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Small scale farming in Kédougou, South-East Senegal- Description of the livestock sector and of an intervention in poultry farming in the framework of a cooperation project

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Abstract: Livestock is essential to global small scale farmers' livelihoods. In Senegal, despite an increasing urbanisation, half of the population lives in rural areas relying on agricultural activities. The present work, which was carried out in the framework of a development project in the Kédougou region (South-East Senegal), analyses activities supporting small scale poultry farming performed in 30 groups of 10 households within the project and evaluates the effects of such interventions, in order to identify the most relevant factors contributing to increase Food and Nutrition Security. Despite difficulties, mainly related to climatic and social-economic conditions, a modest level of success was obtained, as over one third of the groups were able to produce chickens for self-consumption or for sale for minimum 6 continuous months. A positive effect was observed for social relations, improved in most of the 30 groups. Shortcomings and lessons learned are also presented.

Keywords: Food and nutrition security; rural livelihoods; sustainable development; agro-ecology

Introduction

The global relevant role of livestock to small scale farmers' livelihoods is well known, as breeding are an essential asset to the rural poor (Roland-Holst and Otte, 2007; FAO, 2016). In West Africa, livestock dependence is notably high, as this region's large arid areas are particularly suitable for this type of agriculture production (Roland-Holst and Otte, 2007).

In Senegal, despite an increasing urbanisation rate, half of the population lives in rural areas (CIA, 2018), where agriculture and farming represent the main economic activities (ENSAS, 2016). However, the country's agricultural production system is characterized by a relatively low output, which generates less than US$ 1.00 per capita per day. As a consequence, agricultural activities are often of a subsistence nature (Roland-Holst and Otte, 2007; D'Alessandro *et al.*, 2015). Although the agriculture sector output has expanded by 70 percent over the past 30 years, population growth has quadrupled. Thus, the level of production is inadequate to meet national demand and Senegal imports significant volumes of food. For example, the country is dependent upon imports to meet its growing demand for meat. In general, agricultural supply chains in Senegal remain highly

vulnerable to a wide range of risks that particularly affect rural livelihoods (D'Alessandro *et al.*, 2015). As a consequence, according to the Bonilla Index (Diaz-Bonilla *et al.* 2000) food security in Senegal was among the lowest in Africa during the period 1995–2010. Senegal is still listed among the low-income food-deficit countries in the last FAO Food security and nutrition report (FAO, IFAD, UNICEF, WFP and WHO, 2017). According to a national survey on food security in Senegal the highest rate of households with poor or limited food consumption are found in the regions of Tambacounda, Sédhiou, Kédougou, Matam, Kolda and Fatick, where at least one fourth of the population was classified as food insecure (ENSAS, 2016). Although demand exceeds local supply, imported foodstuffs are available throughout the country and only in the most isolated areas food insecurity is due to scarcity in food availability. However, the majority of the rural poor are dependent upon markets to meet their food needs, thus, it is the price of food and a household's capacity to pay that largely determines food security in Senegal (D'Alessandro *et al.*, 2015).

The present work was carried out in the framework of a development project, AFNut, *Action Feminine pour la Nutrition.* AFNut, led by COSPE ONLUS and conducted with several partners, including GIE Koba Club (local group of economic interest), CIRAA (Centre of Agro-Environmental Research "Enrico Avanzi", Pisa, Italy) and ECLOSIO (the NGO of the University of Liege, Belgium), aimed at increasing the food and nutrition security of beneficiaries in the Kédougou region (South-East Senegal), in particular in the departments of Kédougou and Saraya. Given the national food security issues briefly described above, particularly affecting the rural Kédougou region, the overall objective of the project was to increase the food and nutrition security of the most vulnerable part of the population. The project aimed at strengthening knowledge in the local context, always enhancing the resources already present in the area. Women were identified as a key target group in order to promote changes in the local communities, and to tackle gender equality, according with the UN Sustainable Development Goals (https://www.un.org/sustainabledevelopment/blog/2015/12/sustainable-development-goals-kick-off-with-start-of-new-year/). Besides other lines of intervention, including horticulture, cultivation and processing of *fonio* (*Digitaria exilis*, a typical local cereal) with an agro-ecological approach, as well as literacy classes and mutual micro-credit, poultry and small ruminants small scale farming activities were promoted by AFNut. The present article will focus in particular on poultry farming activities. Small poultry flocks are kept in the farmyard by many rural households in low income countries, a practice commonly referred to as village poultry or backyard poultry farming. Village poultry provide households with income and nutritionally-rich food sources and also improves food security in indirect ways, such as enhancing nutrient utilisation and recycling in the environment. In addition, it is flexible and easily adaptable to different agro-ecological zones and it is associated with the self-reliance of women that are generally the most involved in poultry keeping (Hailemichael *et al.*, 2017; Wong *et al*, 2017). Small scale poultry farming is recognized as a priority also by the Senegalese Livestock ministry, specifically supporting such activities with the project *Projet de Développement de l'Aviculture familiale* PRODAF(http://www.elevage.gouv.sn/sites/default/files/Rapport_MEPA_2016.pdf; http://www.elevage.gouv.sn/sites/default/files/PSE-FichePRODAF.pdf), due to its essential socio-economic role, especially in the rural context. Livestock breeding in Kédougou is widely diffused, but mainly on a small scale, as a subsistence activity, thus representing a subsidiary sector of the economy. To the best of our knowledge, a description of the livestock sector in the region is not available in the literature. In the present analysis, the overarching research questions, which should be integrated in the conceptual framework of the food and nutrition security (FNS) and in particular of its four dimensions (availability, access, stability and utilisation, Fig. 1) (Wong *et al.*, 2017), were the following: I) which is the contribution of AFNut livestock related activities to sustainable FNS for the beneficiaries? II) which are the most relevant factors contributing to increase availability, access, stability and utilisation of food and thus supporting FNS? In order to answer

these questions, the present paper will: I) characterize the existing livestock farming system in Kédougou, SE Senegal, and analyse its production constraints; II) briefly describe the interventions performed in the framework of the development project AFNut, focusing in particular on poultry farming, evaluating the effect of such activities on livestock production and people's livelihood, as well as III) discuss shortcomings and lessons learnFig. 1 Food system conceptualisation (Modified from Ericksen, 2008)

