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Typology of farms and application of the assisted natural regeneration strategy in southwestern Burkina Faso

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Abstract
Faced with the multiple challenges of natural resource management, Assisted Natural Regeneration (ANR) is one of the strategies recommended especially in Africa for farmers. The present research therefore aims to study the characteristics of farms in relation to the strategy of application of Assisted Natural Regeneration (ANR) in agroecosystems in the southern Sudanian agro-climatic zone of Burkina Faso. The study took place on the outskirts of the Classified Forest and Partial Reserve of faun of Comoé Léraba located in the southwestern part of Burkina Faso. The methodological approach consisted of collecting socioeconomic data from 102 farms through a survey. The analysis of the results reveals that producers interested in ANR can be divided into three (03) distinct classes. It highlights the socio-economic differences as well as the divergences in the conduct of the work of the ANR.

Keywords: assisted natural regeneration, typology of farms, Burkina Faso, West Africa

Introduction

Natural resources constitute the main economic and food source for the populations of many African states with an agro-pastoral vocation. However, some of these countries are faced with a situation of degradation of their renewable natural resources, so that conventional production efforts very often have unsatisfactory results. Indeed, we are witnessing a saturation of agricultural space and an abandonment of the practice of fallowing in several localities in Africa and this would be partly linked to the phenomenon of climatic variability observed everywhere in recent decades.

Improving the management of agricultural land is therefore an emergency for the protection of the environment and for an increase in production. Aware of this reality and anxious to reverse the trend, the actors involved in the management of natural resources are organizing themselves everywhere. The usual reaction of decision makers and funders is to plant trees. However, E. Botoni and C. Reij (2009) [4] show that this reaction is not necessarily the best one and that other alternatives such as Assisted Natural Regeneration (ANR), water harvesting technics could be promoted and supported. To solve the deterioration of the environment while improving the living conditions of rural populations. Moreover, agricultural extension and development institutions have instead begun to work for the maintenance and regeneration of trees in the fields (J. Boffa, 2000) [3].

According to A. Diouf (2002) [5], the introduction of a new agrarian technique in an environment is always an undertaking that requires the consideration of several factors. These are essentially socio-cultural, economic and ecological factors. Indeed, the introduction of the practice of ANR in a region consists in encouraging active participation of producers in order to protect and manage the regrowth of woody vegetation in their field, and to recreate a woody stratum. Previous studies have concluded that its practice has had numerous socio-economic, biophysical and climatic impacts in the Sahelian and northern Sudanian zones of Burkina Faso and elsewhere in West Africa. However, the introduction of Assisted Natural Regeneration raises questions about the real impacts of its application in the relatively more humid southern Sudanian agro-climatic zone of Burkina Faso. Thus, like the Sahel and the northern Sudanese zone, is the application of ANR of interest to all producers in the southern Sudanese zone of Burkina Faso? In other words, what profile of producers is interested in introducing and carrying out the practice of ANR in this area? The present research therefore aims to study the characteristics of farms in relation to the strategy of application of Assisted Natural Regeneration (ANR) in agro-ecosystems in the southern Sudanian agro-climatic zone of Burkina Faso.

Methodological approach of the research

The fieldwork for this research was conducted in the extreme south-west of Burkina Faso as shown in Fig 1.

