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Abstract. The importance of environmental challenges in agriculture and livestock production requires an ecological transition of the production systems including the sheep and goat ones. In this context, establishing the conditions for agro – ecological changes and building innovative pathways of changes could favor this transition. After a presentation of some theoretical concepts behind the idea of ecological transition and agro – ecology, the objective of this communication is to report the implementation of a participative approach involving scientists, technicians, teachers and breeders in Corsica Island focusing on pastoral systems. This approach aims to design the performances of the systems from their triple social economic and environmental dimensions, how they are in line with the agro – ecological orientations and how to improve them. Inspired from previous methodologies but innovating through a participative approach, an easy-to-implement method has been adjusted to the characteristics of the local systems and agro-ecological criteria for sheep and goat herds and systems, we designed 10 groups of indicators including societal dimensions integrated in an Agroecological Livestock Proximity Index (ALPI). The exchanges during the sessions have shown that agro-ecology is not only an institutional injunction. It is also a collective methodological approach and pathway to design which innovations could support the sustainable development and changes in sheep and goat farming and specially, in pastoral systems. The utilization of this method and its further developments are evoked.

Keywords. Ecological transition – Innovative conception – Sustainable development – Sheep and goat production – Pastoral systems.

L'engagement des systèmes de production ovine et caprine dans la transition agro écologique : Une approche participative collective en Corse

Résumé. *L'importance des défis environnementaux dans l'agriculture et en production animale nécessite une transition écologique des systèmes de production, y compris pour les systèmes ovins et caprins. Dans ce contexte, établir les conditions pour des changements agro-écologiques et la création de voies de changements innovantes pourraient favoriser cette transition. Après une présentation des principaux concepts théoriques derrière l'idée de la transition écologique et de l'agro écologie, l'objectif de cette communication est de mettre en place une approche participative impliquant des scientifiques, des techniciens, des enseignants en Corse en se concentrant sur les systèmes pastoraux. Cette approche vise à concevoir les performances des systèmes à partir de leurs trois dimensions sociales, économiques et environnementales, quelle est leur proximité aux orientations agro-écologiques et comment l'améliorer. Inspirée des méthodologies antérieures, mais en développant une approche participative, une méthode facile à mettre en œuvre a été adaptée aux caractéristiques des systèmes locaux de Corse et des critères agro écologiques pour les troupeaux et systèmes locaux ovins caprins systèmes ont été définis pour 10 groupes d'indicateurs intégrant la dimension sociétale et intégrés dans un Index de Proximité de l'Elevage (ALPI). Les échanges au cours des sessions ont montré que l'agro écologie n'est pas seulement une injonction institutionnelle. C'est aussi une démarche méthodologique collective et un moyen de concevoir quelles innovations pourraient soutenir le développement durable et les changements dans l'élevage ovin caprin et en particulier dans les systèmes pastoraux. Les modes d"utilisation de cette méthode et ses développements ultérieurs sont évoqués.*

Mots-clés. *Transition écologique – Conception innovante – Développement durable – Production ovine et caprine – Systèmes pastoraux.*

I – Introduction

Since World War II, the development of Agriculture and Animal production has been dominated by one main model based on the improvement of technical performances of the production factors. Most of innovations have led to a more intensive use of external inputs (Stassart *et al*., 2012) with a significant and permanent growth of production units. They have not considered their negative effects not only on biodiversity, ecosystems and climate change but also on working conditions, human welfare, resilience of the farms, structural weaknesses and disparities (Mazoyer and Roudard, 1997).

This realty had important consequences on the Sheep and Goat sectors in the Mediterranean. Once based mainly on the use of natural resources provided by rangelands, the production systems have been more and more artificialized with an increasing use of feed stuffs, more and more intensive grasslands, and the use of specialized breeds for milk or meat (Dubeuf *et al*., 2016).

The awareness of these negative effects have emerged in the 80's and several concepts and frameworks have addressed the sustainability of Agriculture (agro-ecology, organic agriculture, integrated production, sustainable intensification, conservation agriculture, etc.). The application of these concepts, and specially agro-ecology for animal production, has been more recent and proposed new ways of producing in favor of the integration of animals in an agro-ecosystem (Gliessmann, 2006; Tichit and Dumont, 2016). But this integration of agro-ecology has been nearly absent for pastoral systems (Bellon *et al*., 2016).

