DEVELOPMENT PERSPECTIVES FOR AN ETHIOPIAN AGRARIAN SYSTEM SINKING INTO CRISIS

AGRARIAN DIAGNOSIS CARRIED OUT FROM MARCH TO OCTOBER 2011
DOYOGENA WOREDA, KAMBATTA, SOUTHERN ETHIOPIA

Aurélie CHEVEAU
Camille HOORNAERT
Hubert COCHET

Abstract

This study aims at understanding the dynamic of the agrarian system of a small agricultural region of *Kambatta*, South Ethiopia. Many interviews carried out during five months in the field with farmers of this region, gave us a in-depth understanding of the historical evolution and of the present production systems. The technical and economic aspects of these systems were closely analyzed to better identify the diversity of farmers' situations. When arriving in this region of Southern Ethiopian highlands, the abundance of vegetation and the very high rural population density are quite surprising. The predominance of *enset (Ensete ventricosum)* or "false banana" plantations combined with the omnipresence of hedges planted with trees surrounding small farms compose a unique landscape in Ethiopia. High amount of rainfall and good quality soils are indeed favorable to agriculture. Whereas food security relies mostly on *enset* and garden production, most annual crops (wheat, broad bean) are rather used as cash crops. Cattle breeding constitutes the keystone of the agrarian system, because of the diverse roles it plays in farms, as a means of production, a source of fertility and a capital asset. At the same time, maintaining cattle has become more and more difficult in a context of land and fodder shortage, which started in the 1980's. So far, farmers have dealt with this problem by implementing a "cut-and-carry" system, allowing them to manage meticulously the decreasing source of fodder. Yet, today's weakening of production systems is worrying, with very low family income, in which external activities play a great role (more than half of families' incomes hardly reach the survival threshold). It is urgent to find a way to increase the added value per hectare in an area where many families face food insecurity. We carried out a discussion about association and diversification of cultivated species, which could increase food and fodder production while getting rid of yoking. Nevertheless, it would not be complete to devise possible changes without taking into account the particular history of this country. The "burden of the state" (J.Gallais, 1989) has always weighed on the shoulders of Ethiopian small-scale farmers, and still greatly influences the evolution of agrarian systems.

Introduction

The ability of Ethiopian agriculture to feed a growing population is often discussed, highlighted by regular food crises that still affect the country. The green landscape of the small *Kambatta* region might suggest that food insecurity is not widespread, contrary to other areas of Southern Ethiopia. Indeed, an original agrarian system characterized by the cultivation of *enset* (*Ensete Ventricosum*), false banana known as « miracle plant » (Gascon, 2006) allows a density of rural population which is among the highest of the country and the world.
Using the agrarian diagnosis methodology, our study of recent transformations and of the present agrarian system, gives some answers to the following questions: How has this remarkable landscape developed? Can this agrarian system ensure food security? What perspectives could help improving peasants' living conditions?

I. An agrarian diagnosis carried out in the core of *enset* region

1. Methodology

a. The agrarian system concept and its over-lapped sub-scales

Farming practices and their transformations are considered herein as an integral part of an *agrarian system*. An agrarian system is "a way of exploiting an agro-ecosystem that is historically defined and sustainable, adapted to the bioclimatic conditions of a given area, and responding to the social needs and conditions of the moment" (Mazoyer, 1987). An agrarian system includes:

- both the operating mode and reproduction mode of one or more ecosystems,
- the corresponding technical baggage (tools, knowledge, know-how),
- the social relationships of production and exchange that have led to this operating mode,
- the social division of labour and redistribution of value added,
- the mechanisms that differentiate basic production units,
- the overall economic and social conditions, particularly those regarding the relative pricing system with which the agrarian system integrates world markets (Cochet, 2011).

From the very concept of system stems the notion of balance and "reproducibility", or sustainability, as we would say today. For this reason, the mechanisms that maintain and reproduce the conditions necessary for the functioning of an ecosystem (such as soil fertility recovery, the management of material and human resources, the stability of social relationships) are an integral part of the agrarian system and are a part of its definition (Cochet, 2004).

Eminently useful for a comprehensive understanding of agriculture, the agrarian system notion encompasses other concepts relevant to smaller scale analyses. Take, for example, *cropping systems*. This concept is not used to analyse crops themselves but rather the way a farmer cultivates a plot (or several plots) of land. It includes the crop(s) that are grown (and how they are associated), the crop sequence, the techniques used and the order in which they are used for any given soil and climate conditions. For example, a crop sequence that starts with wheat and barley (in the 1st year), then changes to tef crops[1] (in the 2nd year), and is followed by a lentil and chick-pea cycle (in the 3rd year), constitutes a full-fledged cropping system, provided it is repeated regularly. The Abyssinian banana

[1] *Eragrostis tef*, very fine grained cereals that originally grow on the high plateaux of Ethiopia.

(*Ensete ventricosum*) crop, with its various stages of transplantations and the crops likely to be associated with it, can be studied as a cropping system (Cochet, 2011[2]).

The *livestock system* analyzes domestic animal herd and integrates aspects such as the herd characteristics (race, sex-ratio, size), its diet and corresponding foraging calendar, the upkeep of the herd (drives, breeding, health care).

The *production system* (or *farming system*[3]) is most relevant at the intermediate scale analysis of production and family units. It permits to analyse the cropping and livestock systems a farmer uses based on available means of production and workforce. Although the concept can be applied to the individual enterprise level to help understand how the family farm functions and thus enable the formulation of personalised advice, it is more efficient to apply the production system concept to a group of farms with the same resources (same amount of surface area, same level of mechanization, same size of labour force) in similar socio-economic contexts, and which have a similar crop mix—in sum, a group of farms that can be represented by the same model (Cochet and Devienne, 2006; Dufumier, 1995).

Of course, family strategies often involve more than basic agricultural activities and can only be understood within a broader perspective called the *activities system* or "rural livelihoods" (Ellis, 2000, quoted by Cochet, 2011). In our research area, external activities include small-scale trade, complementary handicraft activities and seasonal migration.

Our approach calls for a form of telescopic, multi-staged analysis focusing on three different levels:

- the plot of land or the herd of cattle, where farming practices are studied;
- the farm or production unit, where the different cropping and stockbreeding systems and other activities come together;
- the region or micro region, where the agrarian system is relevant.

These three levels are not merely overlapping spatial scales; they represent three interdependent levels of functional organisation (Cochet, 2011).

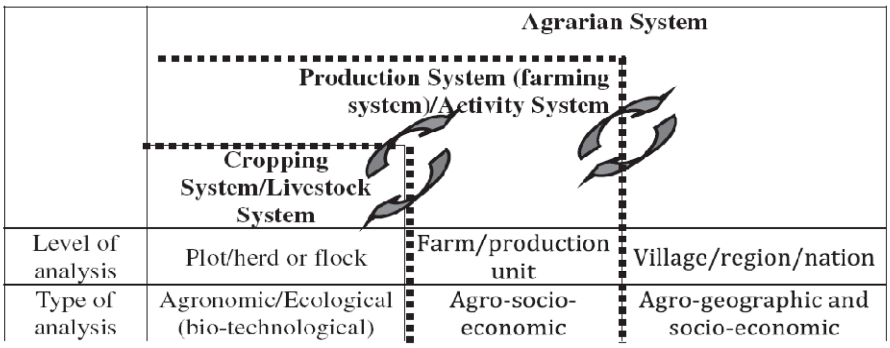

Figure 1: Nested scales of analysis (Cochet, 2011)

[2]Extract from the article "New look at animal traction in Ethiopian agriculture" about to be published in Mekele University review.

[3]For the purpose of this document, the terms production system and farming system are used indiscriminately, although these two concepts are not always understood in the same manner. On this subject, see the comparative analysis by L. Fresco (1984).

b. The agrarian diagnosis, for a deep understanding of the agrarian system

Our research was aimed at understanding the dynamics of the agrarian system. We based it on primary sources of information instead of relying on a statistical approach.

First of all, the reliability of statistical data is uncertain, as we don't know how it is collected and processed and as we imagine how hard it can be to collect data at a large scale in Ethiopia. Then, the geographic units chosen by statisticians (at *woreda* scale) are not relevant to comprehend how diverse the local conditions can be. These administrative scales contain a very large number of production units in various bioclimatic conditions. Finally, as the categories used by statisticians are not systemic, they do not allow the comprehension of the agrarian development processes. For example, the categories of land use can be: annual crops, perennial crops, grazing land and natural forest.

Therefore, these statistical data help identifying regional and national trends but do not explain them; they are inadequate for a deep understanding of agrarian development dynamics. We thus carried out a 5-month field survey collecting primary sources of information (interviews with farmers, direct observation, etc.) in a small region. We used the agrarian diagnosis methodology which includes 4 steps:

- **Analysis of the landscape**

By direct observation and a review of the available data, we studied the environment (climate, geology and soils, ecosystems, etc.) to appraise its diversity and to identify homogeneous and contrasted zones within the surveyed region (Ducourtieux, 2011).

- **Reconstruction of recent transformations affecting agriculture**

By interviewing elders in some 40 village and analyzing available documents, we appraised the trends of technical, social and economic changes that have affected the rural households over the last 50 years.

This step is not limited to recreating a sequence of historical events. It aims at understanding how these events affected the farmers and whether they changed his farming practices. We tried to identify and characterise the different periods that marked the evolution of agro-pastoral activities and determine the underlying causes of this evolution. After all, today's productive systems are as distinct as they are diverse and are a result of a historical process that merits careful reconstruction[4] (Cochet, 2011). Over the farm level, we also reviewed in the history the social relations (social organisation, marriages and inheritance, work division within a household and between households), economic organization (market organization) and the politics that influenced the farming systems.

Therefore, we reconstructed the previous agrarian systems and the associated production systems; we analyzed how each production system has evolved up to nowadays; this led us to a progressive typology, asserting that the historical dynamics of socio-economic differentiation are the key to understand the present diversity.

[4] This historical approach to Comparative Agriculture is founded on methods and knowledge gained in very different historical and geographic contexts and is based on a functional analysis of the landscape and interviews conducted with members of the older generations (Cochet, 2005; Cochet, Devienne and Dufumier, 2007).

- **Technical-economic analysis of a sample of production units**

Having identified today's different farming systems, we studied each of them in detail to assess their rationale:

- to what level of resources (land, workforce, capital) do farmers have access
- what technique do they use: labour calendar, fertility management, animal feeding and reproduction, yields, etc.
- what economic results can farmers expect from agricultural activity: in-kind income for self-consumption, cash revenue, saving capacity, etc.

To ensure a systemic understanding of each farming system, we chose a purposive sampling of case studies. We carried out detailed household surveys (interviews of farmers) with a qualitative sample of 50 families selected to represent the different farming systems identified in the previous phase, thus covering the diversity of agriculture in the region (Ducourtieux, 2011). The bias in this qualitative sample was corrected as the number of surveys increased.

In the time imparted to our mission, conducting a large survey with a statistical sample of families and a quantitative analysis of the data was not feasible, as these case studies are too long and complex.

Though collected data cannot be processed by quantitative methods, we remained concerned about quantifying. Indeed, the method also aims at estimating technical and economic results quantitatively even if the qualitative comprehension of the agrarian system dynamics is privileged.

- **Modelling of the different production systems currently in use**

Based on these detailed household surveys, we underscored various typical production systems by estimating their technical organization and their economic results, which allowed us to compare them. This enabled us to understand the diversity of production systems and their inter relations.

Finally, we estimated the relative proportion of those typical production systems. This estimation does not correspond to a statistical weight; it is approximate but helps us picturing which part of the population is facing a situation of poverty.

2. A very suitable region for agriculture

a. Location of the research area

Our research area belongs to the vast region SNNPR (Southern Nation and Nationalities People's Region) of Southern Ethiopia. More precisely, our agrarian diagnosis was set up in two *kebeles* (equivalent to a group of villages) of the *woreda* (equivalent of department) of *Doyogena* that is located in the *Kambatta* zone. Our study area is crossed by an asphalt road that connects the capital city *Addis Abeba* to the city of *Soddo*, an important market.

Located in the high lands (from 2300to 2600m), our research area belongs to the high *woina dega*[5] in the Ethiopian designation. A set of interfluves lying lengthwise, in a South-West/North-East direction, composes the river system. The depth of the V-valleys ranges from 50 to 100 m. This dense network of rivers guarantees a good drainage of the region.

[5] According to Jean Gallais, the *woïna-dega* or « hill of the vine » is located between 1500m and 2500m.

Figure 2: Relief, administrative boundaries of Ethiopia and location of the research area

Our study area is located on the southern slope of a caldera which is a circular depression of about ten kilometers of diameter with a flat bottom. This caldera was formed by the collapse of the magma chamber of a volcano after successive eruptions. This explosive volcano is the origin of the bedrock present in our study area: the ignimbrite, clear and hard rock formed from the consolidation of pyroclastic ashes.
Thus, most of the soils of the region were formed by the weathering of those volcanic rocks. The soil is divided into two layers: in depth, a red clay loam layer over one meter, created by the alteration of the ignimbrite. Above, there is a black clay loam layer, from 10 to 50 cm thick, with high quantity of organic matter. The thickness of this black layer varies with the slope: very thick on flat grounds (it is then called "black soil"), it disappears on steep slopes (it is then called "red soil").

We walked all over to define a research area which presents a relative landscape unity while including a diversity of production systems. Given the high population density of this region, we limited the research area to approximately 10 km².

b. High and unpredictable rains

The regime of precipitation shows a slight bimodal scheme, with an annual average rainfall around 1800mm. There are four specific seasons:

- a first rainy season from February to May (*glatchoussana* in Kambattinya or *belg* in Amharic),
- a second rainy season from June to August (*matowassana* in Kambattinya or *keremt* in Amharic),
- a season when the rains become rare and unpredictable in September and November (*djabeltchoussana* in Kambattinya),
- a dry season in December and January (*aguissana* in Kambattinya).

Djabeltchoussana and *aguissana* correspond to *bega*, the dry season in Amharic language.

