding. Pasture feeding has been determined to increase the content of some beneficial nutrients such as Omega-3 fatty acids, vaccenic acid, and CLA in the milk. It has been observed that grazing animals have 500% greater CLA concentrations in their milk than animals fed diets containing 50% concentrate and 50% conserved forage. CLA supports immunity and reportedly anticarcinogenic, antidiabetic, antiobesity and anti-atherogenic.

Organic animal husbandry regulations require significant pasture feeding and restrict the use of concentrates. Organic animal foods will get more important due to numerous health benefits and the non-use of chemically-synthesised products in crop production. Several studies show that the content of CLA in organically produced milk and meats were in general higher. The milk produced from organic farming was determined to have a higher CLA content (0.80% among the total fatty acids) than the conventional milk that has 0.61% CLA. According to the previous research, the CLA content was from 12 to 60% higher in organic milk than in conventional milk. Organic meat was found to have a 10% higher CLA than non-organic. More comparative studies, possibly also with consumption studies of different diets, are needed to confirm such quality differences and potential health benefits.

Introduction

Conjugated linoleic acid (CLA) is a natural food component that is obtained from ruminants, refers to a mixture of positional and geometric isomers of linoleic acid (*c*-9, *c*-12, C18:2) with two conjugated double bonds at various carbon positions in the fatty acid (FA) chain. CLA can be produced employing the enzyme delta-9-desaturase which promotes the desaturation of the 11-trans octadecanoic acid. CLA has many different isomers, such as 11-trans and 9-cis in foods (Lehnen et al., 2015).

Organic animal foods have many benefits for human health. For example, CLA is an agent that helps inhibit some cancers by blocking tumour growth and metastasis (Belury et al., 2002). Kritchevsky has found that it suppresses skin, stomach, breast and colon tumours in rats (2000). According to other *in vivo* studies, CLA has proliferative effects on breast and prostate cancers. In addition, it has been found that lipid levels in the test animals fed by CLA decreased plate formation in the aorta.

On the other hand, CLA was found to reduce total cholesterol, low-density lipoprotein cholesterol (LDL cholesterol) and triglyceride levels. Therefore, CLA is one of the significant constituents to reduce the risk of cardiovascular diseases. In addition, CLA is a component that also

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has an antiobesity effect. It reduces body fat level that is an important criterion on obesity development. Studies have shown that dietary CLA in animal models normalises glucose tolerance, reduces plasma insulin levels, inhibits glucose and helps to control fatty acid metabolism (Garibay-Nieto, 2017). Furthermore, various studies have demonstrated that CLA affects bone development (Watkins et al., 2000), promotes immune response, and has an antioxidant effect due to its high radical scavenging activity (Kritchevsky et al., 2000).
The daily CLA consumption has been recommended as 104-151 mg/day for women and 176-212 mg/day for men by Jenkins & Harvatine (2014). With the daily diet consisting of 60% of dairy products and 37% of meats, CLA intake can be 176-212 mg/day for men and 104-151 mg/day for women.

Results

CLA is a component obtained from ruminants and found in the animal foods such as milk, dairy products, and meat. Polyunsaturated fatty acids (PUFA) are consumed by ruminants and modified into other fatty acids in the rumen. CLA is formed as a result of bio-hydrogenation of fatty acids, spreads to the blood and other tissues through the small intestine. When linolenic acid is converted to stearic acid by bio-hydrogenation, vaccenic acid content arises as an intermediate product. Vaccenic acid is one of the fatty acids produced in the intestines and absorbed into the tissues. It is converted to CLA by the action of the delta-9desaturase enzyme. If the animals are fed with rich green grass contained linoleic acid (C18: 2), the meat with a high level of CLA is produced.

CLA content in milk and beef meat is affected by numerous factors such as genetic factors, nutrition/feeding conditions, season, lactation etc. When organically produced milk and meat are compared to conventional, it has seen that heredities of herds and nutrition conditions are the major factors affecting its composition. CLA content of grass-fed beef has been determined as 500-800 mg (4 ounces). This is approximately two to three times more than the amount present in non-grass-fed beef. Seasonal variations in pasture and grazing management and the amount of forages and grains fed affect the product quality and composition. According to the legislation regarding organic animal husbandry, pasture feeding is required and important. In addition, it should not be forgotten that some feeds such as starch-based concentrates or supplements that can affect the milk composition are limited in organic animal production (Alothman M et al., 2019, Jenkins & Harradine, 2014).

In the literature, there has been a considerable number of meta-studies focused on the comparison of the CLA content in milk and meat produced from organically fed animals versus conventional. According to these meta-analyses, it has been observed that the content of CLA in organically fed animal products is generally higher. The CLA content in dairy products was between 3.4 to 7.9 g/kg in terms of the total lipid content. The milk produced from organic farming was determined to have a higher content of CLA (0.80% among the total fatty acids) than the conventional milk (0.61% CLA) (Daley, 2010). According to the previous research, the CLA content was 12, 18, 25, 41 and 60% higher in organic milk than conventional milk (Benbrook 2013, Cintra 2018, Ells 2006, Manzi 2017, Średnicka-Tober 2016). In addition, organic meat was found to have 10% higher CLA than non-organic. The CLA content was 9.5 g/kg among the fatty acids in organic meat, while it was 7.3 g/kg (total fatty acids) in non-organic meat (Cintra 2018, Kamihiro 2015).

Discussion

The number of studies on the effect of functional foods on human health increases day by day. Today, the combination of overeating and a sedentary lifestyle increases fat energy stores and causes various metabolic diseases. Functional food ingredients may play an essential role in the treatment and prevention of many metabolic complications. CLA is a significant food component with high potential. The contribution of organic animal husbandry to the amount of CLA available in animal products is great. Pasture feeding increases the amount of various beneficial nutrients, mainly CLA and vaccenic acid found in milk and meat products. Cow and beef feeding systems also affect the functional characteristics of milk and meat. The feeding systems affect the composition and processability of bovine milk and meat.

More comparative studies, including the effects of different diets, are needed to confirm such quality differences and potential health benefits.

Suggestions for research and support policies to develop further organic animal husbandry

Since CLA is a component found naturally in milk and animal foods, increases with natural feeding and reduces the risk of many chronic diseases, it is important in terms of maintaining human health and reducing treatment costs with preventive measures. Pasture feeding should not only be considered in terms of meat and milk yield and improving the sensory properties of products. However, while determining the feeding and feed policies, it should be taken into account that grazing in the pasture and feeding the animals with green grass have positive effects on human health.

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The effects of slaughtering age on chemical meat quality characteristics of Anatolian Merino and Polatlı lambs under organic management

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Keywords: organic, sheep, meat quality

Abstract

The aim of the project was to determine the effects of slaughtering age on the meat quality characteristics of Turkish Anatolian Merino sheep (n=18) and Polatlı sheep (n=18) under an organic management system. The experiment was done at Ege University, Ödemis Vocational Training School Experimental Farm in Izmir (38°13'03'' N, 27°59'50'' E). The sheep consumed 100% organic ration with the 60:40 ratio of the organic Lucerne hay (ad-libitum) and organically produced concentrated feeds, consisting of maize, soybean meal, wheat, barley and mineral premix. The nutrients compositions, including dry matter, crude ash, crude protein, ether extract and total fatty acids, were determined with lamb meat samples (m Longissimus dorsi) at the slaughter ages of 90 and 180 days. The dry matter, ash and ether extract values for each breed in 180 days were significantly higher than in 90 days of the experiment. In addition, monounsaturated (MUFA) fatty acids concentrations increased with age, and Omega 6 decreased with age ($p<0.05$). These two breeds are suitable for organic sheep production in Turkey; however, other questions linked with organic farming, such as veterinary, feeding, animal welfare, sensory meat quality and marketing, need further investigation for the local breeds.

Introduction

Turkey ranks among the top ten world countries for sheep population, with its 42.1 million estimated sheep population. The number of sheep increased by 13% from 2019 to 2020 (TUIK, 2020). When it comes to organic sheep production, the number of sheep herd under organic management breeds was 16.711 in 2019. However, it was 73.414 in 2013 (Eurostat 2021). Additionally, the proportion of organic sheep has shown fluctuations over the years because plant production is not integrated with animal production, organic feeds are rare, bought from abroad and very expensive, and lastly, many farmers are small landowners and therefore not capable of organising the funds for inspection and certification. East Anatolia and South-East Anatolia are specialised in sheep production, using traditionally grazing systems. In the last 30 years, a progressive decline of the traditional pastoral system based on transhumance has been observed.

As a consequence of the decrease in rural populations and traditional farming systems, sheep farming systems must adapt to improve animal welfare, productivity, efficiency, and quality, particularly concerning food safety. Although organic management is a great challenge, the organic production of sheep has become popular in Turkey. This is driven by the Turkish consumers' perception that sheep meat is healthier, based on the belief that sheep are pasture-fed, choosing meat of domestic origin is important, sheep breeding production requires less medicine than bovine breeding and that sheep meat is considered tastier than cattle meat (Uzmay and Çınar 2017). From an industrial perspective, quality is defined and determined by objective factors relating not only to the quality demanded by the consumer, but also to industrial meat characteristics.

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Slaughter age has a strong influence on the carcass composition and meat quality of sheep. Additionally, consumers' awareness of healthy nutrition is increasing (Komprda et al., 2012), increasing the demand for higher meat quality and fatty acid composition (FAs) of intramuscular fat. Regarding polyunsaturated fatty acids (PUFA), the ratio between *n*-6 and *n*-3 in foods was at the level recommended by the committee on the Medical Aspects and Food Policy (Report, 1994). Therefore, it is vital to know the effects of slaughter age on the meat quality characteristics in organic Turkish local sheep breeds. The aim of the study was to determine the effects of slaughtering age on the chemical composition and meat quality characteristics of Turkish Anatolian Merino sheep (n=18) and Polatlı sheep (n=18) under organic management.

Material and methods

Experimental animals and husbandry practices: Anatolian merino sheep (from German Mutton Merino, 80% and native White Karaman, 20%) and Polatlı Sheep (from Ile de France, 75% and native White Karaman, 25%) male (registered as local breeds in 2004 and 2010, respectively) (Ertuğrul et al. 2011) were used. The experiment was done at Ege University, Ödemiş Vocational School Experiment Farm in Izmir, Turkey, under organic management. Eighteen sheep were housed in two identical pens (18 from Anatolian Merino, 18 from Polatlı were kept at the same pen) with the same direction and orientation; they were equipped with similar concrete troughs for feeding. The pen measured 4.1 m^2 per sheep and 55 cm troughs per sheep. Every sheep had free access to 5 m^2 outdoor run. All sheep were cared for according to veterinary recommendations. The average initial weight (approx. two months of age) was 23.14 kg in Anatolian Merino, 23.17 kg in Polatlı. After 90 days, the Anatolian Merino reached an average of 42.39 kg live weight, and Polatlı reached 41.78 kg average. At 180 days, the average final weight was 63.52 in Anatolian Merino, 62.59 kg in Polatlı. The slaughter procedure was done in a slaughterhouse in İzmir, certified by IMO-Turkey.

Feeding and diets*:* All feeds used to prepare concentrate were organic and obtained from Tiryaki Co. (Gaziantep), certified by ECOCERT-IMO Turkey. The organic starter concentrate was offered for all animals from day 0 to 90, while organic grower concentrate was offered from day 90 to 180. The organic concentrates were formulated to meet the minimum nutrient requirements of sheep (NRC, 1985) standards, and daily dry matter intake was calculated at approximately 4% of the animal's body weight. The organic concentrate was offered to sheep as a maximum of 40% of dry matter intake on dry matter divided into two meals/day (morning feeding at 8:00, afternoon feeding at 16:00). The sheep had free access to Lucerne hay and water during the experiment. The ingredients of organic starter concentrate (0-90 days) consist of maize (250 kg ton^{-1}), soybean meal (210.0 kg ton^{-1}), wheat (355.0 kg ton^{-1}), barley 160.0 kg ton^{-1}), mineral premix (1 kg ton^{-1}), sodium chloride (4 kg ton^{-1}), di-calcium phosphate (2 kg ton^{-1}) and marble powder (18.0 kg ton^{-1}). The ingredients of organic grower concentrate (90.-180. days) consist of maize (371.5 kg ton^{-1}), soybean meal (140.0 kg ton^{-1}), wheat (350.0 kg ton^{-1}), barley (110.0 kg ton^{-1}), mineral premix (1 kg ton^{-1}), sodium chloride (4 kg ton^{-1}), di-calcium phosphate (5.5 kg ton^{-1}) and marble powder (18.0 kg ton^{-1}). Mineral premix provides per kg: Mn; 50.000 mg, Fe; 50.000 mg, Zn; 50.000 mg, Cu; 10.000 mg, I; 800 mg, Co; 150 mg, Se; 150 mg. The chemical composition of organic concentrates and Lucerne hay are shown in Table 1. The chemical compositions of diet and lamb meat (dry matter, crude ash, crude protein, ether extract) were determined according to AOAC (1995). The crude fibre was determined using the Lepper method (Lepper, 1933). The metabolisable energy (ME) values of feed were calculated by using Turkish Standard Institute equation (TSE9610, 2004) ME, kcal/kg organic matter = 3,260+(0.455×crude protein+3.517×ether extract) –4.037×crude fibre.

The fatty acids (FAs): The lipid fraction (approximately 0.5 g) from meat was extracted with chloroform-methanol at a ratio of 2:1; the lipid was then isolated in the chloroform phase after adjustment of the solvent ratio to 2:2:1 (chloroform:methanol:water, v/v). The chloroform phase was removed and evaporated until dry under a vacuum heater below 40°C (Folch, Lees and Sloane-Stanley, 1957). The lipid is refluxed with a 1M solution of potassium hydroxide in 95% methanol. Then all lipid samples were analysed using gas-liquid chromatography to determine the FAs (Agilent Technologies 6890 N Network GC System, Anaheim, CA, USA, Thermo Scientific TRACE TR-FAME GC Column; 60 mL, 0.25 mm ID, 0.25 um thick) at the University of Ege, Central Analytical Laboratory. Detector temperature: 250°C, injection block temperature: 250°C, oven temperature: gradually from 2°C to 240°C, split flow 119.9 mL min-1, helium as the carrier gas. The FAs were identified by comparing their retention time and fragmentation pattern with an established standard (SUPELCO 37 Comp. Fame mix 10 mg mL-1 in CH12Cl2). All FAs, saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA), were expressed as the percentages of total lipids. All tests were carried out using the statistical package of SPSS (15.0).

Table 1. Chemical composition of diets

Analyzed Chemical composition, %	Organic Starter Concentrate	Organic Grower Concentrate	Lucerne Hay
Dry matter	88.89	88.67	92.12
Crude ash	2.42	2.05	9.69
Crude protein	17.81	15.13	13.73
Ether extract	4.06	3.69	1.57
Crude fiber	4.01	3.40	24.77
Calcium	0.78	0.85	1.10
Total phosphor	0.42	0.46	0.20
*Metabolizable energy, kcal/kg	2672	2752	1805

Results and Discussion

The chemical composition of meat and total fatty acids composition of intramuscular fat of Anatolian Merino and Polatlı Lambs (*m. Longissimus dorsi*) with different slaughter ages are presented in Table 2.

Table 2: The effects of the slaughter age on the chemical composition of Anatolian Merino and Polatlı Lambs meat (*m. Longissimus dorsi*) (n=8)

Chemical composition	90. days		180. days		SEM*)	P Value
	Anatolian Merino	Polatlı Sheep	Anatolian Merino	Polatlı Sheep		
Dry matter	24.94 a	23.75 a	28.64 b	27.73 b	0.41	0.000
Crude ash	1.13 ab	1.09 a	1.19 bc	1.23 c	0.02	0.003
Crude protein	23.36	22.46	23.48	23.38	0.17	0.113
Ether extract	0.59 a	0.52 a	0.96 b	0.89 b	0.06	0.004
Total fatty acids composition						
Σ SFA**)	47.281	47.162	47.107	47.099	0.499	0.999
Σ MUFA**)	40.746 a	40.464 a	44.826 b	44.396 b	0.619	0.002
Σ PUFA**)	11.973	12.374	8.067	8.505	0.748	0.056
Σ Omega 3 (n-3)	2.415	2.545	1.829	2.000	0.152	0.311
Σ Omega 6 (n-6)	8.720 b	8.649 b	4.734 a	5.491 ab	0.662	0.036
n-6/n-3	3.68	3.33	2.59	3.02	0.20	0.299

*) SEM, standard error of means, Different letters (a,b,c) within rows indicate significant differences ($p<0.05$).
**) SFA: Saturated Fatty Acids. MUFA: Monounsaturated Fatty Acids. PUFA: polyunsaturated Fatty Acids

As slaughter age increases, the dry matter results, crude ash and ether extract increases, as was expected (Table 2). The chemical composition of lamb meat, excluding crude protein, were significantly affected by the slaughter age. The dry matter, crude ash and ether extract values were higher in 180 days slaughter age than in 90 days for both breeds. However, for crude ash, 90 and 180 days of age were similar in Anatolian Merino lamb. Similar to our study, Morbiddini et al. (2011) reported that dry matter, ash, protein and fat contents in longissimus dorsi muscle of Italian Merino lambs (75 days of age 18.2 kg fast body weight) were 25.6%, 1.3%, 22.3% and 1.9% respectively. Ether extract values were found to be higher than the values found in our study. Bonanno et al. (2012) reported that the chemical composition of 129 days of age (from 17.1 initial weight to 26.0 final weight) of organic Comisina male lamb meat, fed with ad-libitum alfalfa hay pellets and concentrate feed (contains 25% soybean meal), was 25.9%, 1.1%, 18.7% and 6.1% in dry matter, ash, crude protein and fat, respectively. In their study, dry matter and ash values were close to our study, crude protein was lower than in our study, and fat value was higher than our study. Soysal et al. (2011) reported that Karacabey Merino had reached 35 kg live weight in 98 days, while Kıvırcık required 126 days. They informed that the dry matter, ash, crude protein and fat were 26.9%, 1.3%, 21.4% and 2.1% in Karacebey Merino, 26.9%, 1.31%, 21.6% and 2.8% in Kıvırcık. Their findings are similar to our study with the dry matter, ash, and protein values. However, fat values were higher than in our study. Due to the increased dry matter content of feeds, older animals contained significantly higher ash and ether extract compared to lambs slaughtered at 180 days of age, similar to results presented by Polidoria et al. (2017). In our study, crude protein content was not affected by the slaughter age, as informed by Polidoria et al. (2017). Differences in sheep meat quality at different ages necessarily correspond to changes in the amount of carcass fat and its relationship to physical and chemical properties.

The fatty acid % of intra-muscular longissimus dorsi showed, as expected, a dominance of saturated fatty acids (SFA) in comparison to other muscles (Table 2). The effects of slaughter age on the total FAs composition of the Anatolian Merino and Polatlı lambs intramuscular fat was significant for ΣMUFA and ΣOmega 6 values (Table 2). While the differences between 90 and 180 days were significantly lower in ΣMUFA, it was significantly higher in ΣOmega 6 values for 90 days. However, the ΣPUFA value of the 180 days was similar in Polatlı to ΣPUFA value of the 90 days slaughter age for each breed. Morbiddini et al. (2011) reported that ΣSFA, ΣMUFA, ΣPUFA, ΣOmega 3, ΣOmega 6 were 53.1, 33.93, 12.95, 2.34 and 1.15 % of total fat contents in longissimus dorsi muscle of Italian Merino lambs, respectively. Although the findings of the ΣPUFA and ΣOmega 3 are very close to our study (12.95 vs 11.973) and (2.34 vs 2.415), our study's ΣOmega 6 values were relatively higher from their findings. Bonanno et al. (2012) reported that the Σ SFA, ΣMUFA, ΣPUFA, ΣOmega 3, Σ Omega 6 and n6/n3 values were 39.3, 39.3, 21.3, 4.33, 14.4 % and 4.17 in Comisina organic male lamb meat feeding like our study with ad-libitum alfalfa hay pellets and concentrate feed (contains 25% soybean meal), respectively. Their findings of ΣOmega 6 values were close to our study with 14.4%. Polidoria et al. (2017) reported that the ΣSFA, ΣMUFA, ΣPUFA, ΣOmega 3, ΣOmega 6 and *n*6/*n*3 values at 2 months of age were: 40.5, 33.0, 26.6, 5.52, 20.1, 3.64; 5 months of age: 42.0, 31.8, 26.1, 5.57, 19.1, 3.43 in Fabrinose lambs longissimus dorsi fatty acid composition (% of total fatty acids). SFA content was significantly ($P < 0.05$) higher in lambs slaughtered at 5 months of age than 2 months age in Polidoro et al. 2017. This increase in SFA in older lambs can be attributed to the major hydrogenation performed by micro-organisms in the completely functional rumen of older animals, adapted and ready for a dry diet; however, in our study, we did not found this effect. In our study, the *n*-6/*n*-3 ratio was not significantly affected by slaughter age. In contrast, Polidoria et al. (2017) reported a lower value in older animals compared to younger. The fatty acids profiles from both groups of animals were within the nutritional recommendations for the human diet (*n*-6/*n*–3 < 4) (Anonymous, 1994). The influence of weight and slaughter age on fatty acid composition in sheep meat is quite controversial (Dransfield et al., 1990). Some results indicate no influence of slaughter weight on the fatty acid composition of meat (Díerking et al., 2010). However, in our study, there was a positive relationship between the animal's slaughter age and fatty acids concentrations (MUFA) ($p<0.05$).

In conclusion, we found that organic management influences meat quality and FAs. Due to the increased dry matter content ($p<0.05$), older animals showed significantly higher ash and ether extract content than younger lambs. In addition, we found that fatty acids concentrations, and the proportion of monounsaturated (MUFA), increase with age (until 180 days), while the proportion of Omega 6 ($p<0.05$) decreases. Organic sheep can be a valuable part of a sustainable farming system, and two local breeds are suitable for organic sheep production in Turkey. However, many open questions linked with organic farming remain, such as veterinary, feeding, animal welfare problems, sensory meat quality and marketing - these need further investigation for local Turkish breeds.

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The effects of the two rotation programs on the feed value of organic cottonseed

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Key words: Organic, feed value, cottonseed, rotation.

Abstract

The aim of the study was to evaluate the effect of two different rotation programs on the crop yields and feed value (chemical composition and metabolizable energy values) in organic cottonseed cultivation. The crops used in the Rotation-I were Persian clover-silage maize, vetch/triticale mix stand-cotton (cottonseed) during 2014-2015 and 2016-2017. Rotation-II crops were: vetch/triticale mix stand-cotton (cottonseed), Persian clover-silage maize, during 2014-2015 and 2016-2017. The study was carried out in 2 different matched systems with 4 replications in the Menemen Plain in the Aegean Region of Turkey. In Rotation-I, significant differences in crop yield were found for Persian clover, maize silage and cottonseed with an increase of 3050 kg ha^{-1}, 31740 kg ha^{-1} and 530 kg ha^{-1} between 2014-2015 and 2016-2017, respectively ($p<0.05$). The yield of maize silage yield increased significantly by 28840 kg ha^{-1} between 2014-2015 and 2016-2017 in Rotation–II ($p<0.05$), there was no significant yield change in the other crops. Crude ash, crude protein, ether extract, crude fiber, nitrogen free extract and metabolizable energy values of organic cottonseed changed between years and rotations. The crude protein, ether extract and nitrogen free extract were significantly affected by two different rotation programs ($p<0.05$). There is a great need for investigation of organic animal feed crops as a protein source in local organic animal feed production to suit the climate and ecology of the country.

Introduction

Organic feed production is one of the most important inputs in organic animal production and rations prepared for animals have to be made from organic feeds. It is well known that there is insufficient production of organic animal feed crops in Turkey, as in every country. The improvement of organic livestock depends on a sufficient level of quality organic feed input. Considering that feed input constitutes 70% of the costs of production, these problems are among the main reasons why organic livestock farming cannot progress in Turkey and possibly in other countries. It is claimed that an optimal energy to protein ratio in a balanced diet is important to enhance the use of protein, and species, age and growth stage require different protein levels. Cotton *(Gossypium* spp) is mostly used as solvent extracted cottonseed meal or raw cottonseed in cattle rations in some countries as it is somewhat similar to soya meal. However, it's use in monogastric animal diets may be limited because of the presence of gossypol.

Animal husbandry should be an integrated part of the cropping system. The increasing availability of locally produced animal feed should be the foremost element of self-sufficiency in local food systems. It is vital to investigate animal feed crops that suit the climate and ecology of a country to provide a viable protein source for local animal feed production. The aim of this study was to determine the differences in yield and feed value (chemical composition and metabolic energy value) of experimental crops of organic cottonseed used in two different rotations during 2014-2015 and 2016-2017.

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Material and methods

Material: The crops in the study were a Vetch / Triticale mix (Alper / EgeYildizi) (75kg vetch seed+ 25kg triticale seed per ha)), Persian clover, maize silage (Burak) and cotton (Baly 308). The sequence of crops used in Rotation-I were as follows; Persian clover- maize silage, vetch/triticale mix stand-cotton (cottonseed) in both the 2014-2015 and 2016-2017 rotations. Rotation-II was as follows: vetch/triticale mix stand-cotton (cottonseed), Persian clover-silage maize in both the 2014-2015 and 2016-2017 rotations. The trials were conducted in the Menemen Plain in the Aegean Region of Turkey (Figure 1). A typical Mediterranean climate prevails in the Menemen Plain region. The summers are hot and dry, and the winters are warm and rainy. Following a soil sampling analysis, organic fertilizer containing 2 % N, 2.5 % P_2O_5, 2.5 % K_2O, 60 % organic matter and 9/12 C/N was applied to the experimental plots. Fertilization was carried out so as not to exceed 17 kg.da^{-1} nitrogen as stated in the organic farming regulations. The experimental site had an alluvial soil with loamy texture, no salinity problem, medium lime content, low available phosphorus, high available potassium, low organic matter and was slightly alkaline.

Figure 1: Menemen Plain in the Aegean Region of Turkey

Methods: The experiment was established in 2013 and completed in 2017. It was carried out in 2 different systems for 5 years in a randomized block experimental pattern with 4 replications at the International Agricultural Research and Training Center (ARTC), Aegean Region, Turkey. The experimental plots were 2.8 m x 5 m = 14 m^2, with a distance of 1.5 m between each parcel and a distance of 5 m between the 2 rotation systems. Irrigation was employed at the correct times during the growing season to prevent water stress in each experimental crop. Minimum tillage was used. Certified organic preparations were applied when the insect levels passed a threshold and mechanical weed control was utilised. The yields of the crops, Persian clover as dry hay and the green yield of the Vetch +Triticale mix were expressed as kg ha^{-1}. The plants were harvested with a sickle when 1/3 of the plants reached the flowering stage. The maize silage was harvested at the pulp stage of the product and calculated as green yield. After ginning, the fiber and cotton seeds were separated. The seed yield per plot was calculated as kg ha^{-1}, and comprised 60% raw cottonseed and 40% fiber. The oil was extracted from the cottonseed manually, the cottonseed was then ground to pass through a 1 mm screen before chemical analyses. The chemical composition of the organic cottonseed (crude ash, organic matter, crude protein, ether extract, and nitrogen free extract) was determined according to AOAC (1995). The crude fiber was determined using the Lepper method (Lepper, 1933). The metabolizable energy (ME) values of feed were calculated by using the Turkish Standard Institute equation (TSE9610, 2004) ME, kcal/kg organic matter = 3,260+(0.455×crude protein+3.517×ether extract) –4.037×crude fiber. All tests were carried out using the SPSS statistical package (15.0). The differences between the means were tested by using an Independent Samples Test (T- Test) for yields, and a Duncan test was used for the chemical composition and metabolizable energy values.