After a presentation of the several dimensions of agro- ecology for sheep and goat systems, this article explores a methodology implemented in Corsica to include the several actors (farmers, technicians, public services, industrials, etc…) in the process of greening of sheep and goat farming and address their agro-ecological transition. The relationship between agro-ecological transition and sustainable development is also explored.

II – Agro – ecological transition and ecologically intensive bio –diversity based sheep and goat farming

The word agro-ecology used for the first time in 1930 by a Russian agronomist (Bensin, 1928) has been conceptualised by Altieri (1983) as the science to define principles, to study, design and manage productive, efficient to use natural resources, socially just and economically viable sustainable agro-ecosystems. In Agro-ecology, the emphasis is on biodiversity in order to understand better the mechanisms which underlie and strengthen the biologic regulation in diversified systems (Kremen *et al*., 2012).

The first and prevailing vision of agro-ecology is based on the comprehension, the utilization and imitation of ecological processes implemented within agro-systems rather than on their artificialization and utilization of chemical inputs (Griffon, 2006). Although it introduces a first paradigm shift in the organization of production systems, it advocates an "ecological intensification" (EI) and an increasing resource use efficiency, organizing the substitution of chemical inputs by organic ones, developing precision agriculture technologies or even using genetically modified organisms (Godfray *et al*., 2011). Focused on minimizing the negative impact of agriculture on the environment, the main objectives of EI are to keep on raising incrementally the limits of yields and encouraging the still dominant pathways of specialization and modernization (Duru *et al*., 2014). But regarding animal production and especially small ruminant farming, an issue has been mainly ignored: understanding the integration of the animal in its agro-ecosystem to get levers and conciliate sustainably not only environmental but also economic, social and societal concerns (Gliesmann, 2006). The dominant model has largely favored a divorce between agriculture and food systems. There has been a gap between the world of production and the world of consumers, a break between productive practices with mass intensified production on one side and mass distribution of global

products on the other side. Biodiversity based animal production could be a framework for proposing new ways of producing to meet the growing demand for food by linking food to productive practices and the production environment. This new type of agriculture and animal production must also have the status of activity of general interest. This approach would be very relevant for Mediterranean rural areas like Corsica where until more recently than in regions where intensification has been widely developed, village communities have remained very perennial with locally anchored niche products and the dialogue between society and agriculture and /or Animal Production has to be reopened (Sorba *et al*., 2017). It would be more relevant to consider also the ecosystemic services of activities as sheep and goat farming at field, farm, landscape and rural territories level in redesigned systems based on an ecologically intensive biodiversity (Griffon, 2006). To be operational, ecologically intensive biodiversity based agriculture requires a changing regime to organize this transition, change the way to face problems and find solutions.

III – The collective analysis of the current functioning of small – ruminant systems in Corsica: a method, an initiative and a first step to address agro-ecological transition and sustainable development for sheep and goat farming

In Corsica, the regional services of the French Ministry of Agriculture have decided to organize with INRA a training program to sensitize local extension agents and teachers on agro-ecology. This program is a component of an ambitious national project of this Ministry, defined in 2011 to support agro-ecology called “Enseigner à produire autrement” (Teach to produce differently). This project has followed the 5 principles of Agro-ecology (Dumont *et al*., 2013) (P1 Integrated management of animal health, P2 Lower inputs, P3 Lower pollutions, P4 Strengthen diversity to increase resilience, P5 Preserve biodiversity by adapting practices) and promotes the social, economic and environmental triple performance. Within the National project, the Ministry had designed the IDEA method (http://www.idea.chlorofil.fr) based on the monitoring of farm sustainability indicators methodology. This method provides a holistic approach of the sustainability of farm systems through self-assessment for all types of French farming systems. But as it appears not to be specific to animal production and poorly adapted to Mediterranean pastoralism, the regional program decided to use a near but different method.