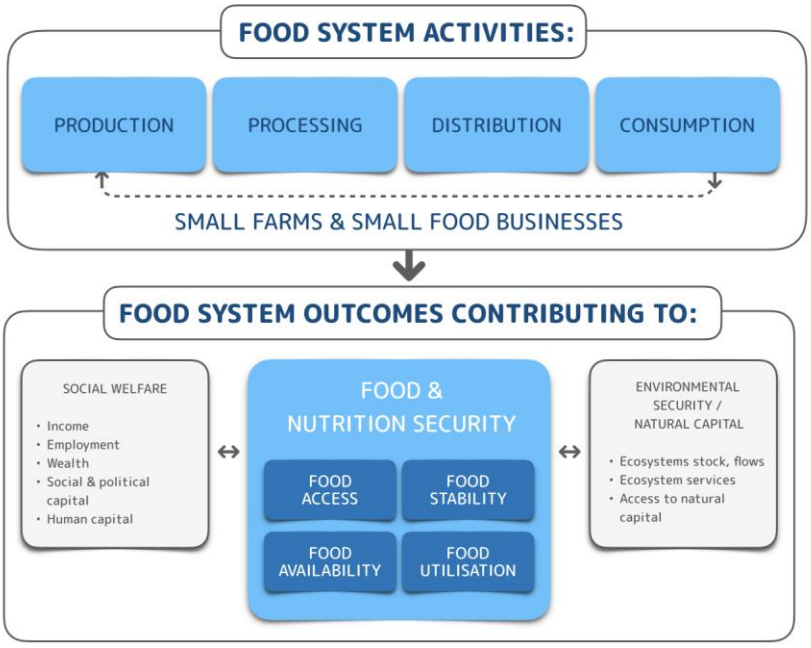


Figure 1 - Food system conceptualisation (Modified from Ericksen, 2008)

Materials and methods

Livestock sector description and baseline assessment

Desk work and data from key informants

An accurate desk analysis of the livestock sector in the region of Kédougou (South-East Senegal) was conducted based on secondary data in order to understand main socio-economic trends and drivers. Desk analysis was conducted based on grey literature and official publications such as existing scientific literature, reports and official data from the Livestock Ministry. That has included an analysis of the role of livestock at household level. The analysis was completed by a general description of the main geographical and socio economics features within the study area. Besides the desk analysis a direct field survey was conducted. Focus groups with key informants of the livestock sector - in particular veterinarians of the *Service Régional d'Elevage* (SREL, Regional sector of the Livestock Ministry) and livestock breeders and sellers - were performed throughout the duration of the study, also during visits to the livestock markets and to the local slaughterhouse. Meetings with other NGOs involved in similar activities in the region were also held. A focus group with the three different Italian veterinary experts involved in the project and a livestock technician enrolled during the last year of AFNut project was also organised, in order to triangulate the information collected (Table 1).

Table 1 - Focus groups held during the study

YEAR	LOCATION	PARTICIPANTS	MAIN TOPICS OF DISCUSSION
November 2016	COSPE Office	Italian veterinary expert (n=1) AFNut Project Manager (n=1) AFNut field staff (n=5) SREL Regional responsible (n=1) SREL Departmental responsible (n=2) Livestock breeders' delegates (n=5) Other ONG delegate (n=1)	• Main issues affecting livestock management in the region (such as conflicts between agriculture and livestock activities, due to uncontrolled animal roaming, lack of professionalism in livestock breeding…) • Main animal health issues, national vaccination planning and difficulties locally encountered • Possible coping strategies to be developed in the project
June 2017	SREL Office	Italian veterinary expert (n=1) AFNut Project Manager (n=1) SREL Regional responsible (n=1) SREL Departmental responsible (n=2)	• SREL organization in the region • Peculiar characteristic of livestock farming in Kédougou • Discussion about AFNut livestock activities • Advantages and disadvantages of different approaches (individual vs collective farming; local vs imported breeds…) • Planning of a common vaccination strategy (COSPE-SREL)
June 2017	Livestock market	Italian veterinary expert (n=1) AFNut Project Manager (n=1) Livestock sellers (n=6) Livestock breeders' delegate (n=1)	• Main breeds present • Livestock prices and price drivers • Livestock sale management
June 2017	Different ONGs offices	Italian veterinary expert (n=1) AFNut Project Manager (n=1) ONGs project managers (n=3)	• Livestock activities in AFNut and in other ONGs projects • Main issues in poultry and small ruminants farming in Kédougou • Advantages and disadvantages of different approaches (individual vs collective farming; laying hens vs buying broilers chicks…)
May 2018	SREL Office	Italian veterinary experts (n=2) AFNut Project Manager (n=1) SREL Regional responsible (n=1)	• Presentation and discussion of official data on animals present in the region, confirmed diseases, vaccination campaigns • Difficulties encountered in AFNut livestock activities
May 2018	Livestock market	Italian veterinary experts (n=2) AFNut Project Manager (n=1) Livestock sellers (n=4)	• Main breeds present • Market dynamics in the period
May 2018	Slaughterhouse	Italian veterinary expert (n=1) AFNut Project Manager (n=1) SREL Regional responsible (n=1) SREL Departmental responsible (n=1) Slaughterhouse staff	• Slaughter management • Hygienic issues and structural constraints • Dynamics in the period (import/export, changes in the demand)
January 2019		Italian veterinary experts (n=3) AFNut Project Manager (n=1) Livestock assistant COSPE (n=1)	• Discussion of the characteristics of livestock farming in the region, main limits and issues encountered • SWOT analysis and identification of lessons learned

