



Farmers using local livestock biodiversity share more than animal genetic resources: Indications from a workshop with farmers who use local breeds

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Abstract: Recognizing the products from farms that use local breeds is key to *in situ* conservation of local animal biodiversity. Recognition often focuses on a small number of specific breeds or products but could be expanded to include multiple local breeds and products. This paper shows that several farmers who use local breeds can share principles among the multiple dimensions of their farming systems. We analyzed the exchanges among nine farmers who use local breeds on the different dimensions of their farming systems at a workshop held in November 2017. We present the principles they shared and discuss (i) the fact that bringing the principles to the fore requires a collective participatory approach, (ii) the fact that shared principles may also concern dimensions often neglected in livestock farming systems approaches, and (iii) how a collective participatory approach can help recognize the products and activities of farmers who use local breeds.

Keywords: Local breeds, livestock farming systems, value, recognition, practices

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Introduction

As reported by the Food and Agriculture Organization of the UN (FAO, 2015), local livestock biodiversity is under threat. As livestock and livestock diversity contribute to livelihoods, food security and rural development, as well as having cultural and environmental dimensions (FAO, 2015), it is important to maintain the diversity of and add value to local breeds, through their sustainable use and development. To this end, several examples of using geographical indications to support the products of these breeds have been reported (Mathias *et al*, 2010). These labels often focus on a specific product associated with a single breed. Beyond labels focused on local breed products, it is hypothesized that, if different civil society stakeholders have a positive image of farmers who use local breeds, this will contribute

to their conservation (Gandini *et al*, 2010). In this line of thought, it is important to raise public awareness of farming activities and products linked to local breeds. General recognition of products and activities of farmers who use local breeds should not necessarily focus on a single breed and product, but could, for instance, apply to a whole territory. Recognition at this scale would then concern a wide range of products and could include several local breeds of different species. It is recognized that the choice of a breed and the way the breed is managed are an integral part of the logic of a whole livestock farming system (Lauvie *et al*, 2015), and that breeds and the types of farming systems within which they are used are linked (Sturaro *et al*, 2013). However, the same breed can be used in different farming systems (Perucho *et al*, 2020). Despite this diversity, to better recognize the activities and products of farms at the territory scale, it is important to identify what they have in common. Indeed, recognition often

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depends on putting the spotlight on elements that justify recognition. These elements could for instance be included in a product specification or charter, or through communication campaigns. A prerequisite condition for recognition is thus to identify shared elements that could be highlighted. We therefore questioned if certain elements are shared by the different farming systems that use local breeds.

To answer this question, we aimed to identify the characteristics shared by several farming systems that use local breeds. We refer to these common underpinnings of a system as shared 'principles'. In this definition, shared principles can be associated with an existing diversity of practices. This paper aims to characterize the nature of common principles identified as shared by several farming systems that use local breeds.

The paper is organized in three sections: First, we present the methodology chosen to analyze the exchanges between local breed farmers on the different dimensions of their farming systems during a workshop on production systems and territory. We then identify the shared principles, and show how farmers who use local breeds may share farming system practices or values that go beyond technical or genetic aspects. Finally, we discuss (i) the fact that bringing these principles to light requires a specific participatory approach and the difficulties in applying this approach to a larger group of farmers, (ii) the fact that these principles concern dimensions often neglected in livestock farming systems approaches, and (iii) how to recognize the specificities of farming systems that use local breeds while supporting diversity.

Materials and methods

This paper analyzes the content of the exchanges that took place during a workshop held in November 2017. The workshop was one of several organized during an action research project conducted in partnership between a research team of the French National Research Institute for Agriculture, Food and Environment, and the *Fédération des Races de Bretagne* (Federation of Local Breeds in the region of Brittany, Federation hereafter). The action research aimed to promote recognition of the products and activities linked with local breeds in Brittany.

The project was organized by the Federation, which gathers local breed associations in the region. Participation was voluntary and open to farmers who are members of the Federation. As a consequence, a variety of farmers using local breeds attended, and several different species were concerned.