The organizers invited not only teachers and trainers of the regional public agricultural schools but also technicians from the Chambers of Agriculture, the regional agricultural office, pastoralists and public officers dedicated to agriculture and twenty five participants on average have attended each session. The first 4 sessions have been devoted to inform the participants about agro-ecology in an interactive way. The 5th session had the objective to characterize the agro-ecological orientations of sheep and goat farming system. The method used has been inspired by that specifically designed for small ruminant Mediterranean farming systems by an international team for pastoral and grazing herds (Mena *et al*., 2012). In this method, the indicators and criteria are chosen by a multivariable analysis (Principal Component Analysis) and the tool tested in a large number of situations including Sardinia (Ruiz *et al*., in press) and Andalusia (Ruiz *et al*., 2016) to identify the diversity of agro-ecological profiles. Regarding the choice of indicators and the discussion of criteria, we adopted a more participative framework following here the participatory approach proposed by Duru *et al*. (2015) in 5 steps:

(i) analyze the current functioning of local agriculture,

(ii) identify future exogenous changes that may determine its future (drivers),

(iii) design local organization of the expected territorial biodiversity-based agriculture (forecasting),

(iv) design the major steps of the transition from the current situation to this new form of local agriculture (back casting),

(v) design governance structures and management strategies adapted to guide the transition.

During the last session, the method has been tested in two farms. The first test has been implemented in the farm of the local agricultural college to survey the agro-ecological characteristics of their organic dairy flock with farm cheese making. The second one has been on a pastoral goat cheese making goat farm.

Each survey lasted during approximately two hours, the farmer having previously collected his own personal documentation.

1. The choice of synthetic indicators and criteria

During the participatory sessions, the choice of indicators proposed by Mena *et al*. (2012) has been analysed. The formulation and the relevance of each criterion were discussed collectively regarding the characteristics of sheep and goat systems in Corsica.A global Agro-ecological Livestock Proximity Index (ALPI) has been estimated and the weight of each indicator has been chosen collectively. The participants have considered also that agro-ecology has a societal dimension and insisted on the interaction with society at a territorial level. Consequently a societal indicator has been added to the three economical, social and environmental performances. Within each indicator, the several criteria have been discussed and chosen to consider the specificity of sheep and goat systems in Corsica. The list of indicators and criteria is given on Tables 1a and b. Each indicator (sum of scores of the respective criteria, see Table 2 as an example) has been positioned on a Radar to characterize the Agro-ecological profile of each farm.

Besides, during the sessions, by considering the historical pastoral background of animal production in Corsica, the hypothesis proposed by the participants is that pastoralism could be a lever for agro-ecological transition in Corsica and the pastoral components of sheep and goat farming must be discussed for implementing the agro-ecological future of Corsica.

2. Results of the surveys in the two farms tested and comments

The results of the survey in the two farms and their profiles are given on Table 3. The two cases have rather good agro-ecological characteristics, the organic dairy sheep farm having an ALPI of 75.32% and the pastoral one 58.94%. Animal welfare and the use of local resources are rather good for the two examples but the characteristics are more contrasted for the other indicators with a lower scoring for feeding and grazing characteristics or for marketing. Besides, these agro-ecological profiles do not say much about the operational management of each case.

The profile of the organic farm in the agricultural college shows that feeding and grazing management are the main weak points in this type of farm. A deeper discussion with its manager has specified that it was mainly due to a lack of control of reproduction. Organic specification forbids chemical or hormonal treatment, and the method to manage natural reproduction by playing on mating effects of the rams has not been stabilized. The consequences are a large period of lambing, a low level of fertility and a difficulty to manage feeding and grazing periods at the flock level. The lack of integration of this didactic farm in the professional environment has been identified as the other weak point regarding its agro-ecological characteristics.

The second farm is a pastoral goat farm. Although he has rather environmental friendly practices, characterized by an exclusive use of good quality rangelands, its environmental and economical characteristics are impacted by a rather important use of hay and grain, usually bought outside the island. Some animal health problems (10% loss of grazing animals, pathologies, loss of productivity,%

of infertility...) are seen as a fatality by the farmers but it shows rather a lack of control of his management practices. Another interesting point is the criterion on stocking rate (4 to 8 heads per ha). The pastoral farm having a very low stocking rate (0.3 goats/ha), the practices of the farmer could not be adapted to control the vegetation of his rangelands with such a little herd. Limiting the area for grazing or increasing the number of heads thanks to some area of forage crop would probably increase the efficiency of his system without negative effect on his agro-ecological characteristics.