Results and Discussion

Table 1 shows the differences of yield (average and standard error of means) of the experimental crops for 2014-2015 and 2016-2017 on the two rotation programs. In Rotation-I, the average yield of crops changed from1700-23260 kg ha^{-1} for 2014-2015, to 2230-55000 kg ha^{-1} for 2016-2017. There was no significant difference between the years for the Vetch +Triticale Mix. Significant differences in crop yield were found for Persian clover, maize silage and cottonseed with an increase of 3050 kg ha^{-1}, 31740 kg ha^{-1}, 530 kg ha^{-1} respectively ($p<0.05$). In the Rotation-II with the exception of maize silage there was no significant difference in the yields of crops. The average yields changed from1580-26340 kg ha^{-1} for 2014-2015, 1720-55180 kg ha^{-1} for 2016-2017. The increase in maize silage yield was significant, increasing by 28840 kg ha^{-1} between 2014-2015 and 2016-2017 ($p<0.05$). Açıkgöz (2001) found watered Persian clover to yield a dry hay value of 600-1200 kg da^{-1}, Çeçen et al.(2005) achieved 12500kg ha^{-1}.These yields were similar to Rotation-11 but lower than the Rotation-1yields recorded in this study.The average yields of maize silage (green) stated as 60000-103720 kg ha^{-1} by Seyithan and Saruhan (2017) and 88760 kg ha^{-1} by Yürekli et al. (2021), were higher than this study (23260-55000 kg ha^{-1} Rotation-I and 26340-55180 kg ha^{-1} Rotation-II). A lower yield can be expected under organic management. Carpici and Celik (2014) found that the average green yield of vetch+triticale (at a ratio of 75:25) was 14480 kg ha^{-1} which was higher than the results of this study. Similarly, in this study the yield of organic cotton was lower than the 3260-4090 kg ha^{-1} reported by Erdal and Sökmen (2017). Notably, this study showed that the yield of organic cottonseed was significantly increased with different crop rotations, being higher in Rotation-I.

Table 1: The differences of yields (average ± standard error of means) of experimental crops (kg ha^{-1}) for 2014-2015 and 2016-2017 years on the two rotation programs

CROPS	Rotation-I		P Value Sig. (2tld)	Sig.	CROPS	Rotation-II		P Value Sig. (2tld)	Sig.
	2014-2015	2016-2017				2014-2015	2016-2017		
Persian clover	17930±350	20980±870	0.017	*	Vetch +Triticale Mix	12390±350	11790±210	0.188	n.s
Maize silage	23260±570	55000±410	0.000	*	Cottonseed	1580±130	1720±50	0.356	n.s
Vetch +Triticale Mix	11430±330	12590±490	0.097	n.s	Persian clover	13300±450	14110±660	0.351	n.s
Cottonseed	1700±70	2230±100	0.005	*	Maize silage	26340±440	55180±980	0.000	*

Sig: Significance * $p<0.05$, n.s: not significant.

The amount of yield obtained from the unit area is as important as the chemical component of animal feed crops. In organic farming, when a proper plant nutrition system in accordance with the organic standards is applied to the soil, a gradual increase in yield can be achieved over the following years. The organic farming system is a holistic approach, that should pay attention to climate conditions, plant nutrient sources, plant variety, choosing rotation crops and sequencing crops carefully, soil tillage techniques, irrigation water sources and efficient use of water. Control of other living organisms contributing to plant disease, weeds and pests should be achieved without harming the environment. It should be clearly understood that the greatest benefits will accrue when the production of livestock and animal feed crops are considered together.

Table 2 shows the change in chemical composition and metabolizable energy values of organic cottonseed on the two rotation programs. Crude ash, crude protein, ether extract, crude fiber, nitrogen free extract and metabolizable energy values were changed between 5.04-5.23%, 20.77-22.27%, 11.93-15.23%, 31.15-34.04%, 24.13-30.95 %, 9.77-10.21 (MJ/kg DM) respectively. Although, crude ash, crude fiber and metabolizable energy values were not significantly affected by the two rotation programs, crude protein, ether extract, nitrogen free extract were ($p<0.05$). The crude ash values in this study were very close to those quoted by

Singh et al (2003), however, Pehlevan and Özdoğan (2015) recorded lower crude ash values (4.18, %).
Crude protein and ether extract values were higher in Rotation-I than in Rotation-II for 2014-2015 time period ($p<0.05$). However, for the years 2016-2017 the crude protein and ether extracts in Rotation–II were similar to Rotation-I.
Many authors (Singh et al. 2003, Bertrand et al, 2005, Delgado and Peyes 2017) have noted changes in crude protein and ether extract values of cottonseed (between 22.40-25.4% and 14.4-20.71 %), similar to the changes found in this study. The crude fibre values reported here were very close to those quoted by Pehlevan and Özdoğan (2015) and were higher than the 21.0% quoted by Osti and Pandon (2006)
Nitrogen free extract was higher overall in Rotation-II for than Rotation-I

Table 2: The change of chemical composition (% on DM) and Metabolizable energy values (MJ/kg DM) of organic cottonseed on the two rotation programs

	Rotation-I		Rotation-II			
	Crops: Persian clover / maize silage, Vetch +Triticale Mix, Cottonseed		Crops: Vetch +Triticale Mix, Cottonseed, Persian clover / maize silage		SEM	P value
	2014-2015	2016-2017	2014-2015	2016-2017		
Crude ash	5.04	5.23	5.19	5.12	0.12	0.961
Crude protein	22.27 a	22.22 a	20.77 b	21.79 ab	0.22	0.036
Ether extract	14.53 a	14.90 a	11.94 b	15.23 a	0.37	0.000
Crude Fiber	34.04	31.80	31.15	31.87	0.44	0.082
Nitrogen free extract	24.13 b	25.80 b	30.95 a	25.99 b	0.76	0.001
Metabolizable energy	9.77	10.18	9.82	10.21	0.08	0.103

DM: Dry matter, SEM: Standart error of the means, Different letters (a,b,c) within rows indicate significant differences ($p<0.05$).

Whole cottonseed is a very popular feed for dairy cattle and is uniquely high in fiber, energy (from fat), and protein. There are differences in the nutrient content between the types of cottonseed products and also between the methods used to extract the oil from the whole cotton seed. The limiting factor for using cottonseed as a feed in farm animals is gossypol, a toxin which causes 'cottonseed injuries'. Calves, as they have an undeveloped rumen, and non-ruminants are more sensitive to gossypol toxicity than adult ruminant animals. Toxicity issues occur when raw cottonseed is fed. One of the easiest methods to reduce toxicity is the expeller method of extracting the oil, due to the required heat and pressure the gossypol is inactivated.

In conclusion, alternative protein sources are necessary in addition to soybean and will make significant contributions to the solution of the organic feed protein problem. Cotton cultivation is limited in terms of climatic and ecological requirements. In organic cotton growing countries, cotton-seed can be considered as protein source in organic animal feed. The cropping system is important in organic farming. The selection of plants grown in rotation contributes to the increase in yield. Rotation-I might be preferable to Rotation-II because of the increased experimental crop yields and crude protein values. There is a great need for further investigation on animal feed crops suitable for the ecology of the countries as a protein source in local animal feed production.

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Variability in forage biomass on extensive pastures and productivity of grazing cows on organic dairy farms in South Germany during a dry year

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Keywords: dairy cattle, grazing systems, forage use, productivity

Abstract

Forage on semi-natural pastures is a valuable feed resource for organic dairy cattle. However, the availability and nutritional value of forage biomass and, consequently, animal performance may vary greatly depending on, e.g., agroecological and grazing management factors and may be particularly constrained in dry years. Therefore, the aim was to assess the forage biomass and productivity of lactating cows grazing semi-natural pastures under diverse agroecological conditions on organic farms in Southwest Germany in the dry year 2018.

Semi-quantitative interviews were conducted on 27 farms in summer 2018 to evaluate farm structures, herd size/composition, and grazing management. Data were complemented by external database records from 2017/2018. Above-ground forage biomass on pastures was harvested in 1-m²-plots, and analysed for its nutritional composition. In addition, faeces and milk samples were taken from five lactating cows per farm to evaluate their nutritional status.

Farms differed considerably regarding land endowment and use, dairy herd size, and thus stocking rates. Farmers implemented rotational (n=12), short-grass (n=10), continuous (n=3), or strip (n=2) grazing schemes with <8 (n=4), 8-12 (n=14), and >12 hours (n=9) of daily pasture access during the grazing season. Average annual milk yield in 2017 averaged 5,852 kg/cow (standard deviation 888; n=18). During summer 2018, the mean available forage biomass on pastures per farm ranged from only 122 to 1,208 kg dry matter/ha. Crude protein and metabolisable energy concentrations varied greatly with 120-282 g and 8.6-10.8 MJ/kg dry matter, respectively. Mean diet digestibility per farm estimated from faecal crude protein content ranged from 61.5 to 71.8 g/100 g organic matter. Milk performance data suggested that some farms succeeded to maintain milk yields despite the lack of rainfall.

Further research should identify the key factors determining the farms' resilience to dry spells. Holistic grazing systems, which consider the interplay between environmental, vegetation, animal, and management factors, are needed to enhance forage use, supplemental feeding, and productivity of dairy cows grazing extensive pastures in organic farming.

Introduction

The use of grasslands for animal grazing is a central element of organic dairy farming being associated with several benefits, such as the conversion of local, human-inedible feed resources to high-quality food, improved animal health and welfare, conservation of biodiversity and culture landscapes, storage and restoration of freshwater resources, sequestration of carbon increasing soil fertility and mitigating climate change, and the lower environmental emissions due to closed nutrient cycles (Bateki et al., 2019).

However, semi-natural, permanent pastures like those in Southwest Germany are characterised by lower yields and, at least partly, inferior nutritional quality of available forage compared

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to improved, cultivated pastures and by both, spatially and temporally, heterogeneous vegetation in terms of growth rate, botanical composition, and feeding value. Consequently, the performance levels of cows grazing these semi-natural pastures are lower than of those on improved grassland. Moreover, their nutrient and energy intakes during grazing are difficult to predict, which, however, is essential to efficiently and sustainably use the forage resources on pastures, optimise grazing management, and adjust supplemental feeding of cows to best meet their nutritional requirements. These challenges are increasingly aggravated by the consequences of advancing climate change with, for instance, lower and even more variable distribution of precipitation and resulting differences in plant growth, botanical composition, and nutritional quality of forage on pastures.

Therefore, the aim was to assess the forage biomass and productivity of lactating dairy cows grazing semi-natural pastures on organic farms in Southwest Germany under diverse agroecological conditions in the dry year 2018.

Materials and Methods

From July to September 2018, 27 organic dairy farms were selected from four main natural areas in the Southeast of Baden-Württemberg, Germany, characterised by different agroecological conditions. Semi-quantitative, face-to-face interviews were conducted with farm owners using a structured questionnaire, which covered aspects of size and structure of dairy herds, animal feeding and health management, as well as type, area, and use of pastures. Additionally, data from national databases were retrieved, if available, including the total land area and use per farm as well as the monthly milk records of individual cows from March to July 2018. Data on climatic conditions were obtained from different weather stations and registered by WetterKontor GmbH, Ingelheim, Germany.

On the same day of the interviews, spot samples of feedstuffs offered to dairy herds in the barn were collected. Additionally, samples of the herbaceous vegetation in pasture paddocks grazed by lactating cows were taken within three randomly positioned sampling frames (1 m x 1 m) per paddock. First, the botanical composition of the above-ground plant biomass was recorded by visually estimating its proportion of grasses or herbs according to DLG (1997). Then, the herbaceous plant biomass was cut manually at 1 cm above the ground and weighed. Concentrations of proximate nutrients, fibre fractions, and metabolisable energy (**ME**) were determined in samples of supplement feedstuffs according to VDLUFA (2007) and of pasture herbage by near-infrared-reflectance-spectroscopy. Moreover, faecal grab samples were collected from the rectum of five lactating cows per farm, frozen at -20°C, and lyophilised. Faeces samples were analysed for dry matter (**DM**), ash, and nitrogen (VDLUFA, 2007), and their crude protein (**CP**) concentrations were calculated (= nitrogen x 6.25).

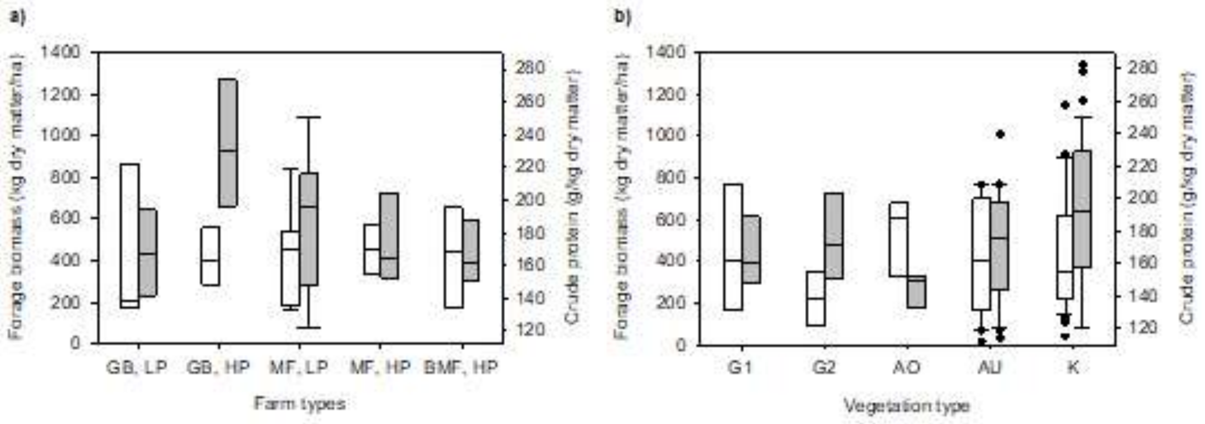
The apparent total tract digestibility of the organic matter ingested by cows (g/100 g organic matter) was estimated from faecal CP concentrations according to Lukas et al. (2005). Total ME requirements of cows were derived as the sum of the ME requirements for maintenance and lactation according to GfE (2001). Daily ME intake from supplement feeds was then subtracted from total ME requirements to estimate the ME intake during grazing, which in turn was divided by 5.5 MJ ME/kg milk to derive the energy-corrected milk yields from pasture.

A partitional k-means cluster analysis was conducted to identify different types of farms based on categorical and numerical variables related to agroecological conditions, farm size, land use, herd size and structure, as well as grazing and herd management as input variables. Pasture and herd performance characteristics were compared between different farm types, vegetation types, grazing management systems, and animal breeds using an ANOVA test for normally distributed variables and the Kruskal-Wallis test for not normally distributed variables. Additionally, Spearman correlation analysis was conducted to quantify the relationships between environmental, farm, herd, animal, and pasture characteristics.

Results

Agroecological conditions as well as land ownership and use, herd sizes and structures, and herd and grazing management greatly varied across farms. Five different types of dairy farms were distinguished. Two farm types included typical grassland-based dairy farms with a great share of their land area (≥61.9%) being grassland, used at relatively low mean stocking rates during the grazing season. In contrast, two types of mixed farming systems used a considerable proportion (≥32.8%) of their land as cropland and greater stocking rates on their grasslands. Each of those farm types was found in regions with either relatively low or high annual precipitation. The fifth farm type represented mixed dairy farms with greater grassland and cropping area than all other farm types. The predominant cattle breeds were Simmental (n=12) and Brown Swiss cows (n=6) with few farms keeping crossbreds or other cattle breeds. Cows on most farms (n=14) had access to pasture for 8-12 h/d, whereas few farms allowed the animals to graze for >12 h/d (n=9) or even <8 h/d (n=12) during the grazing season (210 d/a, standard deviation (**SD**) 31.9). The most common grazing system was rotational grazing (n=12) followed by short-grass grazing (n=10) with few farms implementing strip (n=2) or continuous (n=3) grazing.

Mean forage biomass on pastures of individual farms ranged from 122 to 1,208 kg DM/ha, with CP, neutral and acid detergent fibre, and ME concentrations of 120 to 282 g, 319 to 579 g, 201 to 304 g/kg DM, and 8.6 to 10.8 MJ/kg DM, respectively. Neither forage biomass nor its concentrations of nutrients and ME differed between farm types (P≥0.56) or grazing schemes (P≥0.14), and they were also similar irrespective of the proportions of herbs (including clover), ryegrass, or other grasses in sward biomass (P≥0.16; Figure 1). An exception was the CP concentration in herbage, which tended to be greater for grassland-based farms in regions of high rainfall (P=0.10).



Group	GB, LP	GB, HP	MF, LP	MF, HP	BMF, HP
n	5	4	9	5	4

Group	G1	G2	AO	AU	K
n	4	3	8	20	39

Figure 1. Above-ground herbaceous biomass (white) and its crude protein concentrations (grey) on semi-natural, permanent pastures of organic dairy farms in Southwest Germany during the dry summer of 2018 for (a) different farm types: GB, grassland-based; MF, mixed; BMF, big mixed farms; LP, low precipitation; HP, high precipitation or (b) different vegetation types: G1, ryegrass-dominated; G2, swards rich in grasses other than ryegrass; AO, balanced grass herb-grass swards with overgrown grasses; AU, balanced grass herb-grass swards with understory grasses; K, swards rich in herbs. Bars indicate 5th and 95th percentile.

Across all farm types (P=0.74), lactating cows were supplemented with 0 to 3.2 kg DM/cow and d of concentrate feeds and their mixtures. Additionally, farmers offered 4 to 19 kg DM/cow and d of roughages. Mean apparent total tract digestibility of organic matter per farm estimated from faecal CP concentrations varied between 60.1 and 71.8 g/kg organic matter, with no differences between farm types (P=0.20; Table 1). Accordingly, based on data taken from an external database, also milk yields (P=0.78) and the concentrations of fat (P=0.27) and protein (P=0.96) in milk did not differ between farm types with mean daily milk yields of 21 kg/cow (SD

3.1) and fat and protein concentrations of 3.9 (SD 0.29) and 3.3 (SD 0.18), respectively, across all farms (n=18). Total OM intake and milk yield from pasture did not differ between farm types or grazing systems and suggest that at least some farms succeeded in maintaining milk yields despite the lack of rainfall.

Table 1. Feed intake and performance of lactating cows on different types of organic dairy farms (n=27) in Southwest Germany during summer 2018 (Means ± one standard deviation)

Farm structure		Grassland-based farms		Mixed farms		Big mixed farms	
Precipitation		Low	High	Low	High	High	P-value
Variable	Unit	n=5	n=4	n=9	n=5	n=4	
Milk yield	kg/d	20 ±2.2	21 ±0.9	21 ±2.6	22 ±4.1	22 ±1.1	0.78
Milk fat	g/100 g milk	3.9 ±0.2	3.9 ±0.1	3.8 ±0.2	4.0 ±0.4	3.8 ±0.1	0.27
Milk protein	g/100 g milk	3.2 ±0.1	3.3 ±0.1	3.3 ±0.2	3.2 ±0.2	3.2 ±0.1	0.96
ME requirements	MJ/d	174 ±10.4	179 ±10.4	169 ±21.8	173 ±12.2	175 ±3.8	0.86
dOM	g/kg OM	67 ±1.1	67 ±3.3	65 ±3.2	69 ±2.2	67 ±1.3	0.20
Total feed intake[2]	kg OM/d	15.7 ±0.7	16.7 ±1.7	16.0 ±1.9	15.2 ±1.7	16.3 ±0.7	0.70
Forage intake during grazing[2]	kg OM/d	4.8 ±3.0	9.4 ±2.3	3.7 ±4.1	6.6 ±4.8	9.3 ±1.8	0.05
ECM from pasture[2]	kg/d	192 ±57.0	503 ±421.5	268 ±255.0	468 ±346.5	511 ±286.7	0.21

dOM, apparent total tract digestibility of ingested organic matter; ME, metabolisable energy; OM, organic matter; ECM, energy-corrected milk yield.

There were only a few correlations between climatic, management, pasture, and animal characteristics, indicating that no individual factors determine the availability and nutritional quality of pasture herbage, the forage intake and performance of grazing cows, and ultimately, the milk yield from pasture. The supplementation level increased with declining precipitation in 2018 (r=-0.61), suggesting that farmers tried to compensate for reduced herbage growth by offering more supplement feeds in the barn. Nevertheless, forage biomass on pastures did not correlate with annual precipitation nor the supplementation level, indicating that supplement feeding was not well adjusted to the actual forage availability during grazing. However, as data was limited to one year, results need to be confirmed in multi-year studies.

Suggestions for research and support policies to further develop organic animal husbandry

Even during dry years, extensive pastures allow for considerable nutrient and energy intakes of dairy cows during grazing, thus contributing to their milk performance. Holistic grazing systems, which consider the interrelationships between different environmental, vegetation, animal, and management factors, are needed to enhance forage use, supplemental feeding, and productivity of dairy cows grazing extensive pastures in organic farming and to improve the farms' resilience to dry spells. Further research should analyse the interactions between these factors across different seasons and years in order to derive management recommendations for the efficient and resilient use of these local forage resources.

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Parasitic worms in organic laying hens – Relation with range use

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Keywords: Ascaridia, Heterakis, Capillaria, organic laying hens, anthelmintic use

Abstract

There is a high prevalence of intestinal parasites (Ascaridia galli, Heterakis gallinarum, Capillaria) in free-range and organic laying hens, but the role of the free-range is not unambiguously. Some studies found a higher prevalence and other found a lower prevalence in relation to free-range use. The objectives of this study were to investigate whether the number of parasite eggs in the faeces of organic laying hens and in the soil of their free-ranges could be related to the degree of range use by the hens and to their performance in terms of production, health and mortality. This study was conducted on 20 farms in the Netherlands. Sampling took place when the hens were at least 45 weeks old. Per farm 20 samples were collected: 6 soil samples from the free-range at 5, 20 and 50 meter distance from the pop-holes, 7 manure samples collected in the free-range at least 50 meter from the pop-holes (each sample composed of droppings from 10 different hens) and another 7 manure samples in the hen house. All 20 farms seemed infected with ascarids and 12 with Capillaria. The mean number of eggs/gram (=EPG) was 324 for ascarids in manure and 12 for ascarids in soil. For Capillaria the mean EPG was 33 and 0 in manure and soil. A higher number of ascarid eggs/gram manure was found in samples collected in the free-range, compared to in the hen house. A positive correlation was found between ascarid EPG in soil and mortality. No further correlations were found between parasite eggs in soil or manure and range use or performance of the hens.

Introduction

In free-range egg production, including organic, a free-range use is associated with parasitic worm infection. The exact relation is unclear. Some studies show a higher infestation (Permin et al., 1999), some a lower (Sherwin et al., 2013; Thapa et al., 2015) and some didn't find a difference between a production system with or without a free-range (Jansson et al., 2010). Most commonly found endoparasites in laying hens are Ascaridia galli, Heterakis gallinarum and Capillaria species. Parasite infections can reduce health, welfare and productivity. In the Netherlands, anthelmintic treatments (Flubendazole and Fenbendazole) are widespread in organic egg production, while in Sweden and Italy farmers are more reluctant. We wanted to investigate relations between free range use and infections with internal parasites in organic egg production systems: 1. Is there a relationship between parasite infection of the soil and manure and intensity of range use? 2. Is there a difference in parasite infection in manure collected on the range (from hens expected to range more) and manure collected inside (from hens expected to range less)? 3. Is there a relation between parasite infection in the soil and the manure with laying percentage, mortality percentage and hen health assessed by the farmer?

Material and methods

This study was conducted on 20 organic layer farms in the Netherlands, which are the first of a total number of 40 in the Netherlands, Sweden and Italy. Sampling was done when the flocks were at least 45 weeks of age, had range access for at least the last three months, no treatment with anthelmintics for at least three weeks before sampling and as late as possible on the day

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when most hens are expected to be ranging. The farmers were asked about the percentage of hens using the range under favourable conditions, laying percentage at 60 weeks of age and mortality percentage up to 60 weeks of age. The farmers were also asked to score their hens' general health on a scale from 1 (bad) to 10 (perfect). On the range, we took soil samples of 0-10 cm depth at 6 locations: 2 at 5, 2 at 20 and 2 at 50 meters from the pop-holes. At a minimum 50 m distance from the pop-holes, 7x10 fresh droppings were pooled to generate 7 mixed samples, representing the 'hens that range more' (outdoor hens). Inside the barn, as far away from the pop-holes as possible, another 7x10 fresh droppings were collected, also pooled into 7 mixed samples, representing the 'hens that ranged less' (indoor hens). All samples were counted for eggs of Ascaridia/Heterakis (Asc/Het) and Capillaria (Cap), according to the McMaster method, resulting in 2 EPG (eggs per gram) values per sample. Statistics were done with IBM SPSS 25 (paired samples t-test, Pearson correlation).

Results

All 20 farms were infected with Asc/Het and 12 with Cap. Flocks were on average 64 (45-93) weeks of age; 17 flocks consisted of brown hens and 3 white hens. The ranges had been in use as free-range on average for 15 (7-22) years. The proportion of the flock using the range under favourable conditions was on average 48% (range: 10-80). All but one flock were treated with anthelmintic repeatedly, on average 5 (0-9) times till 60 weeks of age. The mean production at 60 weeks was 89% (range: 84-96), the mean mortality percentage till 60 weeks 4.5% (range: 2.7-9.0) and the mean health score was 7.9 (5.0-9.0).

We did not find a correlation between the proportion of soil samples positive for Asc/Het and the number of years the range was used as poultry free-range (R=-0.066; p=0.781), nor with the proportion of hens seen outside (R=0.020; p=0.934). We also did not find a correlation between EPG of Asc/Het in soil samples and the number of years the range was used as poultry free-range (R=-0.034; p=0.886), nor with the proportion of hens seen outside by the farmer (R=-0.280; p=0.231). We did not find a correlation between proportion of manure samples positive for Asc/Het and the proportion of hens seen outside by the farmer (R=-0.101; p=0.672). We also did not find a correlation between EPG of Asc/Het in manure samples and the proportion of hens seen outside by the farmer (R=0.165; p=0.486).

See table 1 for results of soil and manure samples. Per flock, the proportion of manure samples positive for Asc/Het was higher for outdoor (mean 73%), compared to indoor samples (mean 62% (paired samples t-test; n=20; Df=19; p=0.010). Also, the EPG of manure samples for Asc/Het was higher for outdoor samples (mean 405) compared to indoor samples (mean 243 (paired samples t-test; n=20; Df=19; p=0.026). Concerning Cap, we did not find differences between outdoor and indoor samples.

Table 1: Infected samples per flock and eggs/gram (EPG) of Asc/Het and Cap

	Asc/Het		Cap spp	
Number of samples/farm	% samples infected	Average EPG (min-max)	% samples infected	Average EPG (min-max)
Soil (6/farm)	12 (0-50)	12 (0-100)	0 (0-0)	0 (0-0)
Manure from outdoor hens (7/farm)	73 (29-100)	405 (29-2386)	24 (0-71)	39 (0-186)
Manure from indoor hens (7/farm)	62 (0-100)	243 (0-1486)	19 (0-71)	26 (0-114)
Manure from outdoor and indoor hens together (14/farm)	68 (21-100)	324 (14-1936)	21 (0-71)	33 (0-150)

Average EPG manure were above the level at which anthelmintic treatment is recommended: EPG higher than 200 for Ascaridia/Heterakis and 1 for Capillaria eggs (personal communication Avivet Veterinary Services, Lunteren, NL).