In this paper, we analyze the content of a workshop on the theme: *Production systems and territory*. The workshop brought together nine farmers, four researchers (three participating in the action research and one involved in another part of the project, as an observer), and one facilitator from the Federation. Among the breeds raised by the nine farmers, those con-

cerned by the Federation were Nantaise, Armoricaire, Bretonne Pie Noir, and Froment du Léon cattle breeds, Chèvre des fossés goats, and Landes de Bretagne sheep, all of which were included in this study. Animals of other breeds are also raised on some farms, but these breeds were not among those covered by the Federation.

Six of the farming systems produced meat, three mainly produced dairy products, and one produced both wool and meat. At the time of the workshop, three farmers mentioned they had another activity combined with raising livestock – one grew vegetables, and the other two had off-farm activities.

The four participants from the research institute came from three different fields: one from management sciences, one from sociology and two (including the observer) from livestock farming systems.

The exchanges were organized under three topics: (1) livestock feeding system and land use, (2) breeding practices, and (3) processing and sale of products and other activities such as opening the farm to visitors. The discussion on each topic was divided into two parts: (1) a roundtable to present each farmer's practices related to the topic, and (2) a collective discussion to agree on what they had in common about the topic. The exchanges were audio-recorded for internal report writing, and used for further analysis.

We analyzed the characteristics shared by the farming systems identified by the workshop participants, using the audio recordings and report to stay close to the collective expression of principles shared among the workshop participants.

We analyzed the exchanges concerning individual practices to capture their diversity in more detail. We conducted a thematic analysis of the notes reporting the exchanges. The diversity of practices described for each topic was reported with the aim of illustrating the diversity within a shared principle. We used this empirical data to better characterize the nature of the shared principles.

Results

Elements shared by farmers referred on different dimensions of the livestock farming systems.

[Table 1](#) lists the results of the collective discussion aimed at reaching an agreement on what the farmers' systems had in common. The three dimensions of the farming systems reported in the table are the same as those used to organize the workshop, and correspond to the three topics.

The shared elements listed in [Table 1](#) are phrased in a way that is as close as possible to the way they were expressed by the group of farmers. "Grazing-based systems" and "free-range (quasi integral)" refers directly to the characteristics of the livestock farming systems. "Orientation toward autonomy" refers to the shared desire to move towards livestock feed autonomy, even if the farmers underlined this is more difficult

Table 1. What the participant farmers considered they had in common in their farming systems

Dimensions of farming systems	What farmers considered they had in common
Livestock feeding systems and land use	<ul style="list-style-type: none"> - Grazing-based systems - Free-range (quasi integral) - Orientation toward autonomy (principle to be modulated depending on the species) - Use of hedges - Purchased feed is not industrially processed - Floristic diversity - Match between the choice of environment and the choice of breed - Attention to animal health and animal wellbeing
Animal breeding and genetics	<ul style="list-style-type: none"> - Management of a genepool: “farmers are gene passers”
Product processing and sales and other activities	<ul style="list-style-type: none"> - Farmers make their animals and activities visible - Farmers establish direct links with their customers - Trust is based on mutual knowledge and not on a label - The taste of products is co-built and shared with consumers (and farmers consume their own products) - Association between market relations and friendship - Proximity can be interpersonal and/or geographical - Everything is used/no waste - Farmers seek balance and not expansion

with some species than with others. Alongside their aim to achieve feed autonomy, they pointed out that if they had to buy feed, they avoided buying industrially processed feed. Some of the shared elements concerned the farm ecosystem and how it is valorized: “use of hedges”, “floristic diversity” of the pastured areas was considered important. More generally, they underlined the consistency between the breed and the farm agroecosystem: “match between the choice of environment and the choice of breed”. They also mentioned they all pay attention to “animal health and animal wellbeing”. The only principle linked with genetic management they share is that they consider themselves responsible for the “management of a genepool”. Several shared principles refer to what farm gate sales enable: “farmers can make their animals and activities visible”, there is a “direct link with the customer”, there may be an “association between market relations and friendship”, “trust [is] based on mutual knowledge and not on a label”, “the taste of products is co-built and shared with the consumers”. Another principle linked with farm gate sales is that “proximity can be interpersonal and/or geographical”, as in some cases farmers sell their products at a distance from the farm but where they know the customers. Finally, the last two principles are values shared by the farmers: “Everything is used”, is a declaration of their desire to avoid waste, and “farmers seek equilibrium balance and not expansion”.

