

EVOLUTION OF LIVESTOCK SYSTEMS IN AFRICA FACING CHANGES

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Introduction

In 2011, FAO estimated the African agricultural population at about 560 million people whose livelihoods largely depended on the livestock production of 267 million large ruminants (92% cattle) and 532 million small ruminants (an equal number of sheep and goats). The African livestock production uses large areas given the fact that 78% of the 1.17 million km² of land available for agriculture and livestock are grazing land (FaoStat, 2011). Compared to many other regions of the world, African livestock production has kept a traditional family character, with low intensity (low use of inputs and limited capital) and low productivity (spaced parturition, low numerical productivity) which is the sign of an adaptation to a changing and uncertain ecological and economic environment, of a certain genetic erosion, of poor health care and of frequent feed shortages.

But nowadays the African livestock systems generate multiple local and global changes on agro-ecological and socio-economic domains (Fao, 2009; Steinfled et al., 2006; Coulon et al., 2011). Expected to develop in a changing and uncertain environment with several constraints increasingly marked, the adaptation of livestock systems requires new knowledge and new models that will be based on the biotechnical knowledge and on the knowledge of local stakeholders, especially livestock owners.

Research question: What are the developments induced by the major changes in the main livestock systems in Africa? This is the main question that we propose to address by declining it into three specific questions: How the many changes underway affect livestock systems in

Africa? How these systems evolve under the effect of changes? What are the opportunities and constraints linked to these changes?

Objective of the paper and announcement of the plan: We will start by presenting the diversity of livestock systems in Africa and by characterizing the changes underway, their interactions and their impacts on the components of livestock systems (resources, productive systems, households, supply chains, global environment). Then we will expose the major developments in livestock production linked with the changes, changes that lead to opportunities but also to constraints.

Part 1. Diversity of livestock systems in Africa

In Africa, the pastoral systems predominate in the arid and sub-humid areas sparsely populated, the mixed crop-livestock systems predominate in the most densely populated areas in sub-Saharan savannah areas, in areas with a Mediterranean climate in the Northern and Southern Africa and in the highlands (Ethiopia, Kenya, Madagascar, etc.), the mixed systems associated with irrigated crops predominate in the delta areas (Nile, Niger, etc.) while the systems under intensification and industrial systems are increasing in suburban areas (figure 1).

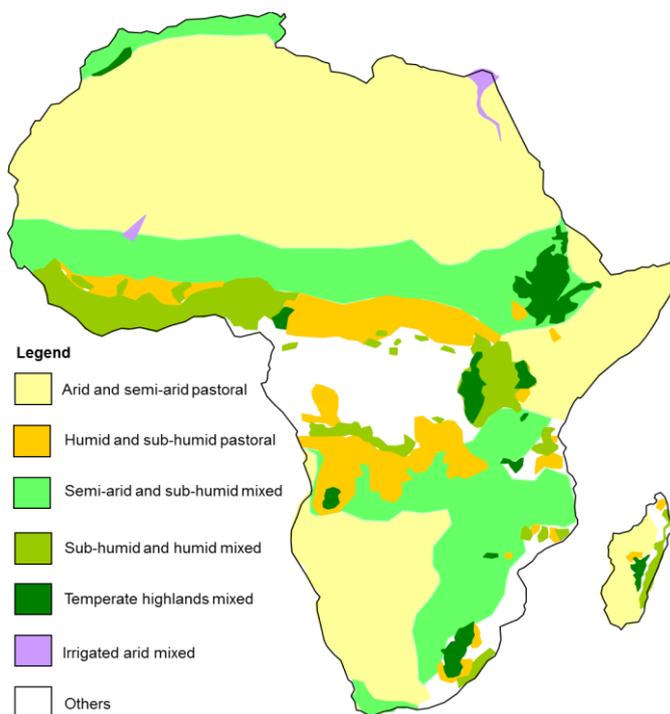


Figure 1: Spatial distribution of the major livestock systems in Africa (figure adapted from Robinson et al., 2011)

Today, crop livestock systems are the majority in numbers in Africa: according to Robinson et al. (2011) data, they involve about 60% of the cattle herd against 34% of pastoral systems. This development is recent since in 2000 Boutonnet et al. (2001) estimated that pastoral systems provided approximately 60% of beef, small ruminants and milk. They have a more intensive character than pastoral systems with an average cattle density of approximately 9.9 head per km² compared to 2.2 head per km² in pastoral areas. Many authors consider that Africa's future relies greatly on livestock systems involving livestock and agriculture (Herrero et al., 2010).