For these two cases a compromise has to be found between organic or pastoral practices and the sustainable development of the farms. Some orientations toward more agro-ecological systems have been suggested, showing that the way to choose has to be designed for every situation.

3. The contribution of the method to the agro-ecological transition; discussion among the participants

Although each indicator is synthetic and gives the same weight to each criterion which has yet to be improved, the method gives a first and systemic approximation of agro-ecology in the studied farms and systems. It is the reason why it could be relevant to extend this analysis to a large number of farms and test its relevance.

Simultaneously, the value and weight of each indicator in the calculation of the ALPI could be questioned as the weights are subjective choices. If ALPI is probably less useful than the profile to understand the transition processes, it shows nevertheless that several agro-ecological profiles could led to the same “intensity” of agro-ecology and that no given production system would have by nature agro-ecological characteristics (like the pastoral systems systematically considered as already agro-ecological) according to the control and knowhow of the farmer.

The participants have also raised several more methodological other questions: how to evaluate the quality of the collected information? How to characterize and evaluate the local practices? How to consider pluriactivity? Is the place given to the food production enough? Radars have been designed to give a synthetic view of the agro-ecological diagnosis on each farm. They are a didactic way to open the discussion between the farmers and agents working with them on their possible pathways to agro-ecological transition. The two examples show clearly that for every farm it could be designed a proper pathway, the proximity to the agro-ecological ideal remaining multi direction. Another point of discussion could be the speed of the transitions to be implemented, given to the concrete situation and the capacity of the farmer. But the systemic relations between the various indicators have still to be specified as aggregation of factors and key points of agro-ecological transition. And the relationship among farmers and local actors at the territorial level needs to be better taken into account.

IV – Conclusions

The method developed in the Corsican training programme proposed a tool to open a broad dialogue between the farmers and the several actors working with them. It gives interesting systemic directions on how to improve not only ecologically but also to make more sustainable their activity. We see by this way that agro-ecology could be a strong driver to formulate objectives of sustainable development and particularly in rural, isolated or mountainous hinterlands with strong social issues. It shows also that the coexistence of several production models in near territories and according to their resources, markets and infrastructures might make possible to think agro-ecological transitions. With a compilation of a large number of this type of surveys at a territorial level, such an approach could help also policy makers and professionals to define their sustainable development strategies.

However, according to the participants, the characterization of the farms has also to be more inserted in their territory. The configuration of the food systems combining agricultural dimensions and consumers practices has been presently largely ignored (only 3 criteria on marketing) as the food autonomy at the territorial level. By choosing a participatory approach to open this dialogue and characterize the systemic functioning of the sheep and goat system, we have only began to cross the first step proposed by Duru *et al*.(2015). Keeping with this participative way of working, it remains to combine drivers, forecasting and back stepping, that is to say identify the exogenous drivers that may determine their futures, design collective organizations and innovations of the expected territorial biodiversity-based livestock and the major steps of the transition from the current situation to this new form of local agriculture (back casting).

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Table 1a. Criteria discussed during a focus group regarding pastoral systems in Corsica [indicators 1 to 4]

If the criterion is considered as applied, the score is one; if not, it is zero. For each indicator, the score is the addition of the score of all criteria – adapted from Mena et al., 2012.

1. Animal nutrition

1.1. Animals graze daily for at least 6 h.
1.2. At least 50% of daily ration (for milked females) and 60% (for other animals) is common forage and/or grass (fibres).
1.3. The farm has lands to produce forage.
1.4. The farm produces grain for goats.
1.5. 80% of the feed for animals have been produced on the farm or near the farm (in the island).
1.6. The farm uses only forage produced regionally (in the island for the Corsican case).
1 7. The goats receive less than 500 g/head/day concentrate.