Shared principles refer to both practices and values

The elements the farmers consider as shared are expressed in different ways, and may be of a different nature. Some are formulated as generic practices

(e.g. “when feed is purchased it is not industrially processed”). When principles are expressed as a shared generic practice, they may include different ways of expressing the practice. Some are not expressed as practices (e.g. “farmers seek balance and not expansion”) but as values, i.e. they refer to elements that are important in the farmers’ views, something they care about. When principles are expressed as values, the values can also be expressed through different practices.

Shared principles associated with a diverse range of practices

We inventoried the diversity of practices expressed during the roundtables. Linking them to the corresponding shared principle revealed the diversity of farmers’ practices as illustrated in [Table 2](#).

Several shared principles refer to relational values and practices

All farmers who attended the workshop practised direct sales (farm gate sales), but when talking about what they have in common, the farmers did not mention this practice per se as a shared principle; instead, they mentioned the values associated with the practices that were not focused on economic but on relational values such as “direct link with the client” and “proximity that can be interpersonal and/or geographical”.

The shared principle “the taste of products is co-built and shared with the consumers” also refers to relational values and interactions. Indeed, the interactions with consumers lead to better mutual knowledge: farmers learn about consumers’ preferences, while the customers learn about the farming activity and the animals. For instance, one farmer mentioned that customers became accustomed to watching the animals they will eat in

Table 2. Examples of the range of practices associated with a shared principle

Shared principle	Illustration of the diversity of associated practices
“Floristic diversity”	<ul style="list-style-type: none"> - Soil preparation practices (e.g. new flora are observed after subsoiling, or the use of limestone to treat acid soil) - Plan to sow pasture (given the difficulties encountered in spontaneously obtaining floristic diversity due to local conditions) - Leaving sowed multispecies grasslands to evolve in the long term (i.e. to become permanent grassland) and improve “by themselves”.
“Farmers are gene passers”	<ul style="list-style-type: none"> - The future of young female animals: when referring to their conservation objective, the farmers pointed out that they do everything possible to keep young female livestock, while other farmers mention situations where it is difficult to keep a young cow (a cow whose behaviour is dangerous, for instance) - Several farmers said they follow the advice on the genetic management of rare breeds, where there are differences in organization among breeds.
“Direct link with customer”	<ul style="list-style-type: none"> - All farmers used farm gate sales (some farmers were also part of a short supply chain with one intermediary) - Farmers chose to sell individual cuts of meat. This requires a dedicated place and time - Farmers chose to sell several different cuts of meat in boxes weighing several kilos. For these purchases, farmers use a dedicated booking organization, and define a sales period linked with the slaughtering and processing period - Farmers may sell both individual cuts and mixed cuts in boxes.

the end, grow, and two farmers mentioned people who had given up eating meat and started eating meat again. Several farmers mentioned receiving feedback about their products, and two farmers who process milk explained that when they develop a new product, they have some customers taste it, and they take the feedback they receive into account when adjusting the recipes.

The shared principle “farmers make their animals and activities visible” refers to a diversity of relational practices and to the description of individual practices illustrating how farmers interact with the public: organizing barbecues or dinners and shows on the farm with the possibility to visit the farm, opening their farm to visits on demand, receiving a helping hand from customers who have become friends, holding art exhibitions on the farm through the intermediary of an association.

Discussion

Identifying shared principles underlying livestock farming systems through collective approaches

The approach we present in this paper consisted of identifying shared principles that underpin livestock farming systems. We show that these principles can be expressed both as practices and values. Agroecology is a scientific field in which the principles underpinning farming systems are widely acknowledged. [Wezel et al \(2020\)](#) reviewed the different agroecological principles reported in the literature with the aim of proposing consolidated principles. These authors defined principles as actionable statements that contain both normative aspects (that assert values) and causative aspects (that explain relationships) ([Wezel et al, 2020](#)). Agroecological

principles are generally defined by scientists and experts to provide a permanent generic scope that can be used to guide analysis, support transition and evaluate systems. The principles are generically formulated but can be applied locally through a range of practices suited to local conditions ([Wezel et al, 2020](#)). In this context, some agroecological studies aim to establish links between generic agroecological principles and the diversity of practices and ways of acting on agroecosystems ([Toffolini et al, 2018](#)). The principles we identified in this study are actionable statements that can be expressed through a diversity of practices depending on the farm. However, these principles are formulated as statements shared by a group of farmers, to support work to achieve better recognition of their activities and products. The shared practices and values identified are consequently the result of bringing together diverse views – the product of a collective process within a group, the contours of which may change. Therefore, in contrast to generic agroecological principles, these principles may change over time. As the identification of shared principles necessarily results from the views of a group, a participatory approach is required.