Severity of parasitic infection, as assessed by EPG for Asc/Het in soil, was not correlated to laying percentage (R=0.025; p=0.917) and health estimate by the farmer (R=-0.015; p=0.951), but correlated to mortality (R=0.601; p=0.005). EPG soil was not correlated to the number of anthelmintic treatments (R=-0.056; p=0.816), nor with time since last anthelmintic treatment (R=0.423; p=0.071). Since no Cap eggs were found in the soil, correlations with Cap EPG could not be calculated. EPG for Asc/Het and Cap in manure, were not correlated to laying percentage (R=0.357; p=0.123 and R=-0.172; p=0.468), health score (R=-0.167; p=0.481 and R=0.213; p=0.368), mortality (R=0.232; p=0.325 and R=0.178; p=0.453), number of anthelmintic treatments (R=-0.191; p=0.419 and R=-0.172; p=0.468) or time since last anthelmintic treatment (R=-0.124; p=0.614 and R=0.285; p=0.237).

Discussion

We aimed to link soil and manure parasite load with range use, laying percentage, mortality percentage and general health of organic layers.

Only 12% of the soil samples were infected with Asc/Het eggs, compared to manure samples (68%). The low proportion of eggs in the soil found could be due to dry soil due to dry years, a condition known to kill ascarid eggs (Velichkin and Merkulov, 1970). Parasite eggs may also have died because of the soil microbial activity, a mechanism described by Thapa et al. (2017a). Further, parasite eggs can be spread over a larger area on the free-range surface compared to the indoor surface. Finally, if most parasite eggs are located in the top 2 cm soil, samples of 0-10 cm would contain fewer eggs per gram. Our results indicate the soil being a small risk for parasite infection. The absence of a correlation between the number of parasite eggs in the soil and the proportion of hens seen outside might be explained by too few soil samples containing too few parasite eggs. Another explanation might be that the distance from the barn where soil samples were taken was still relatively close to the barn (i.e. less than 50 m from the pop-holes). Despite a likely high range use in these areas, the soil samples were not highly or frequently infected. An explanation for the absence of correlations between soil EPG's and the number of years in use and proportion of hens using the range might be that 90% of ascarid eggs disappears within 23 to 38 weeks in pasture soil (Thapa et al., 2017b). If soil only contains ascarid eggs that were excreted recently, then the age of the free-range might not be distinctive enough.

We found that manure samples taken outdoors contained more frequent and higher Asc/Het levels than manure samples taken indoors. An explanation for this could be that 'outdoor hens' can pick up parasite eggs inside and outside. However, Bari et al. (2020) found no difference in the number of Ascaridia worms between hens differing in their ranging behaviour. This may be caused by a different way to distinguish between indoor and outdoor hens in our and their study.

We found a positive correlation between soil Asc/Het infection and mortality at 60 weeks of age. We don't know how to explain this because there was no correlation between manure Asc/Het and mortality or between soil Asc/Het and manure Asc/Het infection. However, a lack of correlation on the flock level does not mean that the health or production of individual hens couldn't be affected. Finally, it may be possible that the investigated parasite species perhaps did impact health and production. Still, we could not detect it due to our limited number of farms or our methods.

Based on our findings, our conclusions are as follows:

1. Free-range soil contained few Asc/Het eggs and no Cap eggs, even in a higher intensity of range use.

2. Manure sampled outdoor was more frequently and more severely infected with Asc/Het eggs compared to manure sampled indoor from the same flock.

3. Infection of soil with Asc/Het was positively correlated with mortality, but there were no other correlations between parasite infections in soil and manure with mortality, production or health parameters.

Suggestions for research and support policies to develop further organic animal husbandry

Conventional anthelmintics are used in organic egg production. Because the new EU regulation comes into force in 2022, farmers need alternatives, such as monitoring parasite infection in combination with treatment when a certain threshold is reached (Tarbiat et al., 2016) or mechanical means of eradication based on the physical properties of parasite eggs. More research is needed to get to know which strategies are effective.

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Efficiency of ruminant organic farming systems: Specialised grass systems perform better than mixed crop-livestock

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Keywords: factor productivity, herbivores, economics, organic farming, production system

Abstract

The efficiency of the production system can be approached by comparing the results obtained (agricultural production) and the means employed (factors of production). We calculated the techno-economic efficiency of 70 organic ruminant livestock farms in the French Massif Central for 2014 and 2015. Multivariate data analyses were used to explore sample variability and identify determinants of farm efficiency. Specialised livestock and grass-based production systems appear to be the most efficient. Crop diversification, mixed crop-livestock farming seems to limit efficiency.

Introduction

The French Massif Central (MC) is a mountainous area accounting for 30% of the national herd of Organic Farming (OF) certified ruminants. MC professional stakeholders express a strong need for references to accompany farmers towards less vulnerable (Bouttes et al., 2019) and/or more efficient systems (Veysset et al., 2015). The BioRéférence project (2015-2020), led by the "Pôle AB Massif Central", aims to produce structural, technical and economic references for ruminant livestock farms in the MC. This project relies on about twenty local partners (development, research, R&D, teaching, associations) and a network of 70 ruminant OF livestock farms. The objective of this study is to identify an overall indicator to measure and evaluate the efficiency of ruminant farming systems. This work is carried out using data from the BioRéférences farms' network. Using multivariate data analyses methods, we explored the determinants of this indicator. Then, based on a typology of farms, we will determine whether there are different strategies to reach a good level of efficiency.

Material and methods

The livestock farms' network

The BioRéférence project's support farms cover the entire Massif Central territory and integrate the three ruminant species (cattle, sheep and goats) and the two main productions (milk and meat) of the MC. The willingness of local actors was to have data from specialised, professional farms with good production levels. Farms are monitored each year according to the INOSYS-Réseaux d'Elevage methodology (Institut de l'Elevage, 2014). Structural, technical and economic data from 70 farms were recorded in the Diapason database for 2014 and 2015 (constant sample): 20 dairy cattle, 16 beef cattle, 12 dairy sheep, 13 meat sheep and 9 goats. Half of these farms have been certified organic for more than 10 years, and only 15% have been certified for less than 5 years. The main structural and economic characteristics of these 70 farms, on average over 2014 and 2015, are shown in Table 1. Beyond the average values, there is great variability within the sample. The detailed annual techno-economic results for each year's production are available on the Pôle AB MC website (Pôle AB Massif Central, 2019).

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Efficiency of the production systems

The efficiency of a production system can be approached by comparing the result obtained (agricultural production) and the means employed (factors of production), i.e. by factor productivity (Veysset et al., 2015). The amount of input used for a given production system is a strong determinant of the economic and environmental sustainability of the system (Lebaq et al., 2015). Therefore, we calculated the techno-economic efficiency by the ratio:

Gross output excluding aids (€) / (intermediate consumption + use of equipment) (€)

Intermediate consumption is the consumption of goods and services acquired from a third party to obtain the output. Equipment use is the annual depreciation charges for equipment, buildings and land improvements. This techno-economic efficiency is calculated for each of the 70 farms for 2014 and 2015.

Data analyses

Data analyses should highlight the links, if any, between the variability of structures, systems, practices and techno-economic efficiency.

First, in order to explore and summarise the variability of our sample of 70 farms, we conducted a principal component analysis (PCA) with 43 active variables: 18 structural variables (labour, area, capital), 20 system organisation variables (intensification of production factors, diversification, crop destination), and five technical variables (food self-sufficiency, animal productivity). Three economic performance variables (value-added/gross product, gross farm income/gross product, farm net income/worker) and five partial factor productivity variables (labour, land, equipment, intermediate consumption and techno-economic efficiency) are used as additional variables. To overcome the "type of production" effect, all data have been standardised by production and year, and individuals have been weighted by the production system to establish an equivalent weight for each production. Finally, the data from both years are combined into a single sample of 140 observations (70 farms x 2 years) and processed together.

Based on the results of the PCA, we performed a hierarchical cluster analysis (HCA). It allows us to construct a typology of farms by grouping individuals with relatively similar characteristics into groups that are significantly different from each other.

Results

Variability analysis and correlations

Three axes explain 42.2% of the total variability of our sample of 140 observations: (A1) the first axis discriminates farms according to their size (ha UAA, LU) and their diversification (number of crops). These variables are positively correlated with self-sufficiency in concentrates, the quantity distributed per LU and animal productivity; (A2) the second axis discriminates large grassland and specialised farms (ha main forage area, LU, forage area/UAA, share of permanent grassland), with high labour productivity (ha UAA/worker, LU/worker) and low intensification of production factors (stocking rate, capital employed per ha); (A3) the third axis discriminates small-scale farms with factors of high intensification production (quantity of concentrate per LU, animal productivity, capital employed per ha and per worker, intermediate consumption per ha). These variables are negatively correlated with size and feed self-sufficiency.

The net farm income per worker is positively correlated with A2 (large grassland farms with high labour productivity) and negatively correlated with A3 (opposite to intensification of production factors). Techno-economic efficiency is significantly and negatively correlated with A3 (opposite to intensification of production factors).

Typology: six groups of farms

The HCA makes it possible to distinguish six groups of farms. Only four groups with the most "extreme" characteristics are presented below and in Table 1.

1. "Small and thrifty farms, with workforce": this group consists of farms that are smaller than the average size of the total sample (-36%) but with almost the same number of workers. 16% of the UAA is allocated to crops, which allows for very good feed self-sufficiency (92%). These farms show slightly above-average techno-economic efficiency mainly due to good equipment productivity (because of their small size with a sufficient number of workers, they have chosen not to invest too much in equipment). Despite labour productivity being 26% lower than average, the net farm income per worker is only 16% lower.

2. "Intensive farms, high labour productivity": these farms, with the highest labour productivity of the six groups, are very intensively managed. They are medium-sized but have the smallest number of workers. In value terms, they use 38% more intermediate consumption per ha of UAA than the average. These high labour productivity farms tend to substitute labour with capital and/or intermediate consumption, but the product does not increase in proportion to the inputs. The techno-economic efficiency is the lowest of the six groups. Despite high labour productivity (+40% compared to the average), the net farm income per worker in this group is 17% lower than the average.

3. "Large grassland farms with high labour productivity": this group includes large grassland farms (ha UAA +60% compared to the average) with high labour productivity. Contrary to group 2, these farms do not seek to increase productivity through the intensification of inputs but to limit expenses. These farms use few inputs per ha of UAA (-28% compared to the average) and have the best techno-economic efficiency of the six groups. A large size associated with good techno-economic efficiency allows this group to obtain the best net farm income per worker (+43% compared to the average).

4. "Large mixed crop-livestock farms, with high labour productivity": this group is made up of large farms with high labour productivity, which devote 21% of their UAA to annual crops (80% for animal feed and 20% for sale). Crops allow the best self-sufficiency in concentrates of the six groups. Due to the high equipment need for the crop, the techno-economic efficiency is slightly lower than the whole sample average. Net farm income per worker remains in the average range due to the relatively high labour productivity.

The two undescribed groups are made up of grassland farms medium-sized, specialized (group 5), and "small", intensive, with low labour productivity (group 6). It should be noted that all production is found in all groups, except for goats, which are not found on large farms (groups 3 and 4).

Discussion and conclusion

Labour productivity and maximization of the output have always been seen as the main drivers of good farms economic performances. These two strategies do not seem the most efficient for OF ruminant farms in the French Massif Central. The productive specialisation, the feed self-sufficiency and input savings are positive determinants of the systems techno-economic efficiency.

Crop diversification and mixed farming seem to limit the techno-economic efficiency of these farms. However, the mixed crop-livestock farms are generally large with high labour productivity. Even so, farm size and labour productivity impact economic efficiency, but either positively or negatively, depending on the combination of other factors. A large grassland specialised farm can be very efficient, while a similarly sized farm in a mixed system has some probability of being less efficient. Smaller farms seeking to increase production by intensifying see their efficiency degraded; in these cases, the additional quantity of inputs, services and equipment used does not lead to a proportional increase in agricultural production, resulting in lower efficiency.

Suggestions for research and support policies to develop further organic animal husbandry

Mixed cropping-livestock farming is generally seen as a system enabling the construction of eco-efficient production systems. Diversification often entails enlarging farms. Farmers' choices in terms of work organisation, equipment investment on these large, diversified farms should be studied to objectively assess the trade-offs made and their impact on the sustainability of the systems.

Table 1: Main characteristics of the 70 farms in the BioRéférence network and 4 of the 6 groups from the hierarchical cluster analysis (HCA)

Average values for the 2 years 2014 and 2015 cumulated	70 farms x 2 years (n=140)	1. Small and thrifty farms, with work-force (n=27)	2. Intensive farms, high labour productivity (n=13)	3. Large grassland farms with high labour productivity (n=11)	4. Large mixed farms, high labour productivity (n=29)
Annual Work Units (AWU)	2,1	2,0	**1,6**	2,4	**2,6**
Agricultural Area (UAA) ha	89	**57**	76	**142**	**145**
Forage Area (MFA) % UAA	88	84	84	**95**	**79**
Livestock Units (LU)	78	**52**	67	**141**	**112**
Stocking rate, LU/ha MFA	1,03	1,09	1,08	1,04	0,95
Crop diversity, Shannon index	1,26	**1,48**	1,49	**1,12**	**1,65**
UAA ha/AWU	46	31	**50**	61	**61**
LU/AWU	39	**28**	**44**	**61**	45
Intermediate consumption €/ha UAA	1160	1150	**1600**	840	890
Concentrate self-sufficiency, %	45	**59**	**23**	23	**74**
Feed self-sufficiency, %	87	**92**	**77**	85	90
Net farm income k€/AWU	29,0	**24,3**	24,0	**41,8**	29,3
Labour productivity	88	**65**	**124**	**114**	95
Land productivity	2,3	2,3	2,6	1,9	**1,8**
Intermediate consumption productivity	2,1	2,1	**1,7**	**2,9**	2,0
Equipment productivity	7,6	**9,6**	6,5	9,8	7,2
Techno-economic efficiency	1,57	1,60	**1,26**	**2,14**	1,52

In bold: significantly discriminating variables

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Are French organic meat sheep farms more sustainable than conventional ones?

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Keywords: meat sheep, organic, sustainability, economics, environment, social

Abstract

Fifty French organic meat sheep farms participating in the "Agneaux bio" (Organic lambs) project were assessed regarding their sustainability, through economic, environmental and social indicators, during two years. Results were compared to those from the national conventional benchmarking network ("INOSYS").

Economic sustainability was mainly assessed by the profitability of the sheep enterprise via the remuneration allowed for farmers' work and expressed in terms of "SMIC" (French minimum wage) per labour unit. Average remuneration was lower for organic farms vs conventional ones, price difference (12%) not offsetting additional costs (30%). The environmental impact indicators assessed with Life Cycle Analysis (climate change, cumulative energy demand, eutrophication), expressed per hectare or kg carcass produced, were generally equivalent or even lower for organic sheep systems, despite lower productivity. Organic pastoral systems fully offset their greenhouse gas emissions by soil carbon sequestration. The "Bilan Travail" (Work assessment) method was used to assess social sustainability. Organic farmers generally had more available time than their conventional counterparts, despite more routine work per ewe.

Some of the indicators used for this evaluation could be improved, e.g. enterprise profitability, for which allocation keys used for overheads and opportunity costs were issued from studies on conventional farms. Environmental evaluation would need to be completed, particularly concerning ecosystem services (biodiversity, landscape, etc.). This first national sample has a limited size and very heterogeneous results. So it should be the starting point for setting up a permanent observatory to regularly produce updated sustainability indicators of French organic lamb meat production, in addition to those already available on conventional lamb production in the framework of the INOSYS observatory.

Introduction

Contrary to the conventional flock, the French organic meat sheep flock continues to grow (+11% in 2018, Agence Bio, 2019), but has seen little effort at the national level. The "Organic Lambs" programme was set up to encourage the sector's development and assess its sustainability. It aimed to produce territorialised references covering the three pillars of sustainability through technical, socio-economic and environmental results via monitoring a network of farms in main production basins.

Material and methods

A broad partnership was built with the Chambers of Agriculture and Organic Agriculture Groups from ten regions to obtain a good representation of French organic lamb production. Fifty farms were chosen to cover a wide diversity of production combinations and marketing circuits. During two years (2012 and 2013), farms were monitored with the methodology of INOSYS-Livestock networks (Jousseins et al., 2015). The farms were divided into two groups, using mainly grasslands or rangelands (pastoral).

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The economic assessment of sheep enterprise was based on the calculation of production costs, expressed in euros per kg of carcass weight (kg CW) and allowed remuneration for farmers' work, expressed in terms of "SMIC" (French minimum wage) per Annual Work Unit (AWU) (Charroin et al., 2010). An environmental assessment was carried out by Life Cycle Assessment (LCA), using the methodology of the Institut de l'Elevage (Moreau et al., 2016). Four impact categories were studied: climate change (expressed in kg eq.CO_2), either gross (only greenhouse gas emissions, GHG) or net (after deduction of compensation by annual soil carbon storage), water quality (eutrophication, in kg eq. PO_4) and fossil energy consumption (in MJ). They are expressed per kg of live weight (kg LW) and per hectare (ha) of on-farm area (excluding common grazing, used by several farmers). For social assessment, working time and available time (for farm maintenance, training, holidays, etc.) were estimated using the "Bilan Travail" (Work assessment) method (Cournut et al., 2018). For each pillar, results were compared to those of conventional farms of INOSYS-Livestock networks.

Results

Economic assessment

Table 1: Cost of production (2013)

	Grassland		Pastoral	
	Org.	Conv.	Org.	Conv.
Number of farms	15	138	5	24
Work productivity (tons CW[a] AWU^{-1} [b])	5.8	9.0	2.0	5.0
Lamb price (€ kg CW^{-1})	7.2	6.3	6.8	6.5
Cost of production (€ kg CW^{-1})	18.1	12.7	33.8	18.5
Allowed remuneration (SMIC[c] AWU^{-1})	0.8	1.1	0.8	1.2

[a] CW: carcass weight
[b] AWU: annul work unit
[c] SMIC: salaire minimum interprofessionnel de croissance (minimum wage)

At the sheep enterprise-level, results point to a trend towards lower remuneration in organic sheep farms compared to conventional ones, for grasslands systems as for pastoral ones: in long-circuit marketing, the difference in lamb price, compared to conventional, do not compensate the costs due to organic farming specifications, particularly concentrate price. The averages presented in Table 1 are based on a subgroup of 20 farms, excluding both highly diversified farms (where cost calculation is more complicated) and short-circuit marketing farms (where costs cannot be compared with long-circuit marketing), both very common in organic meat sheep farming.

Environmental assessment

Environmental impacts of organic systems (climate change, energy consumption, water quality) are generally lower than conventional ones due to lower consumption of inputs (fertilisers, feed, energy). This is true for grassland systems for all studied impacts, expressed per kg of live weight, as well as per hectare (Table 2), even if the differences are sometimes insignificant. For pastoral systems, impacts of organic farms are lower, except for gross climate change and fossil energy consumption expressed per kg LW, due to their lower productivity.

Table 2: Environmental results (2013)

System		Nb of farms	Gross climate change		Net climate change		Eutrophication		Fossil energy consumption	
			kg eq. CO_2 kg LW^{-1} [d]	kg eq. CO_2 ha^{-1}	kg eq. CO_2 kg LW^{-1}	kg eq. CO_2 ha^{-1}	kg eq. PO_4 kg LW^{-1}	kg eq. PO_4 ha^{-1}	MJ kg LW^{-1}	MJ ha^{-1}
Grassland	Org.	14	14.7	3279	5.8	1572	0.035	8.6	25.4	5633
	Conv.	99	15.6	4218	7.2	2223	0.051	14.9	27.2	7340
Pastoral	Org.	11	28.4	4911	-3.4	190	0.070	14.0	37.6	6462
	Conv.	50	19.8	4219	-2.4	305	0.078	27.7	30.1	7108

[d] LW: live weight

Social assessment

Compared to the national conventional reference (137 farms from INOSYS-Livestock networks, RMT Travail, 2010), organic sheep meat farmers devote more time to routine work (Table 3). This could correspond to the need for more farmers' presence, particularly for health management, due to the constraints of organic specifications. Another explanation could be the greater proportion of grass-fattening of lambs. But at the whole farm level organic farms have more time available (Table 4). Explanations could be that structures differ: farms are generally smaller, with a significant share of salaried workers (more delegation, especially on-farm processing). But they can also be related to practices: if routine work seems to be more important, the amount of work devoted to seasonal work can be reduced by a lower proportion of crops in the crop rotation and by or a smaller number of interventions on the flock (less sanitary treatments, no oestrus synchronisation, etc.).

Table 3: Routine work (hour ewe^{-1})

Flock size	< 350 ewes	350 to 550 ewes	> 550 ewes
Org.	7.5	5.6	3.6
Conv.	5.9	4.2	3.4

Table 4: Available time (hour $person^{-1}$)

Nb of persons	Nb of farms	Org.	Conv.
1	18	1009	830
2	23	1208	1120
3 or 4	8	1259	1190

Discussion

On the one hand, these initial national results point to better sustainability for organic meat sheep farms than conventional ones in terms of environmental impacts and farmers' available time. On the other hand, the economic sustainability of organic farms seems a little lower, as the market price in the long circuit does not cover the extra costs resulting from farm management on organic farms. This could partly explain the greater use of short circuits in organic sheep farming compared to conventional farming.

But, this study shows very high variability beyond average differences, partly linked to the great diversity of the areas and systems studied. They are informative of a trend that needs to be confirmed.

Concerning environment assessment, further developments are needed to support farmers' practices improvement and provide environmental information on organic products. During this project, approaches were tested to assess the ecosystem services: biodiversity, pollination, soil quality, etc. (Manneville, 2014). Nitschelm et al. (this conference) also propose applying an LCA biodiversity indicator to organic lamb systems.

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A typology of European organic multi-species livestock farms

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Key words: diversification, practices, work, marketing, ruminant, monogastric

Abstract

Keeping two or more livestock species or categories on the same farm simultaneously is a diversification option that has received little attention to date. We surveyed 95 organic multi-species livestock farms across six European countries to build a farm typology and characterise their diversity in structure, management, and performances. Farms combined cattle (meat, milk), small ruminants (meat, milk) and/or monogastrics. Survey data on the structure, management, and performances allowed for the creation of indicators (including farmer's satisfaction) used to run a principal component analysis and an agglomerative hierarchical clustering to build the farm typology. The following variables structured the first four factors of the PCA: F1: Farm size and crop-pasture balance; F2: Intensification - Feed self-sufficiency; F3: Work productivity - Diversification activities and marketing; F4: Dairy cattle and permanent pasture. Four groups of farms emerged from the clustering: G1: Large area with a high share of crops, low feed autonomy, dairy cattle with beef cattle or pigs, on-farm processing, short sale channels and agritourism; G2: Prevalence of poultry with beef cattle, leading to high labour productivity and low feed autonomy, although ruminant diets highly rely (90%) on fodder; G3: Beef cattle associated with meat sheep, high feed autonomy, frequent short sale channels; G4: Italian farms with predominantly dairy ewes and dairy or meat cattle, rangelands, on-farm processing and short sale channels. Our next objective is to study the relationships between agricultural practices, work organisation, sales management and farm performances.

Introduction

Implementing agrobiodiversity is a core principle of agroecology in livestock farming systems (Dumont et al. 2013), especially in organic production. It is often studied through the lens of crop-livestock integration. Keeping two or more livestock species or categories on the same farm simultaneously is another diversification option that has received little attention to date, even though it is expected to increase the sustainability of livestock farms (Martin et al. 2020). The few studies dealing with this topic at the farm level had at best a regional coverage (Dumont et al. 2020) and, therefore limited possibilities for outscaling these multi-species livestock systems across Europe. We aimed to propose a pan-European typology of organic multi-species livestock farms according to animal species or productive orientation combinations, farm structure and management (land, livestock, human resources, sales).

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Material and methods

We surveyed 95 farms combining cattle and small ruminants (meat or dairy production), cattle and monogastrics (pigs and/or poultry) and small ruminants and monogastrics in six European countries. Each survey was based on a half-day discussion with the farmers and consultation of accounting documents when available (only in France). Survey data covered (i) farm structure in terms of types and areas of cropping areas and grasslands, type and numbers of animals, (ii) management practices, (iii) marketing channels, i.e. type, amounts and prices of products sold and diversification activities (e.g. energy production) and (iv) work organisation via the status, role and satisfaction of farmers. This data allowed the calculation several indicators describing farm production, productivity (per worker, per total livestock unit (LU)), efficiency (e.g. ratio between outputs and inputs) as well as the ability of farmers to manage their farm resources for production (e.g. feeding autonomy), marketing management, farmer's satisfaction etc. Note that rangelands are not included in the Usable Agricultural Area (UAA). The detailed data collection and indicator calculation procedures can be found in Ulukan et al. (2021) (under review).To characterize the diversity of multi-species livestock farming systems, we first performed a principal component analysis (PCA) using four types of variables with a total of 43 variables (using XLSTAT v2020.3.1 software). An agglomerative hierarchical clustering (AHC) was then conducted to identify four groups of relatively homogeneous farms.

Results

The first four factors of the PCA explained 36.5% of the total variance in the farm sample and had the following essential characteristics:

i) Factor 1 (10.6% of the variance. *Farm size and crop–pasture balance*): contrast between large farms including crops, mainly used for feeding the animals on the one hand and mainly dairy sheep farms dependent on purchased feed on the other hand (Fig 1);
ii) Factor 2 (9.6% of the variance. *Intensification – Feed self-sufficiency*): contrast between farms with a low overall stocking rate, a high degree of feeding autonomy based on fodder use with usually the presence of beef cattle, and on the other hand farms with a high animal density and high amounts of purchased feed related to the presence of monogastrics (Fig 1);
iii) Factor 3 (8.9% of the variance. *Work productivity – Diversification activities & short channel*): contrast between farms with monogastrics displaying high labour productivity in terms of livestock unit per average worker unit (LU/AWU) and output (€) per AWU, and a high overall stocking rate, and on the other hand smaller farms with low labour productivity and crops used to produce animal feed, and other diversification of the farm activities;
iv) Factor 4 (7.5% of the variance. *Dairy cattle and permanent pasture*): dairy cattle farms based on permanent grasslands (and opposed to dairy sheep), with on-farm processing, and farmers converted to organic farming a long time ago and generally very satisfied with their system.

Figure 1 depicts the first two factors of the PCA and the ellipses representing the four groups of farms generated by the AHC with an explained 87.8% intra-class variance and a 12.2% inter-class variance. The classes are quite unequal in size, from 7 to 35 farms.
The six countries are well distributed in the groups, with the exception for Group 4, which includes only Italian farms. In addition, Groups 3 and 4 are distant from Group 1 but fairly close to each other.

Group 1 (C1; 35 farms; *large farms – crops – dairy cattle - agrotourism*) can be characterised by a large mean area with a high percentage of crops (1/3 of the UAA) and 78 livestock, lower than the average 87 livestock for the 95 farms sampled. Farms are mainly dairy cattle, associated with beef cattle or pigs. Up to 63% of farms process their products on-farm and 42% use short-sale channels. Agritourism is practised in 37% of farms (compared to the 27% average). Labour productivity is low when expressed in LU/AWU (23.4) but relatively high when expressed in € of sales per AWU due to the added-value induced by on-farm processing and short-sale channels. Despite the presence of cereal production, feed autonomy of these farms is relatively low (68%) due to the presence of monogastrics. However, nitrogen efficiency (Ninput/Noutput) is the highest of the four groups. These farms also have the highest number of workers (n=6 AWUs on average) and the most experienced farm managers, with very early conversion to organic farming (1996 on average), despite the absence of agricultural roots in one third of these farms. These farmers were usually satisfied with their farming system.