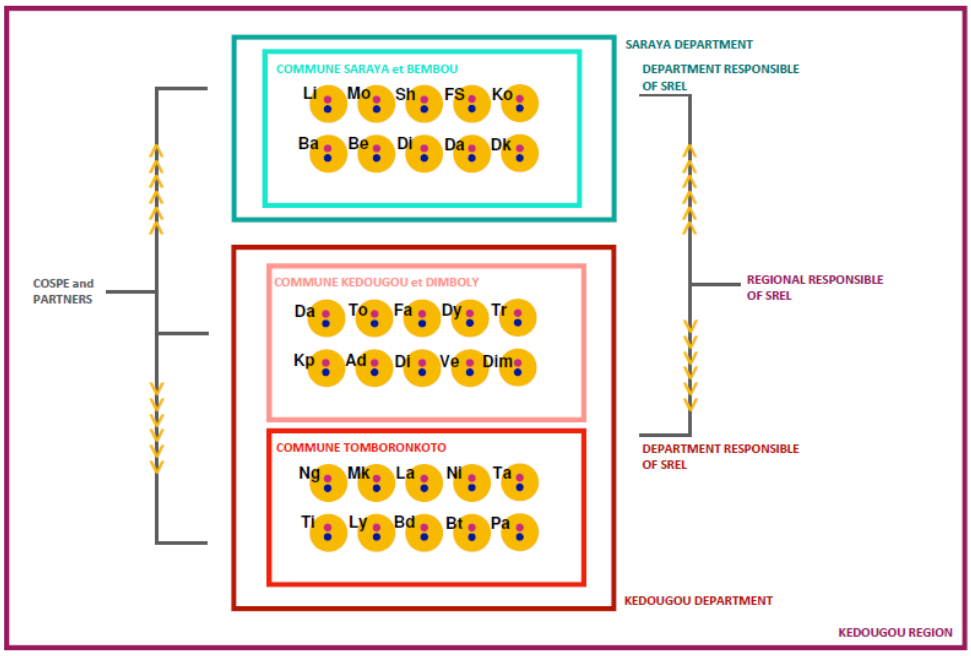
Baseline questionnaire

In November 2016 a questionnaire was submitted to 131 households owning livestock in the region, in particular in the Departments of Kédougou and Saraya. The households were selected by the project according to the criteria regarding income, number of members of the family, presence of children, livestock activities. The questionnaire was structured in 11 sections: identification, description of the family and its members, livestock, livestock management, animals' feeding, animals kept at the household, animal production, general knowledge of animal health, goods possessed, income and market access.

Monitoring and evaluation

Activities in the project

The project selected thirty groups of beneficiaries (resource groups, RG), also taking into account data emerged from the starting study and direct survey. The 30 groups were distributed across two Departments, Saraya and Kédougou (this latter including the *commune* of Kédougou and of Tomboronkoto) (Fig. 2).



***COMMUNE* SARAYA et BEMBOU**
Li: Liberté; Mo: Mosquée; Sh: Sheikhofara; FS: Fongue Samba; Ko: Kondokho; Ba: Badioula; Be: Bembou; Di: Dioulafoundou; Da: Dalafing; Dk: Diakhaba

***COMMUNE* KEDOUGOU et DIMBOLY**
Da: Dandemayo; To: Togoro; Fa: Fadiga; Dy: Diormy; Tr: Trypano; Kp: Kenioto Peul; Ad: Afia dandemayo; Di: Diaguiry; Ve: Velingara; Dim: Dimboly

***COMMUNE* TOMBORONKOTO**
Ngary: Ng; Mako: Mk; La: Lame; Ni: Niemeneke; Ta: Tambanoumouya; Ti: Tiobo; Ly: Lamineya; Bd: Badian; Bt: Bantata; Pa: Parafouté

Figure 2 - Scheme of stakeholders

Each group was composed of 10 members. To strengthen women's capacity for action and resilience, it was decided not to choose entire families as beneficiaries, but women of different households belonging to the same village or neighbourhood. For each group a figure called "*femme référente*", selected by the members of the RG, was identified as the representative and spokesperson. Associated with this figure was the "*monitrice*", a woman, usually young, generally with a higher education level than the average, who had the role of teaching in the part of the project aiming at improving the alphabetization level, and second reference person for the RG.

Each RG was involved in all the lines of AFNut activities (horticulture, *fonio* cultivation, small scale farming of poultry and small ruminants, alphabetization and nutrition education classes and mutual micro-credit). As mentioned, the present study focuses in particular on poultry farming as a case study. In the first year of the project, technical training lessons on correct practices of small scale livestock breeding were conducted by the first veterinary expert and, subsequently, by trained project staff, then improving interventions were implemented in the poultry section, including technical support for the creation of a chicken house, distribution of roosters to each RG and intervention of vaccination against Newcastle disease, in collaboration with the local staff of the SREL. Subsequent training lessons were carried out during the whole project, including practical lessons (field schools). Clearly, village poultry farming activities were generally already existing in the villages. However, for the purpose of the analysis, only activities carried out by the RG as part of AFNut project were taken into account, in order to evaluate the RG involvement as a whole and to better understand dynamic created by the intervention.