2. Sustainable pasture management

2.1. Rangelands provide more than 60% of the dry matter of the diet (Rangelands being defined as spontaneous grass or forest lands grazed freely by the herds including transhumance.
2.2. Rotational grazing is practiced on cultivated pastures (with at least 5 cm of grass before reintroducing the herds).
2.3. Stocking rate is between 4 and 5 goats per ha. (Average optimal stocking rate to valorize the potential of rangelands in the local conditions).
2.4. Stocking rate is adequate (No need for more land according to the farmer's declaration).
2.5. The farmer cultivates leguminous crops in isolation or associated with grains.
2.6. There is a mechanical intervention of the farmer on rangelands to improve them.
2.7. The potentialities of rangelands are adapted for goats (more than 400 kg DM/ha with an opened environment and an high of scrubs between 60 cm and 2 meters).
2.8 The breeder practices transhumance during at least two months.

3. Crops and forage practices

3.1. The farmer uses mineral or organic fertilizers <100 U nitrogen / ha) on the cultivated areas.
3.2. The farmer makes and applies compost, or manure and the lands are always covered in summer (no bare grounds).
3.3. The farmer has already carried out soil profiles and analysis.
3.4. There is no proved risk of contamination soil or water reserves by white waters and manure.
3.5. The farmer uses tines and disc tools for tillage or direct seeding by over seeding or he ploughs less than 20 cm deep.
3.6.The farmer practices rotations of different crops (including green manure).
3.7. No herbicides on forage areas (Direct seeding without herbicides).
3.8. The farmer uses woody resources as forage.

4. Disease prevention

4.1. The body condition of the herd is satisfactory.
4.2. The introduced animals are quarantined (a sufficiently long time).
4.3. The farmer carries out natural treatments mainly with natural products (herbalism or homeopathy).
4.4. The farmer treats parasites only when necessary and never more than twice per year (no systematic treatment, after a faeces analysis, or with natural treatments).
4.5. The farmer controls regularly water quality.
4.6. Livestock facilities are generally clean.
4.7. Hygienic-sanitary control of all aspects of milking is adequate.
4.8. The watering facilities are correct (no direct access to streams, no watering in ponds, etc ...).
4.9. Sick animals are isolated and crawl spaces are provided in accordance with the regulations.
4.10. The rangelands are closed (to avoid contacts with wildlife, wandering of animals and ease the rangelands management).

Table 1b. Criteria discussed during a focus group regarding pastoral systems in Corsica [indicators 5 to 10]

If the criterion is considered as applied, the score is one; if not, it is zero. For each indicator, the score is the addition of the score of all criteria – adapted from Mena et al., 2012.

5. Breeds and reproduction

5.1. 75% or more of the animals are autochthonous and/or adapted to the region.
5.2. Animal reproduction is natural: no hormones are administered to synchronize heat, induce birth, etc.
5.3. Births are distributed in order to minimize dependence on purchased feed.

6. Animal welfare

6.1. The farmer uses natural lactation until 30-35 days.
6.2. Lactation period is at least 40 days (the lambs are not killed at birth).
6.3. Covered area is at least 1.5 m^2 per adult sheep or goat and 0,35 m^2 per kid or lamb.
6.4. Outside space is at least 2.5 m^2 per adult animal (0,5 m^2 per kid or lamb).
6.5. Livestock have permanent access to open spaces, preferably to grasslands.
6.6. The farmer does not systematically tie up or isolate animals and limit their stress by his practices (no electric sting, water spray in summer, soft dehorning...).
6.7. The area for housing offspring is sufficient, protected from inclement weather and clean and well ventilated.
6.8. Adult animals have sufficient access to water, food, ventilation, light and adequate temperature and humidity.
6.9. The conditions of transport before slaughtering are satisfactory.

7. Food safety and hygiene

7.1. The farm can prove the absence of pathogens and is free of governmentally controlled diseases (principally brucellosis and tuberculosis).
7.2. The farm complies with the regulatory criteria of sanitary quality and good practices.
7.3. The farmer makes tests for chronic mastitis.
7.4. Analyses of milk during the past year indicate an absence of bacterial growth inhibitors.
7.5. The farmer follows waiting periods for treatments and had no inhibitors.
7.6. The effluents are stored in such a way that they not contaminate the environment.
7.7. The farmer disinfects the litters.