Mixed crop-livestock systems largely predominate in semi-arid and sub-humid areas and in the highlands where the more favourable rainfall makes possible crop and livestock diversification (ruminants and monogastrics). They are also present in humid areas associated to cropping systems highly productive in plant biomass (rice, corn, etc.), from which livestock takes advantage. In areas where these systems are present, the population density is high (> 70 inhabitants per km²) and is growing. It results in an increasing land pressure, which needs ways of crop-livestock integration that generate intensification effects. Animals provide energy for cultivation work and transport (cattle, horses), they receive feed from the cultivated areas (crop residues, forage crops, agro-industrial by-products, etc.) and they give back fertilizing elements to cultivated lands (compost, slurry, manure, etc.). To these biomass and energy flows are added economic complementarities between crops and livestock (on-the-hoof savings from agricultural incomes, complementary cash in case of economic difficulties, etc.), job creation and as a factor of integration and social status. The presence of diverse crops and animal species (ruminants, monogastrics) provides real flexibility to these systems. They appear as a possible way to improve the resilience of production systems in terms of biomass and nutrients' management and can serve as a basis for the creation of future production systems (Dugué et al., 2012).

The extensive pastoral and agro-pastoral livestock systems occupy sparsely populated areas, often with a population density lower than 10 inhabitants per km² and they are mainly situated in the semi-arid and arid areas. They are recognized as the only way to economically and ecologically develop these dry environments. They are characterized by the high mobility of ruminant herds (cattle, sheep and goats) and by the substantial use of open grazing lands ("communal grazing lands"). Herd mobility is necessary for the viability of these systems, to access water and pasture resources, which spatial distribution varies during the year. But nowadays, it is increasingly constrained by the extension of crops in semi-arid areas and especially in sub-humid regions that were traditionally frequented by large-scale transhumance, but also because of the pastures' degradation in the arid and semi-arid Mediterranean areas. In these systems, the share of livestock in the income and household consumption remains relatively high. They represent the most ancient form of livestock production in Africa, but nowadays, since agricultural diversification is possible, we observe more and more changes towards agro-pastoral and suburban systems.

Suburban systems are currently experiencing a rapid development in response to the growing demand from cities for animal products. They often involve short production cycle's species (poultry, pigs) and intensified forms of ruminant livestock production (fattening, milk). As the

available space is limited on the cities' periphery, intensification is clearly the adopted strategy with significant appeal for inputs (forage crops, animal feed, artificial insemination, etc.), workforce and modern equipment.

Industrial livestock systems, sometimes called "indoor systems", are still few represented on the continent. It is most often monogastric farms such as laying hens, broilers, pigs, aquaculture and dairy farms and marks the abandonment of production complementarities mentioned in the other systems.

Part 2. The mechanism of changes and their impact on livestock production

Livestock production in Africa confronted with changes

Figure 2 shows the major changes that occurred on the African continent and the impacts they had on livestock production from 1960 to 2010 (from decolonization to nowadays) at different scales (from local to global).