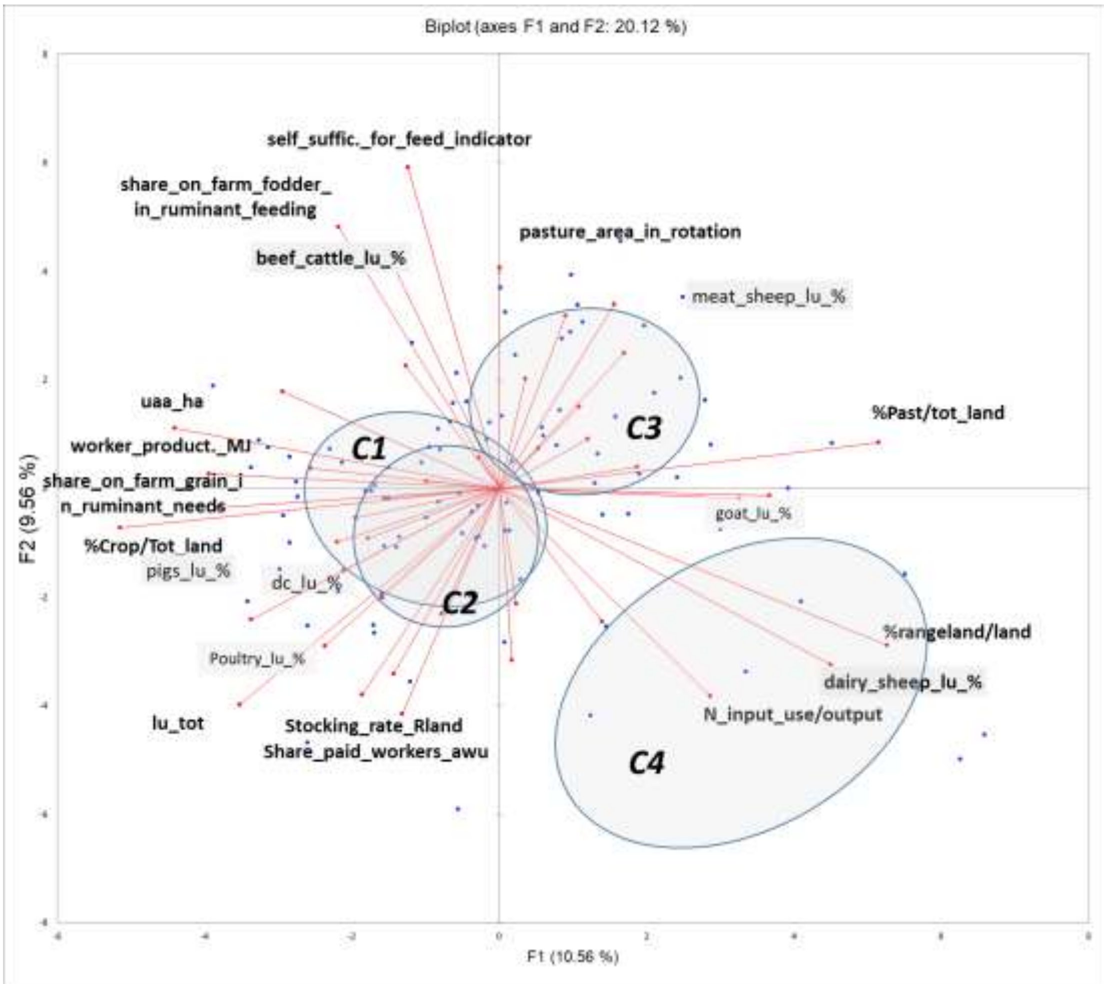

Figure 1. Projection of the main variables (representing more than 5% of factors 1 and 2) of the principal component analysis and the four groups of farms from the agglomerative hierarchical clustering (ellipsis plot with 40% confidence). Radiant lines: projection of the variables. Small dots: 95 farms. Bold labels: variables most contributing to factors 1 and 2. Labels on grey background: % LU for animal enterprises

Group 2 (C2; 17 farms; *Poultry and beef – permanent grassland – work productivity*) represents medium-sized farms with a significant proportion of permanent grassland in the UAA (58% on average). Their specificity is the prevalence of poultry (in LUs), usually associated with beef cattle, leading to high labour productivity expressed in LU/AWU. It is the highest of all four groups, even when expressed in sales per AWU, exceeding 110 000 €/AWU. There are only 2.6 AWUs on average. The percentage of fodder (roughage, pasture or cultivated) in ruminant diets is very high (90%) in relation to frequent beef cattle breeding. Nevertheless, feed autonomy at the farm level only reaches 61.5% on average due to poultry, which also explains the high mean N input/output ratio of 2.45. The farmers in this group are the ones who most frequently attend training courses and they have the highest overall satisfaction, including the income generated.

Group 3 (C3; 36 farms; *Beef cattle & meat sheep – feed autonomy – short channel marketing*) has structural factors comparable to C2 (area used), although temporary grasslands are slightly more prevalent. Beef cattle is the main production and is generally associated with meat sheep. Farm feed autonomy is the highest among the four groups, at 87.9% on average. Short channel sales are present on 92% of the farms and represent 72.5% of the total value of sales. The stocking rate on the grassland area is the lowest, at 0.81 LU/ha (ruminants only). Compared to C2, this group has a comparable UAA but a three times lower stocking rate on the UAA (on average 0.80 vs 2.58 total LU/ha UAA) linked in particular to the absence of monogastrics. Labour productivity is half that of C2, both as LUtot/AWU, €/AWU and mega-joules (MJ) produced per AWU. This group has the least paid workers (13.9% on average) and the highest proportion of first-generation farmers (33%). Farmers in this group considered the complexity of their farming system to be low, and reported the highest human welfare scores and the lowest workload.

Group 4 (C4; 7 farms; *Dairy sheep – No monogastric – Italy - Processing & direct selling*) is a little specific because it includes farms with predominantly dairy ewes, associated with dairy or meat cattle, and sometimes goats. They are all located in Italy and have an important percentage of rangelands (three farms fully rely on rangelands). The other areas (included in UAA) are limited on average to 26.4 ha. With LUs reaching 125.2 (no monogastrics in this group), the stocking rate on the fodder area (including rangelands) is high (1.4 LU/ha on average). On-farm processing (dairy products) is present in five of the seven farms, and 82% of the sales are made in short channels. Note that paid workers carry out 46.2% of farm activities, and the overall workforce is high (5.4 AWUs). The overall satisfaction of the farmers in this group is the lowest compared to the three other groups.

The following key points are highlighted:

- The presence of monogastrics strongly limits feed autonomy, but it provides an important input of nutrients and most likely contributes to the maintenance of soil fertility in the area used by ruminants.
- The most autonomous systems raise ruminants for meat production. The Italian farms are unique, linked to the high frequency in this sub-sample of small ruminants (especially dairy sheep) associated with processing, large workforce and limited arable land.
- The percentage of sales via short channels ranges from 26% to 82% between groups. We can hypothesise that farmers' practices are influenced by this management of sales, e.g. through specific calendars of practices aiming at regular sales across the year. This may result in a part of the off-season production generating high production costs, because of higher use of concentrate feeds. Nevertheless, the added-value generated could compensate for the extra costs. Moreover, this type of sale can increase social satisfaction.
- The pool of workers appears to vary greatly between the four groups. Two out of the four groups have between 5 and 6 AWUs, which is very high and could be related to the high degree of farm diversification. This may also have positive effects on the technical management of farm enterprises in terms of resilience, if the versatility of the workers between enterprises is important.

Discussion

It is important to be aware that the study of very diversified farms across agronomic, environmental and social dimensions taking into account farm structures and management results in highly complex surveying. Thus, based on an initial sample of 146 farms, only 95 were kept for all the analyses of indicators. Different interviewers carried out the surveys with different skills in diverse dimensions and situations surveyed. This may have had a small divergent effect on data acquisition, particularly on social evaluations.

Therefore, our objective is to refine the analysis of the potential relationships that exist between sales management (including the diversity of products sold) and management practices on the one hand and farm productivity and efficiency on the other hand. We also aim to focus on the link between enterprise integration and farm performances, particularly in terms of resource use efficiency. This will require questioning and renewing some traditional indicators that are not adapted to such diversified farming situations and diverse contexts to innovate in terms of appropriate indicators and methods.

Suggestions for research and support policies to develop further organic animal husbandry

We highlighted the impact of the type of animal species combination on feed autonomy. In particular, the presence of monogastrics leads to a high amount of feed purchased. This raises the question of the feed origins and the possibility of promoting collaborations between specialised livestock and crop farms from the same area.

Half of the farms had a large workforce, which seems to facilitate the implementation and success of these highly diversified system usually builds on short-sale channels. To support this type of farming system, which generates employment and social dynamics in rural areas, the CAP should account for the workforce present on the farms; and the cross compliance of subsidies payment (subsidy threshold) per person rather than per hectare.

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Promoting and inhibiting factors for the establishment of organic animal breeding – an exploratory study on initiatives from Germany and Switzerland

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Keywords: organic farming, animal breeding, Agricultural Innovation Systems

Abstract

In its ambition to continuously work towards embracing organic and agroecological values and principles, the organic livestock sector needs new and innovative ways of conducting and organising animal breeding. However, little is known about the current status of organic animal breeding in general and the factors influencing the establishment and growth of existing organic breeding initiatives. This study reviewed the current discussion on organic animal breeding and conducted an in-depth analysis of three breeding initiatives in Switzerland and Germany, which explicitly target the organic sector and represent three different animal species (poultry: Ökologische Tierzucht gGmbH, pig: UnserHausschwein, goat: GoOrganic). The analysis of the case studies builds conceptually on Agricultural Innovation Systems literature and covers the elements: organisational structure, network and value chain, infrastructure and resources, internal and external institutions. The results from the empirical analysis yielded a set of overarching topic areas relevant for the success of organic animal breeding initiatives.

Introduction

Until today, many organic farmers rely on animal breeds from conventional breeding companies or associations (Padel, 2019). This causes various challenges related to health issues, feed requirements, land-use conflicts and behavioural disorders (Nauta et al., 2012). Additionally, some breeding technologies are considered incompatible with or at least questionable concerning organic standards and values (IFOAM, 2017). Heavily relying on conventional breeding stocks might reduce organic farmers' access to robust and adapted animals for organic farming conditions.

This study deepens the understanding of the reasons for such a low proportion of organic animal breeding activities in Europe and provides insights on factors that influence the success of existing organic animal breeding initiatives.

Material and methods

The study was based on three selected case studies from Germany and Switzerland. Based on previous theoretical considerations on organic animal breeding and agricultural innovation systems, the three initiatives (Ökologische Tierzucht gGmbH, UnserHausschwein, GoOrganic) were considered as small innovation systems. They were analysed along the categories derived by different innovation system elements (actors, interactions, institutions, infrastructures) (based on Schiller et al. (2020) and Wieczorek and Hekkert (2012)). The initiatives explicitly target the organic sector and represent three different animal species (poultry, pig, goat). A qualitative approach was chosen for the data collection, including semi-structured expert interviews, backed with online and literature research on the initiatives and their sector contexts. The interview results were processed through qualitative content analysis.

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Results

The results of the interviews are summarised in Table 1 in terms of promoting and inhibiting factors, displayed along with the categories derived from the Agricultural Innovation System literature (Puls, 2021).

Table 1. Results from the qualitative interviews with coordinators of organic breeding programs on promoting and inhibiting factors.

Category	Positive influence	Negative influence
Organi-sational structure (Internal actors and interactions)	Chicken: • formal and informal relationships to different kinds of experts (e.g. veterinarians, process developers) Pig: • small number of actors in the project (facilitates exchange of information and breeding animals)	Pig: • absence of a sufficient amount of farmer-breeders • limited capacity of farmers' marketing channels • mating plans and mating decisions can only be 'suggestions' to the farms (animals owned by farmers) Goat: • inclusion of farmers into the project not realised, yet
Network and value chain ('other' actors and interactions)	Chicken: • good PR skills of cooperation partners in organic retail • decentralised structures in the value chain (e.g. small private hatcheries) Pig: • presence of small local butchers • additional consultancy project for organic husbandry Goat: • general framework conditions the species sector (extensive, high share of organic farms, association structures, …) • public breeding estimation services	Chicken: • lack of publicly paid breeding managers and performance testing service providers in some regions • lack of awareness of end customers and farmers about organic breeding • problems with org. animals existing processing infrastructures Pig: • sector structure (small share of organic farms) • limited possibilities for marketing heterogenous meat qualities Goat • limited farmer participation in existing breeding organisations in the sector • lack of publicly paid breeding managers and performance testing service providers in some regions
Infrastructure and resources	Chicken: • access to funds: legal form (gGmbH) • access to data: small field tests already implemented Pig: • access to rare genetic resources motivates farmers to participate	Chicken: • high need for HR and infrastructure • lack of education structures for organic animal breeding, rearing and husbandry • lack of funds for full lifetime performance testing • lack of larger independent field performance data Pig: • dependence of the project on farmers' physical infrastructure • high requirements to farmers: skills, knowledge on organic husbandry and breeding, sufficient breeding infrastructure • small genetic base (→ slow progress) Goat:

		• access to funding schemes (for projects on small ruminants) • Human resources for coordination • short time frame of the project • no testing structures for all relevant health traits in the sector (→ missing data)
Internal (hard and soft) institutions	Pig: • 'organic mindset' of participating farms • different attitudes/strategies of farmers in the core group (→ balance interests)	Goat: • potential future controversies with regards to traits related to factors like access to pasture and dehorning
External (hard and soft) institutions	Chicken: • farming associations: positive statement towards double use breeding + Clear position against in-ovo-selection Pig: • increased interest in politics/society in alternative breeds within niches	Chicken: • no clear position (against in-ovo / for double use breeding) in the organic sector and EU-organic regulation • general political priorities with regards to research and funding • conflict between two regulations (organic / hygiene) Pig: • hygiene regulations with regards to imports • hygiene regulations prevent multiplier farms from participating • project animals do not fit in large retailers' purchasing standards

The table shows that many different aspects in terms of promoters and inhibitors could be drawn from the interviews. The interviews and background research revealed their individual approaches and strategies, and the different contextual factors they face in their respective sectors and countries. These differences are also reflected in the foundation histories, target groups and the involved actors of each initiative.
To provide a better overview, the promoting and inhibiting factors identified in the empirical analysis were grouped in a set of overarching topic areas which are relevant for the success of organic animal breeding initiatives: (i) availability and exchange of knowledge on breeding and animal husbandry on the farm, initiative and sector level, (ii) sector structure of the specific animal species, (iii) availability of public performance testing infrastructure and data management, (iv) financial support of breeding work, (v) awareness and capabilities along the value chain, (vi) availability and exchange of genetic resources, and (vii) design of soft and hard institutions (especially legal framework conditions).

Discussion

Some of the identified issues, such as internal knowledge exchange structures, can be influenced by the initiatives themselves, while others, such as legal framework conditions or preserving a diverse set of genetic resources, need to be tackled on a broader scale. The high variety of identified aspects indicates a need for further in-depth investigation of some of the topic areas (e.g. knowledge exchange). It also became evident that practices in organic animal breeding are still significantly shaped by individual attitudes and priorities of specific groups of pioneers. This underlines the necessity for broader discussions on potential trade-offs faced in the practical implementation of organic principles in animal breeding and husbandry.

Suggestions for research and support policies to promote organic animal husbandry

To push these and similar initiatives, farming associations, science and policy might consider, for example:

- to invest in education, knowledge development and knowledge exchange on animal breeding and alternative animal management practices in the organic sector;
- promote and scientifically monitor initiatives that consider all steps of the value chain;
- develop financing mechanisms that enable the establishment/coordination of small initiatives that test alternative processes and management methods, and foster peer-to-peer exchange.

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Patterns of allopathic medicine use in European organic livestock farms

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Keywords: anthelmintic, antibiotic, parasite, bacteria, infection, livestock

Abstract

Monitoring the input of anthelmintics (AH) and antimicrobials (AM) into the organic livestock systems is essential to account for animal health, product quality, residual environmental impacts and the responsible use of veterinary medicines. Currently, records are only maintained at the individual farm level, and there is no centralised scheme to quantify inputs on a systems level. The work presented here is funded by the Horizon 2020 project 'Replacement of Contentious Inputs in Organic Farming Systems' (RELACS) and aimed to establish current levels of AH and AM use in European organic livestock. A Europe-wide survey of organic experts provided specialist insight into the proportion of farmers requesting these medicines, either as part of a disease prevention strategy (health plans) or to treat unpredicted disease outbreaks (supplementary requests). The survey received 139 responses from 16 countries, providing data from 17,719 organic livestock farms. The results show distinct country-specific differences. In general, countries with a low proportion of farmers that included AH and AM in their health plans, also had low supplementary requests for medicines. Although the underlying reason for this pattern is not known, closer inspection may reveal areas of best practices in health management or lower level of disease threat. Countries with medium or high AH and AM in their health plans also had medium or high supplementary requests, which may indicate differences in the levels of disease threat across countries. The 16 countries differed in the size and structure of their organic sector, but none of these variables appeared to influence requests for AH and AM. Extrapolated estimates suggest that a total of 45.5 million AH doses and 37 million AM doses may have entered the European organic system over 12 months. This work provides the first benchmark on patterns of AH and AM use in European organic farming.

Introduction

The health and welfare of organic livestock are challenged by the threat of parasitic and bacterial diseases. While anthelmintics (AH) and antimicrobials (AM) can effectively cure these diseases, their synthetic structures pit them as a contentious input in the organic systems. Monitoring their use is essential to account for organic product quality and residual environmental impacts. The global spread of resistance against these medicines demands greater efforts to reduce their use (WHO). Currently, there is no benchmark to document patterns of AH and AM use in organic livestock farming. Consequently, it is not possible to identify strengths or weaknesses in disease management control or gauge if progress is being made. This study aimed to record patterns of AH and AM use by organic livestock farmers in different

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European countries and gain insight into determinants of their use by conducting a European-wide survey of organic experts.

Methods

Across Europe, farmers may include limited use of AH and AM into their health plans to prevent disease spread, or if these measures fail, supplementary requests for medicines can be made to treat unpredicted disease outbreaks to ensure animal health and welfare. The national organic control body must approve all AH and AM medicines prior to use. Organic experts have specialist insight into the use of AH and AM medicines by the farmers in their region and were consequently targeted to address the objective of our study.

An anonymous online survey was designed to capture the experience of organic experts on the proportion of farmers that i) included AH and AM in their health plans and ii) made supplementary requests for AH and AM use in the last 12 months. This data was not indicative of the frequency of AH or AM use or the number of animals treated. The survey was widely disseminated across Europe via IFOAM EU and organic associations, including Soil Association (UK), Ecovalia (Spain), Naturland (Germany), Institut de l'Agriculture et de l'Alimentation Biologiques (ITAB) and La Fédération des Eleveurs et Vétérinaires en Convention (FEVEC) (France).

Additional information on the size and structure of the organic sector in each country was obtained via quantifying: the number of organic farms each inspector was responsible for (survey), the number of organic control bodies in the responding country (European Commission), and the total heads of organic stock per country (EuroStat). To determine whether these factors influenced patterns of requests for AH and AM, each data set was divided into quantiles, ranked as low (quartile 1, lower 25%), median (interquartile range), or high (quartile 3, upper 25%). The classified data were tabulated to facilitate the identification of patterns.

Estimates on the quantity of AH and AM treatments that may be entering the European organic systems were based on data extrapolated from the surveys. The proportion of farmers requesting AH or AM in their plans or supplementary requests were calculated (variable A).

Total proportion of farmers requested AH or AM per country (variable A) =

(AH/AM requested in health plans applied as a % to the total heads of stock)

\+

(supplementary requests for AH/AM applied as a % to the total heads of stock)

Variable A per country (%) is then multiplied by the number of stock per country to give a total number of treatments per country (variable B)

The "weighted average" of the proportion of farmers requesting AH or AM treatments was calculated across all 16 countries to account for differences in the heads of stock for each country (Variable A).

"Weighted average" of AH or AM treatments across 16 countries =

$$\frac{\text{Total AH or AM (the sum of variable B) in 16 countries}}{\text{Total heads of stock 16 countries (BE+HR+CZ+DK+FR+DE+GR+IE+IT+LT+PL+RO+ES+SE+CH+UK)}}$$

Results

The survey received 139 responses from organic experts in 16 European countries, collectively covering 17,719 organic livestock farms.

There were marked country-specific differences in the proportion of farmers including AH in their health plans and those making supplementary requests (Figure 1). For 10 out of 16 countries, the AH included in the health plans were insufficient to control parasitic disease, and supplementary requests were needed, as reported by organic experts.

Similarly, the proportion of farmers including AM in their health plans varied between the countries (Figure 2). For 12 out of 16 countries, supplementary requests for further AM were needed; for six countries, there was a greater proportion of supplementary requests for AM than those requested within the health plans.

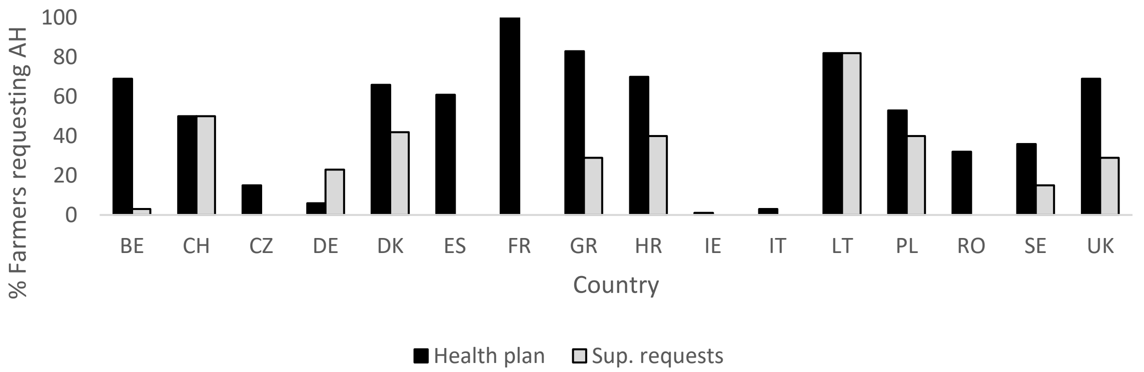

Figure 1. **The percentage of organic farms requesting AH in the health plan and supplementary requests in 16 European countries. There is no data for supplementary requests for AH in Germany**

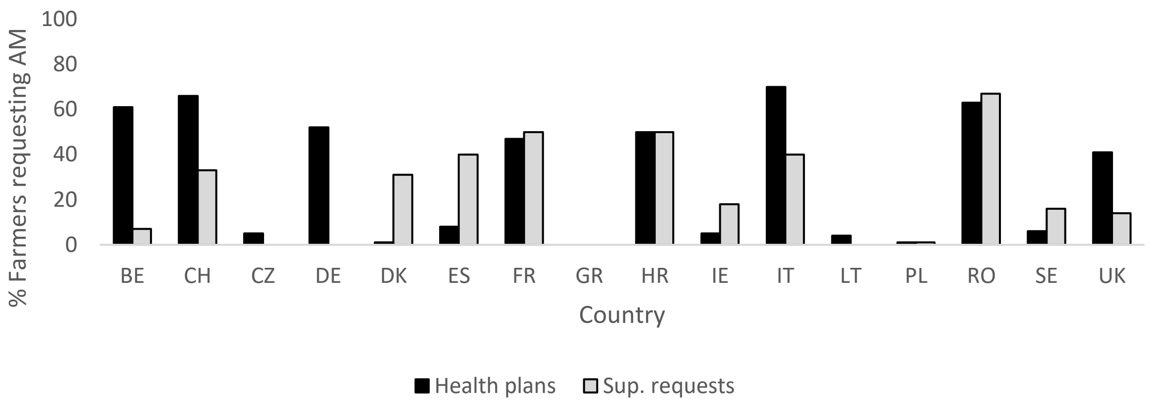

Figure 2. **The percentage of organic farms requesting AM in the health plan and supplementary requests in 16 European countries. There is no data for supplementary requests for AH in Germany**

Countries that ranked as having a low proportion of farmers, including AH in the health plans, such as CZ, LT, PL, also ranked as having a low proportion of farmers, including AM (Table 1). The same countries also had a low proportion of farmers making supplementary requests for AH and AM. Countries that ranked as having a medium proportion of farmers requesting AH and AM in the health plans, such as SE and FR, appeared to have a high number of farmers asking for supplementary requests. Factors such as the number of organic control bodies and total stock per country did not appear to have an impact on AH and AM use.

Extrapolated estimates indicate that organic livestock receive 0.86 AH treatments and 0.7 AM treatments per animal per year. This amounts to 45.5 million AH treatments and 37 million AM treatments entering the European organic systems each year.

Discussion

The results show considerable country-specific variation in the proportion of organic farmers requesting AH and AM to control disease. Countries that ranked as having low requests for AH also had low requests for AM in both health plans and supplementary requests. This may be associated with effective disease prevention or an overall low disease threat. High requests for AH or AM in the health plans did not necessarily result in more effective disease control, as high supplementary requests often followed. The 16 countries differed in the size and structure of their organic sector, but this did not appear to impact the patterns of AH or AM requests. Estimates suggest individual organic livestock are receiving less than one AH and one AM treatment per year. The AH data agree with previous evidence collected during the Core Organic Plus funded PrOPara project (2018), where results from a European farmers survey reported the use of approximately one AH treatment per animal per year. On a system level, however, this amounts to considerable AH and AM inputs. These results provide the first benchmark on patterns of AH and AM use in European organic farming.

Table 1: Patterns of anthelmintic and antimicrobial requests in 16 European countries

Country	AH health plans	AH sup. requests	AM health plans	AM sup. requests	No. Organic control bodies	Total head of organic stock	Mean no. farms / organic inspector
CZ	Low	Low	Low	Low	Med	Med	High
LT	Low	Low	Low	Low	Low	Low	Med
PL	Low	Low	Low	Low	Med	Low	Low
DK	Low	Med	Low	Med	Low	High	Med
SW	Med	Low	Med	Med	Med	Med	Med
ES	Med	High	Med	High	High	Med	Low
FR	Med	High	Med	High	Med	High	Med
HR	Med	High	Med	High	Med	Low	Low
DE	Med	N/A	Med	N/A	High	Med	Med
CH	Med	Med	High	Med	Low	Med	Med
GR	High	Low	Low	Low	High	Med	High
IE	High	Med	Low	Med	Low	Low	High
BE	High	Med	High	Med	Low	High	Med
RO	High	High	High	High	Med	Low	Med
IT	High	High	High	High	High	Med	High
UK	High	Med	Med	Med	Low	High	Low

Ranking of Low (white), Med (medium) (light grey) and High (dark grey) proportion of farmers that required the medicines in each country. N/A (no data available) (black). Sup (supplementary).

Suggestions for research and support policies to develop organic animal husbandry

Reducing the input of AH and AM into the European organic system would be greatly facilitated by acquiring detailed data on their use. The results from this survey are the first step, but it should be noted that estimates of AH and AM inputs were based on assumptions that may not be accurate for all countries. Centralised databases would help improve the monitoring of progress to reduce the use of such medicines and further offer insight into the development of pathogen resistance to medicines. Whether such databases are created at a regional, national or European scale is debatable.

Acknowledgements
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Replacement of antibiotics in livestock production – Protocol to assessment of essential oils to control mastitis - contribution of the Horizon 2020 project RELACS

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Keywords: animal health, essential oils, safety, organic

Abstract

Antibiotic resistant pathogens are a major challenge in veterinary medicine. Mastitis is one of the most prevalent diseases in organic cattle and a key source of antibiotic use in organic farming. Although organic principles give preference to preventive methods, there is a lack of knowledge about the effects of non-antibiotic alternatives when prevention is not sufficient. The RELACS project aims to improve the experience of French farmers' with essential oils (EO) to control mastitis in dairy cows.