Monitoring and evaluation of the livestock activities

In order to monitor the activities' development, AFNut project manager and field staff performed regular visits to the RG, verifying the status of the activities with the aid of a checklist. In addition, after a year from the first interventions in the livestock sector, in the period between May 2018 and June 2018, an assessment of the state of livestock and its management was implemented by two Italian veterinary experts with the help of local staff. Questionnaires with direct interviews were submitted to the entire community of women (RG) participating in the project, during visits to the various villages and neighbourhoods. The questionnaires were previously discussed with the local staff of the project. Respondents were mainly the *femme référente* or the *monitrice*, generally with the assistance of the other women of the RG who participated to the meeting. The questionnaire was structured into four sections: animals of the project, breeding trends during the year and production characters, information on other animals in the village or neighbourhood, main problems. During the same visits the small scale poultry farming activities were specifically evaluated with the checklist used for regular monitoring by the project staff.

A final data collection by questionnaire was organised after 8 months from the previous one, in January 2019, during a last short term mission of a veterinary expert, when visits to all the RG were performed again (second monitoring phase). In a first section of the questionnaire the same technical aspects were investigated (see above). Then, in order to better answer the research questions, a second part addressing behavioural changes occurred during the project, as well as socio-economic effects was added. Another focus group with all the three Italian veterinary experts involved through the duration of the project and the livestock technician was also organised.

A methodological scheme summarizing all the steps is shown in Fig. 3. All the data collected during the desk work, the baseline analysis and the monitoring were analysed in order to answer the research questions.

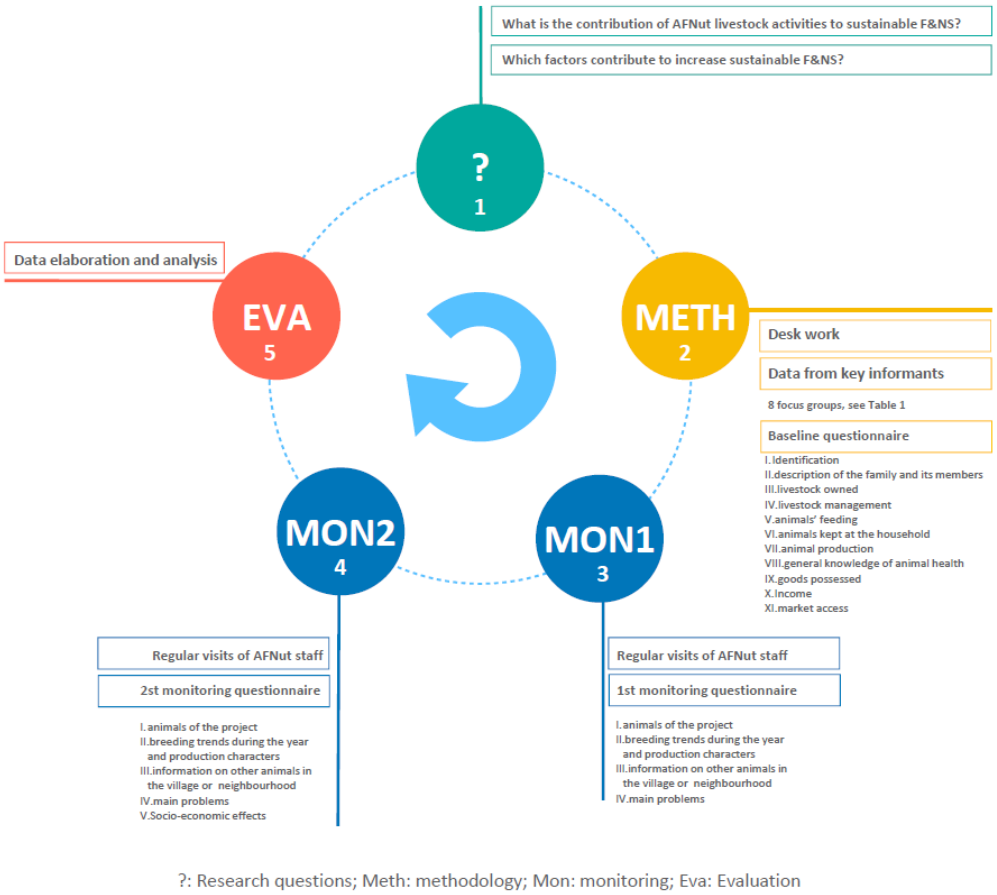


Figure 3 -Methodological scheme

Results and discussions

Livestock sector description and baseline assessment

The desk work and the focus groups with the key informants allowed the characterization of the study area, of the livestock breeding sector and system in Kédougou, of the type and consistency of livestock present and of aspects related to animal health, including the description of the structure of the *Service Régional d'Elevage* (SREL, Regional sector of the Livestock Ministry), of the main diseases present and on preventive interventions. A detailed report of the information collected is reported in Annex 1 (Supplementary material). The baseline questionnaire allowed data collection on livestock, livestock management, feeding and animal products used, animal health issues and related general knowledge, goods possessed, income and market access. Details are reported in Annex 2 (Supplementary material). An overview of the most important aspects emerging from all the information collected in relation to the four dimensions of FNS (availability, access, stability and use) are reported in Table 2.