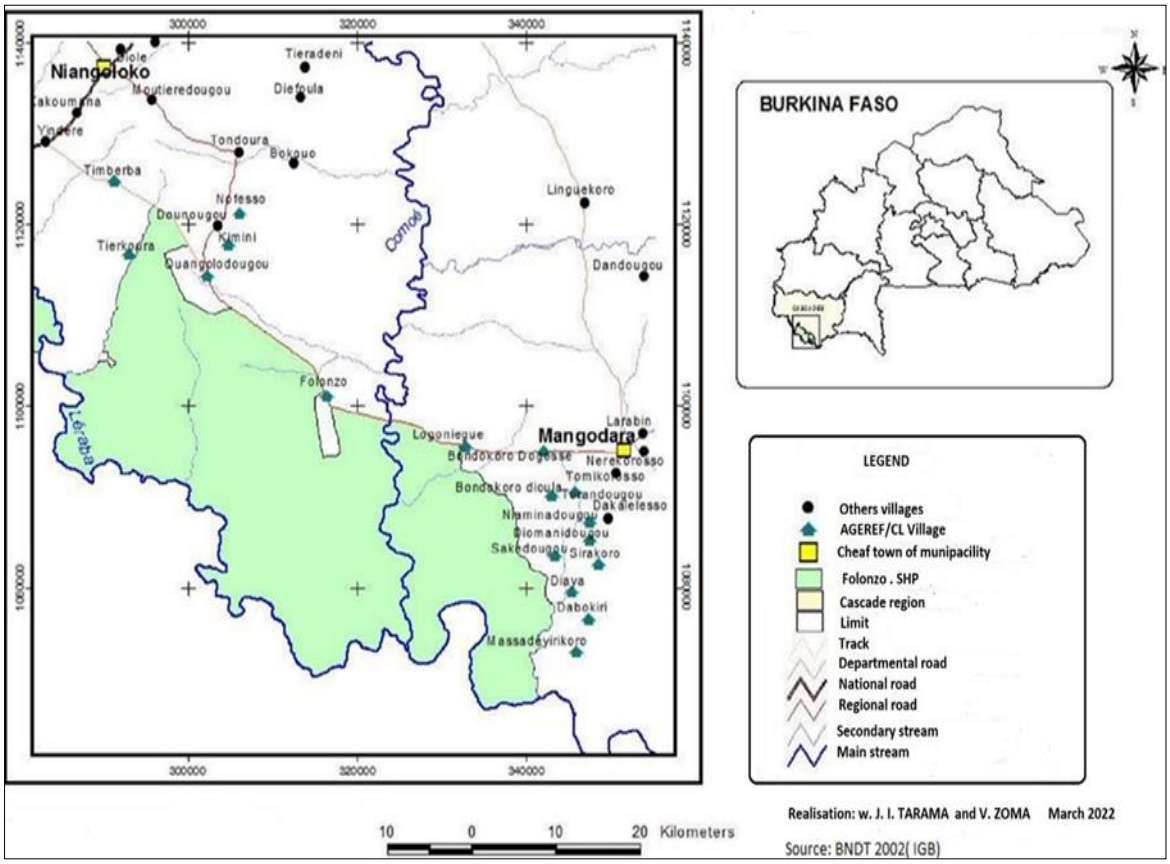


Fig 1: Location of the study area

The study area shown on the map above is between latitude 9°35' and 10°10' North and longitude 4°15' and 5°00' West. It lies along the Ivorian border with Burkina Faso. It is located around the confluence of the Comoé and Léraba rivers. The villages concerned by this research are located between the departments of Mangodara and Niangoloko in the province of Comoé.