There are several criteria to select essential oils for in vivo application: efficiency as determined in aromatograms, chromatograms, origin, availability from organic sources, potential risk for humans and animals, toxicity on tissues cultures, cost, tradition of use on French farms and MRL (Maximum Résidue Level) (regulation). Based on these, EO of two plant species: Litsea cubeba and Origanum vulgare were selected to be evaluated on 66 farms in 3 countries. A protocol is proposed to refine how to apply them in target animals, duration, mode of application).

The results will give recommendations to assess their efficacy and safety as well as effects on animal health and product quality.

Introduction

The Horizon 2020 project 'Replacement of Contentious Inputs in Organic Farming Systems' (RELACS) fosters the development and adoption of tools and techniques to further reduce the use of external inputs on organic farms, including antibiotics in dairy production. Antibiotic resistance threatens animal and human health. According to organic principles, phytotherapeutics should be preferred to antibiotics for securing animal health when prevention is not enough. However, there is a lack of knowledge about the effects, safety for human consumption of animal products, and good practices of these non-antibiotic alternatives.

Mastitis is one of the most prevalent diseases in organic dairy cattle production. Developing novel approaches to mastitis control combining effective preventive herd health management strategies and alternative safe treatments will contribute to reducing antibiotic use in organic dairy farms. Within RELACS, two complementary strategies are studied: (1) adapting well-proven Animal Health and Welfare Planning (AHWP) tools to regional and individual on-farm conditions in a multi-actor initiative and (2) fostering refinement of farmer's innovation capacity related to non-antibiotic mastitis control by external application of essential oils (EO).

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We propose a protocol to optimise target animals, duration and mode of application to validate the efficacy and safety of the EO application and minimise the risks (presence of residues and inhibitors in milk intended for consumption and processing).

French farmers widely use essential oils for their antibacterial and anti-inflammatory effects. However, concerns of efficacy and safety, mainly effects on animal health and product quality, still arise and have not been systematically addressed. RELACS aims to refine French farmers' experiences with essential oils (EO) to control mastitis in dairy cows. The main objective is to optimise a protocol for EO application to control mastitis.

Material and methods to choose EO to control mastitis

Based on the French farmer’s experience, 10 EOs were selected for *in vitro* tests:

- *Litsea citrata* (litsea)
- *Cymbopogon martinii* (palmarosa)
- *Thymus satureoides* (Thyme borneol)
- *Rosmarinus officinalis verbenoniferum* (rosemary verbenone)
- *Eucalyptus citriodora* (eucalyptus)
- *Origanum heracleoticum* (*vulgaris*, origan)
- *Elettaria cardamomum* (cardamom)
- *Ocimum basilicum* (tropical basil)
- *Cinnamomum zeylanicum* (Ceylan cinnamon – leaves and bark)

Chromatograms are used to identify and quantify the different compounds of EO. We performed chromatograms for chemical characterisation of the EO, thereby gathering first information on their potential antibacterial and anti-inflammatory effects.

The aromatogram method quantifies *in vitro* antibacterial effects by measuring the EO activity on pathogenic organisms (the inhibition diameter for essential oils in Petri dish inoculated with the respective pathogen). Aromatograms were done for each EO using several mastitis bacterial pathogenic strains: E. coli, *Klebsiella pneumoniae*, *Serratia marcescens*, *Staphylococcus aureus, Streptococcus agalactiae, uberis, dysgalactiae* (several strains per species). After data analysis, a second series of aromatograms was carried out to identify if there was an impact (negative or positive or none) if selected EOs were mixed. This analysis led to a selection of 3 EO: Litsea, Thymus, and Origanum.

A third step consisted of testing the tissue cultures (bovine mammary alveolar epithelial cells) for the potential cytotoxic effect of the EO’s by monitoring cell growth and proliferation. Eight EO’s showed toxicity against bovine mammary alveolar epithelial cells when tested at 0.1%. Incubation with 0.01% origanum, litsea, thyme thymol and the EO mix (origanum x litsea) resulted in lower toxicity compared to 0.1%. These results indicate potential cytotoxicity risks and possible skin irritation. Some EOs could be dermocaustic. As a result of this test, it is recommended to use EOs diluted in vegetable oil.

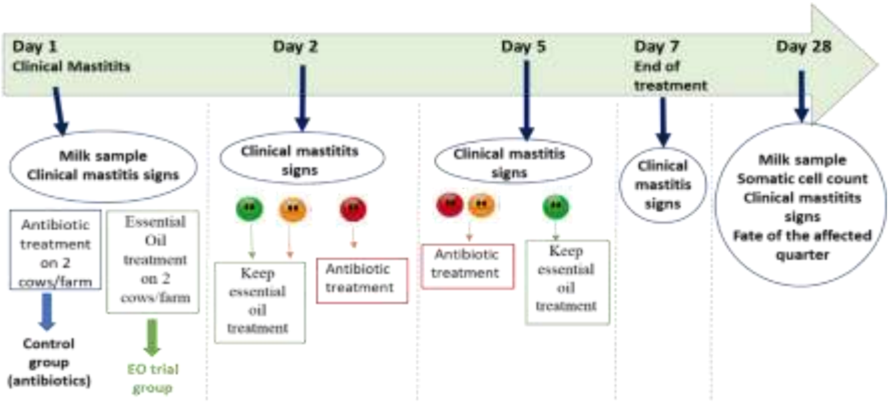
Besides these *in vitro* tests, several other criteria need to be combined to identify EOs. The criteria used to select EOs for the *in vivo* on-farm trials also included: geographical origin, availability from organic sources, the potential risks for human consumption and animal health and welfare, costs, tradition of use in French farms, MRL (regulation) and the shared expertise of RELACS partners. Based on these, EO of two plant species: *Litsea cubeba* and *Origanum vulgare* were selected to be evaluated on-farm in three European countries, following the same protocol.

Mastitis control using essential oils: Assessment Protocol

In the RELACS project, two EO (Litsea and Origanum), diluted in organic vegetable sunflower oil, are tested on-farm in three countries. This trial is conducted on 66 farms: 8 farms in Spain, 21 farms in the UK and 37 in France. Veterinarians or farm advisors identified farmers that are willing to participate and interested in the trials.

The essential oil protocol test took place over two years, from the Fall/Winter of 2019 until Spring 2021, with a higher prevalence of mastitis during winter and spring. The protocol is illustrated in figure 1 below.

Figure 1 : Protocol to assessment of essential oils to control mastitis



Essential oil treatment is being compared with antibiotic treatment to treat light to moderate clinical mastitis cases. In each farm, only light to moderate cases of clinical mastitis can enter the essential oil protocol. Criteria to identify light to moderate clinical mastitis cases are a maximum of one infected quarter (presenting abnormal milk/redness/hardness), absence of blood in the milk, no signs of clinical mastitis during the past 30 days, less than 300,000 somatic cell count (SCC) for the past two months, and absence of high body temperature (>39°C).

When farmers identify a mastitis case, a randomised draw is carried out between essential oil and antibiotic treatment. Each EO is applied individually, one after the other. They are diluted in organic sunflower oil (10% EO, 90% vegetable oil). 2.5 ml of each mixture are applied to the skin of the udder, twice daily after milking, for seven days.

The farmers record the clinical signs using a database on days 1, 2, 5, and 7 to assess the state of the animals' health. If the clinical signs have not worsened, farmers keep administering the EO treatment; otherwise, they must use an antibiotic treatment prescribed by a veterinarian. Milk samples are collected on days 1 and 28 after the beginning of clinical mastitis to compare SCC and bacteriological analysis.

The trials on 65 farms to measure effectiveness to control mastitis in dairy cows are ongoing. The efficacy of EO should result in clinical healing, cell healing, and bacteriological healing.

The safety characterisation of EO is also ongoing *in vivo* by detecting markers of the essential oils contained in the mixture (terpenes and aromatic compounds), measuring their potential impacts on acidification and properties of milk, verifying the absence of reaction in the test for detection of antibiotic residues (Delvotest® T), and assessing their impact on sensory properties of milk. The identification of markers of the essential oils in the milk could assess pharmacologically active substances and their classification regarding maximum residue limits (MRL) in foodstuffs of animal origin.

Discussion and suggestions for research and support policies to develop further organic animal husbandry

The approach followed in the project could be used to select and test other plant bioactives for mastitis control in cattle, other diseases in cattle, or diseases in other animal species. The project will propose recommendations to use essential oils safely in curative health. It will increase accessibility for the European organic dairy farmer community.

Currently, there is no clear authorisation for the use of EOs as a Veterinary Medicinal Product. The results could aid EOs to find an adapted status for « traditional herbal products » used in animal health care.

The trials will provide recommendations to conducts successful research on commercial farms.

Acknowledgements

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Ethno veterinary sciences and practices for reducing antibiotic residue in milk

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Keywords: antibiotic residue in milk, Ethno veterinary practice, animal health, microbime

Abstract

Ethno-veterinary Science and Practices to combat infectious diseases and other clinical conditions in livestock are the key alternatives to antibiotic and other veterinary drugs. Promotion of the farmer oriented cost effective ethno veterinary practices (EVP) based on natural products will largely reduce the use of antibiotics in management of animal health. This would help elimination/ reduction of antibiotic and other chemical use in animal production and the associated residue in the animal products. It also reduces the antimicrobial resistance in the long run. These formulations can be prepared and used by the farmers themselves to prevent and manage health care of their cattle. The usage of herbal formulations for various clinical conditions in cattle for three years in a selected area indicates overall reduction of incidence of mastitis (83.3%), enteritis (63.6%), repeat breeding (96%) and cowpox (100%). It is also observed that about 88 % of milk samples were without any detectable antibiotic residue. These low-cost herbal formulations helped farmers to save on an average 75% of health expenditure for their livestock. The microbiome of milk from the cows with clinical mastitis before and after treatment with Ethno-veterinary herbal formulations shows that after 6 days of treatment, the average abundance of Staphylococcus was reduced from 40.59% to 2.03% (20 times), Streptococcus from 25.8% to 2.06 (12.52 times), Pseudomonas, Pseudomonaceae family 20.28% to 1.9% (10.67 times), Klebsiella from 8.4% to 0.26% (32.31 times) and Enterobacteriaceae family from 24% to 1.69% (14.37 times) indicating the cure of mastitis.

Introduction

Antibiotic resistance (AMR), caused by the excessive and indiscriminate use of antibiotics in health care, is a worldwide problem affecting human and animal health. About 90% of the antibiotics used end up in the environment, affecting the quality of water, soils, and biodiversity. One of the immediate challenges of AMR is to reduce the use of antibiotics, both in human and animal consumption. As antibiotics find their way through the food chain, there is an urgent need to focus on reducing the use of antibiotics in veterinary practice. The focus needs to be shifted to work with veterinarians, farmers and dairy cooperatives to identify approaches and options to use ethno veterinary practices (EVP) based on natural products to control infectious diseases. We have worked with various stakeholders and established that EVPs are efficacious and safe in preventing and curing certain clinical conditions in dairy animals and thereby reduce residues in milk (Nair et al. 2017a, b, (Punniamurthy et al., 2017a, b, Kumar et al., 2018, Suresh et al., 2018).

Intervention impact study

We trained 1050 veterinarians from various organisations, such as the National Dairy Development Board (NDDB), AMUL, Karnataka milk Federation (KMF) and 30 milk unions from 14

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states in India and Bharatiya Agro Industries Foundation (BAIF), to use ethno veterinary practices. We also trained 30,000 farmers and 520 village resource persons to use ethno veterinary practices for preventing and curing 19 clinical conditions without using antibiotics or any other chemical veterinary drugs. Table 1 shows the per cent cure of each condition treated with EVP.

Table 1. Feedback from various milk societies through NDDB on the efficacy of EVPs for clinical conditions in cattle

No.	Clinical condition	Number of animals treated	% cured
1	Mastitis	37,724	89.84
2	Indigestion	9,127	89.0
3	Foot & Mouth (FMD)	6,921	87
4	Foot lesion	4,388	92
5	Fever	51,660	85
6	Diarrhoea	49,718	93.5
7	Joint swelling	500	90
8	Bloat	1,830	86.75
9	Udder edema	1,818	89.5
10	Repeat breeding	4,637	84.37
11	Deworming	4,964	90
12	Wound	1,335	83
13	Uterus prolapse	429	76
14	Retention of Placenta (ROP)	1,128	74
15	Downer	999	76
16	Udder pox, warts	658	67.6
17	Teat obstruction	1,134	75.5
18	Ectoparasites /Ticks	1,186	90.5
19	Haemogalactia	1,319	86.5

An intervention impact study was undertaken with support from the Department of Science and Technology, Government of India, encompassing 220 farmers from 11 milk societies in Kerala, Karnataka and Tamil Nadu. One hundred and forty farmers were included in the study, and 80 were kept as the control (Table 2).

The milk samples from these farmers were tested for antibiotic residue before and after the training. Quinolones, Beta lactams, Gentamicin, Sulphonamides were present as residues in the milk samples from selected farmers, except Thirukanurpatti Union. Tetracycline, Streptomycin, Neomycin, Chloramphenicol were absent.

The 140 farmers were trained to use ethno veterinary practices for mastitis, foot and mouth disease (FMD), diarrhoea, udder pox, repeat breeding, bloat, indigestion, and maggot wounds repeatedly for one year and encouraged to use EVP instead of antibiotics and other chemical drugs. There was no intervention for 80 farmers, which were kept as a control group. The study indicates that milk from 123 out of 140 (87.86%) farmers was without any detectable antibiotic residue (beta-lactams or sulphonamides), 11 (7.85%) farmers had a low positive presence, and 6 (4.29%) had antibiotic residue (Figure 1).

Table 2. The name of the milk society, number of farmers selected as control and intervention groups

No	Name of the society	Farmers selected	Intervention group	Control Group
1	Maneed Kheera Ulpadaka Society Ernakulam Kerala	20	10	10
2	Monippally Kheera Ulpadaka Society. Kottayam, Kerala	20	10	10
3	ChakkampuzhaKheera Ulpadaka Society Kottayam Kerala	20	10	10
4	PuthrikaKheera Ulpadaka Society Ernakulan Kerala	20	10	10
5	Allappara Kheera Ulpadaka Society Ernakulan Kerala	15	15	0
6	Arakkappadi Kheera Ulpadaka Society, Ernakulan Kerala	15	15	0
7	Manikyamangalam KheeraUlpadaka Society Ernakulan Kerala.	15	15	0
8	Sreemoolanagaram KheeraUlpadaka Society Ernakulan, Kerala	15	15	0
9	Thirukanurpatti, Thanjavur Tamil nadu	40	20	20
10	Aralumallige, Doddaballapura, Karnataka	20	20	0
11	Ekashipura, Doddaballapura Karnataka	20	0	20
	Total	220	140	80

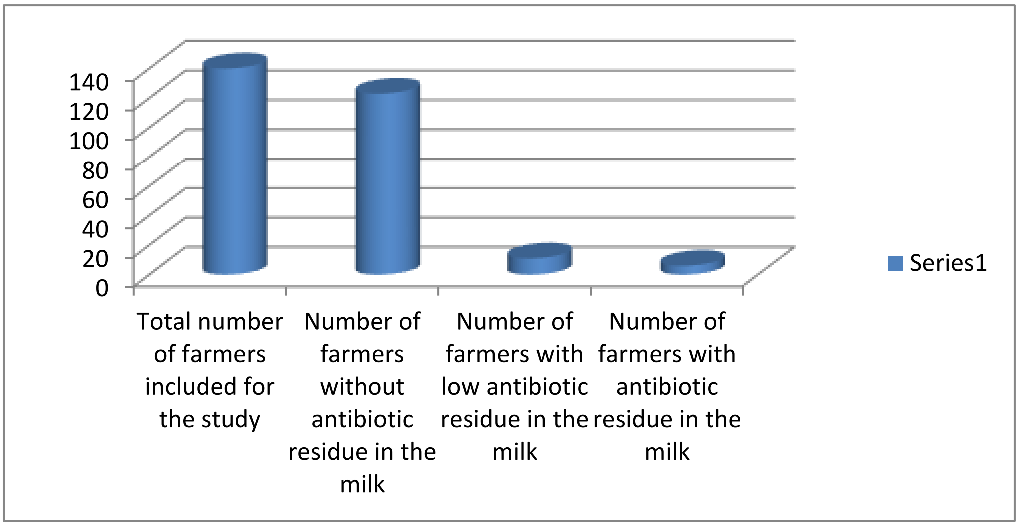

Figure 1. Number of farmers without antibiotic residue in milk, low antibiotic residues or residues after using EVP

These 17 (11+6) farmers admitted that they had used antibiotics along with EVP. The milk from the control group contained beta-lactams and/or sulphonamide. Tetracycline, streptomycin, neomycin, and chloramphenicol gentamicin were absent, indicating the widespread use of beta-lactams and sometimes sulphonamides.

Reduction of incidence of disease conditions in cattle.
There has been a reduction in the incidence of mastitis, enteritis, repeat breeding and cowpox from 2016 to 2018 and 2019 when herbal alternatives were used (Table 3)

Table 3. The reduction of the incidence of mastitis, enteritis, repeats breeding and cow pox from 2016 to 2019

Disease	Mastitis			Enteritis			Repeat breeding			Cowpox		
Year	2016	2018	2019	2016	2018	2019	2016	2018	2019	2016	2018	2019
Average incidence	65.63	36.5	10.6	11.3	7.38	4.38	8.75	2.5	0.38	2.38	2.13	0
Per cent reduction		44.4	83.8		34.7	81.2		71.43	95.7		10.5	100

The microbiome of milk from the cows with clinical mastitis before treatment with ethno veterinary herbal formulations shows presence of several species of bacteria besides, the mastitis causing ones. After 6 days of treatment the average abundance of *Staphylococcus* was reduced from 40.59% to 2.03% (20 times), *Streptococcus* from 25.8% to 2.06 (12.52 times), *Pseudomonas*, *Pseudomonaceae* family 20.28% to 1.9% (10.67 times), *Klebsiella* from 8.4% to 0.26% (32.31 times) and *Enterobacteriaceae family* from 24% to 1.69% (14.37 times) indicating the cure of mastitis. The mastitis was confirmed with CMT (California Mastitis Test. The study indicates that the use of herbal formulations instead of antibiotics reduced the antibiotic residues in the milk. Adopting ethno veterinary science and practices to combat infectious diseases in livestock has been identified and tested as a key game-changer in reducing antibiotic use in veterinary practices and antibiotic residue in milk.

Suggestions for research and support policies to develop further organic animal husbandry

Support more research on the trans-disciplinary understanding of herbal formulations for broader use. Indian systems of medicine give priority to prevention rather than cure, and therefore we have to study the combinations of feed supplements suggested to improve immunity in cattle. Support research and development for products formulation based on the trans-disciplinary understanding. Support pilot project to produce antibiotic-free milk through the usage of EVP.

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Ethnoveterinary herbal approach for organic livestock production without antibiotics: Pan-Indian success

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Key-words: Ethno veterinary herbal medicine, antibiotic-free milk, India

Abstract

Ethno veterinary herbal remedies (EVHM) for mastitis, fever, enteritis, FMD, infertility (including a score of other ailments of livestock validated by the first author and disseminated by TANUVAS-TDU-GLOHMSIWA) are successfully used (since 2016) by vets/farmers in thousands of dairy animals, on a daily basis (as of now) in 30 milk-unions (12 provinces) across India, under the aegis of National Dairy Development Board (NDDB), India. The recent data (vide infra), from an end-user of our herbal approach to organic livestock production (four private dairy companies - monitored by Abbott group India operations), in treating Mastitis, udder Pox/ Warts/ Cracks, Teat Obstruction with only EVHM, showed over 80 % clinical success - without antibiotics,signify the pan-Indian success of EVHM. In Oct 2019 of 94 clinical mastitis cases, 92 got completely cured (97.87%); assessed by parameters like swelling, palpable condition of the quarters, colour and odour of milk, return to previous level of milk production, CMT, SCC etc. In the case of udder pox/warts/cracks, of the 38 animals encountered, 33 showed complete recovery (86.84 %) in three days without antibiotics. Teat obstruction (a problem in Indian native breeds with long teats and pendulous udder) was solved with fresh Azadirachta indica stalks (from neighbourhood); all 36 animals recovered (100 %). Common (GRAS) plants/spices like Aloe vera, Curcuma longa, Ocimum basilicum, Cuminum cyminum, Allium sativum, Sesame indicum are part of the functional remedies to cure udder related issues viz., Mastitis, Teat Obstruction, Pox/ Warts/ Cracks obviating the antibiotics. EVHM approach exemplifies the value of traditional herbal knowledge and natural plant resources in combating AMR issues effectively.

Introduction

Antimicrobial resistance (AMR) is a global issue, and strategies to control AMR are plenty, such as vaccines, newer antibiotics and particularly preventing inappropriate antimicrobial use. But viable alternatives which are practical and user-friendly remain unexplored in most parts of the world. The traditional knowledge-based herbal medicine approach obviates the use of antimicrobial compounds in animal production and health. This paves the way for the clean production of milk, meat and eggs. This approach also facilitates residue-free production of dung and urine from livestock which are essential for organic agriculture. Ethnoveterinary herbal medicine (EVHM) remedies for clinical conditions like mastitis, fever, enteritis, foot and mouth disease, infertility, and other common ailments of livestock have been validated and are being disseminated by the joint efforts of the following organisations: Tamilnadu Veterinary and Animal Sciences University, the Trans Disciplinary University and the Global One Health Mission through Siddhayurveda International Wellness Approach (TANUVAS-TDU-GLOHMSIWA).

The functional herbal remedies for the above-mentioned clinical conditions have been successfully used since 2016 by veterinarians and farmers in thousands of dairy animals. As of

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2019, they have been used daily in 30 milk unions (12 provinces) across India, under the aegis of the National Dairy Development Board (NDDB), India. The results are recorded and monitored digitally.

The same EVHM herbal recipes are currently being used by private dairy operators, such as the Abbott group India operations, Hatsun Agro private limited and farmer milk producers' companies. The real-time data from these field applications of the EVHM knowledge is a game-changer in the battle against AMR (WHO, 2019).

Our natural livestock farming (NLF) partners in Netherlands, Ethiopia, and Uganda have already explored the possibility of using EVHM. They are moving forward to train veterinarians and farmers in EVHM to combat the AMR issue in their respective countries in light of the large-scale success of EVHM in India.

The EVHM approach exemplifies the values of traditional herbal knowledge and natural plant resources in combating AMR issues effectively.

Material and methods

Common and generally regarded as safe (GRAS) plants and spices like *Aloe vera*, *Curcuma longa*, *Ocimum basilicum, Cuminum cyminum, Allium sativum, and Sesame indicum* are part of the functional remedies which were used to cure udder related issues in dairy cattle, namely mastitis, teat obstruction, pox/warts/cracks obviating the use of antibiotics. The EVM treatments for acute mastitis and other conditions are used widely across India as per the ratio and procedure formulated by Punniamurthy (2009).

Results

The four private dairy companies monitored by Abbott group India provided data on the herbal approach to organic livestock production. The treatment of mastitis, udder pox/warts/cracks and teat obstruction with EVHM achieved over 80% clinical success (Table 1). This successful treatment without antibiotics, signify the pan-Indian success of EVHM.

Table 1 Some clinical conditions treated with only herbs

Diseases	Feb'19	Mar'19	Apr'19	May'19	Jun'19	Jul'19	Aug'19	Sep'19	Oct'19
Mastitis	24	37	30	55	81	88	91	81	94
Teat obstruction	3	2	6	21	40	40	49	43	36
Pox/warts	12	17	6	24	25	18	21	17	38
FMD oral lesions	5	35	6	1	1	39	8	0	2

In Oct 2019, of 94 clinical mastitis cases, 92 were cured entirely (97.87%); assessed by parameters such as the swelling, palpable condition of the quarters, colour and odour of milk, return to the previous level of milk production, CMT, SCC, etc.

In the case of udder pox/warts/cracks, of the 38 animals encountered, 33 showed complete recovery (86.84%) in three days without antibiotics. Teat obstruction (a problem in Indian native breeds with long teats and a pendulous udder) was solved with fresh *Azadirachta indica* stalks gathered from the neighbourhood; all 36 animals recovered (100%).

Table 2. Level of success of EVHM treatments on three diseases

Diseases in Oct. 2019	Cases treated	Cured	Not-cured	% cured
Mastitis	94	92	2	97.87%
Teat obstruction	36	36	0	100 %
Pox/warts/cracks	38	33	5	86.84%

Discussion

Mastitis control: a sustainable model for the developing world

EVHM is used to manage acute mastitis without antibiotics. The antimicrobial activity of the preparation and probable mode of action for this mastitis formula have already been reported (Punniamurthy et al. 2017a, 2017b). A total of 48,469 acute mastitis cases in 24 milk unions (1,500 societies) were treated using the preparation; 78% (38,045) showed complete clinical recovery. As per Rana et al. (2019), when Standard Operating Procedures (SOPs) were followed judiciously, the success rate was above 90%. The NDDB, India, has published booklets on "Ethnoveterinary Formulations for Important Ailments in Bovines" for 14 clinical conditions in 12 Indian languages (DKP-NDDB 2018). Herbal approaches are cost-effective, efficacious, and have significantly helped reduce the use of antibiotics (Punniamurthy, 2009, Punniamurthy et al., 2017a, 2017b, Nair et al., 2017).

A hormetic approach - the starting point in ethnopharmacology?

The lead author has treated a range of diseases in thousands of animals, with a clinical success rate of over 80%, across India in recent years. The experience should encourage the scientific community, in general, and pharmacologists, in particular, to work on ethnopharmacology with hormesis as the starting point (Satheshkumar and Punniamurthy 2009, 2010). Researchers attribute the medicinal value of the natural products from plants to bioactive constituents (phytochemicals) and their intrinsic antioxidant properties, as oxidative stress plays a crucial role in most chronic diseases. However, achieving such antioxidant capacity in the blood requires micromolar concentrations of the phytochemicals.

The co-evolution of plants and animals and resulting interactions and reciprocal adaptations has shaped the remarkable characteristics of phytochemicals and their effects on the physiology of animal cells in general and neurons in particular. Survival advantages were conferred upon both plants (capable of producing obnoxious bitter-tasting chemicals) and on animals to tolerate the phytochemicals and consume the plants as an energy source (Calabrese and Mattson,2017).

EVHM against foot and mouth disease

The most striking feature of this approach is its scalability and ability to provide the last mile coverage at the farm level in times of crisis. For example, in an outbreak of a contagious disease like foot and mouth disease (FMD), thousands of livestock can be saved.

The animals treated with EVHM rather than antibiotics and who had recovered were found to have a nearly normal pregnancy rate when followed up. This is a significant result for the natural treatment of a viral disease like FMD, as usually, animals that have recovered cannot conceive for a long time.

Suggestions for research and support policies to develop further organic animal husbandry

EVHM is an effective standalone method

EVHM is a location, resource, species and condition-specific approach. EVHM provides the last mile coverage in the health care of livestock. EVHM can empower farmers, encouraging self-reliance in primary healthcare of livestock, as the first line of defence effective for two-thirds of common ailments.

It is suggested that beneficial effects are felt by animals and humans when they consume phytochemicals. Polyphenols modulate mitochondrial biogenesis, dynamics (fission/fusion) and autophagic degradation to keep the quality and number. Curcumin is shown to promote mitochondrial biogenesis and dynamics *in vivo* and *in vitro.* Hence concerted efforts with a multidisciplinary approach in the research and development of EVHM at the field and laboratory level would help farmers' produce organic animal proteins for the human food basket. This will also help contain AMR.