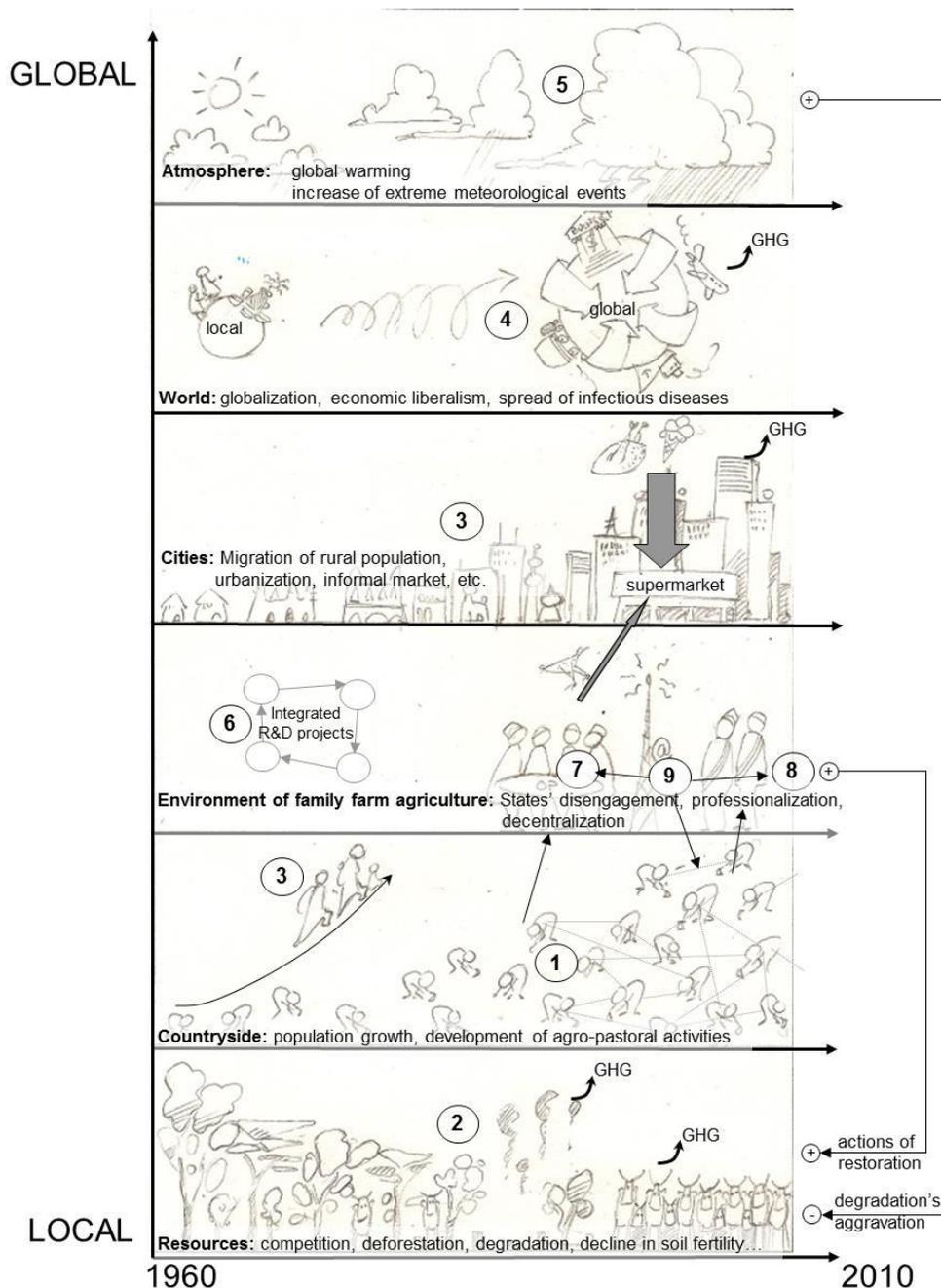


Figure 2: The changes that have affected the African livestock production, from 1960 to nowadays, from local to global scale

The consequences of population growth

During the post-colonial period, the population growth has undoubtedly been the change that influenced the most the development of livestock production, with its multiple direct and indirect effects. From about 280 millions of inhabitants in 1960, the African population increased to more than a billion in 2010, with a growing rate of about 2.5% per year (compared to 1.6% per year in the world) and it should continue to increase to reach between 1.9 and 2.5 billion of inhabitants in 2050 (Unites Nations, 2010).

One of the consequences has been to lead to a high population density in rural areas, changing from 8 to 35 inhabitants per km², from 1960 to 2010 ((1) on the figure 2). During this period, the increase in agricultural production was made possible principally thanks to the increase in livestock numbers and by the extension of cultivated land (Dorin et al., 2001; Petit, 2011). In livestock production, the management practices are still mainly traditional, with a high direct dependence in natural resources and a low productivity. Between 1960 and 2010, the bovine number has doubled, from 123 to 246 million heads, while the production index per head has improved by only 1%, compared to 120% in South-East Asia (FaoStat, 2011).