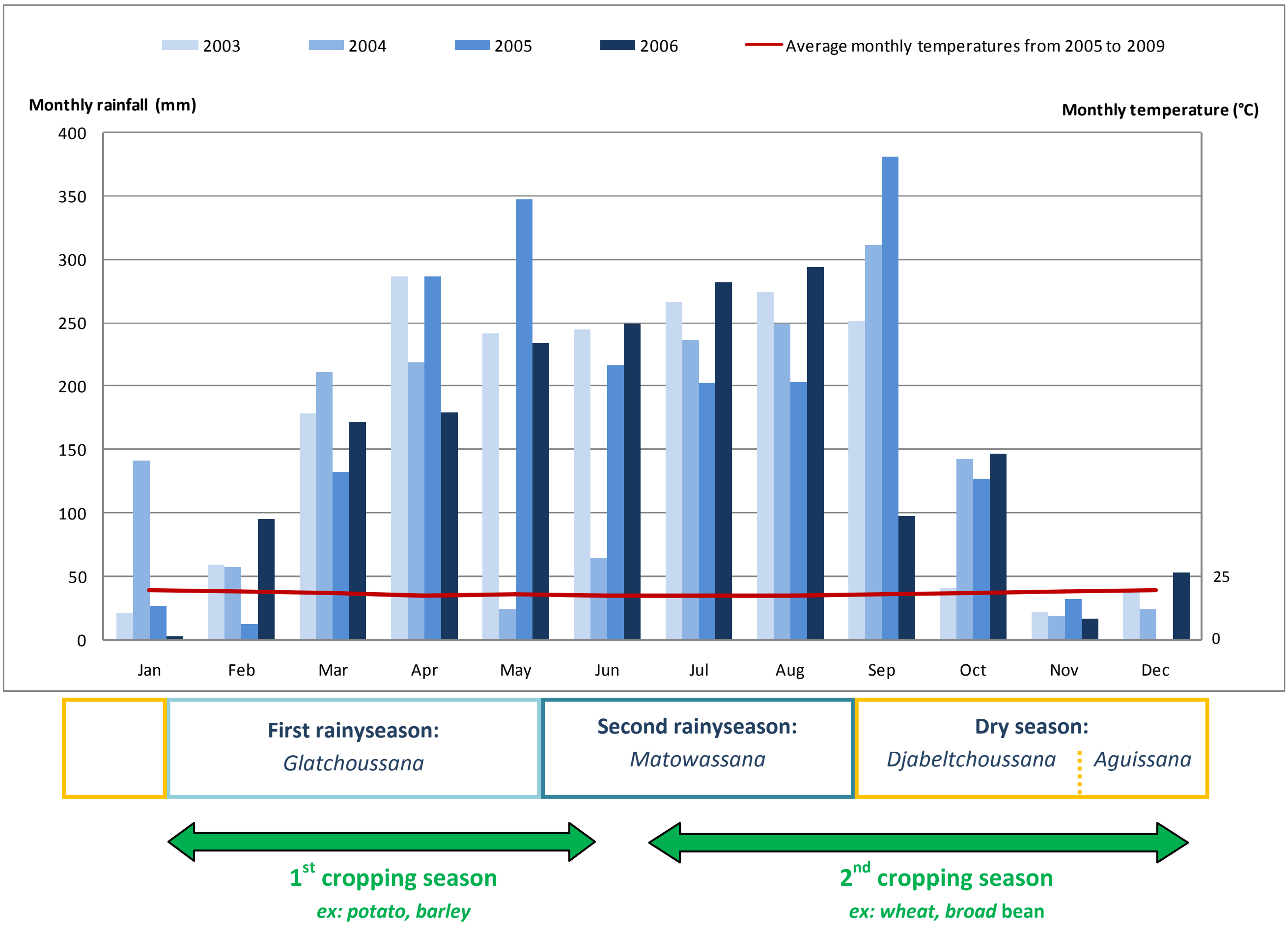

Figure 3: Monthly rainfall and temperatures, rainy seasons and cropping seasons (Data from the National Meteorological Agency of Ethiopia – Station of Angasha)

Farmers have a deep understanding of this climate, as shown in the diversity of vernacular terms they use to discern the different rains.

While temperatures remain stable between years, the inter-annual variability of precipitation is very important and can have strong consequences on cropping systems. According to our interviews with farmers, we identified several periods of risk associated with tillage, sowing, flowering and harvesting.

c. One of the most populated rural region in Ethiopia and in the world

According to statistical data, the population density could amount to 700 inhabitants per square kilometer for the whole *woreda* in 2009. It seems that the censuses are sometimes underestimated so as to avoid the image of an overcrowded country, but also overestimated for the political representation of the region.

As we had doubts about the reliability of this figure, we made an estimation based on a counting of dwellings on a 1976 topographic map. Then we applied the annual population growth rate in Ethiopia[6]. We used the same hypothesis as the local government,

counting 8.9 people per dwelling[7]. This calculation results in a population density of about 900 inhabitants per km².
We cannot decide between these two figures, but it is undeniable that this region supports an extremely high rural population density, one of the highest in the country and in the world.
Moreover, according to the 2007 national census, 57% of the rural population of the *woreda* is less than 20 years old, which suggests a very high population growth in the coming decades.

3. A wooded and totally anthropized landscape

a. The farming unit, basis of the landscape

To understand the whole landscape, we first have to describe the organization of a farm.
The house or *tukul* is circular and is usually located at the top of slope. Nowadays, some families build their house at mid-slope due to the high population density. A nuclear family lives in each house, and constitutes the work and life unit in this region. The *tukul* also includes a cowshed, where animals spend most of their time, allowing an efficient recovery of animal waste. A small pasture is present in front of the house.
The *enset* plantation stands just behind the house for an easy transportation of livestock waste which is essential for the fertility of the plantation.
Several plants are grown in the backyard: maize, local cabbage, marrow, tobbaco, one or two coffee trees and several aromatic and medicinal plants. As it receives a lot of animal waste, it is also located just behind the house.
Below, there are annual crop fields, where the reproduction of fertility is mainly based on the contribution of chemical fertilizers and leguminous plants.
Down below, there is a plantation of *Eucalyptus globulus* and sometimes of bamboos *Arundinaria alpina*. This plantation does not receive any contribution of fertility.
Each farm is very small (from 0.12 ha to 1.5 ha) and is organized according to the slope and to fertility management. It explains the dissemination of the houses, one of the main characteristics of this landscape.

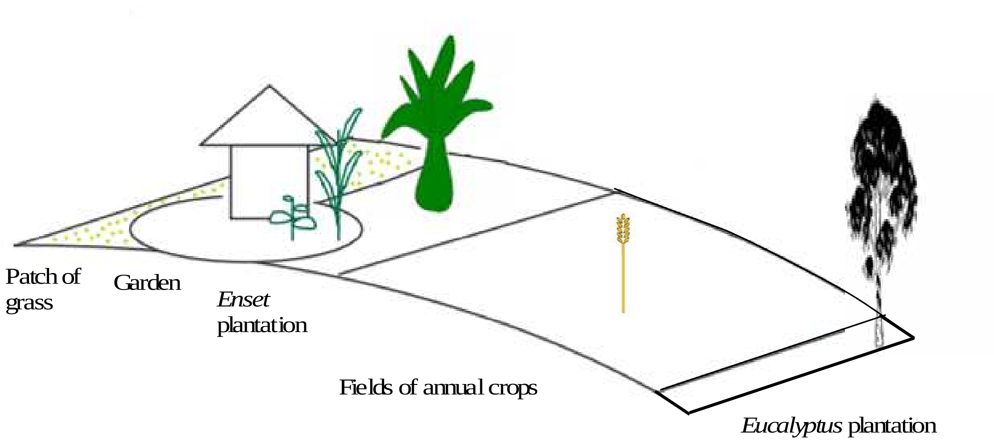

Figure 4: Diagram showing the typical organization of a farm

[6] According to UNICEF data: 2.6% from 1976 to 1990, 3% from 1990 to 2000 and 2.9% from 2000 to nowadays.
[7] This figure might be overestimated according to InterAide findings. However, we used it for a consistent comparison with the population density found in Ethiopian data.

b. Omnipresent and well-cared trees

Many native species of trees can be found: *Podocarpus falcatus*, *Olea africana*, *Croton macrostachyus*, *Acacia abyssinica.* They are usually isolated and located in the middle of the plots of annual crops or pasture. They are used as firewood and timber.

Farms are surrounded by hedges made up of broad-leaved trees (mainly *Eucalyptus globules* and also some *Podocarpus falcatus*, *Olea africana*, *Croton macrostachyus and Acacia abyssinica)* and conifers as *Juniperus procera* and *Cupressus lusitanica.* The wood from pruning is used as firewood and to make fences.

Fences are set up to strengthen the hedges before the implementation of annual crops. It protects them from animals which are led everyday to water in the rivers. Farmers also fence the small pasture in front of their house to let the grass grow. These fences are removed after harvesting in January or after cutting the grass in September. The dry fences are used as firewood.

In spite of the diversity of tree species, *Eucalyptus globulus* is still predominant in the landscape. It is planted as clumps in the collective land located in the bottom of the valleys and also in the bottom part of the farms. Its rapid growth provides for the important needs in firewood and timber. Its harmful effects on soil fertility are well known by farmers, who are trying to make it grow apart from the crops.

c. Three ways of managing the environment

The unity of this landscape is the farm surrounded by hedges and organized according to the slope. The landscape is made up of a mosaic of these micro-farms where *enset* and trees are predominant, so it is highly wooded.

This illustrates that a high population density is not always linked with erosion and deforestation. We will present further how the high population density and the associated processes of agrarian development contributed to make up this wooded landscape.

However, we can notice some open fields of annual crops in the steep slopes, contrasting with the surrounding wooded areas. We will understand their origin with the study of history.

Common pastures and eucalyptus plantations are located in the bottom of the valleys.

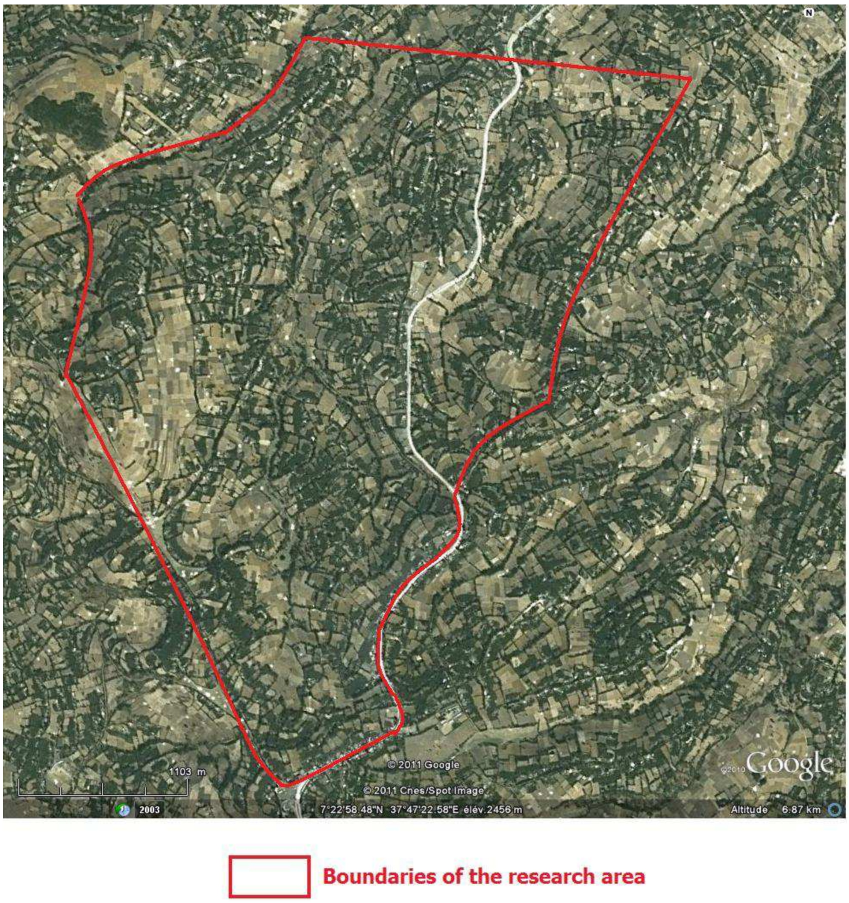

Figure 5: Aerial view of the research area – the multitude of small-scale farms surrounded by hedges is spectacular (picture taken from Google Earth in 2011)

II. Three very different regimes but the same weight on peasantry

1. The imperial period, a non-egalitarian agricultural society

Before the 20th century, some areas were already densely populated in the kingdom of Kambatta. Some other areas which had not been cleared were peopled with small groups of breeders. Like other territories of Southern Ethiopia, Kambatta was conquered and linked to the Ethiopian Empire by Emperor Menelik II in 1894. The low-populated and non-cleared areas were distributed to notables and soldiers coming from Northern Ethiopia in reward of loyal service to Menelik. These areas were called *gasha* land. The densely populated areas remained in the hands of native chiefs, tough they had to submit to the Emperor. These areas became *gimita* land.

Haile Selassie became emperor in 1930. His reign was interrupted by a short Italian invasion between 1936 and 1942. Our historical study starts from the second part of his reign, between 1942 and 1974.

Our research area included about 40% of *gasha* land and 60% of *gimita* land. The organization of society was similar; there were different social groups according to their relation to land:

- **Notables** had large land grants **(> 10 ha)**. They could distribute small plots to tenants and dependents, from whom they required duties. They paid property tax proportionally to the size of their land grant, directly to the government. This social group included soldiers from the North and native leaders.

- **Independent farmers (2 to 6 ha)** shared their land with their family. Usually they did not have tenant nor dependent at their service. The whole family paid property tax directly to the government.
- **Tenants (0.5 to 1.25 ha)** were under the authority of the notable who gave them a plot of land. In compensation, they were required to do heavy duties (2 days per week) and were taxed in money and in kind (30 to 50% of harvest and several sheep per year).
- **Dependents** had to give their full workforce to their master. They were given a very small plot **(< 0.5 ha)** for their garden and *enset* plantation. We faced difficulties to define their social origin and their relationships with the notables. We presumed that they were slaves who had been freed by the abolition of slavery in 1942.

In spite of this common organization, tenants were more numerous and inequalities were higher in *gasha* land than in *gimita* land where independent farmers were many. This difference can still be felt today.

Land size was the first differentiating factor of production systems during the imperial period: it was directly linked to social status and no evolution was possible. We identified 4 production systems corresponding to 4 social groups. Only small-scale farmers were not using animal traction. Inequalities in landholding were very high (less than 0.5 ha to more than 10 ha) but also in cattle holding (0 to 30 head of cattle). Contracts on cattle were then widespread.

Farmers achieved one cropping season per year, between July and December, alternating wheat, barley, linen, broad bean and a grazed fallow for a period of one to three years. *Tef*[8] has never been cultivated in this region because of the cold and rainy climate which does not allow a good yield. Cultivation of leguminous plants and the grazed fallow ensured the reproduction of fertility. After fallowing, farmers ploughed deeply with a ploughing stick (*wonicho*) and a hoe (*kalta*), with the help of two other farmers (*gezima* system).