Table 2 - Factors limiting and enhancing the four dimensions of Food and Nutrition Security. For further detail see Annex 1. SREL: Service Régional d'Elevage, Regional sector of the Livestock Ministry; NGO: Non-governmental Organization

	AVAILABILITY	ACCESS	STABILITY	USE
Limiting factors	- climate: long dry season and unstable rain season, often with flooding - increase of the population, mainly due to immigration for gold mining - lack of professionalism in livestock breeding	- ability to pay - lack of professionalism in livestock breeding, often due to lack of breeder education in the field	- climate: dry season - lack of professionalism in livestock breeding - poor use of feed preservation (such as hay)	- cultural aspects - lack of professionalism in livestock breeding
Enhancing factors	- market (arrival of non-local goods) - support to livestock breeding by SREL and NGOs	- market (arrival of non-local goods) - support to livestock breeding by SREL and NGOs	- education on correct preservation practices both of feed and food	- education on correct nutrition by Governmental bodies and NGOs

Monitoring and evaluation of the small scale poultry farming activities

Productive aspects, livestock management and acquisition of the practices transmitted with the training

Totally, production of eggs, chicks or chickens during at least a part of the project was achieved in 26 RG out of 30. Production can be classified in the first two categories of poultry farming proposed by Thieme *et al.*, 2014: small extensive scavenging (1–5 adult birds) and extensive scavenging (5–50 birds), depending on the RG and on the period. These categories typically describe free-ranging systems, where birds largely scavenge for feed, although supplementary feed may be given, and housing, if provided, is simple and made from locally-available materials (Thieme *et al.*, 2014; Wong *et al.* 2017). Eleven cases were particularly successful and beneficiaries were able to produce chickens for self-consumption or for sale for minimum 6 continuous months: in particular, in 3 cases self-consumption (at the group level), in 4 cases sale and in 4 other cases both. In some (n=4) of these 11 RG chickens were distributed among members, sometimes twice or more, before self-consumption or sale (Table 3). The most used product (both for consumption and sale) was meat, as only 2 RG declared to have eaten eggs. This observation is in agreement with the literature, reporting that livestock is kept especially for meat (Bosso *et al.*, 2007; D'Alessandro *et al.*, 2015) and eggs are generally not consumed due to low production rates, but also to cultural aspects. Bagnol, (2001) reported that in many contexts taboos prohibiting the consumption of eggs by children and pregnant women exist. Other studies in other African countries already reported a low egg production performance of local breeds, mainly due to poor feed availability, disease and low genetic potential (Hailemichael *et al.*, 2017). In Ethiopia, an unbalanced diet due to the lack of combined availability of energy (higher in the dry season due to the availability of cereals) and protein (higher in the wet season due to the availability of invertebrates in the environment) was observed (Dessie and Ogle, 2001). A similar pattern was likely present in the studied area. Interestingly, a limited consumption of chicken and eggs, in the absence of Newcastle disease control, has been reported, as households prefer to keep the eggs to produce chickens that can be sold, often to allow the purchase of staple foods and other less nutritious food (Bagnol, 2001).

Moreover, in a minority of RG (n=5), activities never really started, due to early mortality of roosters and/or chickens and to a general lack of interest in the RG which did not prompt replacement of the animals.

Table 3 - Summary of small scale poultry farming activities in the various Resource Groups (RG)

DEPARTMENT	*COMMUNE*	N OF RG	N OF RG ABLE TO PRODUCE EGGS DURING PART OF THE PROJECT	N OF RG ABLE TO PRODUCE EGGS, CHICKS OR CHICKENS DURING PART OF THE PROJECT	N OF RG ABLE TO PRODUCE CHICKENS FOR SELF-CONSUMPTION OR FOR SALE
Kédougou	Kédougou - Dimboly	10	8	7	2
	Tomboronkoto	10	8	8	4
Saraya	Saraya – Bembou	10	10	10	5
	Total	30	26	25	11

The following aspects were monitored throughout the project: productive data (number of eggs produced and hatched, mortality), animal management (type of henhouse and protection from the sun, control of animals during the day), cleaning level of the henhouse including feeders and waterers, diet, use of perches, litter and nests, animal health and vaccination. Unfortunately, limitations in the quantitative production data collected during the project do not allow a statistical comparison among the interventions proposed by the project. Thus, due to the wide variety of success rate among the RG's experiences and to mentioned limitations hampering a sound comparison among them, it was decided to focus on case-studies. Successful and unsuccessful experiences are summarized in Table 4 and two successful and two critical cases are briefly described below.

Successful stories: the cases of Thiobo and Kondokho

Among the most successful cases are the activities performed in Thiobo (*commune* Tomboronkoto) and in Kondokho (*commune* Saraya). In both cases the poultry house proposed by AFNut was installed in a protected area and shaded with locally produced bamboo mats. The whole RG was involved in managing the hens and cock, by taking turns. The adults were left out during the day and closed in the henhouse at night, while the chicks were kept closed for a couple of weeks with the mother. In both villages more than 100 chicken were produced in the first year, which were distributed among the members of the group for self-consumption or sale. Vaccinations were performed several times, although not very regular. Thus, all four dimensions of FNS, namely availability, access, stability and use were improved.

Unsuccessful stories: the cases of Kenioto Peul and Diakaba

In Kenioto Peul and in Diakaba (department Kédougou) the henhouse was never fully shaded from the sun and protected from the heath, despite continuous suggestions by the project staff. In Diakaba the hens and the cock were rarely left out and were managed as broilers, probably due to the fact that these were farmed by the husband of the *femme réferente*, who was the main person to take care of the project's animals (the rest of the RG was not very interested). Also in Kenioto Peul the animals were never left out from the henhouse, due to worries over the risk of predation from wild animals surrounding the village. However, the diet was very poor (basically only corn bran and rice) and this, together with the stress due to confinement in an unsuitable environment never allowed the production to start. Vaccinations were performed only at the beginning of the activities by the project staff.

Table 4 - Summary of successful (defined as RG where Self-consumption (C), Sale (S) and/or Distribution among RG (D)) for at least for 6 months during the project were achieved), and partially (chicks' (CP) production but no consumption) or totally unsuccessful stories (only egg production (EP) or no production at all (NP)) and main influencing factors identified.