But this growth strategy is progressively reaching its limits as the availability of arable land is becoming scarcer and a source of conflicts. Furthermore, this strategy causes degradation at ecosystems level (deforestation, biodiversity loss and decline in soil fertility; (2) on figure 2). In the agro-pastoral zones, communal land used for livestock are more and more converted into crops. Land competition is more and more fierce. At ecology level, land degradation is a serious concern for 32 African countries, with a degradation that is not compensated by fertilizers' inputs (Stoorvogel et Smaling, 1990). The decline in soil fertility shows the farmers' important economic vulnerability and the high risk for food insecurity within a context of a strong growth in food demand. Another significant fact brought by the African population growth has been a rapid urbanization: between 1960 and 2010, the African urban population shifted from 19% to 60% (FaoStat, 2011) ((3) on figure 2). This population, more and more disconnected to the food production, among which a middle class emerges, represents an important demand in animal products (milk, meat, eggs, etc.). In this context, supply chains get implemented in suburban zones, but also at regional scale for supplying meat and milk to the megalopolis that are generally situated far from the traditional livestock production areas (Boutonnet et al., 2001, Fao, 2009). The local production cannot handle the increased demand of a fast growing population. Several authors predict an important deficit in meat and milk products in most of the Sub-Saharan African zones (Boutonnet et al., 2011); an

important part of this demand being covered by imports from outside Africa (frozen chickens, milk powder, etc.) to the coastal countries with harbors.

The consequences of economic changes

Important economic changes have occurred during the last 50 years, in link with the globalization. The imports' organization has considerably changed (Fao, 2009). In the 60s, from FaoStat data, Africa imported 102,000 tons of milk (mainly condensed) and 87,000 tons of bovine meat while nowadays 246,000 tons of milk (mainly powdered), 234,000 tons of bovine meat and 1,066,000 tons of poultry ((4) on figure 2). In 2010, an African consumed in average 1.5 kg per year of imported animal products compared to 0.6 kg per year in the 60s. The products' origin also changes as more and more imported products are coming from South America for the meat (bovine, poultry from Brazil) and the milk (Uruguay, Argentina). In East Africa, intra-regional live cattle trade represents an important industry with an annual value of more than 65 million USD (IIED, 2009). More recently, land grabbing, another aspect of globalization, is on the rise in Africa. Agribusiness projects (biofuel, food for export) affect important zones, not secluded and with a good agricultural potential. In 2010, the World Bank estimated that between 2008 and 2009 about 30 million of ha have been grabbed by investors. Countries with livestock like Madagascar, Soudan, Ethiopia and Ghana are particularly affected as it is estimated that already 1.0 to 2.5% of arable land are concerned. The expropriations of farmers and smallholders using land taken for these projects plunge numerous smallholders into poverty.

The consequences of global warming

Africa is also affected by global warming but the effects, often controversial, vary depending on the continent's regions. Global warming destabilizes rainfalls which are here naturally randomly distributed, putting the pastures' primary production at stake as well as water stocks, both necessary for livestock production ((5) on figure 2; Steinfeld et al., 2006; Fao 2009). From scenarios developed by IPCC, the annual surface temperature for the 2080-2099 period will increase from 3 to 4°C compared to the 1980-1999 level, with the equatorial and coastal areas being less affected by it (IPCC, 2007). The forecasts on rainfall are less solid. Despite the uncertainties, some models estimate, for the 2080-2099 period a decrease of 20% for annual average rainfall along the Mediterranean coast and up to the North of Sahara. In tropical and East Africa, this yearly average would increase by 7% while in Southern

Africa the winter rainfalls would decrease by about 40%. However, there is a higher uncertainty about the forecasts on the Western Africa's climate (IPCC, 2007).

Concerning land use, illegal deforestation particularly affects Africa and increases the net carbon fluxes within the atmosphere and therefore contributes to the global warming. In Sub-Saharan Africa, these fluxes that were negative at the beginning of the 20th century have reached in 2005 16.3% of the world total and it continues to increase. In Africa, deforestation is not truly implemented to develop livestock production as it is in Amazonia. African livestock production contributes to GHG production mainly by enteric fermentation and the transformation of animal waste. The poor quality of dry season forages leads to a lower digestibility that increases the CH₄ emissions' rate per head (Steinfeld et al., 2006). From IPCC, the coefficient of CH₄ emissions produced by bovines fed with feed with a digestibility lower than 50% is of about 130kg per year, which is five times more than for bovines fed with feed with a digestibility of 75% (GIEC, 1996).