Moreover, access to grazing land varied greatly between farming systems. For large landholders, fodder was plentiful and they could even sell grass during dry season whereas grazing land was sought-after for medium and small landholders. The difficulty to feed cattle is very old for those farming systems.

2. The *Derg* period (1974-1991): from release to impoverishment

Relying on the interviews we carried out with elder farmers, we distinguished two different periods under the *Derg* regime. Indeed, the dynamics of evolution of the agrarian system were quite contrasted.

a. Auspicious years (1974-1979): agrarian reform and labor intensification

In 1974, after the overthrow of Emperor Haile Selassie, agrarian reform was declared by a revolutionary socialist government, the *Derg*. Land became property of the Ethiopian people, managed on its behalf by the state. In our research area, each household was entitled with 0.25 ha per family member, while additional land was confiscated without compensation. Neither *enset* plots nor cattle were taken into account by this reform, even if they were the main assets of the

[8] *Eragrostis tef*, very fine grained cereals that originally grow on the high plateaux of Ethiopia.

production systems. In addition, land distribution was influenced by the former notables. The least and the most fortunate farmers remained the same. Nevertheless, this land reform leveled the size of land property for the small and medium farms, which were the most numerous. In the aftermath of this reform, inequalities were mitigated but not completely suppressed. All the same, it has led to security of tenure for tenants and dependants who were always at risk of being expelled by their masters.

In addition to this land redistribution, taxes that weighed on peasantry were abolished and all farmers were taxed in the same way. This was considered a true liberation. Duties were also abolished even if the government quickly called farmers up again for various community activities. The *Derg* regime also gave access to chemical fertilizers, 75% of their value being subsidized by the state. Those favorable circumstances allowed farmers to achieve a remarkable labor and inputs intensification of their production systems:

- Chemical fertilizers made it possible to get rid of the fallow that ensured the reproduction of fertility during the imperial period. A great majority of farmers started to achieve a second cropping season during the first rainy season (*glatchoussana*). Especially, the potato expanded rapidly, its short cycle allowing it to grow during the short rainy season.
- The use of these inputs as well as new varieties with high yield potential increased cereal yields. It also resulted in an expansion of arable land since the "red soils", considered as poor soils, started to be cultivated.

Then farmers harvested twice a year with higher yields and this on wider areas. Therefore, the agricultural production of the region increased significantly.

- In order to appropriate their land, farmers started to set up hedges around their plot, initiating the development of a bocage landscape.

While some farmers had already initiated these changes at the end of the imperial period, the policy implemented at the beginning of *Derg* allowed a sharp increase of the process. At the end of the 1970's, we can consider that 90% of farmers had achieved this intensification process.

At the same time, open fields appeared at that time: because of the redistribution of wide land concessions, some farmers received a plot located far from the headquarters of their holding. Growing hedges on these plots was complicated by the fact that they were far and by the presence of animals during the grazing of stubble.

Large areas of common grazing were provided, usually in valley bottoms. Thanks to them, the grazing calendar was homogenized between the different farming systems. At the beginning of the *Derg,* the majority of farmers managed to acquire an additional head of cattle, and every one of them accessed an ox.

The agrarian changes of this period are the illustration of an agricultural development process based on labor and inputs intensification. This coincides with the first demographic transition in Ethiopia, which began in the 1960's. If we apply the theory of Boserup, this agrarian revolution would have been stimulated by population density (Boserup, 1965). However, it became possible only when farmers had access to means of production: land, inputs, and to a lesser extent, workforce. This shows that population pressure was a necessary but not sufficient condition to trigger these changes.

b. Hardening of the regime (1979-1991): taxation of peasantry and population growth

At the end of the 1970's, Ethiopia joined the Soviet bloc which resulted in an attempt at collectivization in different areas. For agriculture, the idea was to modernize production systems as quickly as possible in order to industrialize the country. Mangestu said that "Ethiopia can feed three to four times more people if small-scale farming is eradicated" (Gascon, 2006).

Property tax was multiplied by 4 between 1975 and 1978 (at current prices), to which an in-kind tax was added (one quintal of grain per year). Compulsory contributions to the party were multiplied, and every household had to contribute regularly to support soldiers' families.

In 1980, a collective farm was implemented on 50 hectares located in the slope of the caldera. Farmers had to work there, as well as on reforestation areas and on absent soldiers' land. Finally, work taxes amounted to 50% of working time.

Moreover, this period is characterized by a high rigidity of marketing channels. Collectivization aimed at making grain available for cities and war fronts. Indeed, "Agrarian reform, by removing concentration of flux in the hands of large landholders, decreased the quantities delivered to the market. Peasants eat better and provide less trade" (Gallais, 1989). Thus, the government implemented the "Agricultural marketing corporation" in order to provide cities with grain and to control prices. In parallel, an important black market developed, where goods cost twice as much. As farmers needed more and more cash, the proportion of the harvest which was sold largely increased. Therefore, governmental taxes on the peasantry considerably increased during this period.

The removal of the grazed fallow and the increase of livestock led to a decrease of fodder units available in the region and to a pressure on common grazing areas. To solve this difficulty, farmers progressively implemented a "cut-and-carry" system in which every source of fodder is picked up and given to livestock in stalls. This contributed to reinforcing the bocage, since new hedges helped farmers appropriate crop residues. This evolution of animal feeding management is also a process of labor intensification, aiming at managing more and more accurately the decreasing fodder resource.

Cattle waste is used for fertilizing the *enset* plantation, the basis of human food security. In a context of fodder shortage, it has become harder and harder to feed this livestock and the whole system has weakened. Particularly, during such climatic events as the 1984-1985 droughts, fodder was not sufficient anymore. Those temporary crises led to irreversible decapitalization, as farmers were unable to re-capitalize afterwards.

The evolution of farming systems in this period is contrasted. Some farmers increased their incomes selling goods on the black market while the majority of farmers lost some heads of cattle or endured a fragmentation of their land. Some farming systems just maintained themselves. It should be noted that from this period onward, the poorest farmers no longer own an ox.

3. EPRDF[9] period (1991 to present): a return to great inequalities

a. Land fragmentation and reductions in livestock

The political party of Meles Zenawi, currently Prime Minister of Ethiopia, took office in 1991 when the revolutionary regime fell. The coming of this liberal government went with the end of subsidies on fertilizers. From 1997 onwards, the relative price of fertilizers has increased more than cereals, which means that the value added on annual crops has decreased. Liberalization also increased prices fluctuation.

Population growth and low rural migration increased farms fragmentation. Moreover, the government distributed the last available lands to soldiers coming back from war: common grazing land. On top of that, some farmers have expanded their land encroaching on common grazing land, which since then has always been overgrazed. Pressure on the *enset* plantation has increased significantly during this period, since *enset* leaves have become predominant in animal feeding schedule. The land of the collective farm was redistributed in 1991, which generated new open fields because plots are located far away from the headquarters of the holding. Elsewhere, the bocage has continued to spread.
Besides these efforts, all farming systems had to decrease their livestock and the zootechnical performances have strongly been degraded.

b. An agricultural policy which strengthens inequalities

Whereas during the *Derg*, agricultural policies were focused on controlling upstream and downstream channels, they have been directed towards production systems starting from 1991.
Although subsidies were stopped, the Ethiopian state continued to distribute chemical fertilizers and certified seeds to farmers. Nowadays, farmers have to enter into a credit with the Agriculture Department for half of the amount of fertilizers. This credit is paid back at the harvesting period. As a consequence, each farmer must sell a part or all of their harvest at a very low price.
The Ethiopian state has an interest in integrating all farmers to the national market in order to maximize available crops in the country, feed the cities at low price and limit the importations (Planel, 2011). Indeed, importing wheat, mostly for urban consumption, is structural in Ethiopia. As the bill turns to be very high in case international prices rise (such as in 2000, 2003 and 2008), the government could be encouraged to secure national production. Ensuring that cities will be supplied at low price is especially important because, even though the proportion of urban population is low (17% in 2009, FAO), the political danger has always come from the cities. The 1974 revolution was triggered by many strikes in the capital city (Gallais, 1989). The riots during the controversial 2005 elections also took place in Addis Abeba.

The idea of integrating peasants to the market without considering the consequences also matches a vision of agricultural development promoted by many international donors. This vision doesn't take into account how much home consumption is important for agricultural income (Cochet, 2011).

[9] EPRDF means Ethiopian People's Revolutionary Democratic Front.

We include home consumption to evaluate the value created by a system. Indeed, farmers' families work not only for cash revenues but also to feed themselves. Therefore, we make a distinction between the agricultural income and the monetary income. The agricultural income includes the whole creation of value whereas the monetary income is considered only to discuss the management of cash flow schedule.

To meet these objectives, farmers are encouraged to buy a technical package from the Agriculture Department, including certified seeds, chemical fertilizers and pesticides, the doses being checked in the plots by development agents. The recusant farmers are charged with "not accepting the transition from traditional to modern agriculture", said the person in charge of agricultural extension in Doyogena.
Farmers are pressured to put these recommendations in practice : if they don't, they will not benefit from the *Safetynet*[10] program, will not access fertilizers in time, and will pay a very high property tax, etc. But beyond these potential problems, farmers face a situation of land insecurity. A development agent confided us that "if farmers refuse to implement anti-erosive structures, we insinuate that the State can take their land away".

Besides the fertilizers and seed sales that affects all farmers, the government, through the development agents, make means of production (tools, grass seedlings, improved breeds of chickens, etc.) available to some "model farmers", who are expected to disseminate these new technologies to their neighbors. These farmers are selected for their ability to implement and spread new technologies but also for their wealth. Indeed, they have to "make other farmers feel like being rich", according to the person in charge of agricultural extension. Development programs are conceived for farming systems that are already in an auspicious economic situation and are unsuitable for the needs of the others. This policy doesn't take the diversity of farmers' means and interests into account.

On the contrary, the differentiation of production systems is considered here as a tool to identify different farming strategies suitable to the different farmers. Considering that all farmers do not have the same means and the same interests, the differentiation is a relevant basis to design contrasted interventions depending on their contrasted needs.

This top-down scheme has changed: at the beginning, there was 1 model farmer for 30 following farmers (1 to 30) and later, 1 model farmer for 10 following farmers (1 to 10). Since 2010, the Agriculture Department has implemented 1 to 5 programs in all the country, which means groups of 6 farmers. The top-down extension scheme has tightened to follow farmers ever more closely. It is a concerning evolution since the content of the agricultural policy can be put in question. Concretely, there is no control on the effective dissemination of programs in the group. Many farmers told us they are used to "*looking at what model farmers do over the fence"*.

Therefore, this policy has contributed to increase inequalities among farmers, as other elements also have. First, emigration from Kambatta to South Africa has considerably increased for the last 5 years,

[10] The « SafetyNet » programme, which the European Union is funding, offers to the most vulnerable families to involve in community works in exchange of a monetary and/or in-kind salary.

with the support of the Ethiopian ambassador. Secondly, the Doyogena market has grown significantly and has become one of the most important markets of Kambatta since the asphalting of the road in 2005. The most well-to-do farmers were able to invest in a trade activity or in emigration. This period has also seen a proliferation of contracts on land and animals that will be detailed later in the presentation.

During this period, the agricultural income decreased significantly for all farmers, resulting in an impoverishment of the majority, as they cannot rely on external activity.

The rationale underlying farming systems cannot be understood without reference to the activities system including non-agricultural activities.
It seems important to distinguish different types of ''pluriactivities'': those resulting from a de facto semi-proletarianization of farmers and increasing vulnerability, those that help improve living standards and productive investments; and those that contribute to building or maintaining patrimony in view of retirement. In the first type, pluriactivity is the consequence of insufficient agricultural income; the extra revenue is needed to make ends meet. In other cases, pluriactivity is ''structural';' the farming system is just one element.
Anything that is part of an ''activities system'' and that can help explaining the why and how of a productive process in agriculture must be carefully examined (Cochet, 2011).
Therefore, we differentiated the agricultural income of a household (obtained from the agricultural activity only) from the total family income (to which we added the income from external activities).

4. Trajectories of production systems from the Imperial period to nowadays

Asserting that each current production system is the result of historical events and trends, we established the various trajectories of production systems, and presented them in the progressive typology below.
Let us notice that since the 1980's farmers' strategies have consisted in maintaining their cattle in priority. As it will be detailed further, cattle is indeed the keystone of the agrarian system so in case of fodder shortage, the whole farming system is weakened. That is why from the second part of the *Derg*, our typology is based on the number of cattle, whereas it is based on the area for the previous periods.

- Tenants and dependants of the Imperial period who owned a very small plot and no animal, accessed a draught ox and a cow thanks to agrarian reform. A few years later, these production systems either endured land fragmentation and decapitalization, or simply maintained themselves. Then their evolution led to the current production systems named A, B and C, which are actually the most vulnerable.
- Notables of the Imperial period lost a part of their large land grants and livestock because of agrarian reform. Although these production systems endured successive land fragmentation and decapitalization, they have remained the better-off until today, forming the current production systems E, F, G and H.
- As for the intermediate production systems, the trajectories are various. During the Imperial period, independent farmers and tenants who had a large plot constituted the majority of farming systems. The inequalities between these production systems were mitigated by the agrarian reform. During the second period of the *Derg*, some of the better-off farmers managed to become wealthier. These farming systems evolved into the current production system H. However, most of

these production systems have lost land and capital since the second period of the *Derg*. Their trajectory has led to current production systems C, D, E and F but also B (for the ones who had less than 1 ha at the beginning of the *Derg*) and G (for the ones who had more than 1.5 ha at the beginning of the *Derg*).