The need for a collective process leads to a methodological challenge. The workshop reported in this paper involved only a small number of farmers. Although this study confirms that this group of farmers who use local breeds share more than genetic resources, it is impossible to conclude what all farmers using local breeds share at the Federation scale. The Federation has many members, and it would be impossible to include all the farmers of the member associations in a face-to-face collective reflection. One possible way to proceed would be to design a collective form of governance to enable each farmer to monitor the process and give their view,

even if they do not participate actively in the workshop discussions.

The shared principles of livestock farming systems concern several dimensions.

This study showed that farmers who use local breeds not only share the genetic resources they use but also other elements of their farming systems. Those elements are expressed as values and practices, and are interrelated, as values are related to “how farmers ‘make sense’ of their practices” (Darnhofer *et al*, 2012). This calls for further developments in the field of genetic resources management to better understand what farmers who use local breeds do share.

We have shown that principles shared by all the farmers are reflected in practices that vary with the farm. Diversity among farming systems is indeed a key research object of livestock farming systems, and is often tackled through the use of different kinds of typologies depending on the aim of the study (Alvarez *et al*, 2018). Here, in accordance with the aim of our study, our approach was more focused on the identification of common principles than on the characterization of the diversity of possible practices that each principle covers.

Our work also shows that shared principles of livestock farming systems using local breeds are not only linked with breeding and genetics but with other dimensions, including feeding and sanitary systems. The systemic approach to livestock farming considers several dimensions and their associated practices in a given farming system. Although feeding, sanitary, reproduction and renewal practices are at the core of the livestock farming systems approach, what Landais (1994) termed the “valorization practices” of animal products (processing, sales, etc.) are also an integral part. Our study confirms the importance of the processing and sale of farm products in the overall functioning of the system. Few studies of livestock farming systems pay sufficient attention to the sale of farm products (Nozières, 2014), even though it may play an important role. Indeed, here we have shown the key role of farm gate sales or short supply chains. Although direct sales strategies are important in terms of the farm’s overall economic strategy as well as work organization, our results show that the relations established with consumers are also very important and interact with other dimensions of the system. Milk and meat processing, for instance, can be influenced by direct sales, as the range of products and the recipes can evolve in response to consumer feedback about the products. The relational dimension of short supply chains is studied in social and economic sciences (Chiffolleau *et al*, 2019), and livestock farming system approaches also consider this relational dimension increasingly relevant, as underlined by Darnhofer *et al* (2012).

More generally, this work underlines the importance of the different relationships created by the farmers around their farms, not only through direct sale, but

also farm visits or other activities. These different interactions could be the subject of further studies in livestock farming system approaches.

Challenges: how to recognize specifics of farming systems that use local breeds without excluding diversity?

Gaining recognition for the products and activities of farms using local breeds is a challenge. This is fully consistent with the wider challenge of adding value to local breeds and helping ensure their continued viability (Ligda and Casabianca, 2013). Several studies focused on products made from local breeds, with or without specific labelling, showing the advantages of adding value to breeds by adding value to products, particularly in an approach focused on economic value. (Verrier *et al*, 2005; Mathias *et al*, 2010). However, other kinds of value may also be at play, and an approach focused on products and activities could broaden the perception of adding value to one or several local breeds. This would include the interrelated strategies identified by Ligda and Casabianca (2013):

- ”1. linkage of local breeds to traditional products and/or tourism/agritourism;
2. promotion of local breeds in specific farming systems, such as organic production, conservation grazing, sylvopastoral systems and small-scale low-input farms and hobby farms; and
3. general strategies focusing on the promotion of local breeds (marketing, legislation, organizational issues and raising public awareness) (Papachristoforou *et al*, 2013).”