The investigation area belongs to the southern Sudanian agro-ecological zone with an annual rainfall that varies between 1000 and 1200mm (S. Guinko, 1997) [6]. Indeed, S. Guinko (1997) [6] identified the well-represented species there as *Daniellia oliveri* (Rolfe) Hutch. & *Dalz, Isoberlinia doka Craib & Stapf, Pterocarpus erinaceus Poir., Khaya seneglensis (Desr.)* A. *Juss*., *Detarium microcarpum Guill*. *& Perr*., *Burkea africana Hook*., *Vitellaria paradoxa Gaertn.f*. In dense, tall gallery forests, species *Berlinia grandiflora* Hutch. & Dalz., Cola *laurifolia* Mast., *Diallium guineense Willd*., *Pterocarpus santalinoides L'Her*. Ex DC, *Manilkara obovata* (Sabine & G.Don) *JHHem*sl., *Syzygium guineense (Willd.)* DC… are dominant while *Khaya senegalensis* (Desr.) *A. Juss*., *Cola gigantea A. Chev*., *Cola cordifolia* (*Cav*.) RBR, *Erythrophleum guineense* G. Don, *Anogneissus leiocarpus G. & Perr*., *Diospyros mespiliformis* Hochst. ex A. Rich…are commonly observed. In developed wooded to tree savannas, on lowlands and on deep soils, the dominant species are *Isoberlinia dalzielli* Craib & Stapf., *Isoberlinia doka Craib*. And Stapf., *Afzelia africana* Sm., *Pterocarpus erinaceus Poir*., *Erythrophylum guineense* G. Don. The herbaceous cover appears discontinuous and is essentially composed of *Anchomanes welwitschii Rentle*, *Sapium grahamii* (Stapf) *Prain*, *Cissus populnea* Guill. & Perr., *Andropogon tectorum* Schumach. & Thonn., *Beckeropsis uniseta* (Ness) K Schum. The population density is around 8.7 to 20.3 inhabitants per km². 90% of the population is engaged in agriculture (S. Guinko, 1997) [6]. In addition to agriculture, animal husbandry is also practiced here. Hunting is one of the traditional practices deeply rooted in local cultures (D. Sirima, 2010) [12].

Concerning the collection of field data, in particular for the choice of the farms studied, the study consisted in carrying out a survey which focused on a group of 230 households having adopted Assisted Natural Regeneration since 2012 and listed in a database from the Comoé Léraba Natural Resources and Wildlife Management Association (AGEREF/CL). Consultation of the database made it possible to take stock of the number of producers concerned by the introduction of the technology in the area. It also made it possible to locate them and organize the implementation of data collection. This is why, concerned about spatial representativeness, a fixed number of 06 operators per village was retained. These 06 operators were chosen by their peers at the village level in view of their availability.

Thus, for the conduct of the investigation, an exploration trip first made it possible to inform the leaders of the villages concerned. This outing made it possible to collect general information on the study area from the personnel of various technical services. All the villages bordering the Comoé-Léraba classified forest and partial wildlife reserve (17 in number) were concerned. The information was collected using semi-structured interviews. The observation unit of the survey was the agricultural holding of the agricultural household type. To do this, the

questions were addressed to the heads of operations. Field observations supplemented the comments of the respondents. Indeed, based on observations and surveys, the analysis of farm diversity leads to the construction of typologies (MAEF, 2002).

For the choice of segregation criteria and variables, the approach consisted first of all in identifying the basic variables for the constitution of the typology. A Pearson correlation analysis was performed to select inter-correlated variables. This analysis made it possible to retain a reduced number of variables (08 in total) for the classification analyses. A survey of the correlation coefficients then made it possible to verify the interest of carrying out a principal component analysis (PCA) of the data. The analysis of the correlations between the variables led to the conservation of 08 variables for the PCA (Table 1).

Table 1: Correlation matrix of the variables retained for the typology of producers

Nbpers[1]	1	0,382	0,431	0,539	0,341	0,476	0,280	0,443
Suptot[2]	0,382	1	0,528	0,395	0,492	0,433	0,305	0,538
SupRNA[3]	0,431	0,528	1	0,363	0,587	0,607	0,490	0,399
Coutotéq[4]	0,539	0,395	0,363	1	0,419	0,773	0,354	0,478
Coutotin[5]	0,341	0,492	0,587	0,419	1	0,709	0,218	0,465
Revprod[6]	0,476	0,433	0,607	0,773	0,709	1	0,428	0,544
Fraiseco[7]	0,280	0,305	0,490	0,354	0,218	0,428	1	0,226
Qtfumorg[8]	0,443	0,538	0,399	0,478	0,465	0,544	0,226	1

Source: Fieldwork

Table 1 above presents the correlation matrix of the variables retained for the typology of producers. In this table, the significant values (off the diagonal) at the alpha=0.050 threshold (two-tailed test) are in bold. The figures after allow an understanding of this table:

1. Number of people living on the farm;
2. Total area exploited during the survey period;
3. Area under assisted natural regeneration;
4. Total cost of farm equipment;
5. Total cost of inputs used during the crop year of the survey period;
6. Income from the production of plots under assisted natural regeneration;
7. Costs saved thanks to the use of organic manure;
8. Quantity of organic manure used.