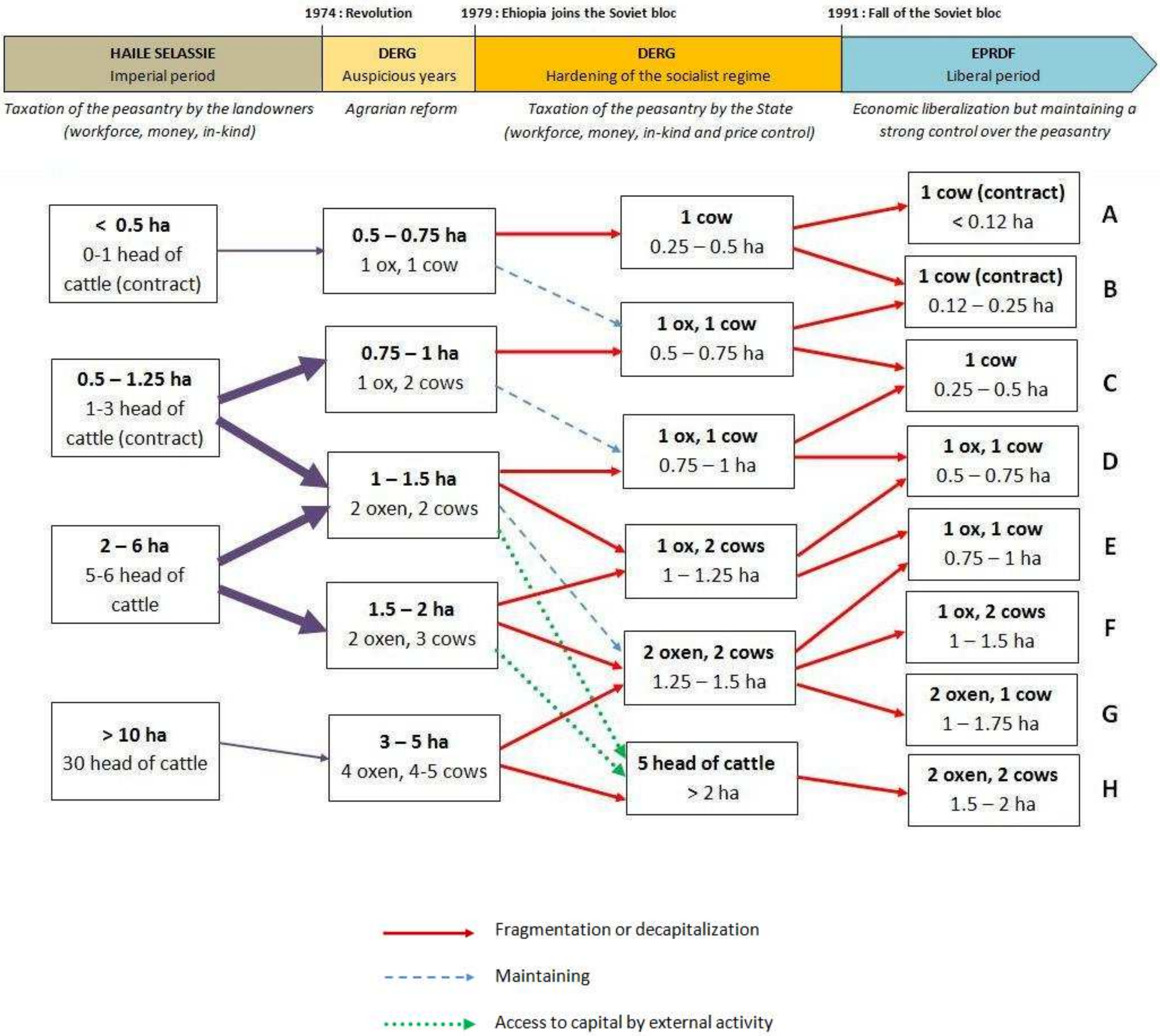

Figure 6: Progressive typology from the Imperial period to nowadays

Further in the report, we will sometimes refer to the current 8 production systems, while their diversity will be appreciated by the detailed presentation of three of them:

- On their tiny plot (less than 0.5 ha), farmers of production systems A, B and C cannot breed an ox and have only one cow which is in contract for production systems A and B. One of these three production systems will be presented further: production system B, which is particularly interesting for the cultivation of annual crops despite the absence of draught ox and the small size of the available land.
- In production systems D and E, one ox and one cow are bred, while farmers of production system E cultivate a larger area thanks to additional sharecropped land. Production system D will be

presented further, so as to understand the influence of breeding one ox compared to the previous systems.

- Farmers of production system F breed two cows and one ox and have more than 1 ha available.
- In production system G, two oxen and one cow are bred, which allows farmers to cultivate a large area in sharecropping.
- Farmers of production system H breed two cows and two oxen and cultivate the largest land. This production system will be presented further in order to emphasize the diversity of activities allowed when capital, livestock and land are available.

III. The present agrarian system, sinking into crisis

We apply the concept of "overlapping sub-scales": the detailed study of how each cropping and breeding system is operated is the first step; then we will be able to understand how they are combined in each production system; finally, it will allow a comprehensive understanding of the whole agrarian system.

1. Cropping systems

a. The *enset* plantation, central to the farm

i. An endemic plant essential for food security

The *Ensete ventricosum* is a specie characteristic of Southern Ethiopian agrarian systems. Our study area is in the heart of the *enset* growing region, as plantations represent at least 25 % of the farm areas. *Enset* resistance to drought is a well-known advantage. An *enset* plantation can produce up to 6 tons of dry mater per ha (V.Barthès and N.Boquien, 2005). However, foodstuffs coming from *enset* are very poor in protein (0.012 kg of proteins per kg according to S.A.Brandt et al, 1997). Apart from its role of food security for the households, *enset* leaves are given to the cattle all along the year. The *enset* plantation is also the source of several non-food products (ropes, mats, bonds).

Enset plants are cut to be processed after a growth of 5 to 9 years. Farmers transplant each plant three times during this growing period. At each transplantation, *enset* plants are spaced out to optimize the density and the soil coverage in the plantation. These transplantations are done in January and constitute the male work peak. Ploughing the soil with the ploughing stick in February is another work peak. These work peaks are managed thanks to mutual aid.

The weeding of the plantation takes place in May or June. All the weeds are given to cattle in the cowshed.

The *enset* processing period generally takes place in January and July. It is a female work peak and mutual aid is crucial. Some families pay daily workers in cash for this work.

In order to make the main food products, *qotcho*, *merero* and *bulla*, men cut 6 to 20 *enset* plants and women grate the leaves. The pulp obtained by grating is put into a hole. After three days, women take this pulp out to press it and add ferment. They put the pulp back into the hole and wait for one month at least before starting to eat it.

Farmers try to have *qotcho* all along the year to ensure their food security. The harvest of potato and barley allow them to keep *qotcho* for the month of August, before the next preparation.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Qotcho	1st preparation		▨	▨	▨	▨	▨	▨				
	▨	▨				2nd preparation			▨	▨	▨	▨
Potato					▨	▨	▨					
Barley						▨	▨					
Red bean						▨	▨					
Wheat	▨	▨										
Broad bean	▨										▨	▨
Maize						▨	▨	▨				

Table 1: The most common food schedule – qotcho is available all year long and vital to face the hunger gaps of March-April and September-October.

ii. *An important organic provision compensating the high biomass production*

In the *enset* plantation, most of the organic matter is exported:

- All of the *enset* plant: for human consumption (pseudo stems and roots), for animal consumption (leaves and roots) and for the fabrication of mats and ropes (dry leaves, fibers);
- Weeds for animal feeding.

Only few residues from the transformation of *enset* remain on the soil.
Due to all these exportations, the balance in organic importations and exportations is shaky and its instability depends on the frequent spreading of organic matter (V.Barthès and N.Boquien, 2005).
Therefore, the *enset* plantation and cattle breeding are closely linked: the main part of animal food comes from the *enset* plantation and most of the livestock waste is spread on this plantation.

iii. *Various management strategies depending on the size of the plantation*

Based on the diagnosis made by V. Barthes and N. Boquien, we confirmed the following differentiating criteria:

- **Age of *enset* when processed**

The flowering time, around 8 or 9 years old, is the most appropriate time to process a plant because the yield and the taste would be higher. However, for most farmers, waiting until flowering time is not possible.

- **Number of plants processed at each transformation**

The number of *enset* processed at each transformation is directly related to the size of the plantation. When the area of the plantation is reduced, there is only a few mature trees available.

- **Annual frequency of *qotcho* preparation**

According to the women we met, it is better to process *enset* in two periods: December-January and June-July. We can make several hypotheses to explain it.

On the one hand, crop residues and weeds are available in the farm during these periods so it is not necessary to cut *enset* leaves for animal feeding. It would be the reason why quantity and quality of *qotcho* are better when it is made in these two periods.

On the other hand, we can see in the food calendar that *enset* is the only food available in March-April and in September-October. It is also essential to have *enset* products for the *Meskel* feast in September. To face these needs, the transformation must take place two months earlier. However, many farmers who don't have an *enset* plantation large enough prepare *qotcho* 3 or 4 times a year to ensure their food security.

- **Duration of *qotcho* fermentation**

The gustative quality of *qotcho* depends on the length of fermentation. Longer than or equal to three months is generally recognized to be the minimum period to make a good *qotcho*. However, some families cannot afford to wait more than one month.

- **Sale of *qotcho* and *bulla***

Bulla is produced in small amounts and taste better than *qotcho*, which is why it is about 4 times more expensive than *qotcho* in the market. *Bulla* constitutes a significant source of income so that the poorest families do not hesitate to sell it whereas they eat all their *qotcho* production.

On the contrary, rich farmers have enough *qotcho* for family consumption and can sell the surplus. They keep all the *bulla* they produced for special events (feasts, family gatherings or special guests).

- **Mats confection with dry leaves**

Some families have enough *enset* leaves to feed their animals and to let other leaves dry to make mats. Fifty leaves are needed to make a mat. The sale of these mats represents a significant income (from 50 to 80 Birr[11] per mat in Doyogena market).

Enset gross value added per ha varies from 14,880 Birr to 20,400 Birr according to the criteria of management of this cropping system.

	PS B	PS E	PS H
Size of the plot	**0.1 ha**	**0.25 ha**	**0.4 ha**
Number of processing/year	3 to 4	2 to 3	2
Number of plants/processing	3 to 6	10 to 15	20 to 22
Age of plants when processed	6	7	8 or 9
number of qotcho breads/plant	*15*	*15*	*19*
Sale of *qotcho*	0%	10%	25%
Sale of *bulla*	100%	50%	0%
Number of mats made/year	0	2 to 3	5 to 10

Table 2: Differentiation criteria according to the size of the plantation

NB: *PS: Production System; basic information about production systems B, E and H are available page 17-19*

[11] We used the exchange rate effective during our stay in Ethiopia: 1€ = 24 Birr.

After establishing these criteria, we calculated the gross product and the value added of each cropping system.

Gross Product = value of sold, home consumed and intra-consumed products
Sold products: *products effectively sold in the market (ex: fibers resulting from enset processs).*
Household consumption: *products consumed by families which they would have to buy if they did not produce it (ex: qotcho production).*
Intra-consumed products: *products used in another system of the farm (ex: leaves of enset used for animal feeding).*
We chose the prices of agricultural products on the basis of interviews with farmers and market actors. These prices reflect the amounts expected during a "normal year".
For domestic consumption and intra-consumed products, we took the price at which these products would be purchased if farmers did not produce them.

Gross Value Added = Gross Product – Intermediate Consumptions
We focused on value added instead of gross product because value added includes what farmers spend in the production process (fertilizers and seeds for example). Farmers' interest is to maximize the value added rather than gross product.
The GVA we calculated reflects the real wealth created, including food and biomass production. It is indeed necessary to understand farmer's strategies which aim at getting a balance between monetary income, home consumption and animal feeding needs.

b. The garden, second beneficiary of fertilizing

All farmers cultivate a garden from 0.03 to 0.04 hectares located behind their house. The two main crops are maize and a local cabbage. We can also find one or two marrow plants, some coffee trees, a couple of sugarcane plants, along with aromatic and medicinal plants. Compared to other very populated regions like Haiti, we can consider that this garden is not very diversified: there is not plenty of species associated in complex ways.

The reproduction of the fertility in this garden is only based on the contribution of livestock waste. Soil preparation is exclusively manual: farmers use a hoe twice a year to loosen the soil.
All the work in general (transplanting, weeding, harvesting) is made before or after the working day although this cropping system is very labor intensive (about 600 man-day/ha/year compared to 95 man-day/ha/year for the most common crop sequence) and highly productive (33,600 Birr/ha of gross value added compared to 9,600 Birr/ha for the same crop sequence).The large amount of work required for such a garden associated with the great need of organic fertilization are the limits for the expansion of the garden.

We can distinguish two groups of products depending on their destination:
- more than half of the harvest of cabbage and marrows are sold in the market every week, which allows women to buy salt, coffee, kerosene etc.
- the harvests of maize and coffee are for domestic consumption.

Indeed, the *woreda* of Doyogena is characterized by its cold and very wet climate which allows a good harvest of cabbage and marrow, while coffee and maize prefer warmer and drier climates of lower agro-ecological levels. Coffee prices reflect the production costs in warmer regions and are therefore not profitable for Doyogena farmers, whereas marrow and cabbage are easier to produce. Thus, there is a relative specialization of productions according to the possibilities of each agro-ecological region.

We considered that the garden is not a differentiating factor between the different types of production systems. Indeed, the interviews with farmers showed a certain homogeneity in the management of this cropping system.

c. Annual crop fields: common techniques but numerous crop rotations

Annual crops play various roles in production systems:

- Crops growing during the first rainy season (potatoes, barley) are exclusively for family consumption.
- Crops growing during the second rainy season (wheat, broad beans) are partly or completely sold, allowing the payment of land tax and debts incurred during the year.
- All crop residues and weeds are collected and distributed to animals.

The most common crop rotation is: Potato/Wheat//Potato/Wheat//Barley/Broad beans[12]. It includes a leguminous, two cereals and a tuber.
Despite the expansion of the double cropping season, we can still observe many uncultivated land during the first rainy season. Indeed, some farmers acquired from land reform a plot of land which is located far from their house. This distance limits the intensification of work (for example, it's difficult to carry the harvest of potatoes everyday) and thus the double cropping season. The rotation performed on these plots is: Wheat//Wheat//Broad bean. This crop rotation is also found on land cultivated in sharecropping contract, the practical details of which will be presented further.