The desire to better recognize the products and activities of farms that use local breeds also reflects a general need to raise awareness of local animal biodiversity. In a previous study on the motives for buying products, conducted with short supply chain consumers who buy products from five French rare local breeds, it appeared that the breed was not spontaneously mentioned as a reason for the purchase. This was considered interesting from a global perspective for consumers to better understand the origin of the food they eat (Couzy *et al*, 2017). Although the conclusion of this study cannot be extrapolated, it illustrates the dual need to improve awareness of local biodiversity and provide information about the breeds raised, along with additional information on the production process.

Identifying the principles shared by farming systems based on the use of local breeds is a first step towards better recognition of the activities and products of farms using local breeds. Achieving recognition could be inspired by existing strategies (e.g. labels on products, labels on farms, labels on sales outlets, logos, charters, specifications) or designed ad hoc. In a study of participatory guarantee systems for organic agriculture, Lemeilleur and Allaire (2018) provide

insights into the different dimensions of recognition setups. They distinguished three types of shared resources in such setups: ideas (shared principles, shared knowledge about practices etc.), equipment (frames of reference, e.g. specifications or charters, guarantee mechanisms, e.g. participatory guarantees or third party certification, etc.) and artefacts (logos, denominations, etc.) (Lemeilleur and Allaire, 2018). The results of the present study offer more possible ideas for such a setup. However, as we explained earlier, it is a challenge to develop a collective governance that would allow each farmer, who cannot be directly involved in a discussion held to define common principles, to nonetheless be able to follow the process and give their views.

Diversity is a key notion for farmers who use local breeds. As shown in a previous study (Lauvie et al, 2014), diversity is considered not only in terms of genetic resources but also in terms of the farmers involved, the different farming systems, farm products, etc. Identifying the activities and products of farmers who use local breeds to make them easier to recognize without reducing the existing diversity is a challenge. Finding a balance between diversity inclusion and differentiation and/or protection, depending on the final aim of such a setup, questions the degree to which products and activities should be specified.

Conclusion

This article presents the results of an action research project aimed at identifying the principles shared by farming systems that use local livestock breeds. We observed that farmers who use local breeds share more than just a breed: they also share principles concerning livestock feeding systems and the sale of products, for instance. We also observed that the shared principles are expressed both as practices and values. We identified the methodological challenges associated with identifying common principles shared by livestock farming systems using local breeds. We finally discussed what can be done to increase recognition of the activities and products produced by farmers using local breeds – a process that can both maintain and develop the use of local breeds and, consequently, favour local livestock biodiversity.

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Authors contributions

Anne Lauvie: study conception and design, data collection, analysis and interpretation of results, draft manuscript preparation and manuscript revision. Nathalie Couix and Jean Michel Sorba: Study conception

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Conflict of interest statement

The authors declare no conflict of interest.

References

- Alvarez, S., Timler, C. J., Michalscheck, M., Paas, W., Descheemaeker, K., Tittonell, P., Andersson, J. A., and Groot, J. C. J. (2018). Capturing farm diversity with hypothesis-based typologies: An innovative methodological framework for farming system typology development. *Plos One* 13, 24–24. doi: <https://doi.org/10.1371/journal.pone.0194757>
- Chiffolleau, Y., Millet-Amrani, S., Rossi, A., Rivera-Ferre, M. G., and Merino, P. L. (2019). The participatory construction of new economic models in short food supply chains. *Journal of Rural Studies* 68, 182–190. doi: <https://doi.org/10.1016/j.jrurstud.2019.01.019>
- Couzy, C., Markey, L., Lauvie, A., Audiot, A., Thuault, F., Olliver, D., and Chiron, G. (2017). Varape : des outils pour accompagner les démarches collectives de valorisation des produits des races à petits effectifs. *Innovations Agronomiques* 55, 29–40. doi: <https://doi.org/10.15454/1.5137751023185098E12>
- Darnhofer, I., Gibbon, D., and Dedieu, B. (2012). Farming Systems Research into the 21st Century: The New Dynamic, ed. Darnhofer, I., Gibbon, D., Dedieu, and B. (Dordrecht: Springer), 3-31.
- FAO (2015). The second report on the state of the world's animal genetic resources for food and agriculture - In brief. FAO Commission on Genetic Resources for Food and Agriculture. Assessments . url: <http://www.fao.org/3/a-i5077e.pdf>.
- Gandini, G., Avon, L., Bohte-Wilhelmus, D., Bay, E., Colinet, F. G., Choroszy, Z., Diaz, C., Duclos, D., Fernandez, J., Gengler, N., Hoving-Bolink, R., Kearney, F., Lilja, T., Maki-Tanila, A., Martin-Collado, D., Maurice-Van Eijndhoven, M., Musella, M., Pizzi, F., Soini, K., Toro, M., Turri, F., Viinalas, H., Consortium, T. E., and Hiemstra, S. J. (2010). Motives and values in farming local cattle breeds in Europe: a survey on the 15 breeds. *Animal Genetic Resources* 47, 45–58. doi: <https://doi.org/10.1017/S2078633610000901>
- Landais, E. (1994). Système d'élevage. D'une intuition holiste à une méthode de recherche, le cheminement d'un concept. *A la croisée des parcours. Pasteurs, éleveurs, cultivateurs* 15-49.
- Lauvie, A., Couix, N., and Sorba, J. M. (2014). Transition toward systems linking animal genetic resources, low input farming systems and products processed on the farm; development logics of the Bretonne Pie Noir local cattle breed. In European IFSA Symposium, Berlin.
- Lauvie, A., Paoli, J. C., and Moulin, C. H. (2015). Managing local breeds: a dynamic connected to livestock farming systems that concerns different