Many correlation coefficients (r) are quite strong and are above a fixed threshold (r>0.4), which suggests that the analysis is relevant

For the processing of the data collected, they were entered in Microsoft Excel and then processed using XLSTAT software version 7.5.2 and version 16.3.01 from Addinsoft and SPSS (Statistical Package for Social Science).

After checking the correlation, a classification by principal component analysis (PCA) was carried out with the selected variables. The method of moving centers, also called dynamic clusters or K-means, was used to group together individuals who are close. This is the technic best suited to large tables of data. It has the advantage of being efficient and very fast. It is based on the principle of classification based on the criterion of the nearest neighbors. This principle means that each individual is assigned to a class if it is very close to its center of gravity. Moreover, its particularity is that the number of classes must be specified beforehand (M. Hadd 1999).

The last step in processing the collected data consisted of validating the types formed by a discriminant analysis (AFD). In this analysis, the different classes (types) to which individuals belong are used as variables to be explained to characterize the types of farms established.

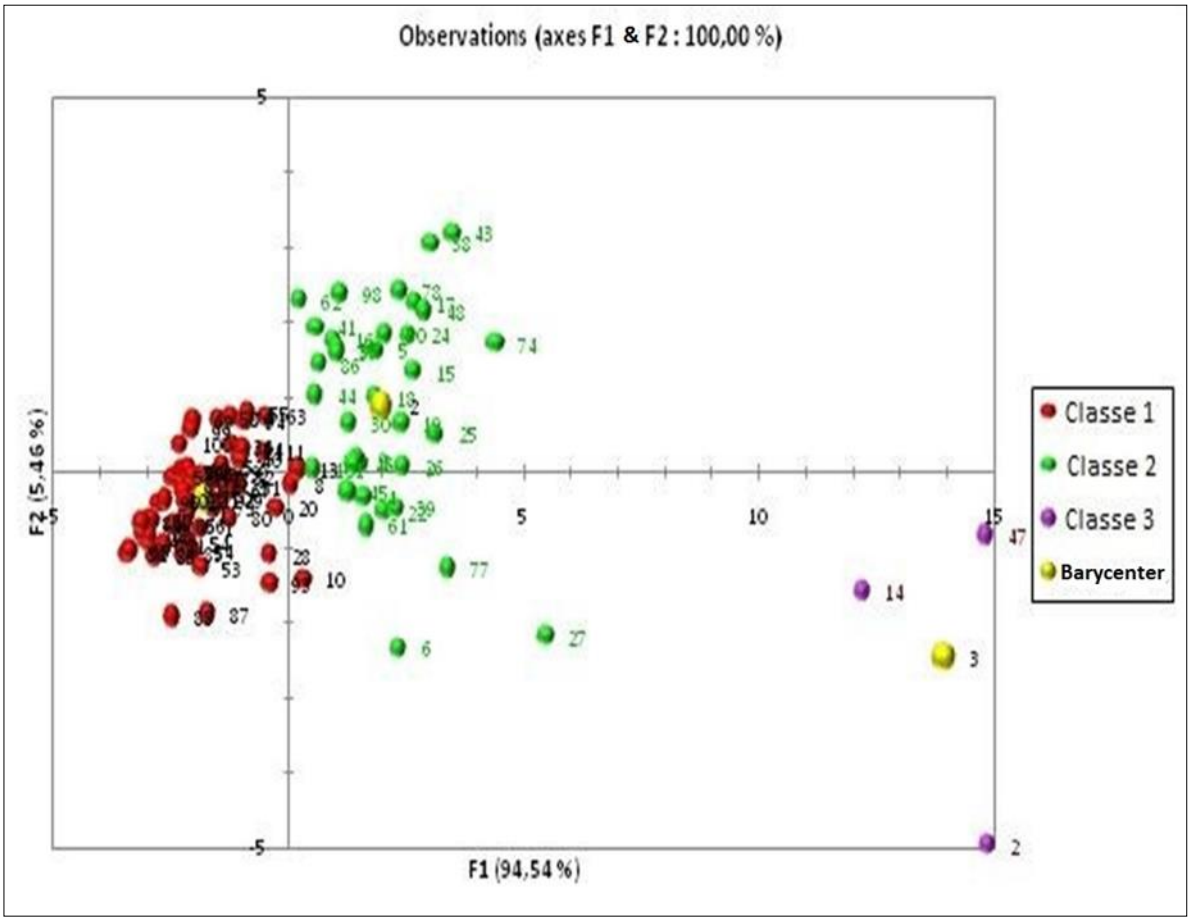
The present methodological approach described in this part made it possible to obtain results which are presented and discussed in this work.