Farmers prepare the soil and the seedbed with a swing-plough. This tool doesn't allow them to make a deep plough, turning the soil over, but helps them to control weeds. Tilling with a ploughing stick is very rare even if it is more efficient to control weeds thanks to a deeper plough. Actually, it needs a very long and hard work which doesn't allow farmers to sow during the first rainy season.
Between the two cropping seasons, farmers till twice before sowing broad beans and three times before sowing wheat. The tillage between the two cropping seasons represents the work peak of this cropping system and determines the maximal area that a farmer can cultivate.
Indeed, farmers have 25 days to prepare the soil between harvesting potatoes and sowing wheat. 15 effective days remain after deducting non-working days away (rainy days, social obligations). Now, farmers have to till at least thrice with a week-break between each tillage. Two oxen can till 0.25 ha per day. As a result, a farmer who has two oxen can cultivate up to 5 plots of 0.25 ha that is 1.25 ha maximum. The majority of farmers in our study area just have one ox. They are associated with another farmer who has also one ox to make a yoke. Half of the time, their ox is used by the other farmer. Therefore, they can cultivate to the maximum half of the previous area that is 0.63 ha.
Purchasing seeds and chemical fertilizers in June is the most important cash need during the year so that it impacts greatly the family cash flow. Every year, the government sells fertilizers and improved

[12] / marks the passage between two rainy season in the same year and // marks the passage between two different years.

seeds to farmers. The government also provides a credit for fertilizers: farmers have to pay half of the amount at sowing and half at harvesting. Improved seeds have to be entirely paid at sowing. Many farmers take out a loan to compensate these expenditures, at a 50% lending rate. Some of them manage to get this money by selling a sheep.

Considering the fertility balance, we realize that all the biomass is exported from the annual crops fields: residues, weeds and grains. As a consequence, these fields need a lot of importation. Chemical fertilizers allow farmers to solve this problem. With the increase of the prices of chemical fertilizers these last few years, some farmers started to put animal waste in annual crops fields. It contributes to weaken the *enset* plantation and consequently, the food security of the family.

We can ascertain several differentiating factors for annual cropping system. Indeed, the crop rotation described previously varies between the farming systems, according to the size of the plot. The smallest plots are about 0.01 ha whereas the biggest can measure 0.75 ha, among which a part is cultivated in sharecropping contract.

- **Frequency of leguminous plant in the crop rotation**

The poorest farmers implement a four-year rotation, including a single season of broad beans (Potato/Wheat//Potato/Wheat//Potato/Wheat//Barley/Broad bean), while the richest farmers cultivate broad beans every other year (Potato/Wheat//Barley/Broad beans). The low emphasis on leguminous plants in the crop rotation for the poorest families has always existed in history. It was hard to understand this link, since the gross value added of wheat and broad beans are quite similar (respectively 4,800Birr/ha and 4,320 Birr/ha). We found two hypotheses to explain it:

- The interest could be to maximize potato production so that the *qotcho* stock, essential in August, could be preserved. This is valid only with a short gap between the harvest of potato and the sowing of broad bean.
- Farmers could prefer to plant wheat instead of broad beans because of the importance of wheat straws in animal feeding schedule.

Some farmers grow red beans during the first rainy season (example: Potato/Wheat//Red Beans/Wheat//Barley/Broad beans). Our hypothesis is that these farmers have a sufficient area to ensure their potato and barley production so that they can cultivate a leguminous which allows them to improve their feeding balance and to increase the fertility of their soils.

- **Presence of a maize plot**

Farmers who dedicate more than 0.5 ha to annual crops keep one plot for maize during the first rainy season (example: Potato/Wheat//Barley//Broad Beans//Maize/Barley). Several sowing of maize are implemented in order to stagger the harvests from May up to August. It allows the animal and the human feeding schedules to be more flexible. Since maize is harvested quite late, it is followed by barley which has a shorter cycle than wheat or broad beans.

- **Presence of grazed fallow**

Moreover, farmers who dedicate more than 0.5 ha to annual crops carry out a grazed fallow during the first rainy season (example: Potato/Wheat// - /Wheat//Barley/Broad Beans). The interest of this fallow is to improve soil fertility and to spread over tillings between the two cropping seasons.

- **Harvest selling period and percentage of home consumption**

The value added of each cropping system depends on the harvest selling period, since the price variability during the year is extremely high. Thus, the price of a quintal of wheat doubles from harvesting time in January to sowing time in June, and it increases again up to September for *Meskel* feast. Even though the poorest farmers sell all their harvest in January, the majority manage to keep one part for home consumption and the richest farmers can even keep one part to sell it in September.

- **Yields**

It has been very hard to evaluate the yields, considering the various and rough units of measurement used in the region. The yield seems to be an important criterion of differentiation but we could not find a clear relation between quantity of fertilizers, crop rotation and yields. In our model, we defined for each crop a quantity of fertilizer and a yield which are common for every type of production system.

Anyway, we don't have to focus only on the yield in the analysis of production systems. Indeed, farmers aim at increasing their value added. Increasing the yield is just one way to increase value added, as it increases gross product. Another way could be to decrease intermediate consumptions.

	4 examples of production sytems			
	PS B	**PS E**	**PS F**	**PS H**
Size of the owned plot (ha)	0.125	0.23	0.6	0.25
Size of the sharecropped plot (ha)	none	0.25	none	0.5
Frequency of leguminous plants in the crop sequence	1 year over 4	1 year over 3	1 year over 3	1 year over 2
Presence of a maize plot	no	yes	yes	yes
Presence of a grazed fallow	no	no	yes	no
Harvest selling period and percentage of home consumption (products of 2nd cropping season)	100% sold at harvesting period, 0% for home consumption	90% sold at harvesting period, 10% for home consumption	1/3 sold at harvesting period, 1/3 sold at sowing period, 1/3 for home consumption	1/3 sold at harvesting period, 1/3 sold at feast period, 1/3 for home consumption

Table 3: Differentiation criteria of annual crops and examples in 4 production systems
***<u>NB</u>**: PS: Production System; basic information about production systems B, E, F and H are available* *page 17-19*

d. An economic comparison of cropping systems

	PS B	PS D	PS H
***Enset* plantation**	20,400	14,880	19,680
Garden	34,800	34,800	34,800
Annual crops	P/W//P/W//P/W//B/BB 6,960	P/W//P/W//B/BB 7,680	P/W//B/BB 18,240

Table 4: Gross Value Added (GVA) of different cropping systems (Birr/ha)

***NB**: PS: Production System; basic information about production systems B, D and H are available page 17-19; P: Potato, B: Barley, W: Wheat, BB: Broad Bean*

The gross value added presented above embraces the whole biomass from the field as we counted the residues. Indeed, residues are always given to livestock as fodder and have a high cost of opportunity in this region.

The GVA of the *enset* plantation is different for each production system because it depends on several differentiating factors:

- As *enset* leaves are included in the GVA, the GVA varies with the amount of leaves given to livestock. The GVA of production system B reflects the predominance of *enset* leaves in the fodder management. However, cutting enset leaves corresponds to a destruction of living capital and is not sustainable on the long-term.
- In PS H, the plantation is large enough to wait until 9 years to cut *enset* trees so the *qotcho* yield is higher.

The GVA of the garden is the same for all production systems because we did not consider it as a differentiating factor.

The rotation is the main differentiating factor for the fields of annual crops.
First, we can notice that the less potato is planted, the higher the GVA is. Indeed, cropping potato generates a low GVA – about 480 Birr/ha compared to 2,640 Birr/ha for barley – because of the very low price of potato at harvesting time (only 70 to 120 Birr per quintal). However, potato is totally dedicated to home consumption and is essential for food security in May and June, as shown by farmers of PS B who have a very small plot of annual crops and who cultivate potato very often.
Secondly, the huge difference between the GVA of annual crops of PS H compared to PS B and D is due to the selling period. Farmers of PS B and D sell all their wheat and broad bean harvests in January at the lowest price (4,800 Birr/quintal for wheat and 4,320 Birr/quintal for broad bean). Farmers of PS H have enough cash flow in January to wait until June and even until September to sell their harvest at a double price (8,800 Birr/quintal for wheat in June, 9,600 Birr/quintal for wheat in September and 6,720 Birr/quintal for broad bean in June).

2. Breeding systems

a. Cattle breeding, the keystone of the agrarian system

Cattle breeding represent the keystone of the agrarian system since it is at once a means of production, a source of monetary income, a capital asset and a source of fertility.

For the smallest farms, a cow is rather acquired before an ox because the area to be tilled is still small and the farmer expects to get a calf and milk.
The most vulnerable production systems cannot afford to breed young cattle and the replacement of adults is based on purchase. When purchase is not possible, farmers get a cow in contract with another farmer. The two contracting farmers share the money earned from the sales of calves and the cull cow. The owner takes the cow at home half of the time when it is lactating (which equals to 25% of the time when considering it gives milk every other year). The owner prefers to keep the cow at home when lactating instead of fetching the milk directly at the user's home. This indicates that the opportunity cost of manure is very high. Finally, the user benefits from half of the gross product of the cow while he feeds it 75% of the time.

	User	**Owner**
Dairy products	50%	50%
Calves	50%	50%
Manure	75%	25%
Fodder	75%	25%
Cull cow	50%	50%

Table 5: Terms of the contract on a cow

Moreover, male cattle are essential to provide traction power during the very short calendar interval between the two cropping seasons. There are various ways to access this important means of production:

- A few farmers own two oxen.
- Most of the farmers own one ox and make a pair with another farmer.
- A small proportion of farmers have one ox in contract, sharing equally with the other farmer traction power, food and the price of the cull.
- Farmers who don't have any ox try to borrow them in return of three working days, and usually face great difficulties to sow on time. Yet, they prefer to wait to find oxen, and as a last resort, they plough their land manually (with the ploughing stick and the hoe) or even give their land up for a share farming contract.

Animal feeding relies on a "cut-and-carry" system, in which fodder is cut and then distributed in the cowshed inside the house. The ground is carved with dung channels so that manure goes directly into the *enset* plantation. The few farmers who have straw surplus can mulch the cowshed to form manure which is more stable and more available for soils than just excreta.
For all farmers, *enset* prevails most of the year, except in January when broad beans tops and wheat straws are plentiful. Animal food diversification is possible only when the farm area is important, whereas the most vulnerable farmers completely depend on *enset* leaves. These farmers have no choice but to buy fodder or countertrade it with working days (for example, they get straws and weeds).
The duration of distribution of wheat straws, harvested in January, depends on their quantity and the possibility to store them. Storing straws can ease the transition of the short rainy season, a period during which fodder availability is low and *enset* is the only source of fodder for many farms.

Then residues of potato, barley and later maize take over from *enset* leaves. Some farmers can sow maize at different moments so that maize leaves are available over a longer period. This strategy allows them to postpone the cut of weeds in the *enset* plantation up to June whereas it is done in May for the other farmers.

A second gap period takes place from mid-August to October, before the weeding of broad bean plots. Most of the farmers take advantage of a small deferred grazing area in front of their house, fenced and fertilized in April. However, the area is quite small so *enset* is needed again to secure animal feeding.

We noticed that a few farmers started to sow grass in the *enset* plantation and were careful to cut them after fructification to favor their dissemination. This grass called "*marga*" grows among other weeds under *enset* plants, but this sowing is a farmer innovation since it corresponds to a selection based on forage quality.

Generally speaking, it is important to highlight that every source of forage can be sold and has a high value because animal feeding is in delicate balance. For example, *enset* pseudo stems, which are usually processed for human consumption, are sold in the market for livestock feeding. Some farmers who have a large *enset* plantation even grow special varieties to feed their cattle only.

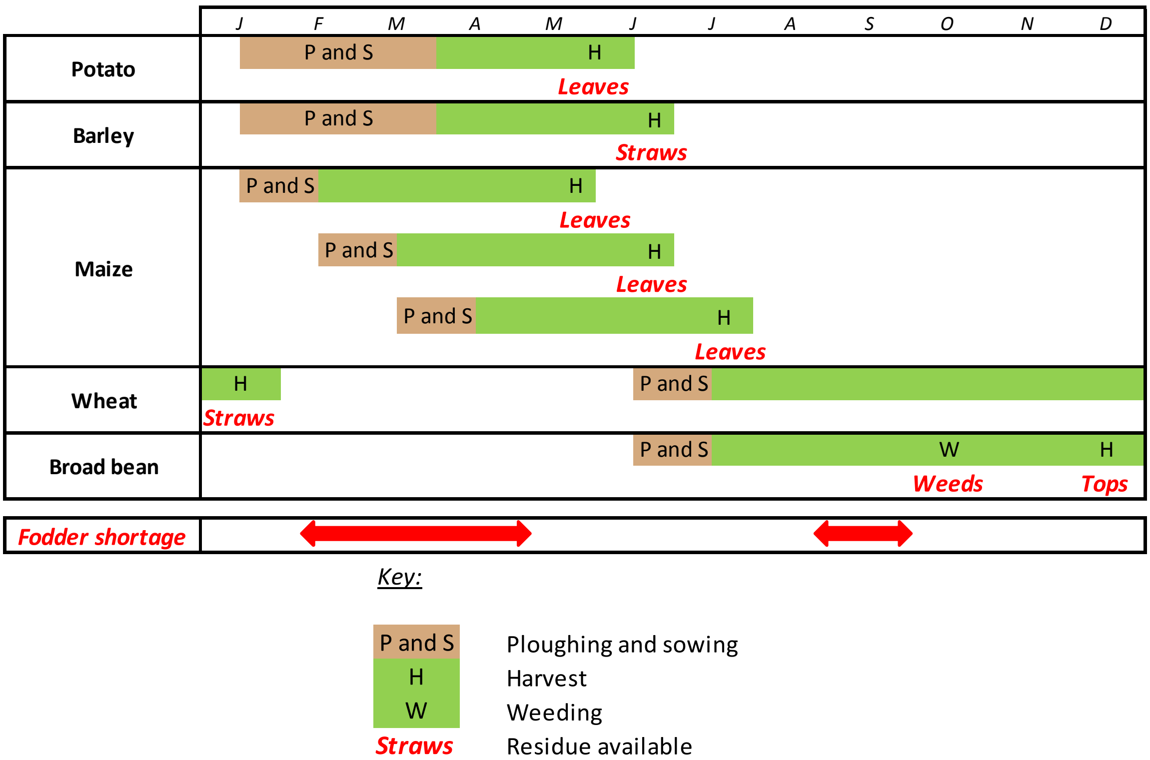

Figure 7: Calendar of the available crop residues – enset leaves are vital to face the periods of fodder shortage in February-March-April and September.

Livestock performances have been decreasing constantly since the imperial period. Due to the decreasing quantity and quality of forage the age at first parturition has increased, as well as calves mortality and parturition interval. Today, most of the farmers have no choice but to sell the calves because of the fodder shortage or in case of emergency (death, disease, emigration). The quantity of milk per lactation varies from 800 to 1,800 L depending on the quality of feeding and the cow breed. Women milk the cow 2 or 3 times per day and use it to make butter and cheese that they frequently sell in the *Doyogena* market. Butter and cheese are worth respectively 1.5 and 2 times more at the end of the dry season compared to the rainy season. This variation directly reflects the availability of fodder throughout the year.