The consequences of changes in politics and development strategies

The development strategies in livestock production have considerably changed from 1960 to nowadays. After the mitigated success of the African Green Revolution which did not affect a lot livestock production, the politics of organizational adjustments implemented by IMF and the World Bank from the 80s have led to a disengagement of the states towards rural development (Bichat, 2012). Important integrated Research & Development projects progressively disappeared and the state agricultural extension services lost a lot of their financial and workforce capacities. ((6) on figure 2). In the 90s, local private stakeholders have had difficulties taking it over. Today, in a lot of African countries livestock extension, veterinary as well as financial services do not cover the demand. In 2008, the World Bank again allocated investments in agriculture to its priorities (Banque Mondiale, 2008).

The animal health sector has been particularly affected by these evolutions (Fao, 2009). In the domain of major infectious and parasitic diseases, important financial and human means has been allocated up to the 90s for the development of vaccines and strategies for fighting and eradicating the diseases' vectors. Whole cattle health has clearly improved with the eradication of important epizootics such as Rinderpest in 2011 and with the decline of areas infested by tsetse flies, which is actually an indirect positive effect of the deforestation. But numerous other infectious and parasitic diseases are still present (PPR, lung plague, Rift Valley fever, African swine fever, trypanosomosis, etc.). Animal movements, decrease of animal health services, climatic changes and anarchic urbanization are some of the factors

complicating diseases' control in Africa (Lancelot et al., 2011). In Africa, the unfavorable sanitary situation for humans and animals has been and is still an important cause of its slow development.

Since the 90s, a vast movement of professionalization has developed in African agriculture with farmers' organizations ((7) on figure 2). Nowadays, the most powerful organizations are related to crop production but organizations of livestock producers are getting structured and lead to the creation of regional networks. In Eastern and Southern Africa, mainly in Kenya, South Africa and Namibia, national organizations of livestock producers reached a high level of professionalization and are keeping updated databases on the genetics and performances of different local breeds, allowing the improvement of herds' productivity for the livestock owners who are part of these networks. In West and Central Africa, local and national organizations of livestock producers are present since several decades. Regional networks have been implemented, such as Apess and Billital Marrobé network that take into account the mobility and cross-border transhumances. These organizations have multiple objectives such as the reinforcement of livestock owners' technical capacities (feeding and reproduction management), an easy access to inputs (feed, veterinary services), a better added value for the farm outputs, the reinforcement of livestock owners' capacities via training and information, the farmers' structuring, legal support, added value to the cultural heritage of the pastoral way of life, etc.

Important changes have also recently occurred at a local scale. They are linked to the decentralization politics implemented by regional authorities to whom states progressively transfer responsibilities, such as natural resources' management, offering to livestock owners forums of cooperation for managing pasture resources ((8) on figure 2). At Pan-African level, except in the Sahel, national politics tend to favor the livestock owners' settlements. But, from a process carried out by the African Union (2006-2011), a politic framework for the pastoralism has been validated in 2011 to promote livestock production, to protect and recognize the rights to livestock herders and to provide discussion forums to pastoral communities.

At regional level, actions have been implemented to facilitate the mobility and cross-border transhumance with, for example, the adoption of an international transhumance certificate developed by CEDEAO in 1998. At national level, pastoral codes exist and numerous bilateral agreements supervise the cross-border movements. However, by lack of text completion and implementation of institutions and related workforce responsible for checking its application, these politic frames remain often unapplied.