RG CLASSIFICATION	RG NAMES (GEOGRAPHICAL AREA)	SELF-CONSUMPTION (C); SALE (S); DISTRIBUTION AMONG RG (D); EGG (EP) OR CHICKS' PRODUCTION (CP) BUT NO CONSUMPTION OR NO PRODUCTION AT ALL (NP)	INFLUENCING FACTORS
Most successful cases	*Kondokho* (S)	C/S/D	Collaboration within the RG Involvement of a very dedicated person Animal protection from heat Chicks protection Vaccination Good diet integration Help from men
	Badioula (S)	C/D	
	Bembou (S)	C/S	
	Dioulafondue (S)	S/D	
	Mosqueée (S)	C	
	Afia Dandemayo (K)	C/S	
	Dandemayo (K)	C/S	
	Ngari (T)	C/S	
	Mako (T)	C/S	
	Tiobo (T)	S/D	
	Bantata (T)	C	
Partially successful	*Diormy* (K)	CP	Collaboration within the RG Involvement of a very dedicated person Animal protection from heat Inconstant vaccination Sufficient diet integration
	Diaguiri (K)	CP	
	Velingara (K)	CP	
	Dimboly (K)	CP	
	Trypano (K)	CP	
	Lame (T)	CP	
	Badian (T)	CP	
	Parafouté (T)	CP	
	Liberté (S)	CP	
	Sheikhofora (S)	CP	
	Fongue Samba (S)	CP	
	Dalafing (S)	CP	
	Diakaba (S)	CP	
	Lamineia (T)	CP	
Unsuccessful cases	*Kenioto Peul* (K)	EP	Animals not protected from heat Uncontrolled roaming: exposure to predators and/or trauma Insufficient cleaning Inadequate diet General disinterest of the RG or of the representatives Lack of vaccination Heavy mortality
	Niemeneke (T)	NP	
	Tambanoumouya (T)	NP	
	Togoro (K)	NP	
	Fadiga (K)	NP	

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Main problems encountered during the activities

As shown in Table 4, the most important factors supporting successful stories were: i) collaboration within the RG; ii) involvement of a very dedicated person; iii) correct animal protection from heat; iv) chicks' protection; v) regular vaccination; vi) correct diet integration; vii) help from men, especially for manual work.

On the contrary, among the most commonly encountered incorrect animal management practices were: i) insufficient heat protection of the poultry houses and of the animals in general (this aspect is not crucial if the animals are left out during the day, but it becomes so if they were not released from the hen house); ii) uncontrolled roaming exposing animals to death by trauma (road accident), predation (domestic or wild animals depending on the more urban or rural context) or theft, and making sanitary interventions very difficult (animals must be captured before they can be vaccinated); iii) insufficient level of cleaning of the poultry houses, including feeders and drinkers; iv) laying hens are not provided with a nesting area and must independently search for quiet areas for brooding, often outside the henhouse, where elements of disturb may intervene and interrupt the brood; v) incorrect diet: most RG tried to improve feeding by integrating what animals found during the wander, but the feed given (generally corn or corn bran) was not sufficiently varied and thus not always ensuring sufficient protein, vitamins and minerals; vii) general disinterest of the whole RG or of the representatives, in some areas due to the preference to engage in gold mining; vii) lack of vaccination and heavy mortality due to epidemic diseases. In particular, the high mortality (100% in some cases) was an obvious problem in some RG and it was indicated as the main limit by the majority of them. The epidemic outbreaks are generally attributed to infectious diseases, in particular to Newcastle disease, which is known to be responsible for losses in the country (http://www.oie.int/wahis_2/public/wahid.php/Countryinformation/Animalsituation). However, the absence of a local laboratory limits the diagnosis and the epidemiological studies that would be useful to better understand the causes of each mortality episode and to better address prophylaxis and treatment. Vaccination against this disease is a priority for the Senegalese Ministry of Livestock in the framework of a project supporting small scale aviculture, that specifically mentioning reduction of mortality due to diseases in its overall objectives (http://www.elevage.gouv.sn/sites/default/files/PSE-FichePRODAF.pdf). Unfortunately, despite the signing of a collaboration protocol with the SREL, difficulties in vaccinating against Newcastle disease were encountered and did not allow to ensure adequate protection for the poultry population. Difficulties were related to several factors: i) lack of willingness of some owners to vaccinate their animals due to distrust and fear of the vaccination; ii) the habit of buying animals from different markets, frequently using as the sole criterion of choice the low price and not the apparent health status of the animal, and to put them immediately in contact with other animals of the house/village, often after stressful and debilitating journeys that may predispose to the onset of disease; iii) mismanagement of dead animals that are almost never properly disposed of (burned or buried), but frequently discarded in the bush (causing possible contact with other animals, especially wild animals that may become carriers of disease). High mortality due to diseases as well as a scarce use of veterinary services by the poultry keeper households was already observed in other countries, such as Ethiopia (Hailemichael *et al.*, 2017), and were attributed to due to the fact that village poultry producers have small flocks and are sparsely located, as in Kédougou.

Another frequently encountered problem was the lack of water available for animals: the water supply in most villages and neighbourhoods is inconstant and the water is rationed even for human use, so animals do not have constant access to water. Especially in Saraya and in the highest quarters of Kédougou the lack is very serious. In order to avoid waste, water is often given to the animals only in the early morning and in the evening. Although this practice seems rational and understandable given the difficulties of water supply

especially in certain periods of the year, during these hottest months' this supply is often insufficient, particularly for young, lactating or sick animals. Unbalanced diet and inadequate water expose animals to malnutrition and dehydration, making them more vulnerable to disease.