The detailed study of cattle breeding system allowed us to point out many differentiating criteria regarding the feeding and the zootechnical management:

- The **percentage of *enset* in feeding management** reflects the availability of other sources of forage in the farm and is linked to the weakness of the *enset* plantation.

- There is also a great variation in the **duration of feeding with wheat straws**, which lasts from 1 to 7 months. Indeed, the presence of a storing hut when straws are plentiful allows to give straws over a longer period and to avoid the shortage of fodder in the first rainy season.

- The **moment when the weeds growing under *enset* are cut** can vary among different farms. It is preferable to cut them in June so that the collected biomass is more abundant, but some farmers are obliged to start in May when they have no other available source of forage.

- The **presence of maize leaves** in the animal feeding schedule indicates how diversified the sources of fodder are. Some farmers have enough land to incorporate maize in their crop rotation and thus to increase fodder availability in June and July.

- Farmers who have a **patch of grass** in front of their house which is larger than 0.04 hectare enclose it and fertilize it in April. They can cut 2 to 3 times during August and September.

- Farmers who have sufficient cash **supplement the food with wheat bran.** This bran is given to lactating cows, to oxen during tilling periods and to fattening animals. This supplement definitely improves zootechnical performances.

- The **presence of hybrid animals** indicates an ability to have cash flow and capital assets. Indeed, these farmers were able to buy the hybrid cow (which is 50% more expensive than a local cow), or they were able to breed a hybrid calf and to avoid to sell it.

- All these criteria directly influence the **number of liters of milk per lactation**. It varies a lot from one farm to another. We estimated that farmers who have a contract cow and not much fodder can get 800L per lactation, and this low production will be shared with the owner of the cow. Farmers who have some maize manage to produce around 1,000L per lactation with a local cow. Those who complement the fodder with bran and who have plenty of wheat straws can expect to get around 1,200L per lactation with a local cow and up to 1,800L with a hybrid cow.

- The **interval between two parturitions** is 2 or 3 years depending on the feeding quality. None of the farmers we met can manage to impregnate his cow during lactation: the low quantity of fodder doesn’t provide enough food for the cows to breed and lactate at the same time.

- As we explained before, the **replacement of cattle** is not possible for all farmers. The fattening of cull animals is rare because they need an abundant and nourishing fodder. It is necessary to cut *enset* pseudo stems for fattening animals.

- the poorest farmers systematically **sell butter and cheese** whereas the richest keep it for their own consumption, as they have other sources of monetary income.

These multiple criteria on cattle breeding system explain the high variation of gross value added between the different production systems.

- Farmers of production systems A and B, who breed one cow in contract, generate a GVA of 48 Birr. It seems illogical to keep one cow for such a low GVA. As we explained before, this calculation doesn't take into account the opportunity cost of manure, although it could explain why farmers keep on breeding a cow in contract.
- Farmers of production system H create a GVA of 3,840 Birr with two milking cows and two oxen.

	3 examples of production sytems		
	PS B	**PS E**	**PS H**
Percentage of *enset* in feeding management	75%	40%	60%
Duration of feeding with wheat straws	1 month	2.5 months (stored under *enset*)	7 months (stored in a small hut)
Moment when the weeds growing under *enset* are cut	May	June	June
Presence of maize leaves in quantity	no	yes	yes
Presence of a patch of grass	no	yes	yes
Supplement the food with wheat bran	no	no	yes
Presence of hybrid animals	no	no	yes
Number of liters of milk per lactation	800	1,200	1,200 (local cow) 1,800 (hybrid cow)
Interval between two parturitions	3 years	2 years	2 years
Replacement of cattle	no	yes	yes
Sale of butter and cheese	100%	50%	25%

Table 6: Differentiation criteria of cattle breeding system and examples in 3 production systems
NB: PS: Production System; basic information about production systems B, E and H are available page 17-19

b. Sheep breeding, useful in case of cash flow needs

All farmers have one or two ewe in property or in contract, from which they can expect one lamb per year. Whereas cattle are sold to face emergency crises, sheep allow shouldering the usual annual expenses (feasts, seeds and fertilizers purchase). Thus the interest of sheep breeding is not so much to create value but to have a small capital asset that can easily be mobilized. Contrary to cattle, the replacement is always ensured in the farm.
Sheep are fed with a cut-and-carry system, like cattle.

3. The limits of the agrarian system

a. Several constraints

It is necessary to understand the different limits shaping the production systems so as to grasp the global agrarian system.

i. Fodder shortage

As common grazing land is always overgrazed, sources of forage are found only on farm. During the past three decades, the average farm size has decreased more than the number of animals, resulting in a sharp decrease of available fodder unities per animal. Due to this fodder shortage, we estimated that the zoo-technical performances have been quite deteriorated between the imperial period and nowadays. Yet, the study of breeding systems showed how farmers manage the decreasing fodder resource with high precision to make it available all year long. Still, the small quantity of fodder directly limits the number of animals and represents the main limit of this agrarian system.

ii. Fragmentation of land

The major part of our research area is nowadays allocated and cultivated. When the head of the family dies, his farm is divided between all his sons. Thus, the demographic growth combined with a low level of rural migration considerably decrease the size of farmland.
The low rural migration in Ethiopia is an exception in sub-Saharan Africa. Several factors can explain it: on the one hand, the supply of non qualified work in cities is very low; on the other hand, farmers who would have interest to abandon their farm cannot sell their land to constitute a small capital which could allow them to move to cities. Nevertheless, promoting the activation of land market as a way to improve living conditions in rural areas might be a risky strategy. A possible consequence could be the expansion of the largest farms whereas gross value added per ha is higher in the smallest farms (Cochet, 2007-2008).
It is thus getting harder for young people to start farming in this context of land shortage. Generally, they end by choosing agriculture for lack of success in emigration and trading.

iii. Lack of capital

The majority of peasants face a capital scarcity. The impossibility to renew all their cattle and the reduction of the age of *enset* plants or eucalyptus trees at cutting time are indicators of a worrying loss of living capital. In this situation, any immobilization of capital becomes impossible. For example, local cabbage seeds are not affordable for the poorest families even if only two months are needed before its harvest and the corresponding inflow. The cash availibility is too low for these families who have other important needs.

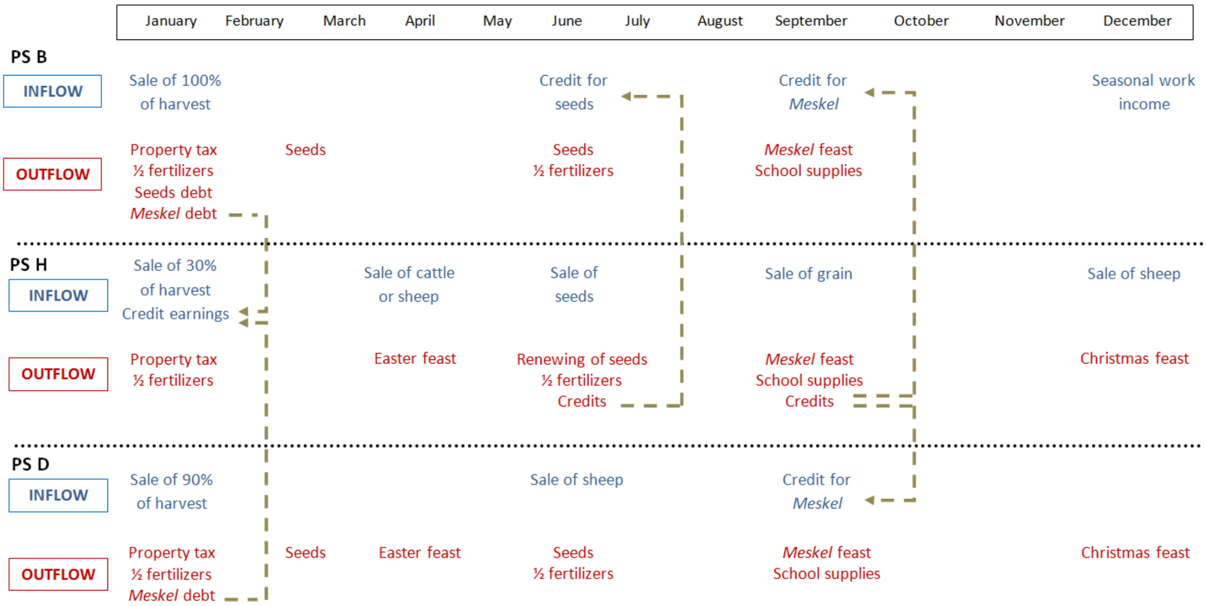

Figure 8: Three examples of cash flow calendars – see the relations of credits between families.
***NB**: PS: Production System; basic information about production systems B, D and H are available page 17-19*

iv. *Fertility crisis*

During the imperial period, animals grazed off farm and the excreta were collected and carried to the *enset* plantation and sometimes to the fields of annual crops. Thus, there were transfers of fertility from grazing land and forest to the farm.

Since the second part of the *Derg*, grazing land has no longer been a source of fodder. All the transfers of fertility take place within the farm. Up to the 2000's, the *enset* plantation has benefited from all the transfers of fertility on farm, to the detriment of:

- the fields, through the exported weeds and straws ;
- the garden, through the exported weeds and maize leaves;
- the patch of grass, through the exported grass.

Moreover, fertility is renewed within the *enset* plantation through the *enset* leaves and roots given to cattle as fodder. For annual crops, the reproduction of the fertility only relied on chemical fertilizers.

Today, most transfers of fertility are organized in the same way, but sometimes the fertility of the *enset* plantation is not totally renewed anymore. In the smallest farms, a part of the plantation is not fertilized every year due to a shortage of animal waste.

With the reduction of subsidies on chemical fertilizers, the increase of their price and the constrained cash flow schedule, it is now common to see manure spread on the fields of annual crops.

Thus, we now observe that the fertility crisis is getting more acute. The *enset* plantation is now weakened, which is worrying for the future of food security in this region.

b. Crisis process

We will now examine how these limits combine together, resulting in a decapitalization process that an increasing number of farmers are facing.
As cattle are the keystone of this agrarian system, the shortage of both fodder and land force farmers to reduce their livestock, leading to several mechanisms which increase vulnerability.

First of all, the reduction of the number of animals per farm makes farmers choose to breed a cow rather than an ox. Yet, owning an ox constitutes a striking advantage as it allows farmers to sow on time during the best period between the two cropping seasons. As a farmer told us, "*an ox is like a worker*". This agrarian system is, like many agrarian systems of Ethiopian highlands, affected by the "*hunger for oxen*" (Cochet, 2007-2008).
The lack of oxen makes farmers lease their land with a sharecropping contract. Indeed, the extent of the loans necessary to buy seeds and fertilizers requires a high yield while the lack of oxen forces farmers to sow lately and put their yield at risk. As poor farmers cannot run this risk, they lease their land to richer farmers who own oxen. Generally, farmers who have oxen look for entering into a contract on additional land which is sometimes located very far from their own farm, as they do not cultivate the maximum area allowed by their yoke. The two contracting farmers put in common seeds and fertilizers and share harvests equally. The user brings the yoke and the workforce.

	User	**Owner**
Seeds	50%	50%
Fertilizers and herbicides	50%	50%
Workforce	100%	0%
Yoke	100%	0%
Grain	50%	50%
Straws/Tops	50%	50%

Table 7: Terms of the most common sharecropping contract

Net Value added = Gross Value added – Depreciation charges of fixed capital (tools)
The Net Value Added represents the actual wealth the farmers create with their work.
The depreciation charges of fixed capital reflect the loss of capital the tools endure each year due to their use.

Agricultural Income = Net Value added – Land Tax – Interests – Salaries – Contracts
The agricultural income aims at representing what farmers earn each year. Indeed, we deducted from the net value added what they pay to access resources: land tax, interest on the borrowed capital, salaries, share cropping and share breeding contracts.
For example, in a share cropping contract, we counted the whole production of grain, whether it is sold or kept for home consumption, in the net value added. To calculate the agricultural income, we deducted the part of the production the user gives to the owner.

In this sharecropping contract, the battle of wills is swapped since the "user's" power of decision is higher than the "owner's". For example, the crop rotation implemented in these fields is generally wheat//wheat//broad bean. The interest of the user is to cultivate only once a year so as to spread out the soil tilling tasks before the second cropping season, whereas the owner would rather cultivate twice a year to maximize the production of his plot.
Another type of contract regarding land is gaining in importance in our research area. Farmers who need an important amount of money (to repay their debts, to pay for funerals, to send a relative abroad, etc.) put their land in pawn. The owner and the user decide the duration of the lease and the amount paid by the user at the beginning. At the end of the lease, the owner has to give back the amount of money paid by the user if he wants to get his land back. These veiled land sales are often irreversible and represent the last step in the decapitalization process for the most vulnerable farmers (Planel, 2011).

Secondly, the decrease of livestock leads to another mechanism of decapitalization concerning cash flow. Selling calves and lambs allows farmers to meet their important cash needs (seeds, feasts, funerals), while dairy products are sold regularly to meet weekly cash needs (salt, kerosene, coffee etc.). When the number of animals decreases, cash inflows shrink and farmers have to borrow money to face their cash needs. Becoming indebted can ultimately drive them to pawn their land, whether to get an important amount of money or to get rid of the risk of not being able to repay their debts.
Thirdly, the reduction of livestock affects the quantity of manure available on farm, which weakens directly the *enset* plantation. As a consequence, there is a drop of *qotcho* production, leading to food insecurity since it is the main food for rural households in Kambatta.

Food insecurity is also a consequence of land leasing since it generally implies a single cropping season per year. Therefore, poor farmers who pawn their land have nor potato nor barley harvest during the hunger gap.

Two retroactivity mechanisms are included in this decapitalization process:

- The weakening of the *enset* plantation and the absence of first rainy season crops limit the quantity of fodder, intensifying the fodder shortage issue.
- The land leasing leads to the concentration of the land in the hands of the most favored farmers, increasing the problem of land fragmentation for the most vulnerable farmers.

It is therefore very hard to get out of this scheme. Moreover, the future demographic growth will increase the fragmentation of land so there is a high risk that this will concern an increasing part of the population.

We can consider several solutions to make the current constraints less harmful, with projects that impact fodder shortage, cash flow needs or the inability to breed an ox. It is urgent to find solutions that can halt the whole decapitalization process, and prevent a possible catastrophic food situation in a few years.