Study results

The results of this investigation focus on the one hand on the typologies and the main characteristics of the different exploitation groups and on the other hand on the strategies and the conduct of Assisted Natural Regeneration in the identified classes.

Typology and main characteristics of the different farm groups

After different analysis scenarios, 3 homogeneous groups of producers were selected. These groups present a certain proportionality between groups and in relation to all individuals. The factor components retained make it possible to explain 82.88% of the variations observed. Chart 1 shows the discriminated grouping of producers by axis**.**



***Source**: Field Works*

Graph 1: Representation of producer classes in the factorial space

Chart 1 shows the discriminated grouping of producers by axis. From this graph above, there are three classes. The first relates to Small Family Farms (PEAF), the second is to Medium Family Farms (EAFM) and the third relates to Large Family Farms (GEAF).

Regarding the class Class 1 (Small Family Farms (PEAF)), it forms 62.74% of the farms surveyed. Farms in this class are the most widespread and are poorly endowed with factors of production. Mechanization is relatively weak there. Half of the constituent producers of this group, i.e. 50% of the farms, have teams. Thus, this class alone concentrates the total number of manual operations. Farms in this class spend less than 2,500 FCFA to 1,600,500 FCFA for equipment and less than 2,500 FCFA to 193,000 FCFA for production inputs. They farm small areas for all of their annual production (on average around half a dozen hectares per farm). The minimum total area harvested in this class is 1.5 hectares and the maximum is 20 hectares. The areas under Assisted Natural Regeneration range from 0.25 ha to 2 ha, i.e. an average of 0.99 ha per farmer. The crops most exploited in these farms are peanuts, maize, cowpeas and sesame.

As for class 2 (Medium Family Farms or EAFM), it represents 34.31% of the producers met during the survey. Farms in this class are moderately endowed with factors of production. The level of mechanization in this class is interesting. All farms (100%) are equipped with hitching. On average, they farm a total annual production area of 12.30 hectares per farm.

The minimum total area is around 5 hectares and the maximum around 24 hectares. They dedicate between 1 to 5 ha of surface area for ANR (i.e. an average of 2.22 ha), and intensify the production of cotton and, to a lesser extent, that of cereals. The minimum cost mobilized for equipment in this class is 270,000 FCFA against a maximum of 3,162,500 FCFA for the same expenditure. With regard to expenses for inputs, the minimum remains identical to that of the class described above but the maximum invested for the same cause is 348,000 FCFA.

Finally, class 3 (Large Family Farms or GEAF) represents only 2.94% of the sample surveyed. The producers have extensive experience in agricultural production. Better equipped with factors of production, they invest at least 2,409,000 FCFA and at most 10,010,000 FCFA to equip themselves. They also spend between 159,000 FCFA and 446,000 FCFA for the purchase of inputs. This explains the high level of mechanization in this class. Indeed, data analysis reveals that 70% of farmers in this group use at least 3 animal traction chains for their work in the field, and one farm is motorized. The highest average total agricultural area exploited (28.17 ha per farm) as well as the average area under ANR (4.08 ha/farm). The minimum total area under exploitation in this class is 9.50 hectares while the maximum is 40 hectares.