The consequences of technological innovations and social evolutions

Within the last 10 years, mobile phone development has significantly reduced the isolation and communication difficulties of the rural population. This technological innovation has deeply modified the livestock producers' practices ((9) on figure 2). The mobile phone has broken the geographical isolation of a lot of livestock herders' communities that are settled in secluded areas. It also reinforced the market integration in allowing cattle traders to organize a network of "touts" in order to quickly obtain information on the animals for sale and on convenient selling events, and, in certain cases, to follow at distance the cattle's exchange rates. The livestock herders use it also to check with pathfinders the pastures and water points' conditions; it also facilitated the pursuit of cattle's thieves. It allowed to better organizes animal movements thanks to pathfinders sent to explore available pasture land. Mobile phones facilitated as well the coordination and preparation of livestock owners' organizations' activities. Internet gives an international visibility and accessibility to wide organizations and livestock owners' networks that developed websites.

Besides, numerous social changes that occurred during the last 50 years affected the livestock owners and livestock production. Following the important droughts in the 70s and 80s, a lot of livestock owners have left arid zones and have settled in more humid areas where agricultural populations already lived. In West Africa, the cultural and religious syncretism favored the peaceful coexistence of populations with different cultures. However nowadays, when land and resources' competition become fierce, the conflicts linked to land use are on the rise and become focused on conflicts related to religion or ethnic group. Moreover, it has to be mentioned that, despite the progress towards democracy, corruption and instability continue to hamper the continent's development, to maintain an environment of important insecurity, notably for livestock owners' populations who are often isolated and exposed to sociopolitical crime (insecurity in Sahel and diverse rebellions in Eastern Africa). However, new aspirations are coming to light with progress in education and diffusion of modernity symbols (new transportation means, communication and information tools and household comforts).

Part 3: New trends in livestock systems in relation to changes, opportunities and constraints

New trends in livestock systems

Nowadays, given what has been presented so far, it appears that the level of direct dependence on natural resources and the level of market integration (goods, inputs, services and labor) are two major differentiating factors of farming systems in Africa. It seems interesting to ask ourselves about the possible changes in farming systems in relation to major changes, shown schematically in figure 3.