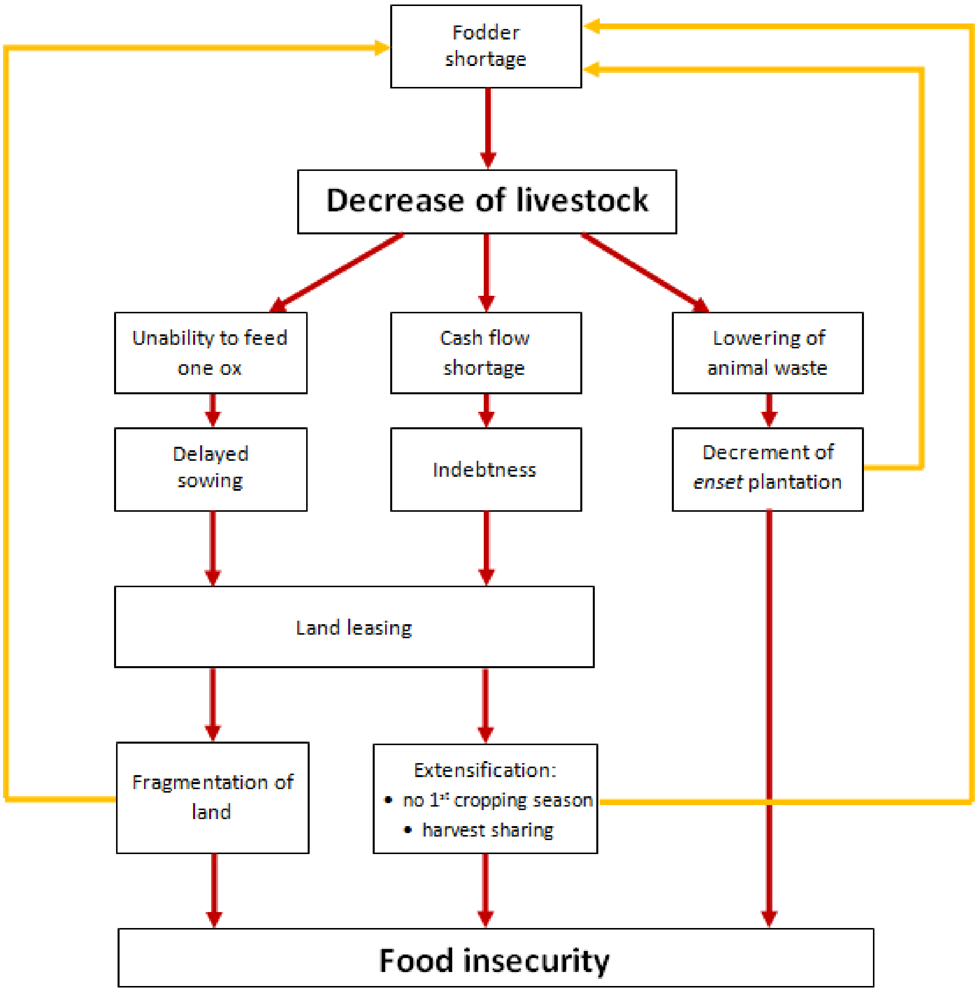

Figure 9: The crisis process

c. Presentation of three production systems

Basing ourselves on the way farmers organize their farming system, on their technical practices and on the economic performances they can expect, we defined 8 typical production systems which are a combination of cropping and breeding systems in a whole activity system. These 8 production systems are an illustration of the diversity of existing farming strategies and of the corresponding agricultural incomes for a range of farm areas.

In spite of an apparent homogeneity of farms, we encountered a great diversity of strategies; indeed, in this agrarian system, "*the least little thing changes everything*" (Cochet, 2011). Among the 8 production systems identified above, we present thereafter 3 production systems as examples of how cropping and breeding systems combine together along with pluriactivity, with the constraints of the limiting factors presented above. Each production system is managed by a nuclear family which is the prevalent social unit in the region.

Production systems B, very small farms in a quite precarious situation

Farmers of production system B have 0.12 to 0.25 ha and breed one cow and one ewe, both in contract. They choose to dedicate half of their plot to a crop sequence which gross value added is rather low (6,960 Birr/ha) whereas the *enset* plantation is only 0.06 ha and creates 20,400 Birr/ha. This choice goes against the usual strategy of maximizing the value created per ha when the size of the farm is decreasing in order to generate sufficient income. We can presume that a shortage of capital prevents these farmers to enlarge their *enset* plantation or their garden instead of annual crop fields. Although it is less visible, the State's influence is a key to understand this strategy. Farmers of production system B enter into credits with the Agricultural Department to buy certified seeds of wheat and broad bean (thus becoming obliged to sell all their grain at low price at the harvesting period) instead of putting the limited capital they have into market garden seeds that could increase the value added per ha. Indeed, as we presented in the historical part, farmers are encouraged to adopt a technical package under pressure; the poorest farmers are also the most vulnerable because they cannot afford to take any kind of risk.

These families consume all the *enset* products, along with all the products from the garden and the first rainy season harvests. Nevertheless, all the dairy products and 90% of the wheat harvest are sold in the market. This is typically the case for families who endure malnutrition, as their diet is mainly made up of carbohydrate, with a very rare intake of proteins, lipids and vitamins. Indeed, if agricultural products are valuable in the market, they are sold so that a cheaper food can be bought. Therefore, these families are the most integrated to the market and the most vulnerable to price variations, which contradicts the idea that integration to the market is the solution to stop poverty from escalating.

As food needs are not totally covered by agricultural production, these farmers must have a second activity. Men go in other regions of Ethiopia during 3 months to work as a seasonal worker.

Both men and women trade alcohol or butter and make bamboo mats. This small-scale trading activity hardly provides a familial income higher than the survival threshold, estimated at 7,020 Birr per year and per family in our research area.

The survival threshold corresponds to the minimum income necessary to survive in this region (1320 Birr/year). The needs we considered include food but also clothes, children scholarship, contributions to Church and Iddir, and the payment of property tax.

It is therefore totally different from the poverty line which is defined internationally.

Production system B			
Number of agricultural labourer: 1		Equipment: some manual tools (sickle, hoe, ploughing stick, ax)	
Total area of farm: 0.25 ha [0.12 - 0.25]		Depreciation charges of fixed capital (tools): 240 Birr	
Cropping systems			
Enset	0.065 ha	GVA/ha: 20,350 Birr	**GVA: 1,320 Birr**
Garden	0.03 ha	GVA/ha: 34,820 Birr	**GVA: 1,060 Birr**
Trees	0.005 ha	GVA/ha: 40,000 Birr	**GVA: 190 Birr**
(Potato/Wheat)x3//Barley/Broad bean	0.125 ha	GVA/ha: 6,860 Birr	**GVA: 860 Birr**
Total cropping systems GVA: 3,430 Birr			
Breeding systems			
1 cow in contract			
GP	Dairy products / Calves / Thin cull cow	860 Birr / 48 Birr / 24 Birr	18 year-old thin cull cow ↑ 1 cow; 1 calf/ 3 years; 40 % mortality; 266 liters/year shared with the owner (local breed) → Male calf: 100 % sold at 1 year-old; Female calf: 100 % sold at 1 year-old
IC	Fodder	740 Birr	
	GVA: 170 Birr		
1 ewe in contract - **GVA : -48 Birr**			
Total breeding systems GVA: 120 Birr			
Total GVA: 3,430 Birr		**Total NVA: 3,170 Birr**	
NVA / ha: 12,700 Birr		**NVA / worker: 3,170 Birr**	
Income calculation			
Ewe in contract : 48 Birr for the owner			
Property tax : 20 Birr		Interest on credit : 100 Birr	
Agricultural income: 3,000 Birr		**Agricultural income/worker: 3,000 Birr**	
External income: 4,560 Birr			
Total familial income: 7,560 Birr		**Familial income/worker: 3,360 Birr**	

Table 8: Main characteristics and economic performances of production system B

NB: *GVA = Gross Value Added, GP = Gross Product, IC = Intermediate Consumptions, NVA = Net Value Added*

J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Wheat straws				Potato leaves	Barley straws	Maize leaves					Broad bean tops
				Enset weeds					Broad bean weeds		
	Enset leaves										

Table 9: Animal feeding schedule of production system B

Product from farm	**% home consumption**
Enset products	100%
Dairy products	0%
Garden products	100%
1st rainy season products	100%
2nd rainy season products	10%

Table 10: Importance of home consumption in production system B

Production systems D, small farms with one ox

Production systems D can be found on farms ranging from 0.5 to 0.75 ha. The main asset of this system is the presence of an ox, in addition to a cow in property. On-farm forage is sufficient to ensure the replacement of only one head of cattle.

Thanks to this ox, these farmers are able to sow on time and thus limit the risk of yield decrease; however, the value added created is reduced compared to a cow which produces milk and calves. Farmers could till up to 0.63 ha with one ox, whereas only 0.25 ha of annual crops are to be tilled in this cropping system. Therefore, the ox is underused in this production system.

A 0.25 ha plot is dedicated to *enset*, which is the maximum size considering the available livestock waste. According to farmers, it is indeed not possible to fertilize a plantation larger than 0.25 ha with two adult heads of cattle.

The production from the *enset* plantation is sufficient for the family, and a part is sold to meet with the weekly cash flow needs. Half of the dairy products are consumed at home, thus a tidy quantity of proteins is provided to balance the diet.

These farmers have sufficient working time to have a small-scale trading activity, which allows their familial income to overtake the survival threshold.

Production system D			
Number of agricultural labourer: 2		Equipment: 1/2 oxteam, 1/2 swing plough, various manual tools	
Total area of farm: 0.6 ha [0.5 - 0.75]		Depreciation charges of fixed capital (tools): 530 Birr	
Cropping systems			
Enset	0.25 ha	GVA/ha: 14,930 Birr	**GVA: 3,740 Birr**
Garden	0.03 ha	GVA/ha: 35,500 Birr	**GVA: 1,060 Birr**
Pasture	0.05 ha	GVA/ha: 1,920 Birr	**GVA: 100 Birr**
Trees	0.02 ha	GVA/ha: 19,990 Birr	**GVA: 410 Birr**
Potato/Wheat//Potato or Red bean/Wheat//Barley/Broad bean	0.25 ha	GVA/ha: 7,750 Birr	**GVA: 1,940 Birr**
Total cropping systems GVA: 301 €			
Breeding systems			
1 cow, 1 young cattle			
GP	Dairy products	3,290 Birr	**18 year-old thin cull cow ↑ 1 cow, 1 calf / 2 years, 40 % mortality, 500 liters/year (local breed)**
	Calves	70 Birr	**Male calf: 50 % sold at 2 year-old, 50% for replacement**
	Thin cull cow	24 Birr	**Female calf: 100 % sold at 2 year-old**
	Thin cull ox	120 Birr	
IC	Fodder	1,920 Birr	
	Veterinary	100 Birr	
	GVA: 1,510 Birr		
2 laying hens GVA: 260 Birr			
Total breeding systems GVA: 1,780 Birr			
Total GVA: 8,780 Birr		**Total NVA: 8,260 Birr**	
NVA / ha: 13,750 Birr		**NVA / worker: 4,130 Birr**	
Income calculation			
Property tax: 50 Birr		Interest on credit: 140 Birr	
Agricultural income: 8,060 Birr		**Agricultural income/worker: 4,030 Birr**	
External income: 1,560 Birr			
Total familial income: 9,620 Birr		**Familial income/worker: 4,270 Birr**	

Table 11: Main characteristics and economic performances of production system D

NB: *GVA = Gross Value Added, GP = Gross Product, IC = Intermediate Consumptions, NVA = Net Value Added*

J	F	M	A	M	J	J	A	S	O	N	D
Wheat straws				Potato leaves	Barley straws	Maize leaves					Broad bean tops
				Enset weeds					Broad bean weeds		
	Enset leaves										
			Exclosure				Grass cuts				

Table 12: Animal feeding schedule of production system D

Product from farm	% home consumption
Enset products	90%
Dairy products	50%
Garden products	50%
1st rainy season products	100%
2nd rainy season products	10%

Table 13: Importance of home consumption in production system D

Production systems H, the largest and most diversified production systems

Farmers of production system H have at least 0.8 ha and cultivate some additional land in sharecropping. They breed two oxen, two cows (among which one is hybrid) and are the owners of the contract cows found in production systems A and B.

These farmers sell cattle to other farmers as a credit for *Meskel* feast, with a 50% interest rate repaid in January. They also sell some bamboo trees that will be processed by other farmers who will sell the resulting mats.

The cropping sequence includes broad beans every other year. These farmers can afford to keep a part of their wheat and broad bean harvests to sell it at high price in June or September. As a consequence, the value added created by annual crops is much higher than for other farming systems (23,040 Birr/ha).

Moreover, these farmers produce vegetables (especially red beets and onions) in a small plot (0.1 ha). In spite of the high value added created by the crop sequence including vegetables (16,080 Birr/ha), most farmers do not practice it probably because the investment to buy seeds is too high. Moreover, a vegetable cycle replaces a potato cycle which is essential for food security and livestock feeding. On the contrary, farmers from production system H have enough land to ensure their potato production and enough capital to buy vegetable seeds.

These farmers are also able to invest in sugar cane production over 0.2 to 0.3 ha, which needs a capital immobilization during 3 years but brings a very high value added (60,000 Birr/ha after 3 years). Finally, they can afford to send a relative abroad. As a consequence, their familial income outperforms the one of every other farming system[13].

These families sell about 25% of their dairy and *enset* products since their production exceeds familial needs.

[13] We estimated that they could get up to 28,800 Birr (1,200€) per year from their relative abroad.