8. Marketing and management

8.1. The farmer adequately records information (of vet .treatments feed management, purchases and sales).
8.2. All the products are sold locally to industry, cooperatives or regional shops.
8.3. The farm closes the productive cycle (farm processing).
8.4. The farmer sells his products to local consumers directly at the farm or through local shops or markets.
8.5. The milk is processed in units where local material is used and accepted.

9. Conditions of social and economic sustainability

9.1. The farmer thinks he has good standards of living and good working conditions.
9.2. The farmer is less than 55 years or his succession is planned.
9.3. The farmer thinks he has a correct income.
9.4. Without public subsidies (Pillar II of the European CAP), the farm could continue his activity?
9.5. The farmer has other agricultural, livestock not agricultural activities.
9.6. The farmer is an active member of professional Associations or Unions.
9.7. Collective works with other farms are usual (formally or not).
9.8. The farmer thinks he is well integrated socially
9.9. There are other sources of income within family?

10. Environmental sustainability and societal contribution

10.1.The farm is well integrated in one's environment, looks clean and without visual pollution.
10.2. The farmer is involved in the restoration of his heritage (old buildings, terraces, threshing areas...).
10.3. The farmer is aware of his animal (local breeds, wild species...) or vegetal (protected natural plan reserves) heritage and assumes it (for instance by participating to collective actions in favour of bio -diversity.
10.4. The farmer practices transhumance regularly and follows his herd at least one a week.
10.5. The location of the farm is a real contribution for maintaining local traditional landscapes.
10.6. The farm is not located in natural hazard zone or the farmer tries to limit it (cleaning of rive banks against floods, firewalls area...).

Table 2. Example of application of the method on management of feeding (indicator 1) for the pastoral goat farm[1] tested in Corsica

1. Grazing on pasture during more than 6 hours a day	1
2. More than 50% of the diet is composed by fibers	1
3. The farm has lands to produce forage	0
4. The farm produces grain for goats	0
5. 80% of the feed for animals have been produced on the farm or near the farm (in the island)	1
6. The farm has used only forage produced in the Island	0
7 .The goats receive less than 500 g/head/day concentrate	1
8. The farm distributes shrub woody resources (“a frasca”)	0
Total	4/8 (50%)

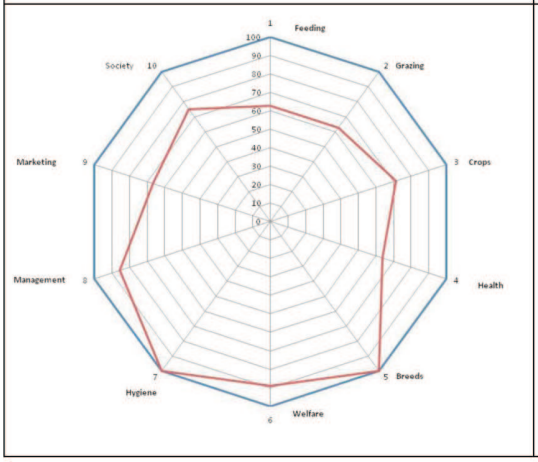
[1] Farmer description: “The goats graze all day long during the day but the farm has no lands to produce its own conserved forage and its grain. Consequently, concentrates and hay are bought and a part of it (grain and hay) is bought on the French continent. Consequently, to control the body conditions of his herd, the breeder gives an average of 520 g/day of concentrate”.

Table 3. Examples of agro – ecological profiles and ALPI (Agro – ecological Livestock Index)

Case 1 – organic dairy sheep farm

Score (%)	Indicator	Weighing factor
62,50	Feeding	0.16
62,50	Grazing	0.14
71,43	Crops	0.08
63,64	Health	0.08
100,00	Breeds	0.08
88,89	Welfare	0.06
100,00	Hygiene	0.09
85,71	Management	0.11
66,67	Marketing	0.12
75,00	Society	0.08

ALPI =75.32



Case 2 – Pastoral farm

Score (%)	Indicator	Weighing factor
50	Feeding	0.16
50	Grazing	0.14
42,86	Crops	0.08
72,73	Health	0.08
75	Breeds	0.08
100	Welfare	0.06
50	Hygiene	0.09
71,43	Management	0.11
44,44	Marketing	0.12
62,5	Society	0.08

ALPI = 58.94