- levels of organization. *Animal Gen. Res* 2-2. doi: <https://doi.org/10.1017/S2078633614000502>
- Lemeilleur, S. and Allaire, G. (2018). Système participatif de garantie dans les labels du mouvement de l'agriculture biologique. Une réappropriation des communs intellectuels. *Économie rurale*. doi: <https://doi.org/10.4000/economierurale.5813>
- Ligda, C. and Casabianca, F. (2013). Adding value to local breeds: challenges, strategies and key factors. *Animal Genetic Resources* 53, 107–116. doi: <https://doi.org/10.1017/S207863361300026X>
- Mathias, E., Mundy, P., and Koehler-Rollefson, I. (2010). Marketing products from local livestock breeds: an analysis of eight cases. *Animal Genetic Resources* 47, 59–71. doi: <https://doi.org/10.1017/S2078633610001001>
- Nozières, M. O. (2014). La commercialisation des produits, source de flexibilité pour les éleveurs? Le cas de l'élevage ovin allaitant en Languedoc-Roussillon. Ph.D. thesis, Montpellier SupAgro.
- Papachristoforou, C., Koumas, A., and Hadjipavlou, G. (2013). Adding value to local breeds with particular reference to sheep and goats. *Animal Genetic Resources* 53, 157–162. doi: <https://doi.org/10.1017/S2078633612000495>
- Perucho, L., Paoli, J. C., Ligda, C., Moulin, C. H., Hadjigeorgiou, I., and Lauvie, A. (2020). Diversity of breeding practices is linked to the use of collective tools for the genetic management of the Corsican sheep breed. *Italian Journal of Animal Science* 19, 158–172. doi: <https://doi.org/10.1080/1828051X.2020.1713027>
- Sturaro, E., Marchiori, E., Cocca, G., Penasa, M., Ramanzin, M., and Bittante, G. (2013). Dairy systems in mountainous areas: Farm animal biodiversity, milk production and destination, and land use. *Livestock Science* 158, 157–168. doi: <https://doi.org/10.1016/j.livsci.2013.09.011>
- Toffolini, Q., Cardona, A., Casagrande, M., Dedieu, B., Girard, N., and Ollion, E. (2018). Agroecology as farmers' situated ways of acting : a conceptual framework. *Agroecology and Sustainable Food Systems* 1-32. doi: <https://doi.org/10.1080/21683565.2018.1514677>
- Verrier, E., Tixier-Boichard, M., Bernigaud, R., and Naves, M. (2005). Conservation and value of local livestock breeds: usefulness of niche products and/or adaptation to specific environments. *Animal Genetic Resources Information* 36, 21–31. doi: <https://doi.org/10.1017/S1014233900005538>
- Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., and Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development* 40, 40–40. doi: <https://doi.org/10.1007/s13593-020-00646-z>