Production system H			
Number of agricultural labourer: 2.25		Equipment: 1 oxteam, 1 swing plough, many manual tools, straw storing hut	
Total area of farm: 1.75 ha [1.5 - 2]		Depreciation charges of fixed capital (tools): 624 Birr	
Sharecropped area: 0.5 ha		*Area taken in contract: 0.25 ha*	
Cropping systems			
Enset	0.5 ha	GVA/ha : 19,680 Birr	**GVA : 9,260 Birr**
Garden	0.04 ha	GVA/ha : 33,500 Birr	**GVA : 1,340 Birr**
Pasture	0.15 ha	GVA/ha : 860 Birr	**GVA : 120 Birr**
Trees	0.09 ha	GVA/ha : 19,780 Birr	**GVA : 1,780 Birr**
Vegetables//Red bean/Wheat//Barley/Broad Bean	0.1 ha	GVA/ha : 16,100 Birr	**GVA: 1,610 Birr**
Potato or Red bean/Wheat//Barley/Broad Bean OR Barley/Broad bean//Maize/Barley	0.15 ha	GVA/ha : 23,110 Birr	**GVA: 3,460 Birr**
Wheat//Wheat//Broad bean	0.5 ha	GVA/ha : 7,220 Birr	**GVA: 3,620 Birr**
Sugarcane	0.25 ha	GVA/ha : 20,040 Birr	**GVA: 5,020 Birr**
Total cropping systems GVA: 26,210 Birr			
Breeding systems			
2 cows, 2 cows in contract, 2 young cattle			
GP	Dairy products	9,620 Birr	**18 year-old fat cull cow** ↑
	Calves	170 Birr	
	Fat cull cow	140 Birr	**2 cows**
	Fat cull ox	340 Birr	**1 calf / 2 years**
	Cow in contract	1,820 Birr	**40 % mortality** **600 liters/year (local breed)** **900 liters/year (improved breed)**
IC	Fodder	8,090 Birr	← →
	Others	220 Birr	**Male calf** **50% sold at 2 year-old, 50% for replacement**
	GVA: 157 €		**Female calf** **100% for replacement**
3 laying hens - GVA: 380 Birr			
1 ewe - GVA: 170 Birr			
Total breeding systems GVA: 4,320 Birr			
Total GVA: 30,190 Birr		**Total NVA: 25,590 Birr**	
NVA / ha: 19,730 Birr		**NVA / worker: 13,150 Birr**	
Income calculation			
Sharecropping redistribution: 1,800 Birr		External workforce wages: 1,200 Birr	
Property tax: 75 Birr		Sale of one cattle for credit : 1,510 Birr	
Agricultural income: 29,010 Birr		**Agricultural income/worker: 12,460 Birr**	
External income: 25,010 Birr			
Total familial income: 53,020 Birr		**Familial income/worker: 23,570 Birr**	

Table 14: Main characteristics and economic performances of production system H
NB: *GVA = Gross Value Added, GP = Gross Product, IC = Intermediate Consumptions, NVA = Net Value added*

J	F	M	A	M	J	Jt	A	S	O	N	D
				Potato leaves							
Wheat straws stored in a hut					Barley straws						Broad bean tops
1st sowing		2nd sowing		Maize leaves							
					Enset weeds				Broad bean weeds		
	Enset leaves										
			Exclosure				Grass cuts				

Table 15: Animal feeding schedule of production system H
NB: *Farmers also complement their cattle with wheat bran.*

Product from farm	% home consumption
Enset products	75%
Dairy products	75%
Garden products	50%
1st rainy season products	100%
2nd rainy season products	30%

Table 16: Importance of home consumption in production system H

By modeling the technical and economic working of 8 typical production systems, we were able to draw a picture of family incomes in the region. The result highlights that earnings remain very low for all families. Agricultural incomes reach only 3,000 to 29,000 Birr per year and per family (125 to 1,200€). It explains why pluriactivity is vital for the great majority of families, as it complement the total family incomes, reaching 7,560 to 53,000 Birr per year and per worker (315€ up to 2,200€).
Moreover, we estimated that more than half of the farms get a total family income which is close to the survival threshold.
Let us notice that the highest income is 5 to 6 times higher than the lowest income. Farmers who are in an auspicious economic situation are able to invest in productions of high value added and in emigration, which contributes to widen the income gap. In addition, the contracts on livestock and land prevent the most vulnerable farmers to create as much value as they could and thus contribute to impoverishment.

IV. Discussion

1. Reviewing of the policies and projects

With this study, the complexity of this agrarian system and its limits has been emphasized. We have then been led to review the policies and projects which are set up by different development agencies.

First, the objectives of these development policies and projects often target one particular limiting factor and do not link it to others. Thus, they cannot counter the whole decapitalization process and are therefore not fully adapted to the existing production systems. Yet, the challenge is to watch carefully the impact of projects or policies on other linked factors.
For example, families who are involved in the *Safety Net* program may receive a cow and/or an ox but they are unable to feed them. Indeed, they are chosen for their high vulnerability which means they have already entered the decapitalization process. These farmers usually end up by selling the animals they received after a few months.
Policies regarding annual crops usually aim at increasing the yield and the gross product. Before disseminating seeds varieties, it is however essential to take the value added into account by considering the expenses of the farmers (seeds and fertilizers) and to compare it to their actual earnings (since the harvest is mainly sold at the lowest price). The varieties sold by the Agriculture Department aim at increasing only the grain yield without considering straw production while wheat straws are absolutely essential in every fodder schedule. Moreover, farmers have noticed for a few years yield losses estimated at 10% per year when saving the seeds sold by the Agriculture Department. To avoid this risk, they buy new seeds of wheat and broad bean every year at high price,

whereas they still select and save barley seeds. This yield loss is difficult to explain without further investigation but we can give some hypotheses. The seeds sold by the Agriculture Department are multiplied in the rift valley that is in very different bioclimatic conditions from those of our research area. The yield could decrease because of a reduced genetic potential that does not allow an adaptation of these seeds to the local bioclimatic conditions. This illustrates the standardization of the activities of the Agriculture Department.
Another example deals with the allocation of the excreta within the farm. Development agents advice farmers to gather manure, crops residues and *enset* leaves to create a compost which will be set aside for annual crops fields so that the quantity of fertilizers purchased can decrease. This advice to allocate more manure on the annual crops aims at solving the problem of cash shortage. However, manure has a very high cost of opportunity and is always directed in priority to the *enset* plantation which releases a higher value added (as we consider products for home consumption like *qotcho*, and intra consumed products like *enset* leaves for animal feeding).

Secondly, the methods used by development actors are often counterproductive even if the objectives pursued can be interesting. Development agents extend « technical packages » which farmers can access only if they follow some pre-determined conditions.
Indeed, the Agriculture Department sells seeds and chemical fertilizers provided that farmers respect the advised quantities per ha. At sowing time, we met development agents who were controlling these quantities on field. However, all farmers have different interests and if they could, they would put different amounts according to their need for straws, their available cash etc.
Another example concerns fodder plants given by the Agriculture Department and some NGOs provided that farmers will implement anti-erosive structures. Then collateral effects can be observed. Some farmers will then build anti-erosive structures in flat areas so as to receive these fodder plants. Other farmers will refuse to take fodder plants in order not to be constrained to make anti-erosive structure even though they probably need to increase their fodder production. In both cases, the initiative appears to be particularly counterproductive because the access to a resource conditioned by the implementation of “good practice”.

It seems urgent to embrace the whole complexity of production systems with a systemic approach linking the constraints that farmers face. It is also pressing to stop restricting farmer’s choices with unilateral and counterproductive development actions. We exposed in this thesis how farmers’ know-how has led to a very highly productive agrarian system. Let us trust farmers who know better than anyone how to increase their value added so that the global wealth could increase as well.

2. Ideas to halt the growing poverty

As opportunities for non-agricultural jobs are still quite limited in Ethiopia – if not non-existant – we argue that options for maintaining poor households in rural areas are economically meaningful. Since most of the rural households are currently facing a situation of poverty, this can be seen as a way of increasing the of the greatest part of the population.
Moreover, this development objective is taken by most NGOs, such as the NGO InterAide which requested and supervised our research in Ethiopia.

Some development actions aiming at providing support to poor households will be discussed below. *The following propositions contribute to answer the question: what investment choices could be made to maintain and develop rural employment?*

In our research area, livestock is the keystone of the current agrarian system and feeding animals is the main difficulty for farmers.
Farmers' innovative attemps to improve animal feeding must be sustained. The production and dissemination of grass seeds growing under *enset* could be eased by implementing a nursery or by multiplying seeds. Propagating fodder plants can contribute to diminish the fodder shortage constraint. The implementation of forage trees and shrubs in the hedges must also be promoted as a way to produce forage and fertility without encroaching on the already small areas available.

However, the difficulty to feed livestock will not stop considering the continuous fragmentation of farmlands. In this context, feeding one draught ox that doesn't contribute directly to create value added will weaken farming systems even more. It has already become unaffordable to breed one ox for some farmers who have entered the decapitalization process described above.
There is a real *"draught oxen paradox"* in Ethiopia (Cochet, 2007-2008). Today, oxen are essential to manage a very short calendar gap between the two cropping seasons. At the same time, the area tilled in each farm is far below the work ability of a yoke (3 to 4 ha per laborer) and could be tilled by hand.
In the long-term, it may be urgent that production systems evolve towards a different cropping system that could help getting rid of yoke. Farmers could then focus on feeding their cows which give them milk, calves and manure.
The diversification and the complexifying of cropping systems with manual tools could greatly increase agricultural and forage production, and thus the value added per ha.

To add to the discussion, let us introduce the case of the rainy and populated mountains of the close Burundi. Like in Ethiopia, the small-scale farms (around 0.5 ha per family) are organized according to the slope and to a decreasing fertility gradient. The house, located at the top of the slope, is surrounded by a banana plantation and a coffee plantation, benefitting from the majority of fertility transfers. Breeding and cropping have been associated for several centuries but cattle have decreased significantly in the 20th century. It is important to notice that agriculture has always been exclusively manual in Burundi, whereas animal draught has dominated for a long time in Ethiopia.
In Burundi, several favorable conditions were met in the 1950's and allowed farmers to implement a "labor-intensive gardened mixed-farming". They have progressively made their cropping systems more complex by associating in the same plot several cereals (maize, sorghum), several leguminous plants (bean, niebe, garden pea), several tubers (sweet potato, cassava, taro) along with fruit trees.
During 2 or even 3 cropping seasons per year, farmers associate species with cycle lasting from a few months up to several years, leading to an overlapping of plant cycles. As a consequence, the work is continuous but relatively better distributed over the year, and several tasks can be carried out at the same time (for example, weeding maize, harvesting red bean and planting sweet potato can be done simultaneously). Moreover, each specie has a different port, root system, has the ability to fix nitrogen from the atmosphere or not, and has a different sensitivity to agricultural risks.

These agrarian transformations resulted in a sharp increase of production per land unit: national food production increased by 150 % without new means of production (nor tools or vegetal material) (Cochet, 2004).
It doesn't mean that Burundian farmers' agricultural incomes are higher than Kambatta farmers' but it is clear that the diversity of crops increases the resilience of Burundian farms and limits the risks linked to prices evolutions or climatic changes. Moreover, these farms are not dependent on yoking animals.

In our research area, we met a family who had a very small land (0.25 ha) but had developed a complex and diversified garden over 0.04 ha, including about ten different species and generating a high value added – approximately 72,000 Birr/ha. Among the species we noticed were red bean under maize, tomato, cabbage, sugarcane, marrow, a local tuber, qhat, fodder grass, along with avocado and mango trees. As a result, workload and harvests are staggered over the year, the local tuber being particularly useful during the hunger gap of September, and both food and fodder productions are ensured.

In our research area, farmers who have a very small land could also develop a diversified cropping system so that the wealth they create per ha could increase.
Some additional interviews with farmers who have started diversifying their crops could help to define some species that are adequate in the region. Crop associations could start in the backyard garden, and could spread little by little over the plot of annual crops.
However, several limits must be taken into account.
Today, **pluriactivity** is essential to ensure a decent income for families who are in a precarious economic situation. Daily tasks done before or after a work day would not go against pluriactivity. Staggering working periods over the year seems quite relevant for the most vulnerable farmers, contrary to their concentration within a reduced calendar gap as it is the case today. In the family who implemented a diversified garden, both workers have a second activity. The diversified garden doesn't compete with pluriactivity because the diversity of cultivated species goes with a staggering of work peaks. However, the work necessary to manage such a garden must not be under-estimated and might be difficult to hold in case of seasonal migration.
The **reproduction of fertility** would be an important constraint in case of diversification and association. Indeed, it would be necessary to compensate the high exportations due to both forage production and human food production. It could be difficult to relie on animal waste, since the *enset* plantation is already weakened. In the short-term, it seems therefore necessary for farmers to keep on providing chemical fertilizers to crop plots, without any conditions so that they can choose the most effective way to use them.
Nevertheless, the **risk** that vulnerable families would take might be excessive, since they usually have no other choice than focusing on their short-term needs. Some further studies could be carried out to design some insurance systems so as to ease initiative and lessen the risk taken.

Tree species could be a central element of a complex cropping system. In Burundi, the development of fruit trees has increased and diversified production (fruits, leaves, firewood and timber) as well as the restoration of the fertility of soils. Indeed, thanks to their deep rooting system, trees allow vertical transfers of fertility from the deepest up to the superficial layers of the soil (Cochet, 2004).

The **need for capital** may be curbing the diversification of crops. Particularly, diversified manual tools and new seeds or plants must be obtained. Providing new tools could help working faster, with more precision and less tiredness. We were amazed by the keen interest aroused by some special tool that rare farmers had brought home (a hay fork, for example). Let us notice that the family who has implemented a diversified garden has regular monetary income thanks to the *SafetyNet*[14] program and thus has a starting capital to buy seeds and several manual tools.

Today, the diversity of tree species in our research area is low. We met a few farmers who recently planted fruit trees (apple and mango trees) or forage trees (*Albizia lebbeck* and *Grevillea robusta*). The increasing interest of farmers regarding these species indicates that they could play a growing part in the agrarian system. In this context, it seems particularly adapted to provide seeds or seedlings of diverse tree species while letting farmers choose which ones they want to introduce in their farm.

We call for further investigations and for small-scale actions to better define what could be more efficient to improve farmers' living conditions. Each farmer innovation should be considered with the highest interest and every farmer should be free to decide which direction he will choose to develop his own production system. Many actions can contribute to build a better economic foundation for these families who should have the right to develop as they want.

Conclusion

Implementing the agrarian diagnosis method in this small region of Ethiopian highlands revealed an alarming situation, showing that most families are currently facing a situation of high vulnerability and great poverty. The situation could become as serious as in the neighbouring Wolayta where the food deficit is chronic.

The agrarian system in place today will probably not manage to feed the growing population. It is now urgent that both food and fodder production per area unit increase so that famine doesn't strike the Ethiopian population in the coming years. In this region particularly favorable to agriculture, farmers have already intensified their production systems when they were free to do so. It has become urgent that development actors support peasants' innovations and ease their access to means of production. Farmers should always have a choice in implementing the processes they consider to be the most adapted and effective for the improvement of their own living conditions.

[14] The "*SafetyNet*" program, partly funded by the European Union, proposes to the most vulnerable families to participate in community works in exchange of a monetary and/or in-kind salary. According to our interviews, the majority of the selected families actually belong to the least vulnerable ones because of corruption within the deciding authorities.

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