Another element of complexity found in the region is the growing search for gold, which in some villages, despite the harsh working conditions of men and women, is preferred over livestock breeding because of the hope of big sudden gains (Daffé, 2012; Niane *et al.*, 2015). According to ENSAS (2016), the first source of income in the Kédougou region is derived from selling mineral products (21%), followed by selling agricultural products (18%) and bush meat or plants (13%). As mentioned (Annex 1), despite the recent rise in gold prices, the expansion of gold mining has yet to translate into improvements in the well-being of local inhabitants and of migrants to the Kédougou region, who continue to be affected by poverty, child labour, trafficking, mercury use, and hazardous and arduous working conditions. However, the Senegalese Government, as well as private companies and non-governmental organizations (NGOs), have started to address these growing concerns related to both industrial and artisanal mining, including developing alternative avenues of income for the benefit of local communities (Daffè, 2012).

Finally, bushfires, which are common in the area, can have a significant impact on livestock production: while early burning can result in regrowth from soil moisture reserves, which can help to extend the grazing season, late burning tends to result in fiercer fires that damage the bush upon which cattle and goats graze in the dry season. Although bushfires are a national phenomenon, the vast majority of them occur in the southern half of the country, including Kédougou (accounting for 10.2% of total national affected land) (D'Alessandro *et al.*, 2015).

Changes in the farming practices and perceived impact

In the framework of the second monitoring phase, changes in the farming practices following the project were evaluated both by direct survey and through visits. In addition, the positive or negative effect of small scale poultry farming on social relations and on the economic and food availability were examined.

The following changes related to breeding practices were identified according to the beneficiaries: higher awareness of the importance of taking care of the animals, including vaccination and feed (12 RG); greater attention to the level of cleaning of the poultry houses and of shelters in general (8 RG); integration of the diet, which before was not integrated at all (7 RG); better control of animal wandering (7 RG), especially introducing the protection of chicks for the first 2 weeks since hatching (performed by 3 RG). One RG spontaneously started to regularly vaccinate by calling and paying the paravet and one RG started preparing nests for laying hens.

As regards the effect, the most positive result was registered for social relations, described as improved in most cases (67%). In fact, many RG declared that they did not work together before the project, and others said that, although they already worked together, they started to do it in a more structured way. It is clear that this effect is not related only to the livestock activity, but more in general to a combination of all project interventions. The cultivation of *fonio*, as well as the literacy classes and the mutual micro-credit were particularly appreciated. Obviously, there are also negative cases. In 3 RG, for example, relationships deteriorated, generally because of defaulted loans. In 5 cases, the relationships have not changed.

As regards the effect of the small scale poultry farming activities carried out during the project on economic and food availability, in 8 cases there has been an improvement at least in part of the project's course (in 3 of these RG only at the household level, as livestock is now linked to an individual initiative), while in most RG

(16) livestock activities did not have a real impact. This is clearly attributable to the fact that although productivity was achieved in 11 RG during the project, it was not durable.

Lessons' learnt, recommendations and conclusions

As emerged from the initial sector description (see Annex 1) and from the issues listed above, livestock breeding in the Kédougou region presents characteristic problems. Clearly, AFNut intervened in a context that presents many issues limiting the success of breeding activities. The project aimed to improve many aspects,

first by acting on training to enhance beneficiaries' knowledge on good poultry farming practices, which would limit losses and increase sustainable production. Unfortunately, the acquisition of a theoretical knowledge did not always correspond to a concrete change, suggesting that, even if a concept is learned at a theoretical level, reinforcement is needed for an actual acquisition of change.

A SWOT analysis has been performed to take into account all the positive and negative factors influencing FNS in relation to the small scale poultry farming activities, as indicated in the methodological framework used in the present study, with the specific focus on the dimensions of availability, accessibility, stability and use (Table 5).

Table 5 - SWOT analysis. AVAIL: Availability, ACCE: accession; STAB: stability.

	STRENGTHS					WEAKNESSES			
	AVAIL	ACCE	STAB	USE		AVAIL	ACCE	STAB	USE
Beneficiaries' engagement	X		X		Inconstant support from AFNut staff	X	X	X	
Agro ecological approach			X		Inconstant monitoring of vet experts			X	
Small scale farming approach sustainability	X		X		Inconstant SREL support			X	
	Opportunities					Threats			
	AVAIL	ACCE	STAB	USE		AVAIL	ACCE	STAB	USE
Valorisation of local resources in terms of both locally adapted breeds and raw materials to be used as feed	X		X		Dry and hot season			X	
Creation of a durable source of income	X		X		Epidemic/endemic diseases	X		X	
Independence from market purchase		X			Bush fires			X	
					Other activities seen as more profitable (gold mining)	X	X	X	
					Emigration			X	

Thus, taking all the presented elements in consideration, an answer to the overarching research questions, can be given. Despite the issues already discussed, the project obtained a modest level of success, at least for a certain period. Besides the small amount of animal origin products obtained, the strengths are represented by social relations reinforcement and increased awareness of good livestock breeding practices, although limited acquisition of these practices was the main weak point.

As regards the contribution of the livestock related activities in AFNut to sustainable FNS for the beneficiaries, it can be said the potential contribution was high, as it involved over 300 direct beneficiaries (10 women in each of the 30 RG) and it proposed a sustainable model of self-production of poultry, using locally sourced animals and raw material, in opposition to the purchase of broiler chicks and industrial feed which is popular in the area. However, the issues above discussed have strongly limited the actual contribution of the intervention and, as mentioned, food availability was increased only in a minority of RG, and not in a stable way. The low level of adoption of the proposed management system can be explained considering the general practice of leaving animals completely unattended, often without any control nor feed for days. Thus, the transition from a totally unmanaged system to another requires gradual steps. Lessons learned and remarks are summarized in Table 6.