After having presented the results in relation to the typologies and the main characteristics of the different exploitation groups, we also present the strategies and the conduct of Assisted Natural Regeneration in the identified classes.

Strategy and conduct of Assisted Natural Regeneration (ANR) in identified classes

In terms of tree regeneration techniques, the survey essentially recorded two regeneration processes implemented in the localities surveyed. The first consists in sparing the natural rejections of foot. This technique is used by 100% of producers of all classes. It is essentially the only process used by all producers of Small Family Farms. In addition to natural shoots from tree trunks, producers of other classes sow or transplant wildlings of species that are not found on their plot in a timely manner. Thus, during the investigations, 41.66% of producers from Small Family Farms and 44.64% of producers from Medium Family Farms claimed to have already sown the species *Tamarindus indica L*. or *Adansonia digitata L*. in their field. This practice has the advantage of contributing to specific diversity in the fields. Those on the relatively more intensive Large Family Farms do not plant.

The silvicultural assistance and care given to trees in the conduct of ANR in the fields varies from class to class. Producers of Small Family Farms are more involved in silvicultural operations to assist regeneration in the fields. In addition to the choice to spare tree bases, to practice thinning and pruning to allow them to grow better, they intervene in the protection against all forms of aggression (mainly men, animals and wind). For this, some producers (more than 3%) in this class said they had installed protection devices for spared feet in their plots. Producers of Medium Family Farms mainly practice thinning to select the plants to be saved and pruning to support their growth. No form of protection has been recorded in this class. Producers of Large Family Farms provide the trees with the care of thinning and pruning mentioned in the previous class, but they are less involved in maintenance operations than producers of other classes. All classes assist the regeneration of feet in the fields through the control of fires. Grazing control is carried out by all producers of Small Family Farms and Medium Family Farms. Producers of Large Family Farms allow grazing in their fields. This is probably linked to the fact that they themselves own cattle or because their fields are very large and therefore difficult to control.

The productivity of the fields under RNA was measured through the calculation of yields per hectare for each speculation and by class. The results are shown in Table 2.

Table 2: Breakdown of yields per hectare by speculation and by class (in kg)

Class	Yield (kg/ha)						
	Maize	**Sorghum**	**Sesame**	**Cowpea**	**Cotton**	**peanut**	**Cassava**
PEAF	974	382	201	166	1100	546	0
EAFM	1849	400	213	156	1000	2000	2250
GEAF	2612	0	80	0	0	0	0
Total	1692	387	199	160	1009	712	2250

Source : *Field Works*

In general, Table 2 shows that yields per hectare are low and vary depending on the class. This is related to the depletion of land eluted for RNA.

In addition, the performance of the farms was also analyzed in relation to the Non-Timber Forest Products (NTFP) harvested in the fields under AN. The distribution of average production at the level of each class is given in table 3.

Table 3: Breakdown of average NWFP production by class (in kg)

Classe	Average production (kg)				
	Shea (almond)	**Néré (seed)**	**Tamarind (fruit)**	**Bombax (flower)**	**Detarium (fruit)**
PEAF	330	94	41	36	0
EAFM	437	76	67	24	8
GEAF	1253	16	70	5	0
Total	394	85	53	32	1

Source : *Field Works*

This table provides insight into the repair of average NWFP production by class. It presents the average production of Shea, Néré, Tamarind, Bombax and Detarim according to the three classes which are Small Family Farms (PEAF), Medium Family Farms (EAFM) and Large Family Farms (GEAF).

After presenting the main results of our study, the last part is devoted to the discussion of these results in relation to especially the literature review concerning our research topic.

Discussion of study results

The discussion of the results addresses respectively the number of classes obtained, the difference in the socio-economic characteristics of the producers and the low technicality of the producers.