Acknowledgements

The contributions by the traditional healers, field veterinarians from dairy unions and government sectors, NDDB of India, Abbott India, TANUVAS,TDU-FRLHT, GLOHMSIWA and particularly the acceptance by livestock farmers for the success of EVHM in antibiotic-free animal production, are duly acknowledged. The lead author thanks the co-authors in helping to propagate the EVHM across India.

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Case studies on innovative combined indoor/outdoor organic pig systems

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Keywords: pig, outdoor, combined systems, animal welfare, fact sheets, innovative farming

Abstract

In many European countries, organic pigs are housed indoors with a concrete outdoor run. However, previous results have shown that combined systems with indoor housing and access to pasture have some advantages concerning animal welfare and environmental impact compared to sole indoor systems. These combined systems vary considerably across countries. Some farmers have only specific age categories on pasture, some provide limited access and others developed new approaches to management or infrastructure.

The goal of this study, which is part of the CORE Organic Cofund POWER project, was to analyse specific innovations in combined systems for weaners, fatteners and sows in Denmark, Italy and Switzerland. For example, the selected innovations comprise a self-constructed mobile pen on a trailer, which is large enough to keep the pigs on the trailer if the weather does not allow them to use the pasture. Another example was a mobile pen that can be moved, including the attached fences. Moreover, farms with innovative management practices were included, like the alternating use of grassland, cropland and forest.

The selected farms have been visited four times between summer 2019 and autumn 2020. Trained observers assessed individual animal health and welfare status according to a common protocol. Indicators were, for example, species-specific behaviour, lesions, lameness or body condition score. Farmers provided extensive data regarding farm management, feed production, housing etc., to analyse the different systems and identify their strength and weaknesses. The farmers' experiences, the collected data and analysis of the different innovative systems were summarised in factsheets to use this knowledge for advising other farms. These factsheets can help to diversify and improve such combined systems.

Introduction

Free-range management of pigs allows the animals to show their innate behaviour in a natural environment. Organic pig production systems aim at a high animal welfare status with low environmental impact. However, free-range pig farming is not mandatory due to the EU regulation on organic farming. With optimal management, free-range farming has several advantages regarding animal welfare and health status, as already investigated in the CORE Organic project ProPig (Leeb et al., 2019). On the other hand, the free-range management of pigs poses several challenges. Ecological factors such as the destruction of grass cover must be balanced with economic factors such as workload or feed consumption. Several farmers have developed individual systems to keep the pigs outdoors during the vegetation period or the whole year to overcome these challenges. These strategies differ between European countries as a result of varying climatic conditions as well as different regulations, national or association based. Such innovative systems were investigated within the CORE Organic project POWER in the three countries Denmark, Italy and Switzerland. Based on this research advantages and disadvantages of the systems were identified. This knowledge can be used for

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further research and agricultural consulting to promote the wider adoption of free-range elements in organic pig production.

Material and methods

The project group has organised workshops with stakeholders to identify innovative practices in the three countries. As a result, two systems per country were chosen to be investigated within the POWER project.

Specific protocols were developed to assess the impacts of the innovations on animal welfare, environment, economy and the resilience and vulnerability of the whole farm (**Error! Not a valid bookmark self-reference.**). All farm visits are carried out according to a common standard operating procedure. Each farm was visited once every season to identify the differences between the seasons.

Table 1: Overview of the protocols

Protocol	Content	Collected data
Welfare indicators	Animal-based indicators	Behaviour observation, soiling, consistency of faeces, runts, ectoparasites, body condition, eye inflammation, ocular discharge, ear lesions, injuries, shoulder lesions, vulva lesions, tail length, tail lesions, lameness, sun burn, etc.
	Resource-based indicators	Hospital pens, flooring and pen hygiene, provision of water, elements of pen design and enrichment
Lifecycle Assessment	Data on environment and economy	Management, productivity, manure storage, labour, costs, feed components, on-farm feed production, grass cover, nutrition input into soil, use of medication
Resilience questionnaire	Data on resilience and vulnerability	Reactions of the farms to various scenarios, impact of changes on farms, possibilities for farms to adapt to changes (e.g. climate, input costs, labour, legislation, outbreak of pig diseases, price for pigs and pork etc.)

Results

The results of the analyses are not yet complete and will be published at the end of the project. This chapter provides an overview of all innovative farms that participated and summarises the factsheet evaluation. The advantages and disadvantages of the systems are shown in Table 2. Except for CH1 in Switzerland, all farms were certified organic.

Italy

IT1**:** The farm had one boar and ten sows of the local breed *Cinta Senese.* The sows in gestation were kept together with the boar outdoors on a vast area with bushes, trees, and grassland and access to small huts. For the farrowing and lactation period, the sows were kept in groups in a stable with access to an outdoor run. Growing, fattening and finishing areas were in a stable with permanent access to arable land that was part of the crop rotation. The animals foraged directly on the cultivated crops. Due to sown fodder plants made available at the ripened stage, up to 40% feeding could be saved during the fattening period. The farmer experimented a lot with different plants and thus optimised this innovative husbandry and feeding system.

IT2: The farm had one boar and twelve sows of the local breed *Cinta Senese*. The breeding area was located between a large field and a forest to take advantage of the different climatic conditions in the seasons. The pigs were kept in the forest from growing to finishing period with access to small huts. After a few months of grazing, the forest recovered for one or two years. The innovative approach of the system was to create an environment as natural as possible with minimal infrastructure and at the same time to use and preserve the forest ecosystem sustainably.

Denmark

DK1: This farmer bred pigs and sold seven weeks old piglets just after weaning. The sow breed is Danish Landrace-Yorkshire. The herd consisted of 112 sows. The farmer developed movable huts for four sows in order to allow better working conditions, higher efficiency and better animal welfare. Each hut provided feed and water and contained all elements of a permanent breeding barn. In addition, the piglet nest was equipped with electricity and heat to reduce piglet losses. A tractor moved the huts after each lactation (approx. eight weeks) and integrated the sows into the crop rotation to reduce soil nutrient loss.

DK2: The farm kept 150 growing pigs from farm DK1 in mobile self-constructed wagons. The wagon, including fencing, was moved jointly 1-2 times a day to provide new pasture areas for the pigs, depending on the season and pig size. It ran on caterpillar tracks and was moved by tractor. A camera pointed at the pasture area connected to a tablet in the tractor secured no pigs get hurt when moving the wagon and fence. The size of one hut was about 108 m^2 with a fenced area of about 150 m^2. The huts were only moved as far as half and three-quarter the size of the fenced area to obtain an even distribution of nutrients. The farmers' main production was crop production, and he used the pigs for fertilising the fields. This was achieved by continuously moving the mobile hut and thus evenly spreading the manure. Thus, the pigs were on pasture all season.

Switzerland

CH1: The farm worked with the traditional English breed Berkshire. There were 15 sows and 3 boars on the farm. Pigs of all age categories and production stages were kept in different groups on pasture all season. The farmer used professional huts from England that could be easily built and were quickly moved by tractor. The pigs were integrated into an alternating pasture system and were moved once every year to a new area. Sows and their piglets have been kept together for three to four months. The farm's innovative approach was year-round free-range farming in a country that traditionally keeps pigs indoors and rarely outside during summer. This system was enabled by the insulated huts and the robust alternative breed.

CH2: The farm created a trailer on which ten fattening pigs can be kept in compliance with organic conditions. The trailer included a feeding place, drinking troughs, a lying area with straw, and a small activity area with a slatted floor. Faeces and urine fell through the slatted floor and were thus distributed on the pasture. The area around the feeding and sleeping zones that were intensively used by the pigs did not result in over fertilisation and silting of the area. This innovation protected the grass cover as the pigs were kept on permanent grassland and were not integrated into the crop rotation. Two doors on the trailer could be opened to different fenced areas if the weather allowed it. After one of these areas was intensively used by the pigs, this door can be closed, and the other door can be opened to use the other pasture without moving the trailer. The so-called "Sau Karawan" ("Pig Caravan") could be moved by tractor. The farmers kept their own crossbreed of pigs called Distelschwein mixed with the German breed Schwäbisch Hällische Landschweine. The sows and piglets were kept in a permanent barn with access to an outdoor run and during summer to pasture.

Table 2: Advantages and disadvantages of the different innovative systems

	Advantages	Disadvantages
IT1	• Efficient use of nutrients • Protection of the soil through regular plot changes • Feed savings	• High labour input for fencing the areas • High planning effort for integration into crop rotation • Land-intensive
IT2	• Natural environment for pigs • Use of forest area for food production	• High labour input for fencing the areas • Land-intensive • Biosecurity risk
DK1	• Efficient use of nutrients • Reduction of piglet losses	• High technical effort • Only possible on flat land with crop rotation
DK2	• Efficient use of nutrients • High working efficiency	• High technical effort • Expensive investments in infrastructure • Only possible on flat land with crop rotation
CH1	• Low labour input for fencing the area and moving the huts • Little infrastructural input • Also possible on hilly terrain	• Risk of nutrient leaching • High risk or parasites and pathogens • Strong impacts on the soil structure and grass cover
CH2	• Protection of grass cover • Efficient use of nutrients • Low labour input for fencing the area and moving the trailer	• Expensive investments in infrastructure • High labour input for constructing the self-made trailer

Discussion

To protect the health of the soil, it appears that farms are pursuing either land-intensive or infrastructure-intensive systems. If the pigs are integrated into the crop rotation, the influence on soil structure and nutrients can be balanced with tillage and the following crop. When pigs are kept on permanent grassland, the protection of the grass cover has a high priority so that no weeds can develop on the bare soil. Free-range pig production systems should be adapted to the topography of the area and the climatic conditions. Four of six farms work with alternative breeds that are traditionally kept and bred outdoors. These breeds have a pigmentation that protects them against sunburn; they have more hair and higher fat than conventional breeds. These characteristics make them more robust and well adapted to outdoor conditions.

Suggestions for research and support policies to further develop organic animal husbandry

The combination of indoor and free-range pig farming systems can be further developed. Based on the size and orientation of the farm, the appropriate combined system or innovation should be analysed and selected. This could primarily be a task for advisors from the various organic labels.

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Pigs integrated in cropping systems to support a sustainable and diversified organic meat production

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Keywords: free-range, pork, resource efficiency, nutrient losses, animal behaviour

Abstract

The objective was to investigate the effects of two foraging crop systems on pig growth, behaviour, feed efficiency, and soil nutrient load in integrated systems allowing pigs to meet their natural needs. Under temperate climate conditions, 24 growing pigs with an initial mean live weight of 65 kg were foraging in late autumn on an area either with 100% grass-clover (GG) or on a combination of grass-clover (50%) and fodder beets (50%) (BG) until slaughter at 105-118 kg. All pigs were fed restrictedly with supplementary feed corresponding to approximately 70% of recommendations. The pigs were offered additional land three times weekly to encourage foraging behaviour and even spatial distribution of excreted nutrients. Across treatment, the pigs spent 63% of observations in the range area (outside the huts), and 83% of these observations were spent on foraging activities. Compared to GG pigs, BG pigs had 31% higher daily weight gain (981vs. 750 g, P<0.001) and used 26% less supplementary feed per kg live weight gain (2.0 vs 2.7 kg, P<0.1). No significant differences in dressing percentage or lean meat percentages were observed. Calculated paddock nitrogen (N) balances were 101 and 65 kg N ha^{-1} for GG and BG paddocks, respectively. After pig foraging, average soil inorganic N in 0-25 cm depths was 35% lower in BG than in GG paddocks (47 vs 72 kg N ha^{-1}). The results indicate that fodder beet is a very suitable foraging crop for pigs of more than 70 kg live weight. Direct foraging of attractive crops combined with restricted access to supplementary feed may be a valuable strategy for accommodating nutrient and energy requirements of organic growing pigs, thereby supporting diversified and sustainable organic pork production.

Introduction

Despite clear animal benefits, free-range fattening is rare in conventional and organic pig production in Denmark and other European countries. Central obstacles for broader adoption are poor feed efficiency rates and the risk of nutrient losses in pasture systems. The latter relates to high nutrient inputs from supplementary feed combined with poor vegetation cover due to the pigs' characteristic rooting behaviour (Eriksen et al., 2006). The pigs' non-random deposition of urine and faeces creating nutrient hotspots reinforces this risk (Jørgensen et al., 2018). 'Strip-grazing' providing the pig continuously new access to attractive foraging crops combined with restricted access to supplementary feed to encourage foraging behaviour (Kongsted et al., 2015) may be a more sustainable alternative to the current pasture systems. Under temperate climate conditions, pastures represent high dry matter and protein yields during summer, but there is a need for supplementary foraging crops in cooler autumn and winter seasons. The objective was to investigate the effects of two foraging crop combinations on pig behaviour, growth, feed efficiency, and nutrient load in an experimental design in late autumn.

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The experimental pigs, feed and forage crops were not organically certified. This needs to be taken into account when interpreting the results.

Material and methods

Experimental site and animals

Twenty four female growing pigs were included in the experiment carried out from September to November 2019. The pigs were born in a commercial pasture system and reared in stables with access to outdoor concrete runs from weaning at around 10 kg live weight until arrival at the experimental site two weeks before initiation of the experiment. In this pre-experimental adaptation stage, all pigs were located in one paddock with a mixture of grass-clover and fodder beets and the pigs were fed 2 kg conventional feed pig^{-1} day^{-1}.

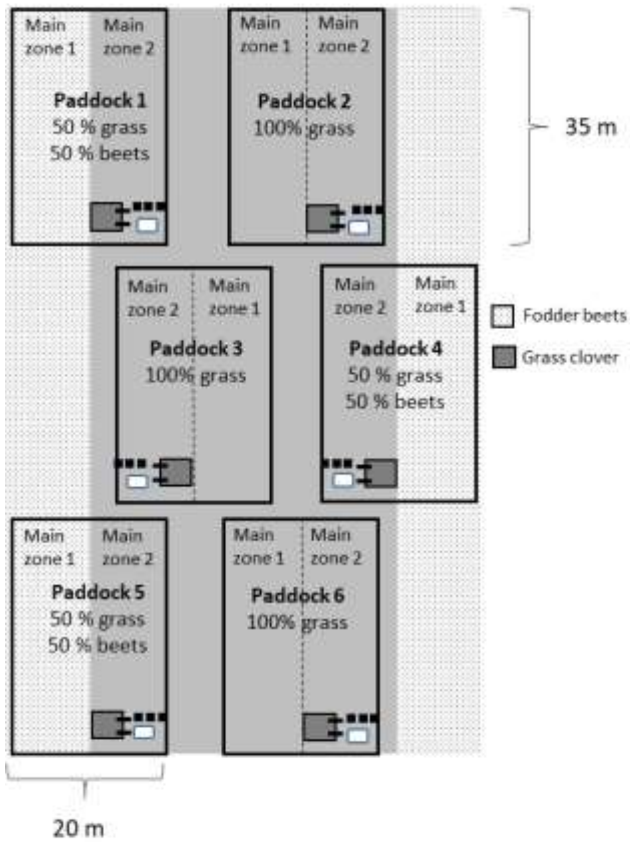

Figure 1. Six experimental paddocks in three blocks with location of huts (grey boxes), feeding (black boxes) and water troughs (white boxes). Each paddock was divided into two main observation zones (main zone 1 and 2).

The pigs were divided into three blocks based on their live weight at an average of 65 kg (SD=8 kg). Within each block, they were randomly allocated to one of two paddocks representing two different foraging crop systems: 1) 100% grass clover (GG) and 2) 50% grass clover and 50% fodder beets (GB) (Figure 1). The grass-clover was established in spring 2016, whereas the fodder beets (Alisha KWS) were established in spring 2019.

Each paddock measured in total 20m x 35m corresponding to 3.4 m^2 pig^{-1} day^{-1}. Initially, the paddock size was 80 m^2. By moving the fences, the paddocks were enlarged by 1 m and 2 m each Monday, Wednesday and Friday, respectively, from day 5 to day 49. This corresponded to 80 m^2 additional area each week. By day 49, the pigs gained access to the remaining paddock area measuring 120 m^2. According to USDA soil taxonomy, the experimental paddocks were located at Research Centre Foulum (56°29'44.4"N 9°33'34.8"E), where the soil type is loamy sand. The experimental area is cultivated according to conventional crop production standards; however, without artificial N-fertiliser in the year 2019.

Throughout the experimental period (54 days), the pigs were fed 2 kg pig^{-1} day^{-1} a low-protein feed mixture based on conventional feed ingredients (137 g crude protein, 8.2 g Lysine and 12 MJ ME kg^{-1}). The pigs were fed once a day at approximately 09.00 h. Three open feeding troughs were placed in each paddock, which provided enough space for all pigs to eat simultaneously. The feeding troughs were moved every second week following the enlargement of the paddock. Pigs in each paddock had access to an insulated hut supplied with straw and an area of 4 m^2. The resources (hut, feed, water) were located in main zone 2 (Figure 1) and orientated in the same way according to the fodder beet area in all experimental blocks

Recordings and observations

In order to estimate daily live weight gain, the pigs were weighed when introduced to the experimental paddocks and at the end of the experiment.

Behavioural observations were carried out Tuesdays and Wednesdays from 07.30 to 17.35 h, 12 observation days and eight observations hours per day (excluding breaks). Each block was observed for 40 minutes four times per day (each paddock within block two x 10 minutes four times per day). The order of observation was randomised between and within blocks. Excretory behaviour (urinating, defecating) was recorded as all occurrence, whereas the remaining behavioural elements (time spent inside a hut, eating supplementary feed, drinking, lying, sitting, standing/walking/running, rooting, grazing, chewing uprooted grass, biting/eating fodder beet roots and tops) were recorded as scan samples every five minutes. This gave 16 scan samples per paddock and 96 scan samples in total per observation day except for the last three observation days with only 87-92 scan samples per observation day. The latter due to darkness at the end of the observation period. In total, 1,120 observations were included in the analyses. Two trained observers carried out the observations. Each paddock was divided into two main zones of 350 m^2 (Figure 1) and each main zone into nine sub-zones of 40 m^2 per zone. The location of the pigs was recorded for each behavioural element.

To estimate forage crop quality and availability, forage samples were taken in undisturbed zones on October 31, 2020. Grass-clover from 0.5 m x 0.5 m squares were randomly sampled within each of the six paddocks. Eight fodder beets samples (separated in root and leaves) were randomly taken within each of the three paddocks.

To evaluate paddock appearance, the foraging crops were evaluated weekly (Tuesdays) throughout the experimental period. For each subzone area, percentage grass-clover cover, uprooted area, bare soil, grass regrowth, and eaten fodder beets were visually determined by a trained observer.

For each of the two cropping systems, the nutrient balance was calculated by summing the nitrogen (N) and phosphorus (P) inputs in feed and N inputs in atmospheric deposition and subtracting the N and P output in pigs (live weight gain). N and P in the supplementary feed were calculated from recorded feed use, crude protein and phosphorus content in the feed, and the standard value of N content in protein (16%) (Tybirk et al., 2018). Calculated N and P retention were based on live weight gains (Table 2) combined with a literature standard value of N and P content per kg live weight gain (2.96% N and 0.55% P) (Tybirk et al., 2018). Yearly atmospheric deposition was estimated to be 13 kg N ha^{-1} (Ellermann et al., 2019). Yearly nitrogen fixation was estimated at 30 kg N ha^{-1} in the period of foraged clover zones (Høgh-Jensen et al., 2003).

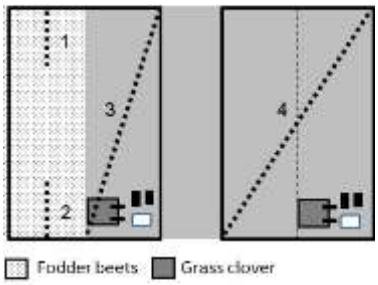

Figure 2. Soil samples were taken before and after pig foraging in paddock 1 to 4.

Soil samples at 0-25 depth were collected in paddock 1, 2, 3 and 4 before and after pig foraging, September 23 and November 29, respectively, as shown in Figure 2. Soil samples were collected at 2 x 5 grid points (sample 1, 2), 1 x 5 grid points (sample 3) and 1 x 10 grid points (sample 4). Soil samples collected before pig foraging were pooled in the following way: Soil samples 1 + 2 and 3+4 (Figure 2). After pig foraging, only soil samples 1+2 were pooled.

Statistics

The effect of crop combination on pig performance traits (initial live weight, live weight at slaughter, daily gain, lean meat percentages) was investigated by the following mixed model using the MIXED procedure in SAS (Littell et al., 1996):

$Y_{ij} = \mu + \alpha_i + \lambda_j + A_{ij} + E_{ij}$, where Y_{ij} is the observation for the individual pig, μ is the overall mean, α_i is the effect of the cropping system (i = BG, GG) and λ_j is the effect of the block (j = 1-3). A_{ij} is the normally distributed random effect of the group (i = BG, GG) within block (j = 1-3). E_{ij} was assumed to be normally distributed. Observations from different groups were assumed to be uncorrelated, while those from the same group were assumed to be correlated. When investigating the effects of the cropping system on daily gain, initial live weight was included as a covariate. Dressing percentage and feed conversion ratio were investigated at the group level (n = 6) with a model including the cropping system and the block only. Data regarding forage crop availability, pig behaviour, paddock appearance and nutrient balances were analysed descriptively.

Results

Forage crop availability

Forage crop nutrient content and amount of available forage dry matter (DM) are given in Table 1. In the experimental paddocks with 50% fodder beets (BG), available forage DM (fodder beet roots, fodder beet leaves and grass-clover) were 7.6 times higher compared to paddocks with 100% grass-clover (GG) (14,160 vs 1,870 kg DM ha^{-1}, respectively). The available forage crops corresponded to 18.8 vs 1.3 MJ ME per m^2 and 122 vs 38 g CP per m^2 for BG and GG paddocks, respectively.

Table 1. Forage crop nutrient content and available forage from areas with grass-clover and fodder beets, respectively. The crops were cultivated under non-organic conditions

	Grass-clover1)	Fodder beets	
		Root	Leaves
DM %	17.3	22.5	11.8
Crude protein, % of DM	20.3	5.1	15.3
ME, MJ kg DM^{-1}	7.1	8.6	15.6
DM forage availability, kg DM ha^{-1}	1,870	19,400	7,040

1) Grass roots and clover roots not estimated and therefore not included

Pig performance

The effect of the cropping system on the growth performance, feed conversion and lean meat percentage are shown in Table 2. Pigs with access to grass-clover and fodder beets (BG) had 31% higher growth rates and used 26% less supplementary feed per kg live weight gain compared to pigs with access to grass-clover only. There were no significant differences in dressing or lean meat percentages between the two groups.

Pig behaviour

Across treatment, pigs spent 63% of behavioural observations outside the huts in the range area, and 83% of these observations were spent on foraging activities. The proportion of foraging behaviour in the two main zones was almost equal within paddocks, with 52 and 55% of all foraging activities in main zone 2 for GG and BG paddocks, respectively.

In the paddocks with 100% grass-clover (GG), the behaviour “grazing” increased from 48 to 75% of all foraging activities during the six observation weeks (Figure 3). “Grazing” included “grazing non-disturbed pasture” and “biting uprooted grass and clover including roots”, representing 4 and 96%, respectively, of all “grazing” observations.

In the paddocks with grass-clover and fodder beets (BG), the behaviour “biting fodder beets” increased from 8 to 48% of all foraging observations during the six observation weeks (Figure 3).

The pigs got access to an additional range area each Monday and Wednesday. In GG paddocks, in the first four observation weeks, the percentage of foraging observations spent on rooting was numerically higher the second observation day with access to new pasture in the morning (09.00 h) than the first observation day, which was one day after access to additional pasture (Figure 3).

Table 2: Performance traits for fattening pigs with access to paddocks with 100% grass-clover (GG) and paddocks with 50 % grass-clover and 50% fodder beets (BG), respectively

	N	LS means		S.E.	Significance level[3)]
		GG	BG		
Initial live weight, kg	24	64.4	65.0	1.2	ns[2)]
Live weight at slaughter, kg	24	104.9	118.4	2.5	**
Slaughter weight, kg	24	76.9	85.1	2.0	*
Dressing percentage	6[2)]	73.3	71.9	0.5	ns
Daily live weight gain, g day^{-1}	24	750	981	27	***
Lean meat percentage	24	64.7	64.1	0.4	ns
Feed[1)] conversion ratio, F:G	6[2)]	2.7	2.0	0.06	#

[1)] Supplementary feed. kg, [2)] Paddock level, ns: non-significant, [3)] *,**,**: P<0.001, <0.01, <0.05, respectively, #: P<0.1

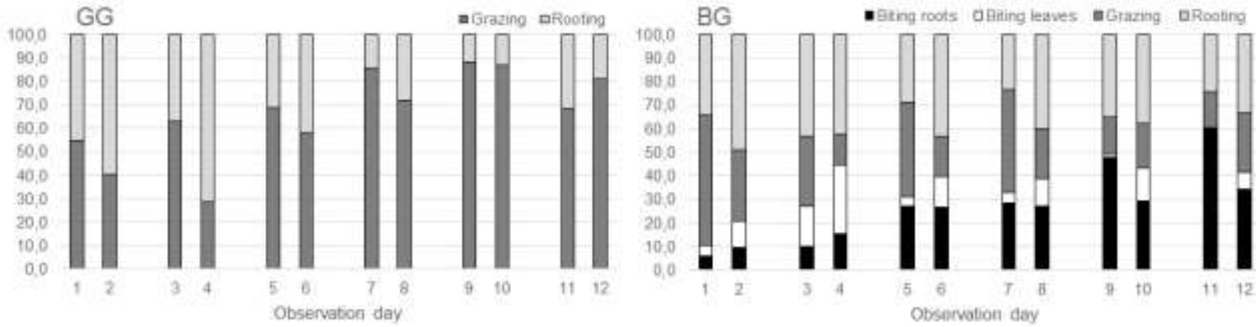

Figure 3. Foraging elements (grazing, rooting, biting fodder beet roots, biting fodder beet leaves) shown as the percentage of all foraging observations for each of the six observation weeks (two observation days per week) and for each treatment (GG: 100% grass-clover, BG: 50% fodder beets and 50% grass-clover).

Regarding excretory behaviour, in total, 229 urination and 313 defaecation frequencies were observed. This corresponds approximately to six urinations and eight defaecations per pig per day. In total, 58% of urination and 57% of defaecation behaviours, respectively, were observed in BG paddocks.

Within paddocks, the distribution of elimination behaviour in the two main zones differed markedly between treatments. In paddocks with 100 % grass-clover (GG), the majority of excretory behaviour was observed in main zone 1. In contrast, in paddocks with 50% fodder beets, the majority of elimination behaviour was observed in main zone 2, representing the area with grass-clover (Figure 4). Across treatments, only 6% of urination and 3% of defaecation behaviours occurred in the first subzone of 40 m^2, where the hut and water were located throughout the experimental period.

Paddock appearance after pig foraging

There was no undisturbed grass-clover area on the days of paddock appearance evaluations corresponding to 1.5 days after enlargement of the paddocks in both treatments. However, grass regrowth was observed from experimental week five but only in the GG paddocks, especially in main zone 1 (Figure 5). The estimated percentage of eaten fodder beets increased from 0% in week 1-3 to 51 and 45% in week 6 and 7, respectively.