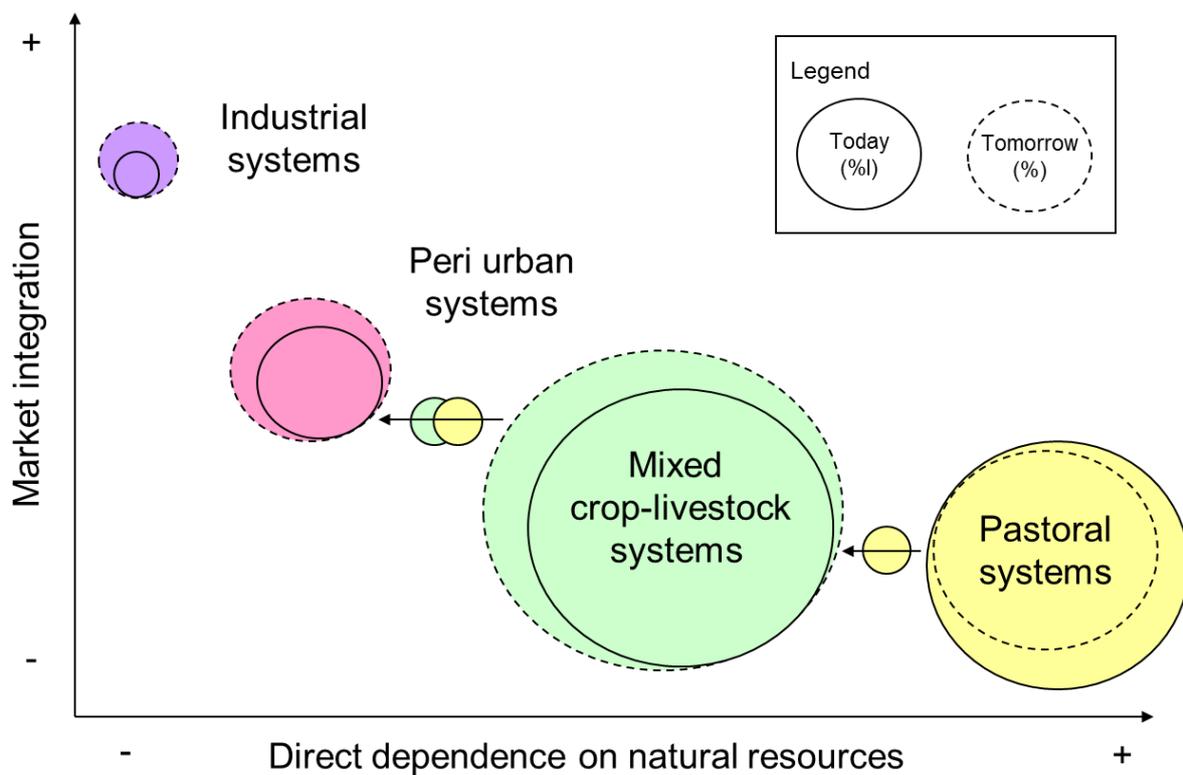


Figure 3: Schematic representation of the diversity, the number and the possible evolutions in livestock systems in Africa in line with changes

With increasing pressure on land and the reduction of pastoral areas, the majority of crop livestock systems and a significant part of the livestock herders are now entering into a production's intensification strategy, moderated by many uncertainties linked to climatic hazards, the volatility of agricultural prices, rising input prices, which could be qualified as an intensification at lowest cost (represented mainly by the integration of crop and livestock activities). These uncertainties also bring farmers to diversify livestock (ruminants and monogastrics) and crop productions or to develop non-agricultural activities whenever

possible. In the coming years the mixed agro-pastoral systems will become even more important, in reducing their direct dependence on natural resources and increasing their market integration. In pastoral areas a fraction of farms could also move towards mixed systems when local conditions will allow it (availability of agricultural land and market access).

Also, the combination of a population increase, the rapid urban growth, and the emergence of a middle class will stimulate the demand for animal products in quantity, quality and diversity but with a strong pressure on prices as incomes are still limited for the majority of households and the increase of livestock products' global competition. It can be argued that the farms that enter this production's specialization strategy to bring to market products at low prices will be better positioned to respond to this type of social demand. Thus, family suburban and semi-industrial farms should have an important development in the coming years. Nevertheless, land speculation observed in recent years in the major cities' periphery such as Cairo led many farmers to sell their plot of land and to settle in agricultural periphery. Concerning the industrial farms, their development is also conditioned by a sufficient investment capacity, the existence of well-structured distribution channels, organized supply chains and a secure business environment that, considering the overall situation of African countries, could for now hinder their development.

Opportunities and constraints linked to changes

Some changes in progress offer new opportunities to the livestock sector. The population increase and the emergence of new consumption patterns induced by the emergence of a middle class therefore drive the demand for animal products that is expected to double by 2050. Similarly, the structuring of farmers' organizations increases the local supply and the more fairly distribution of the added value along the local supply chains. In contrast, other changes will require an evolution of current practices. The reduction of communal pasture for the benefit of crops and the fragmentation of village territories limit the herds' mobility, increase the competition for forage resources and contribute to the obsolescence of the communal grazing land and to the increased grazing pressure on resources (water, rangelands, and soil). This practice is not enough to support the increase of livestock herds without risking irreversible ecosystems damages; changing environments and farming systems lead to new animal diseases (decline of Trypanosomiasis, emergence of new ticks, etc.). Global warming disrupts rainfall patterns and makes the primary production of biomass and water supplies during the dry season more uncertain, the increased incidence of

extreme weather events (floods, tropical cyclones, drought, etc.) leads to a degradation of resources, greater variability of production and increased price volatility. Rising oil prices and the depletion of fossil fuels lead to the consequent increase in the price of mineral fertilizers and concentrated feed, etc.

With the objective of a sustainable development, given the wide diversity of farming systems implemented, there are issues and questions on their adaptation to changes that are obviously different.

Conclusion and perspectives

In Africa, many changes have affected the local and global environment of farming systems over the past 50 years. Some changes have been a source of weakness while others offer opportunities for African farms. Faced with this situation, farming systems have gradually transformed even with a more moderate level than in other parts of the world. Mixed crop-livestock farming systems occupy an increasingly important part, pastoral systems continues and allows to environmentally maintain vast territories, mostly arid, and more intensive systems are growing in suburban areas. Today's innovations continue.

In pastoral systems innovation mainly concerns the management of pastoral resources and livestock mobility; in the mixed systems it mainly involves diversification and crop-livestock integration; and in suburban and industrial systems it mainly are specialization and intensification of production inputs, capital and labor. Finally, all these systems require innovative and coherent public policies to manage the impact of farming on the environment, to secure the entrance of local products in market, to facilitate access to inputs and services.