Table 6 - Lessons learned and remarks

LESSONS LEARNED	REMARKS
Strengthening training on animal management, paying particular attention to practical training	to enhance the transfer of knowledge from a theoretical to a practical level, participatory training should be conducted, ensuring beneficiaries contribution by encouraging them to give their own experiences on local practices and problems
Target specific problems encountered by beneficiaries	in order to capitalize on past experience and reinforce lessons learned, it is important to note that each RG did not face the same problems, and differences can be observed for example between rural and urban/semi-urban context
collaboration with the Technical Services for aspects related to animal health, such as	ensuring regular vaccinations for the most important diseases of the area and treatments for sick animals when needed
coordination with other NGOs operating locally	to avoid overlapping interventions and to create synergies.
Enrolment of a specialized figure, with competences in animal health and management, for the whole duration of the project.	To ensure continuous training and active involvement of the Technical Services in the project activities
Improving diets	Valorization of local raw materials, also with the collaboration of the Technical services
inform beneficiaries also on the risks arising from contact with animals and their products	Training on preventive measures that can be put in place, also considering that food safety is included in food security
explaining also the risks related to the abuse of antibiotic	antibiotic should only be used if advised by a veterinarian and only in case of clinical symptoms, to prevent the spread of resistance phenomena

Considering the different difficulties encountered in the various RG in the course of the project, as well as the specificity of the context, both described in the present article, the following recommendations can be given for future interventions in similar areas.

First of all, training on animal management should be strengthened, and particular attention should be given to practical training, in order to enhance the transfer of knowledge from a theoretical to a practical level. In all phases, it is essential to conduct the training in a participatory manner, ensuring beneficiaries contribution to the discussion by encouraging them to give their own experiences on local practices and problems. The participatory method will create a direct connection between training and the challenges that

the producers meet when they apply the new methods, also increasing their ability to remember what they learned (Network for Smallholder Poultry Development, 2004). In the project, a participatory approach was used in the theoretical lessons, but the practical training should have been reinforced. In fact, another important recommendation is to target specific problems encountered by beneficiaries, also to capitalize on past experience and reinforce lessons learned, promoting rural participatory technological development.

It is important to note that each RG did not face the same problems, and differences can be observed for example between rural and urban/semi-urban context. In the first context, for example, social relations worked better as people from the village are more used to work together, but other problems such as predation by wild animals are common. On the contrary, in Kédougou the collaboration among women of the RG were poor as activities are more often individualized. With regard to the diet, its improvement by giving value to the local resources is a critical point. In particular, the choice of by-products should be favoured in order to avoid competition with the human diet. One of the major food security concerns related to livestock production is the diversion of potential human food sources to livestock feed (Flachowsky, 2002). Global competition for high standard feed-food resources between man and livestock, such as industrial broilers, is a concerning problem. The feeding of industrial broiler chickens is often criticized because of the extensive use of feed sources which are neither socially nor ecologically sustainable. The diet of intensively-raised broilers consists mainly of maize, soy, mile and wheat, ingredients that could also be used directly in the human diet. On the contrary, the scavenging feed resource base utilised in extensive and semi-intensive poultry production transforms feed ingredients in the environment that are less suitable or unavailable for human consumption, including plant seeds, earthworms, and insects, into palatable and nutrient-rich food products for people (Wong *et al.,* 2017). It is advisable however, to reinforce the use of the remains of the meal and especially the remains of dried fish, which must be collected and given to the animals in a dedicated area, to encourage their immediate consumption (while they are now just thrown next to where they are produced, thus promoting unnecessary losses). In the study area, the local production of concentrated feed from locally grown products should be promoted by collaborating with the Technical Services, such as the SREL and the Agriculture Service. This is particularly relevant considering that within the poultry sector, volatility in price of imported feed components, notably corn and soya, which contribute 80 percent of industrial poultry feed, is considered a major source of risk for the agricultural sector (D'Alessandro *et al.,* 2015).

Another essential recommendation is the collaboration with the Technical Services for aspects related to animal health, also in order to coordinate with existing national activities, such as the mentioned project PRODAF. The overall objective of the project is the sustainable improvement of the living conditions of populations with family poultry farms, by reducing disease-related mortality, improving poultry farming conditions and productivity as well as the marketing of poultry products (http://www.elevage.gouv.sn/sites/default/files/Rapport_MEPA_2016.pdf). The coordination with other NGOs operating locally is also strongly advisable, in order to avoid overlapping interventions and to create synergies. In order to ensure continuous training and active involvement of the Technical Services in the project activities, a specialized figure, with competences in animal health and management, should be enrolled for the whole duration of the project.

Other specific recommendations that can be drawn: inform beneficiaries also on the risks arising from contact with animals and their products, as well as preventive measures that can be put in place, also considering that food safety is included in food security (http://www.fao.org/3/y4671e/y4671e06.htm). Particular attention must be given in explaining also the risks related to the abuse of antibiotic, which sometimes have been used autonomously by RG, also as "prevention" in the absence of symptoms. It must be

Senegal made clear that an antibiotic and veterinary drugs in general should only be used if advised by a veterinarian and only in case of clinical symptoms, to prevent the spread of resistance phenomena (Founou *et al.*, 2018; Grace, 2015).

If carefully targeted policies are put in place, livestock may play a crucial role in diminishing poverty and enhancing food security (Roland-Holst and Otte, 2007; http://www.elevage.gouv.sn/sites/default/files/PSE-FichePRODAF.pdf), providing a very wide and diversified range of products and representing an opportunity to give sustainable value to available local resources. It is believed that interventions to improve village poultry production can help women and their families to generate social capital and enter a positive spiral of events that may move them out of poverty (Hailemichael *et al.*, 2017). Taking account specific differences, findings of the present study may have implications for other countries in Africa and around the world.

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