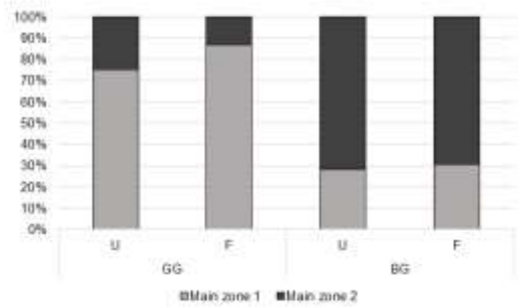

Figure 4. Elimination behaviour (U: urination, F: defaecation) distribution in main zones for paddocks with grass-clover (GG) and with grass-clover and fodder beets (BG), respectively. Main zone 2 represents the zone with grass-clover in BG paddock.

Nutrient load

When considering only the experimental period and using the figures in Table 2, paddock nitrogen balances were 101 and 65 kg N ha$^{-1,}$ and phosphorus balances were 12 and 8 kg P per ha for GG and BG paddocks, respectively.

Total N content in the soil in grass-clover areas increased from 25.7 kg N ha^{-1} before pig foraging to 56.2 and 72.4 kg N ha^{-1} after foraging in GG and BG paddocks, respectively. In contrast, total N content in fodder beet areas decreased from 77.3 to 37.6 kg N ha^{-1} due to a marked reduction in nitrate N; however, ammonium N more than doubled in the areas with fodder beets. Total N in BG paddocks was on average 47 kg N ha^{-1} when considering the whole area.

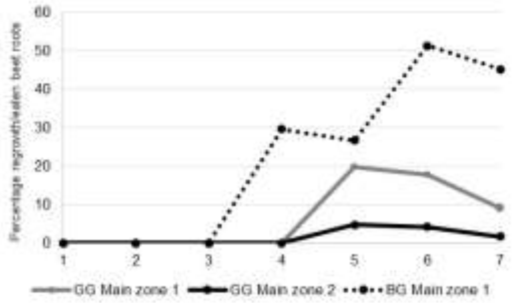

Figure 5. Grass regrowth in main zone 1 and 2, respectively, in GG paddocks (solid curve) and eaten fodder beet roots in BG paddocks (dashed curve) in the seven experimental weeks.

Table 3. Soil ammonium, nitrate and total N contents (kg N/ha, 0-25 cm depths) before and after pig foraging

	Treatment/ foraging crop	Kg N/ha		
		Nitrate	Ammonium	Total N
Before	Fodder beets	66,0	11,3	77,3
	Grass clover[1)]	2,6	23,1	25,7
After	BG-fodder beets[2)]	11,0	26,6	37,6
	BG-grass clover[3)]	7,5	48,7	56,2
	GG-grass clover	6,9	65,5	72,4

[1)] All main zones with grass clover across treatment, [2)] main zone 1, [3)] main zone 2.

Discussion

To support sustainable, free-range pig systems, it is important to improve the nutritional value of the "occupied" range area. The current study indicates that introducing fodder beets as a foraging crop in late autumn in combination with restricted access to supplementary feed is a feasible strategy in the fattening stage (70+ kg live weight). Improved growth performance (31%) and feed conversion (24%) with no detrimental effects on lean meat percentages were obtained when combining fodder beets and grass-clover compared to only grass-clover. Consequently, calculated paddock nutrient balances were 36% (N) and 33% (P) lower in the combined system. Soil samples indicated accordingly a reduced N load. The experiment was performed under conventional conditions. Although lower crop yields can be expected, it is likely that similar positive results can be obtained under organic conditions, as even a 50% reduction in DM availability would have been sufficient to cover the pigs' nutritional needs. For a general discussion of suitable foraging crops, see Studnitz et al. (2019).

Suggestions for research and support policies to develop further organic animal husbandry

Free-ranging animals comply well with organic principles. However, free-ranged pig systems are under pressure in many European countries. It is crucial to support the development of robust and sustainable free-range systems through research and development initiatives. The focus should be on management strategies to reduce nutrient losses, *pre-* and *post morten* treatments to improve meat quality and development of technologies to reduce workload, improve work environment and the possibility to isolate and treat individual animals with impaired health and/or welfare.

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Multi-centre approach to improve outdoor runs for organic pigs: Preliminary results of on-farm experiments

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Keywords: welfare assessment, roughage, rooting area, shower

Abstract

Within the CORE Organic Cofund project POWER, European stakeholders and scientists identified elements to improve animal welfare and reduce environmental impact in concrete outdoor runs for organic growing-finishing pigs. The selected innovations included 1) roughage, 2) showers, and 3) rooting areas. We evaluated the effectiveness of these innovations on nine commercial organic pig farms in three European countries (Austria, Switzerland and Denmark). This multi-centre study requires a common approach to ensure the best possible standardisation regarding experimental set-up and data collection whilst acknowledging differences between countries and farms. Assessment protocols including animal-based (clinical and behavioural) indicators were jointly developed. To ensure comparable results, training and inter-observer reliability testing took place in on-farm sessions and via online training and showed acceptable to good agreement. Preliminary descriptive results of the three experiments are presented for clinical indicators, pig faecal soiling and use of the outdoor run. Most clinical indicators showed a low prevalence across all farms and experiments. For pig soiling, a potential effect was only observed in pigs with access to showers; they were slightly cleaner. The use of outdoor runs was generally high and seemed to be influenced by the improvement measures. We conclude that multi-centre on-farm studies are suitable for ensuring external validity as an important step in implementing improvement measures. However, the high effort for training and potential trade-offs between the highest possible standardisation and the need to adapt to farm-specific conditions must be acknowledged when planning such projects.

Introduction

Within the CORE Organic Cofund project POWER, stakeholders and scientists identified measures such as providing roughage in racks or rooting areas and possibilities for thermoregulation through showers as the most important elements to improve the concrete outdoor runs in organic growing-finishing pigs (Wimmler et al. 2021). Whereas these innovations have already been studied in controlled experiments (Olsen et al. 2001; Høøk Presto et al. 2009; Olsson et al. 2016), on-farm studies across different husbandry conditions are lacking. Apart from specific research questions related to the respective improvement measure, the common aim across all experiments was to investigate the effectiveness of measures to improve the use of the outdoor run, support animal wellbeing and reduce faecal soiling as well as associated ammonia emissions.

Materials and methods

We evaluated each of the three measures adapted to the on-farm conditions in at least two countries on two to three organic farms per experiment (Table 1). Farm recruitment inclusion

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criteria (e.g. breed; at least four comparable pens) were defined to enhance comparability and representativeness. Assessment protocols were jointly developed based on existing protocols for on-farm use (Leeb et al. 2015) and included animal-based indicators (behaviour, clinical parameters and soiling of pigs). We carried out an on-farm training session for clinical parameters on two Austrian farms in March 2018 with part of the assessors. Due to the low prevalence of the indicators, we performed additional online training. All assessors accomplished inter-observer reliability (IOR) testing using a set of approx. 30 photos per indicator. Training and IOR testing of behavioural parameters took place via video recordings from different farms. After a first round, the definitions were discussed and adjusted appropriately, followed by a second round for final IOR testing. Data collection was conducted in 2019/2020 by between one and three persons per country. Farms were visited repeatedly in an interval of 10-14 days, depending on the experiment (Roughage: 3-6, Showers: 2-3, Rooting: 6-7 visits per group). Behaviour was assessed from outside the pen before other assessments, allowing the pigs to become accustomed to the observer for at least two minutes. Clinical parameters were assessed in the afternoon on a group level by counting the number of affected pigs. We used binary scores for parameters with low prevalence (e.g. lameness), i.e. the whole pen was scored as affected if at least one pig displayed the indicator. Data were processed in Microsoft Excel 2019.

Table 1: Description of on-farm experiments

Experiment	Description
Roughage (A)	Daily provision of (clover-) grass silage or hay in a rack in the outdoor run. Control pens with roughage provided indoors. Three farms, two in AT and one in DK**, Sept. 2019-June 2020
Roughage (B)*	Changing the type of roughage (clover-grass silage and barley-pea whole seed) every second week. Two farms in DK, Sept. 2019-April 2020
Showers (A)	Showers installed in the outdoor run, running for 30 min, 5-6 times per day. Control pens without showers. Three farms, one in AT and two in CH, Aug.-Sept. 2019
Showers (B)*	Comparing different duration of shower activation: 10 minutes per hour, 30 minutes per hour or continuous shower. Three farms, two in AT and one in CH, June-Sept. 2020
Rooting area (A)	Daily mixing of corn pellets in the compost rooting area in the outdoor run. Control pens with only compost in the rooting area. One farm in CH, Oct. 2019-Mai 2020
Rooting area (B)*	Comparing two types of rooting material (wood chips vs. soil/turf). One farm in DK, Oct. 2020-Feb. 2021

Bold = experiments presented in this paper. *Data not presented. **Experiments on roughage in one farm in Italy were cancelled due to the COVID-19 pandemic.

Preliminary results

A summary of results for selected parameters across experiments and farms is presented in Table 2. Clinical parameters and soiling of pigs relate to the proportion of pigs in the group per assessment day, use of the outdoor run to the proportion of pigs in the group per observation round. All results are presented as medians and ranges.

Table 2: Preliminary results for selected parameters across three experiments in Austria (AT), Denmark (DK) and Switzerland (CH). Results provided as median (min. – max.) percentage of affected pigs from total pigs in a group.

Experiment	ROUGHAGE					
Farm	AT02		AT03		DK01	
Treatment (n pens)	**IN** (n=6)	**OUT** (n=6)	**IN** (n=3)	**OUT** (n=3)	**IN** (n=4)	**OUT** (n=4)
Ocular discharge (%)	53 *(11-89)*	56 *(10-100)*	14 *(0-36)*	17 *(0-45)*	18 *(0-56)*	26 *(0-75)*
Scratches (%)	0 *(0-22)*	0 *(0-20)*	0 *(0-9)*	0 *(0-9)*	0 *(0-29)*	0 *(0-31)*
Total soiled pigs (%)	25 *(0-70)*	28 *(0-90)*	30 *(0-70)*	18 *(0-46)*	0 *(0-6)*	0 *(0-31)*
Use of outdoor run (% pigs outdoors)	55 *(0-100)*	58 *(0-100)*	45 *(9-80)*	54 *(8-91)*	0 *(0-100)*	6 *(0-100)*

Experiment	SHOWERS					
Farm	AT01		CH01		CH02	
Treatment (n pens)	**NO** (n=3)	**shower** (n=3)	**NO** (n=2)	**shower** (n=3)	**NO** (n=2)	**shower** (n=2)
Ocular discharge (%)	18 *(9-42)*	12 *(5-33)*	0 *(0)*	0 *(0-14)*	3 *(0-9)*	0 *(0-11)*
Scratches (%)	0 *(0)*	0 *(0-7)*	0 *(0)*	0 *(0)*	0 *(0)*	0 *(0-3)*
Total soiled pigs (%)	28 *(0-100)*	14 *(0-75)*	21 *(10-65)*	3 *(0-35)*	8 *(0-19)*	6 *(0-71)*
Use of outdoor run (% pigs outdoors)	69 *(28-100)*	58 *(4-100)*	75 *(45-100)*	57 *(0-80)*	40 *(15-82)*	35 *(0-86)*

Experiment	ROOTING AREA	
Farm	CH01	
Treatment (n pens)	**Compost only** (n=6)	**With corn pellets** (n=7)
Ocular discharge (%)	7 *(0-24)*	6 *(0-45)*
Scratches (%)	0 *(0-12)*	0 *(0-12)*
Total soiled pigs (%)	0 *(0-26)*	0 *(0-18)*
Use of outdoor run (% pigs outdoors)	35 *(0-100)*	48 *(0-95)*

Inter-observer reliability

The IOR for most clinical indicators was substantial (PABAK >0.6) to almost perfect (>0.8). Most difficulties were found for the soiling of pigs (PABAK=0.7) and ocular discharge (PABAK=0.8). The IOR for behaviours was more challenging and resulted in good (ICC >0.9) to satisfactory (ICC >0.7) agreement for general activity (standing/sitting, lying, lying-active) and did not differ considerably between the first and second round. Other behaviours such as exploration, play, agonistic behaviour, and tail biting showed relatively poor agreement (ICC <0.7); however, it improved considerably in the second round.

On-farm experiments

Many clinical parameters showed a very low prevalence (e.g., signs of diarrhoea, ear lesions, lameness). The most prevalent clinical indicator was ocular discharge with high variation within and between farms. Scratches on the body due to agonistic interactions occurred only sporadically and on a very low level. Most of the pigs had intact tails. However, out of the 62 groups assessed, five groups (on three farms) showed more than 75% of the pigs with short tails. Tail lesions occurred in only six groups (out of 62), and only two of them were affected severely (more than 10% of the pigs). None of the clinical welfare parameters differed between control and treatment groups, so no effect from the improvement measures was found. Also, the soiling of pigs varied considerably within and between farms without indicating considerable differences between treatments, except for the shower experiment. Pigs with showers were less dirty on two of the three farms. The median proportion of pigs in the outdoor run was around 50% (35-75%) for most farms, except DK01, which showed meagre proportions. Also, a high variation within farms and groups exists for this parameter. A rack with roughage in the outdoor run and mixing corn pellet into the compost of the rooting area seemed to attract more pigs to the outdoor run. Interestingly, in the shower experiment, even fewer pigs were in the outdoor runs with showers.

Discussion

Generally, the chosen approach of a multi-centre study across nine farms in three countries was practicable but required flexibility to adapt experimental designs to the on-farm conditions. Close collaboration with farmers and regular interaction between researchers helps to overcome these challenges. The results show large variations across farms, emphasising the need for multi-centre studies to develop and implement improvement measures. Observer training is essential to ensure the reliability of results in this kind of study. However, the more participants and the more countries involved, the more challenging it is. As data collection included live observation, training on-farm was needed, although demanding. Online training was a feasible complementation and proved good IOR for clinical parameters. For practical reasons, agreement on behavioural parameters was only tested via video recordings, which may not always represent direct on-farm observation. However, improvement of IOR in the second round shows the potential to enhance observers' common understanding and performance.

Preliminary results show a very low prevalence for clinical indicators such as signs of diarrhoea and lameness, which typically affected individual pens without a plausible link to the improvement measures. Therefore, clinical indicators can be seen as parameters “to control for” when analysing and interpreting outcomes. Tail length is difficult to interpret as it may be a result of previous tail biting. Therefore, development during the experiment and prevalence of tail lesions should be considered. Yet, indicators such as tail lesions or scratches, which might have been affected by treatments, also occurred infrequently without obvious differences across treatments. Hence, we do not expect an increased risk for tail-biting or resource competition through the implemented measures. The level of ocular discharge seems to be farm-specific with a considerable variation and gives reason for further in-depth analysis of its development over time. Results for soiling of pigs indicate some differences in cleanliness for pigs with access to showers. Evaluation of pen soiling will further shed light on the potential effect of the measures to improve hygiene and reduce ammonia emissions. While Olsen et al. (2001) found on average 15% of pigs outdoors during the day, the proportion was higher for most farms in our studies and may depend on the design and available resources of the outdoor run. The measures seem to affect the number of pigs in the outdoor run: While roughage provided outdoors and rooting areas with corn pellets increased outdoor run use, showers reduced the number of pigs outdoors. Upcoming evaluation of other parameters assessed, such as behaviour parameters and pen hygiene, may provide a more precise picture at the level of the individual experiments.

Our suggestions for research and support policies to develop further organic animal husbandry

With this approach, we illustrate possibilities for standardisation of on-farm experiments under varying practical conditions. However, flexibility to react to a farms' condition is required (e.g., varying group size and pen design across farms and countries). On-farm experiments may also provide the opportunity to adapt research questions according to practical relevance. However, for this approach, sufficient time, resources, and flexibility are needed in the initial phase of the project. While challenges for experimental design occur when covering many different situations in different countries, this approach may enhance the external validity of the outcomes and increase relevance and practicality for farming. Finally, reacting to and acting with practice may broaden the horizon for science.

Acknowledgements

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Do piglets need iron supplementation in organic farms?

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Keywords: piglet, iron status, indoor, outdoor

Abstract

The neonatal pig is prone to iron deficiency, which can lead to growth retardation, cognitive and immune deficits. This study aimed at describing the iron status of piglets at weaning in French indoor and outdoor farms.

It was carried out in 11 outdoor and 10 indoor organic farms located in the West of France. In each farm, approximately 30 piglets (half males and females) from 4 to 7 litters were blood sampled. In total, 606 piglets of 42 ± 3 days of age, weighing 12.0 ± 3.0 kg live weight were bled at 1.1 ± 1.7 days from weaning (mean ± SD).

Iron injections were used in most indoor farms (400 mg: 1 farm, 200 mg: 8 farms, 100 mg: 1 farm, no supplementation: 1 farm), while in outdoor systems, primarily no supplementation was performed (200 mg: 1 farm, no supplementation: 10 farms). In comparison with the indoor where 200 mg of iron was injected, the outdoor non-supplemented piglets had a greater blood haemoglobin concentration (118 vs 105 ± 3 g/L, $P < 0.001$) and a higher red blood cell volume (60 vs. 54 ± 1 fl, $P < 0.01$), indicating a better iron status. In the only indoor farm that did not use iron supplementation, these two variables were low (81 ± 3 g/L and 48 ± 1 fl, respectively), showing an iron deficiency.

To conclude, outdoor piglets find a sufficient amount of iron in their natural environment to fulfil their needs, probably by foraging and ingesting soil. Indoors, iron supplementation is necessary, but a single intramuscular iron injection, besides its controversial acceptability in organic farming, might be suboptimal to prevent anaemia in piglets. Thus, there is a need for finding alternative oral solutions to iron injection, ensuring a sufficient, natural and progressive iron intake to newborn piglets.

Introduction

Piglets have low iron stores at birth and sow milk is naturally poor in iron, while piglet requirements are high due to rapid growth (Lipinski et al. 2010). Thus, piglets may develop iron deficiency anaemia during lactation, which in turn can lead to growth retardation, cognitive and immune deficits. In organic farming, unlike conventional farming, iron administration in injectable form is not systematic. According to current knowledge, iron supplementation seems essential for piglets raised indoors, but outdoors, soil ingestion might be sufficient to avoid deficiency. However, few data are available.

Infections and proinflammatory states can also generate iron-deficiency anaemia. This adaptive response against microbial development relies on the sequestration of iron in erythrocytes under the action of hepcidine. Again, piglet health and inflammatory status in organic pig farming have been the subject of very few publications.

Thus, the objective of this study was to compare haematological parameters, inflammatory status, and oxidative stress in piglets raised indoors and outdoors and according to the dose of iron administered.

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Material and methods

Organic farrow-to-finish farms (11 outdoors, 10 indoors) located in the west of France were selected among the voluntarily farmers. The visit occurred the day of weaning (11 farms), one to six days before (nine farms), or the day after (one farm). On each farm, 18 to 30 piglets of both sexes from 4 to 7 litters (sows of different parities) were weighed and blood sampled. In total, 606 piglets were assessed.

The Procyte Dx Idexx automated system was used to measure haemoglobin (Hb) concentration, haematocrit, red blood cell and reticulocyte counts, mean blood cell volume and mean corpuscular Hb. Blood iron content and indicators of health were also measured: haptoglobin (Hp) concentration to assess inflammatory status, dROM (hydroperoxides) and blood antioxidant capacity (BAP) for oxidative stress.

Statistical analyses (type 3 mixed ANOVAs) were performed using the lmer test package from the R software (version 3.5.3). Housing type and sex were included as fixed factors, body weight as a covariate and farm as a random factor. A square root transformation was performed for Hp and iron to normalize the data. For age at sampling, a t-test was performed. All results are expressed as adjusted means ± SE.

Results

The practice of iron supplementation varied between farms (Table 1). Indoors, piglets received no supplementation on one farm (In-No), one injection of 100 mg iron on one farm (In-100), one injection of 200 mg iron on seven farms (In-200) or two injections of 200 mg iron on one farm (In-400). Outdoors, animals did not receive iron supplementation in 10 out of 11 farms (Out-No) and received one injection of 200 mg iron in the last one (Out-200). Only the Out-No and In-200 conditions could be statistically compared because, for others, the condition and the farm effect were confounded.

Table 1: Number of farms and animals per group

Condition	Rearing	Iron supply[1]	Nb farms	Nb pigs
In-No	Indoors	0 (0)	1	30
In-100	Indoors	100 (1)	1	30
In-400	Indoors	400 (2)	1	30
Out-200	Outdoors	200 (1)	1	30
In-200	Indoors	200 (1)	7	206
Out-No	Outdoors	0 (0)	10	280

[1]the first number indicates the dose of iron in mg/pig and the number in brackets the number of injections/pig

Live weight of In-200 and Out-No piglets at blood sampling was similar ($P > 0.1$, Table 2). Age at sampling was slightly lower in In-200 and Out-No conditions, but the difference was not significant (40.9 ± 0.8 vs 43.7 ± 1.0 days of age, $P = 0.07$).

The mean Hb concentration ranged from 81 ± 18 g/L (In-No farm) to 125 ± 9 g/L (out-200 farm, Figure1). It was significantly higher in Out-No than in In-200 animals ($p<0.001$). The red blood cell volume ($P<0.001$), the haematocrit ($P<0.001$), the mean cell volume ($P<0.001$), and the mean corpuscular haemoglobin content ($P<0.001$) were also significantly higher in the Out-No compared to the In-200 animals. Hb concentration and the haematocrit were greater in females (Hb: 113.0 ± 1.6 vs. 110 1.6 g/L, $P<0.01$, haematocrit: 40.2 ± 0.2 vs 39.3 ± 0.6, $P < 0.05$).

Table 2: Bodyweight, blood antioxidant potential (BAP), hydroperoxides (dROM) and haptoglobin (Hp) plasma concentrations.

Con-dit-ion	Weight (kg)	BAP (µM Eq Vit. C)	dROM (mg Eq H2O2/dL)	Haptoglo-bin (g/L)
In-No	11.1 ± 0.6	2607± 31	771 ± 44	1.35 ± 0.26
In-100	12.5 ± 0.4	2661 ± 39	833 ± 26	1.45 ± 0.22
In-400	10.2 ± 0.6	2390 ± 34	1009 ± 45	1.13 ± 0.16
Out-200	11.2 ± 0.6	2676 ± 33	824 ± 30	0.45 ± 0.05
In-200	11.4 ± 0.9	2476 ± 68	798 ± 40	0.89 ± 0.11^{A}
Out-No	12.7 ± 0.6	2454 ± 45	812 ± 27	0.52 ± 0.0.6^{B}

^{A,B}: different superscripts indicate a significant difference between In-200 and Out-No conditions.

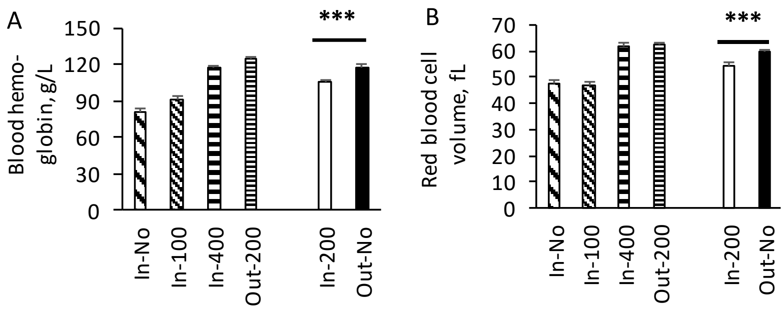

Figure 1. Plasma haemoglobin concentration (A) and red blood cell volume (B).

*** indicates significant differences between In-200 and Out-No treatments with a P-value < 0.001.

Plasma iron was lower in In-200 pigs than in Out-No pigs (14.0 ± 2.2 vs 21.5 ± 1.8 µmol/L, P < 0.05) and in males than in females (16.2 ± 1.3 vs 19.0 ± 1.6 µmol/L, P < 0.01). The haptoglobin concentration was higher in piglets kept indoors than outdoors (p<0.01). The BAP and dROM concentrations were not influenced by the farming system (Table 2) or the sex of the piglets.

Discussion

Present data show that iron supplementation is not necessary to prevent anaemia in piglets raised outdoors in agreement with previous studies carried out in 3-4-weeks-old piglets (Kleinbeck and McGlone 1999; Brown et al. 1996). Our results demonstrate that this is still true in 6-week old piglets, even though they depend less on milk for feeding. Outdoor piglets can ingest iron from the soil present in their environment. This is sufficient in most outdoor farms as in the present study, but it may not be in locations where soil bioavailability in iron is very low (Brown et al. 1996; Szabo and Bilkey 2002). Indoors, a minimal dose of 200 mg iron was necessary to achieve a sufficient haemoglobin level, as previously shown (Svoboda et al., 2018). The better status obtained outdoors shows that this might not be the optimal supplementation method.

The inflammatory status was higher indoors, possibly linked to a heavier microbial load than outdoors, as previously suggested by Kleinbeck and McGlone (1996).

Conclusion and suggestions for research

This study revealed that outdoor piglets usually find a sufficient amount of iron in their natural environment. Indoors, iron supplementation is necessary, but a single intramuscular iron injection might be suboptimal to prevent anaemia. Thus, there is a need for finding oral alternatives to iron injection to ensure a sufficient, natural and progressive iron intake to newborn piglets and in line with organic principles.

This work was carried out with financial support from the INRAE in support of an Era-Net CORE Organic Cofund project (Power project: https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/power/).

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Ways to raise uncastrated males or to alleviate the pain of castration in organic pig production

Antoine Roinsard[1], Valérie Courboulay[2], Didier Gaudré[2], Marie Souquière[2], Jean-François Deglorie[3], Armelle Prunier[4]

Key words: welfare, pig castration, entire male

Introduction

From January 1, 2022, farmers practicing surgical castration of piglets will have to perform an anesthesia in France. This regulation raises questions for pig farmers in terms of cost and feasibility. The pain alleviation of different protocols is being studied under organic farming conditions as well as the rearing conditions of entire male pigs. These two possibilities are studied under the framework of the CASDAR FARINELLI. First results concerning the feasibility of rearing entire male pigs are presented here.

Material and methods

Based on the literature describing the main risk factors, a questionnaire was built in order to describe organic farms according to the risk of boar taint and welfare problems. Then, a survey was conducted on 30 farms belonging to the project partner groups. In addition, observations were made on the cleanliness of the animals and the management of straw. Finally, multi-criteria statistical analyses were carried out to propose groups of farmers according to whether their practices influencing the risk of sexual odours in entire male pigs.

Results

Based on studies performed mainly in conventional or experimental farms, **table 1** shows the most important factors that organic farmers should pay attention to in order to limit the boar taint risk. These factors are related to feeding management, weight/age at slaughter (boar taint risk is higher in older and heavier pigs), genetics (Pietrain breed is at lower risk), housing/rearing conditions (animals have to be as clean as possible which depends a lot on straw management, good ventilation is also needed) and social behaviour during the fattening period.

Table 1: Risk factor limitation for entire male and levers – literature review

Feeding	Age and weight at slaughter	Breeds	Rearing conditions	Social Behaviour
Feed with high protein digestibility	Slaughter early in the pubertal development	Secure genetics : Pietrain, Large White, Landrace	Good management of the litter in order to maintain clean building, good ventilation, respect of animal density	Create animal groups as soon as possible
Add fiber feedstuffs 1 month before slaughter				
Soup and restricted feed		Risk genetics : Duroc, Local breed, Sino-european		
Fasting 12 hours before slaughter				

From the survey, 4 groups of organic farms could be identified and characterized for their boar taint risk in entire males (**Table 2**). The practice of self-renewal gilts and boars as well as leaving boars used for oestrus detection to breed sows are important risk factors on all farms,

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but this concerns a small number of animals. Indeed, boars from self-renewal, may represent an increased risk in terms of meat odour, as they are, at least in part, from maternal genetic type (often Large White crossed with Landrace) that are more at boar risk than pure Pietrain boars. Boars for oestrus detection that are involved in breeding should also be considered for the same reason. In addition, some genetics used for sows (Duroc, sino-european) are considered to be more at risk than standard crossbred Large-White x Landrace sows.
In addition to the risk factors related to the genetics of the animals, other factors should be highlighted. In some cases, animals are slaughtered heavier than usual, which does not seem favourable. The amount of straw used for the litter varies greatly from farm to farm and may influence greatly the cleanliness of the animals. The duration of fasting is relatively long (30 hours and more) and may induce problems of welfare (animals may suffer from hunger). Various fiber-rich raw materials are sometimes distributed at the end of fattening, which could be positive in terms of welfare and reduction of boar taint risk.