References

- Alvarez S., Rufino M.C., Vayssières J., Salgado P., Tifton P., Tillard E., Bocquier F. 2013. Whole-farm nitrogen cycling and intensification of crop-livestock systems in the highlands of Madagascar: an application of network analysis. *Agricultural Systems* (DOI 10.1016/j.agsy.2013.03.005).
- Coulon J.B., Lecomte P., Boval M., Perez J.M., 2011. Elevage en régions chaudes. Numéro spécial, *INRA Prod. Anim.*, 24, 160 p.
- Dorin B., Paillard S., Treyer S., 2011. *Agrimonde. Scenarios and challenges for feeding the world in 2050*. Editions Quae, Versailles, 296 p.
- Dugué P., Vayssières J., Chia E., Ouédraogo S., Havard M., Coulibaly D., Nacro B. H., Sissoko F., Sangaré M., Vall E., 2012. L'intensification écologique : Réflexions pour la mise en pratique de ce concept dans les zones de savane d'Afrique de l'Ouest. In: Vall Eric (ed.), Andrieu Nadine (ed.), Chia Eduardo (ed.), Nacro Hassan Bismarck (ed.). *Partenariat, modélisation, expérimentations : quelles leçons pour la conception de l'innovation et l'intensification écologique ? : actes du séminaire Asap, Bobo Dioulasso, Burkina Faso, 15 - 17 novembre 2011*, 15 p.
- FAO, 2009. *La situation mondiale de l'alimentation et de l'agriculture. Le point sur l'élevage*. FAO Rome, Italie, 202 p.

- GIEC (1996), Lignes directrices du GIEC pour les inventaires nationaux de gaz à effet de serre, version révisée 1996, Reference Manual (Volume 3), GIEC, Genève.
- Herrero M., Thornton P.K., Notenbaert A.M., Wood S., Msangi S., Freeman H.A., Bossio D., Dixon J., Peters M., van de Steeg J., Lynam J., Parthasarathy Rao P., Macmillan S., Gerard B., McDermott J., Séré C., Rosegrant M., 2010. Smart investments in sustainable food production: revisiting mixed crop-livestock systems. *Science* 327, 822-825.
- IIED, 2009. Modern and mobile. The future of livestock production in Africa's drylands. IIED and SOS Sahel, London, 88 p.
- IPCC, 2007, Africa: Climate change 2007. Impacts, Adaptation and Vulnerability. Contribution of Working Group II (Chapter 9), Cambridge University Press, UK, pp. 433-469.
- Lancelot R., Zundel E., Ducrot C., 2011. Spécificité de la santé animale en région chaude : le cas des maladies infectieuses majeures en Afrique. *INRA Prod. Anim.*, 24 (1) : 65-76.
- Petit M., 2011. Pour une agriculture productive et durable. Editions Quae, Paris, France, 112 p.
- Robinson, T.P., Thornton P.K., Franceschini, G., Kruska, R.L., Chiozza, F., Notenbaert, A., Cecchi, G., Herrero, M., Epprecht, M., Fritz, S., You, L., Conchedda, G. & See, L. 2011. Global livestock production systems. Rome, Food and Agriculture Organization of the United Nations (FAO) and International Livestock Research Institute (ILRI), 152 p.
- Salgado P. & Tillard E., 2012. Conservation des ressources fertilisantes dans les systèmes d'élevage des pays du Sud. Salon International de l'Agriculture de Paris 2012 (fiche de compétences). France. CIRAD, 2 p.
- Steinfeld H., Gerber P., Wassemar T., Castel V., Rosales M., De Haan C., 2006. Livestock's long shadow. Environmental issues and options. FAO, Rome, Italy, 390 p.
- Stoorvogel J.J., Smaling E.M.A., 1990. Assessment of soil nutrient depletion in sub-Saharan Africa: 1983-2000. Report 28. Wageningen, The Netherlands, Winand Staring Centre.
- United Nations, 2010. World Population Prospects: The 2010 Revision, Population Database, United Nations Population Division, New York (<http://esa.un.org/unpd/wpp/index.htm>).