Number of classes obtained

The analysis of the survey data led to the constitution of 3 main classes. The same number of classes is also that found by A. Diouf (2002) [5] in the groundnut basin of Senegal when making the typology of farms that have adopted fodder technology in their production system. However, he then proceeds to the dissection of one of the large classes into 2 subclasses to better characterize it. It is also the same number of classes that was found in Burkina Faso by M. Ouedraogo (2008) [11] in the west and by O. Ouattara (2010) [10] in the Loop of Mouhoun region. But, in a study of two villages in the cotton zone of Burkina, Mr. Sy (1992) obtained 5 classes of producers in one of the villages and 04 classes in the other village. The authors M. Sy (1992) and M. Ouedraogo (2008) [11] established their typology empirically while A. Diouf (2002) [5] and O. Ouattara (2010) [10] used factorial analyses. The present study is therefore from a methodological point of view close to the last two authors cited.

In addition to the number of classes, it is important to analyze the socio-economic characteristics of the producers.

Different socio-economic characteristics of producers

The producers concerned by this study differ from one class to another by their own socio-economic and technical characteristics. These results are similar to those of O. Ouattara (2010) [10] regarding the characteristics of Small Family Farms and Medium Family Farms. Indeed, Small Family Farms are similar to type 1 "small family farms" (PEAF), while type 2 called "traditional market family farms" (EFMT) has similarities with Medium Family Farms of this study. However, the fundamental distinction between the two studies has to do with the targetting of farms. O. Ouattara (2010) [10] had targeted family farms while the present study concerned family farms that are not oriented towards entrepreneurship.

The choice to adopt and lead the saving and the planting of trees in the fields is affected by the 08 main variables which contributed to constitute the classes. Since these variables are inter-correlated, they influence each other in a reciprocal manner. From the point of view of age, for example, the youngest and oldest producers are relatively poor in means of production (production area, labour, equipment, inputs, etc.). They are small family farmers. However, they are more respectful of the prescriptions of the technical supervisors and conduct the ANR better in their fields than the producers of the other classes. They are grouped together in Small Family Farms. Furthermore, the different analyzes show that the large family farmers (GEAF) of class 3 are well supplied with factors of production and obtain better yields than those of the other classes. However, these producers seem to neglect certain silvicultural operations in the conduct of ANR. The intensive nature of their production system means that they do not plant trees in their fields. The results obtained by F. Kagne (2012) [8] in the eastern region of the Sudanian zone of Burkina Faso corroborate ours. This author had counted 06 variables that influence the choice of adoption of ANR.

Finally, after having discussed the number of classes, the socio-economic characteristics of the producers, we approach the result relating to the low technicality of the producers.

Low technicality of producers

The study noted in some producers a weak application of agricultural technical prescriptions and in others the persistence of shifting cultivation practices on slash and burn. The same forms of technical deficiencies have already been reported by F. Kagne (2012) [8] in the eastern region of Burkina Faso among producers practicing ANR.

In general, the functioning and structuring observed in the farms studied is similar to the type of agriculture that J. F. Belieres and al. (2002) [1] qualify as family farming. These characteristics were also observed by R. Blein and al. (2008) [2] on 80 to 90% of farms in the entire West African region. According to these authors, these are types of exploitation whose areas vary between 3 to 5 ha. Our results indicate the commitment of a diversity of producers in the adoption of FMNR, but also in the conduct of this agroforestry technique. The commitment to the application of FMNR is therefore not linked to the uniformity of the socio-economic conditions of producers.

Conclusion

This research is a study on the characteristics of farms in relation to the strategy of application of Assisted Natural Regeneration (ANR) in agro-ecosystems in the southern Sudanian agro-climatic zone of Burkina Faso.

The research shows that the actors involved in the application of this strategy in the peripheral zone of the Classified Forest and Partial Wildlife Reserve of Comoé-Léraba correspond to a wide variety of farmers.

They are made up of small, medium and large family-type farmers characterized by significant differences. These differences mainly concern the available surface areas and the technical means with, in some cases, a high level of investment.

These producers also diverge in terms of the technical conduct of ANR. The typology carried out revealed the existence of 03 distinct classes of producers. The practice of ANR therefore interests different categories of producers in the area studied.

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