Table 2: Summary of the practices of the 4 groups in relation to the identified levers

	Group 1	Group 2	Group 3	Group 4
Feeding		Dry feed, feed restriction, fiber > 5%	Soup, feed restriction	High fibre level
Age and weight at slaughter	Heavy pigs (>130 kg)			
Breeds	Risk (Duroc, Sino-european)	Secure (Pietrain, LW, LF)		Diverse, lack of information
Rearing conditions		New building, 70/100kg of straw per pig during the fattening period	Resting area, cleaned only once during the fattening period	Resting area cleaned between two batches
Social Behaviour		No animals mix		

Practice with a positive impact to decrease odorous male risk
Practice with a negative impact on odorous male risk

Discussion

the great diversity of practices in organic pig farms makes it difficult to formulate general proposals. Overall, an increase in straw provided, particularly at the end of the fattening period, seems interesting, especially during periods of high heat. The incorporation of fiber in the diet already developed should be continued and is the main nutritional lever as the presence of highly digestible protein sources limiting the risk for skatole is very limited in organic farming. Finally, age and weight at slaughter are also important, particularly in farms where the heterogeneity of growth performance increases the risk of slaughtering some pigs with an high weight and age.
In a second part of the project, a descriptive study will be set up in partnership with 6 farms, a slaughterhouse, organic pigs companies and researchers to evaluate on 600 pigs the prevalence of odorous males along the year. This study plus an experimental trial at the INRAe organic farm and organoleptic tests on processed products from pigs produced on the commercial farms, will be the basis of practical recommendations for an optimized production and use of entire male pigs.

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Fresh grass-clover intake in summer and energy requirements of organic sows in winter and summer

M. Eskildsen[1], U. Krogh[1], A. G. Kongsted[1] and P. K. Theil[1]

Abstract

A control and a low dietary protein strategy were tested in 47 organic 1st and 2nd parity sows in winter and summer under Danish weather conditions. Sows on the low protein strategy ingested more fresh grass clover than the control group from April to September (2.60 kg/d vs 2.29 kg/d; P = 0.007). The mean SID lysine intake from grass-clover amounted to 21 g/d in gestation, which is well above the daily SID lysine requirement throughout pregnancy. There were no differences between the two dietary regimens on sow productivity, body composition, locomotive activity or blood- and urine metabolites (data not shown; P>0.05) in both seasons. The daily intake of protein and amino acids exceeded the requirements during pregnancy, also when sows were fed the low protein compound feed. Still, the low protein diet supplied insufficient SID lysine during lactation, which compromised milk production. Sows lost 794 g/d of body fat from d5 to d40 in lactation, and the energy requirement amounted to 120 MJ ME/d at peak lactation. In conclusion, sows with access to pasture can be fed lower protein during gestation in the grazing season.

Introduction

Organic sows in pasture systems spend extra energy on thermoregulation, have a prolonged lactation period and the opportunity for increased locomotive activity as compared to conventional sows. These aspects increase the energy requirements of outdoor sows, whilst their protein (and hence lysine) requirement most likely is comparable on a daily basis (Close and Poornan, 1993; Jakobsen and Hermansen, 2001). However, organic sows are often supplied more feed with greater protein but lower lysine concentration than indoor sows; hence they ingest considerably more protein per day than indoor sows. Excess dietary protein reduces feed efficiency and increases the N-excretion to the environment. Hence, the protein-to-energy ratio formulated for indoor pigs is most likely not optimal for organic sows.

We hypothesised that grass intake in summer and silage intake in winter would enable a 13% reduction in protein content in the compound feed without compromising sow productivity.

Materials and methods

Forty-seven lactating LY sows were randomly assigned into low protein (12.8% of DM) or control (14.7% of DM) diets. Two periods (winter or summer) were tested. The two diets were adjusted to be iso-energetic and were of 100% organic origin. To meet the extra demand for thermoregulation and locomotory activity, the energy allowance from both treatments was increased by 10% and 15% during summer and winter, respectively, compared with the recommended feeding curves for indoor sows (Danish Pig Research Centre).

During summer, sows were fed 4.2 kg in early gestation until d81 and 4.8 kg/d until farrowing. Lactating sows were fed 4.7 kg/d on 1-3 days in milk (DIM), from 4-14 DIM, the feed allowance increased by 0.5 kg/d, reaching a plateau of 11.1 kg/d from 14 DIM until weaning at 47 DIM. On top of that, sows had ad libitum access to grass-clover sward in the summer period (April 15th to September 1st) and grass silage in winter (November 1st to April 15th). All sows and piglets were individually weighed, backfat scanned, and milk, blood, and urine samples were collected from the sow in mid and late gestation (d60 and d100) and early, peak and late lactation (d 5, 20, and 40 DIM). Body pools of fat and protein were estimated using the deuterium dilution technique. $HE_{locomotory\ activity}$ was measured using GPS trackers, and total heat production was estimated from the pulse measured with a heart rate monitor. Individual fresh

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grass-clover intake was estimated using plasma pipecolic acid as a biomarker as described by Eskildsen et al. (2020).

Results

There were no differences in liveborn, birthweight or daily gain of the piglets in the two dietary groups (Table 1). The season was confounded with parity, as sows were 1st parity in winter and 2nd parity in summer, and productivity was generally higher in 2nd parity sows.

Table 1. Reproductive performance in 1st and 2nd parity sows fed 100% organic diets differing in proportion of protein winter and summer

	Season			Dietary Protein			P-values	
	Winter	Summer	SEM	Control	Low	SEM	Season	Protein
Liveborn	13.5^{b}	16.8^{a}	0.5	15.1	15.2	0.49	0.005	0.83
Stillborn	2.10	2.17	0.64	2.59	1.69	0.64	0.93	0.37
Birthweight, g.	1320^{b}	1509^{a}	30.2	1413	1416	30.8	0.007	0.95
Piglet weaning weight, kg	14.6	16.1	1.07	15.5	15.2	1.07	0.36	0.86
Weaned piglets/litter	10.9^{b}	12.6^{a}	0.29	11.7	11.9	0.3	0.009	0.65

Protein strategy did not affect sow live weight, body pools or energy used on locomotive activity. Sows on the low protein strategy ingested 31 g/d more of DM from grass-clover than the control fed sows (p=0.05). For pregnant sows fed semi ad libitum amounts of compound feed, the voluntary consumption of grass-clover was 0.42 kg dry matter or 5.3 MJ ME/d in summer. (Table 2).

Table 2. Grass clover intake (only summer), live weight measurements, body pools, heat production and locomotive activity in 1st and 2nd parity sows fed iso-energetic organic diets differing in proportion of protein winter and summer at different reproductive stages (parturition = d 0)

	Reproductive stage						Dietary protein			P-values	
	-55	-15	5	20	40	SEM	Control	Low	SEM	Stage	Protein
Sow weight, kg	238c	273a	255b	232c	218d	2.89	243	243	2.85	<0.001	0.85
Back fat, mm.	17.5b	20.1a	20.2a	16.3b	13.4c	0.78	17.3	17.7	0.87	<0.001	0.79
Protein pool, kg/sow	41.5b	45.8a	42b	40.1bc	39.3c	0.58	42.2	41.3	0.48	<0.001	0.32
Fat pool, kg/sow	41.4b	60.4a	57.8a	37.4bc	30.oc	3.05	45.3	45.5	3.49	<0.001	0.95
Heat production											
Distance, Km	2.46a	1.88b	0.70d	1.48c	1.7bc	0.16	1.73	1.56	0.19	<0.001	0.56
ME locomotive, MJ/d	4.83a	3.9b	1.4d	2.62c	2.96c	0.28	3.21	3.07	0.26	<0.001	0.74
ME, thermo-regulation, MJ ME/d											
Grass clover intake in summer, Kg/d	2.45b	2.44b	1.55c	3.16a	2.62b	0.13	2.29b	2.60a	0.78	<0.001	0.007
Grass clover intake in summer, g DM/d	428b	409b	225c	574a	472b	0.02	403	440	0.01	<0.001	0.04
SID lysine intake from grass clover, g/d	21.2b	20.9b	14.7c	26.9a	19.7b	1.20	20.0	21.4	0.72	<0.001	0.18
Total ME requirement, MJ/d	27.5c	31.2c	94.2b	120.3a	91b	2.01	72.3	70.3	1.37	<0.001	0.62

Discussion

When feeding organic sows, the aim is to ensure sufficient body reserves to compensate for the adverse environmental conditions and a prolonged lactation period compared to conventional sows. The current experiment showed very high levels of mobilisation both summer and winter, as feed intake was insufficient in early and peak lactation. The total energy requirement of high yielding second parity outdoor sows was found to be around 30 MJ ME/d during gestation and approximately 120 MJ ME/d at peak lactation. The energy demand for thermoregulation corresponded to 20% and 7% of the daily energy requirement in winter and summer. The daily energy requirement for locomotive activity corresponded to 4% and 5% of the daily energy requirement in the two seasons.

It was possible to reduce the protein content of organic compound feed in the summertime as grazing pregnant sows obtained 16-17% of their daily SID lysine requirement from the sward in mid and late gestation. There was a considerable individual variation in grass-clover intake, and as far as possible, nutritional management should aim to consider individual animals or small groups rather than the whole sow herd.

Suggestions for research and support policies to develop further organic animal husbandry

An adjustment on the protein to energy ratio in organic gestation diets should be considered to match the increased energy demand for thermoregulation and to reduce the negative environmental impact from organic pig production. It is suggested that organic sows need more energy (kg feed) on a daily basis but less dietary protein per kg of feed, because they ingest protein from grazing in summer and probably also from silage intake in winter.

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Behavioural observations of piglets in an organic free farrowing pen

Katharina Heidbüchel[1], Lisa Baldinger[1], Ralf Bussemas[1]

Key words: piglet behaviour, piglet losses, piglet nest, video observation

Abstract

A prolonged stay in the piglet nest can improve the probability of piglet survival because there is a reduced risk of hypothermia and crushing by the sow. Different piglet nest designs and management strategies were compared to find the conditions under which piglets are most likely to use the nest: electric lid heating vs underfloor heating, with vs without LED-light, and with vs without confinement in the nest during the first four feeding times of the sow. During the first 72 hours after farrowing, videos of the piglet nest were evaluated using scan sampling (ten minutes interval). In total, videos of 1,863 piglets from 129 litters of 58 sows were evaluated. Data analysis is still ongoing, but preliminary results indicate that no piglet was in the nest in 65% of the observations during the first three days of life. In 17% of observations, between 1 and 50% of the litter was found in the piglet nest, and in 18% of observations more than 50% of the litter was present. It is noticeable that litters locked in the piglet nest showed slightly lower proportions of observation times at which no piglets were in the piglet nest than in litters without piglet confinement. These initial results will undergo further evaluations.

Introduction

Although organic husbandry allows the sow to move freely and live out species-specific behaviour, considerable suckling piglet losses can still occur (Prunier et al., 2014). Most of the losses occur in the first days after birth and are partly due to piglets being crushed by the sow (Lohmeier et al., 2020). Thus, we hypothesise that early and frequent use of the piglet nest should increase the survival of piglets. This study compares different piglet nest designs and management to identify the conditions for optimal acceptance of the nest.

Material and methods

The experiment was conducted at the organically certified experimental station of Thünen Institute of Organic Farming in Trenthorst, Germany, from May 2018 to December 2020. The piglets were born of crossbred sows (Landrace x Large White), inseminated with Piétrain. From about one week antepartum until two weeks postpartum, the sows were kept in individual straw-bedded farrowing pens of 7.7 m^2 indoor and 6.0 m^2 outdoor area, equipped with a water and feeding trough for the sow and the piglet nest. The piglet nests were equipped with either electric floor heating or electric lid heating; a red LED light inside the nest was switched on or off, and the piglets were either locked in the nest during the sow's first four feeding times or not. These six different measures resulted in eight variants. Video cameras inside the piglet nests recorded during the first 72 hours after farrowing. The videos were evaluated with scan sampling (time interval of ten minutes) using the Behavioural Observation Research Interactive Software (BORIS) and the following behavioural patterns: piglets within the nest or not, being active, lying in a pile or scattered in prone or lateral position. In total, videos of 1,863 piglets from 129 litters of 58 sows were evaluated, and 49,584 observation times were analysed. The number of alive, dead-born and weaned piglets was noted, and piglets were weighed once a week. In addition, medical treatments and mortality were documented.

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Results

Most of the sows (90%) were in their 1st to 6th parity (max. 15). The average litter consisted of 1 stillborn and 15 alive piglets with an average birth weight of 1.45 kg. After a mean lactation period of 49 days, an average of 11 piglets were weaned at 17.1 kg live weight. A total of 22.8% of the suckling piglets were lost, half of which were crushed by the sow. 71.2% of the piglet losses occurred before the fourth day of life. In 65% of the observations during the first three days of life, no piglet was in the nest. In 17% of observations, between 1 and 50% of the litter was found in the piglet nest, and in 18% of the observations more than 50% of the litter was present. The use of the piglet nest increased over time: in nearly 80% of the observations, the nest was empty during the first 24 hours of life, after another 24 and 48 hours it increased to 63 and 53%, respectively. Accordingly, the proportion of observation times at which more than half of the litter was in the piglet nest increased from the first to the third day of life from 4 to more than 30%. When differentiating between the eight variants, it is noticeable that piglets of the litters locked in the piglet nest during the first four feeding times of the sow were more frequently in the piglet nest outside of these times. The proportions of observation times at which no piglet was in the piglet nest were slightly lower in variants with piglet confinement than variants without confinement. The different piglet nest designs do not yet reveal a clear effect when comparing the eight variants (Figure 1).

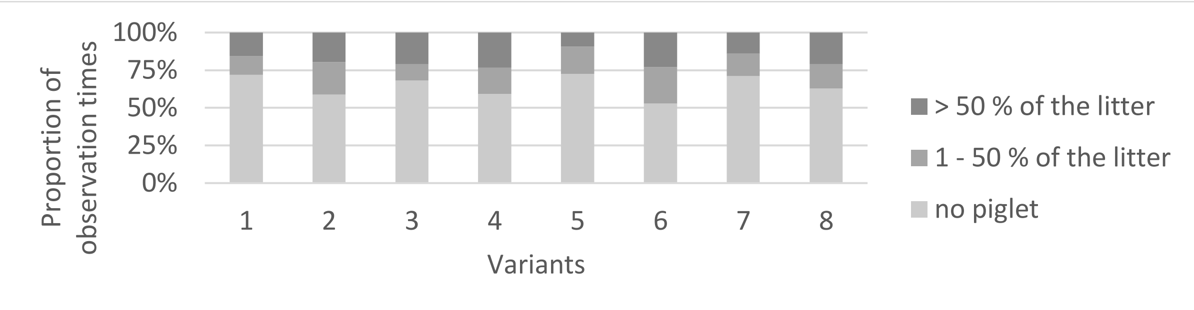

Figure 1. Frequencies of piglets in the piglet nest during the first 72 h after farrowing

Discussion

To our knowledge, our study is the first to investigate piglet nest utilisation in organic piglet production. Accordingly, the knowledge gained has the potential to further advance free farrowing. Weissensteiner et al. (2018) reported comparable levels of suckling piglet losses under organic housing conditions (22.7-29.3%) and the weaning weight of 17.1 kg corresponds to the usual level of the farm. Furthermore, we could see that the use of the piglet nest increases during the first three days of the piglets' life. In addition, the observation that the temporary confinement of the piglets in the piglet nest can increase the use of the piglet nest coincides with statements from farmers who have had good experiences with this management measure. However, at the current time of evaluation, it does not seem to make a difference whether the piglet nest is heated from above or below and whether it is lit or not.

Suggestion for research to develop organic animal husbandry

As meat consumption and animal husbandry as a whole are currently the subject of critical debate, it is imperative to keep animal welfare in focus, further develop it and not be satisfied with existing conditions, both in conventional and organic systems.

Acknowledgements
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1. Sept. 2021

Program of IAHA Pre-Conference on "Organic Animal Husbandry systems – Ways to improvement" on 6 - 7 September 2021 in Rennes / France

linked to the 20th Organic World Congress of IFOAM

at the Couvent des Jacobins Congress Centre, Room 6 (on level 1)

planned as mixed video & on-site conference

Instruction for participants:

Oral presentations: 12 minutes + 3 min questions

Poster presentations: 3 minutes + 1-2 questions then time to return and ask further questions

*** Abbreviations of involved EU projects**

PYS	ProYoungStock	https://www.proyoungstock.net/
GD	GrazyDaisy	https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/grazydaisy /
PO	POWER	https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/power/
MI	MIX-ENABLE	https://projects.au.dk/coreorganiccofund/news-and-events/show/artikel/mix-enable-improving-organic-mixed-livestock-farming/
RE	RELACS	https://relacs-project.eu/

Monday, 6th September 2021 Please note Time is CEST

				*
	08:30-	**REGISTRATION**		
	09:00 - 10:30 9.00 OS 9.05 Fr 9.10 GS 9.25 FC 9.40 MC 9.55 IA 10.10 open	**PLENARY I: Organic Animal Husbandry systems – development and challenges in different contexts and macro-regions** **Opening by organisers:** Otto Schmid, IAHA Chair **Official welcome of French host of OWC:** Jérôme Ménard, administrator ITAB and milk cow breeder *(in French, text in English)* **Speakers with International perspectives –** - 1 Gidi Smolders: Options and challenges for certified organic milk production in East African mixed smallholder farms - 2 Fabián Cruz, Gustavo Ruiz, Milena Uribe, Germán León: Model of sustainable livestock systems in a rural community in the Colombian Andean region through social appropriation processes - 3 Mahesh Chander: Promoting Organic livestock production: Supporting the growing number of start-ups - 4 İbrahim Ak & Metin Guldas: Organic Livestock Production in Turkey *Moderator: Otto Schmid, IAHA Chair*		
	10:30 - 11:00	**Coffee Break**		
	11:00 - 12:00	**Session 1** *Moderator:* Chris Atkinson	**Improving organic cattle systems**	
Monday – 06. Sept. 2021	11.00	5 Lisbeth Mogensen, T. Kristensen, C. Kramer, A. Munk, P. Spleth, M Vestergaard	Production of organic beef from dairy male calves – aiming at reduced carbon footprint	
	11.15	6 Anna Bieber, Michael Walkenhorst, Rennie Eppenstein, Johanna K. Probst , Susann Thuer, Cem Baki, Anet Spengler Neff	Effect of calf rearing with mother contact compared to bucket feeding on health and welfare of calves	*PYS*
	11.30	7 Mette Vaarst , Cynthia Verwer, Caroline Constancis, Kristen Sorheim, Juni Rosann, E. Johanssen	'Whose views and ways are changing?' Perspectives of change and transition related to cow-calf contact systems in European dairy farming	*GD*
	11.45	*8 Jesper Overgård Lehmann & Lisbeth Mogensen*	*Mother-bonded calf rearing in organic milk production: Lessons from pioneer farmers in northern Europe (POSTER)*	*GD*

Monday -06 Set.2021	11.50	*9 İbrahim Ak, H. Umur, M. Guldas, A. Deniz, S. Kara, H. Hanoglu*	*General conditions of organic cattle farms in Turkey (POSTER)*	
	11.55	Discussion		
	12.10	**Session 2** *Moderator:* Mahesh Chander	**Organic production and product and process quality**	
	12.10	**10** Sedef Ziyanok Demirtas, M. Guldas, E. Yildiz, O. Gurbuz	Antihyperlipidemic and anti-oxidant properties of CLA of grass fed milk and meat	
	12.25	**11** Muazzez Cömert Acar, Yılmaz Şayan, Erdal Yaylak, Taner Kulay	The effects of slaughtering age on chemical meat quality characteristics of Anatolian Merino and Polatlı lambs under organic management	
	12.40	**12** Ülfet Erdal, Hülya Hanoğlu, Hülya Özelçam	The effects of the two rotation programmes on the feed value of organic cottonseed	
	12.55	Discussion		
	13.00-14:00	**Lunch**		
	14:00-16:00	**Session 3** *Moderator:* Antoine Roinsard	**Sustainable livestock rearing and breeding systems**	
	14.00	**13** E. Velasco, U. Dickhoefer, S. Binder, B. Egle, C. Nieland, S: Griese, J. Werner	Variability in forage biomass on extensive pastures and productivity of grazing cows on organic dairy farms in South Germany during a dry year	
	14.15	**14** Monique Bestman, T. van Niekerk, E. N. de Haas, V. Ferrante, S. Gunnarsson	Parasitic worms in organic laying hens – Relation with range use	
	14.30	**15** Patrick Veysset, M. Gautier, J. Grenier	Efficiency of ruminants’ organic farming systems: Specialized grass systems perform better than mixed crop-livestock	
	14.45	**16** Vincent Bellet, C. Experton, A. Gac, M. Benoit	Are French organic meat sheep farms more sustainable than conventional ones?	

	15.00	**17** Marc Benoit, G. Martin, G. Bernes, M. Blanc, C. Brock, M. Destruel, B. Dumont, M. Fuselier, M. Grillot, E. Lang, M.-A. Magne, T. Meischner, M. Moerman, M. Moraine, B. Oehen, D. Parsons, R. Primi, L. Schanz, L. Steinmetz, P. Veysset, C. Winckler	A typology of European organic multi-species livestock farms	*MI*
	15.15	**18** Svenja Puls, Mariateresa Lazzaro, Monika Messmer, Stefanie Sievers-Glotzbach	*Promoting and inhibiting factors for the establishment of organic animal breeding - an exploratory study on initiatives from Germany and Switzerland (POSTER)*	
	15.20	Discussion		
	16:.00-16:30	**Coffee Break**		
Monday – 06. Sept. 2021	**16.00-17.30**	**Session 4** *Moderator:* Marion Johnson	**Animal health management and use of bioactive medicinal plants and other alternative therapeutics**	
	16.00	**19** S. Athanasiadou, M. Borthwick, D. Michie, B. Moeskops, V. Mitschke, I. Lang, S. Fittje, Á. Morell Pérez, O. Tavares, C. Experton, A. Fauriat, Caroline Chylinski	Patterns of allopathic medicine use in European organic livestock farms	
	16.15	**20** Catherine Experton, O. Tavares, A. Fauriat, P. Sulpice, E. Chemin, L. Duperray, B. Lemaire, C. Chylinski, S. Athanasiadou, David R. Yañez-Ruiz, K. Still, M. Walkenhorst, V. Maurer	Replacement of antibiotics in livestock production – the contribution of the Horizon 2020 project RELACS	
	16.30	**21** M N Balakrishnan Nair, N. -murthy and S. K. Kumar	Ethno-veterinary sciences and practices for reducing antibiotic residue in milk	
	16.45	**22** Natesan Punniamurthy, MNB. Nair, SK Kumar	Ethnoveterinary herbal approach for organic livestock production without antibiotics: Pan-Indian success	
	17.00	Discussion		

Monday – 06 Sept.2021	**18:00 –** **22.30**	**Departure for farm visit by bus** *(ca. 30 minutes)* **Visit to a farm near Rennes with milk production and processing** Ferme du P’tit Gallo Yves Simon, La Janaie, 35520 Montreuil le Gast https://www.fermeduptitgallo.fr https://www.agrobio-bretagne.org/wp-content/uploads/2019/10/fermobio-yves-simon-2019-web.pdf **Afterwards evening meal on the farm** **Driving back to Rennes**	

Tuesday, 7th September 2021 Please note TIME is CEST

	09:00 - 10.30	**Session 5** *Moderator:* Barbara Früh	**Sustainable livestock rearing and breeding systems for pigs**	
Tuesday 07. Sept. 2021	9.05	**23** Anna Jenni , M. Holinger, B. Früh, D. Bochicchio , A. G. Kongsted , R. Thomsen	Case studies on innovative combined indoor/outdoor organic pig systems	*PO*
	9.20	**24** Anne Grete Kongsted, H. M.-L. Andersen, E. Salomon, I. Sillebak Kristensen	Pigs integrated in cropping systems to support a sustainable and diversified organic meat production	
	9.35	**25** Cäcilia Wimmler, M. Holinger, M. Knoll, H. M.-L. Andersen, R. Thomsen, D. Bochicchio, A. G. Kongsted, C. Leeb	Multi-centre approach to improve outdoor runs for organic pigs: Preliminary results of on-farm experiments	*PO*
	9.50	**26** E. Merlot, M. Pauwels, G. Hervé, V. Muller, C. Belloc, A. Prunier	Do piglets need iron supplementation in organic farms?	
	10.05	27 Antoine Roinsard	Alternatives to the castration of pigs	
	10.20	**28** *Maria Eskildsen, U. Krogh, A.G. Kongsted, P.K Theil*	*Fresh grass-clover intake in summer and energy requirements of organic sows in winter and summer (POSTER)*	
	10.25	**29** *Katharina Heidbüchel, L. Baldinger, R. Bussemas*	*Behavioural observations of piglets in an organic free farrowing pen (POSTER)*	
	10.30 - 11.00	Coffee Break		

	11.00 - 12:30	**Small Group thematic workshops**	**RECOMMENDATION Sessions** **- development and research and dissemination needs** Recap of papers given (10 minutes) Discussion (60 minutes), Conclusions and recommendations (20 minutes)	
	Group A Digital	*Moderator:* *Mette Vaarst* *Rapporteur:* *Anna Bieber/Anet Spengler*	**Sustainable and animal welfare-friendly cattle production – the cow-calf management and feeding systems - what do we know and what is needed?**	
	Group B Digital	*Moderator:* *Marion Johnson* *Rapporteur:* *Nitya Ghotge*	**Research and dissemination needs for animal health strategies and the use of complimentary medicines - what do we know and what is needed?**	
	Group C Digital	*Moderator:* *Barbara Früh* *Rapporteur:* *Anne Grete Kongsted*	**Organic pig production – what do** we **know and what is needed?**	
	Group D In Rennes On-site	*Moderators:* *Otto Schmid* *Tina Leeb* *Rapporteurs: to be determined*	**Open topic discussion for those in Rennes, most likely split in 3 sub-groups** (Cattle, pigs, animal health)	

	13.00 14.00	**Lunch**		
	14.00 - 15:30	**PLENARY SESSION II:** **Part I: The future of animal husbandry – from a sustainability and climate perspective**		
	14.00	**Emeritus Professor Donald Broom**	University of Cambridge	Assessing Food Sustainability
	14.30	**Dr Laurence Smith**	Reading University	Learning from innovative practitioners: exploring Socio-ecological and Sociotechnical advances in livestock systems
	15.00	**Dr Florian Leiber**	FiBL Switzerland	Can global grassland regions be a backbone of sustainable food production? A case study roadmap
		Moderators: Mette Vaarst and Marion Johnson		
	15.30 - 16:45	**PLENARY SESSION III:** **Part II: Conclusions**		
	15.30	**Reports from the seminar group discussions**		
	16.00	**Dr Marc Benoit** INRA – How could livestock farming maximize organic production at a global scale?		
	16.30	**Acknowledgments of organizers**		
		Moderators: Otto Schmid and Mahesh Chander		

Conference organisers and supporters:

IAHA - IFOAM Animal Husbandry Alliance	
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