International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Difficulties to the Crops Forage Integration in Agricultural Farms in the Sudanian Area of Benin (West Africa)

Gbenou B[1], Adjolohoun S[2]*, Houndjo DBM[3], Saïdou A[4], Ahoton L[5], Houinato M[6], Dahouda M[7], Sinsin A.B[8].

[1, 2, 3, 6, 7] Département de Production Animale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Jéricho, Cotonou, Benin
[4,5]Département de Production Végétale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Jéricho, Cotonou, Benin
[8]Département de l'Aménagement et Gestion des Ressources Naturelles, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Jéricho, Cotonou, Benin
*Correspondance ADJOLOHOUN Sébastien, Département Production Animale, Faculté des Sciences Agronomiques de l'Université d'Abomey-Calavi, Bénin. 01 BP 526 Abomey-Calavi (Bénin), Tél: (229) 61781381, E-mail: s.adjolohoun@yahoo.fr

Abstract: ***Inadequate feed and nutrition are major constraints to livestock production in sub-Saharan Africa. The available foraging of natural pastures is gradually decreasing with the degradation of grasslands pastures and extensive cultural practices combined with climatic variability. It is urgent to think of alternatives to alleviate this state of affairs. It is for this purpose that a survey was conducted among 122 cattle farmers on the difficulties related to the integration of fodder crops on farms in northern Benin from April to June 2016. Data for the study was collected by the use of interview schedule. Percentage, mean score and standard deviation were used for analyzing data collected for the study. Results revealed that, 103 farmers don't opted for grazing land mainly because of the existence of free natural grazing land, land factors and the unavailability of seeds. Pastoralists who have integrated forage farming into their production systems encounter many difficulties. Major problems militating against adoption of forage cropping are the limits to the supply of plant material (38.4%), forage conservation (12%), plot maintenance (9%), the effects of wildfires (8%), high costs of closing forage plots (20.1%) and lack of supervision (12.5%). The successful adoption of large numbers of fodder crops in agro-pastoral farms requires the sensitization, training of agro-pastoralists and the supply of fodder seeds to them. If farmers are to take advantage of forage technology to meet livestock market demands, new approaches need to be applied to targeting, designing and conducting research, and providing outcomes to farmers.***

Keywords: Animal feeds, fodder crop, adoption, difficulties, Benin

1. Introduction

Food insecurity and poverty are major concerns worldwide, particularly in Africa despite the increase in global livestock production (FAO 2009; Kiki *et* al. 2018). This is the case of West African countries, including Benin, where livestock farming is a significant economic activity for rural households. Indeed, livestock contributes to Benin for 6.2% of total gross domestic product (GDP) (DE 2013). Thus, for an improvement of the contribution to the national economy, animal productivity must increase (Lesse 2016). In Benin, animal husbandry is mainly limited by food shortages, especially during the dry season (Gbenou *et* al. 2018; Musco *et* al. 2016; Duku *et* al. 2010; Hamadou *et* al. 2008; Adjolohoun *et* al. 2008). This situation leads to animal production that does not cover the demand for meat or milk and therefore increases the country's dependence on other countries and leads to increased imports of meat products. In 2003, the quantity of meat imported into Benin amounted to 88,283 tons, while it reached 188,940 tons in 2013 (FAO 2017).

In Benin, the cattle's breeding is mostly practiced in the northern region. The cattle herd, at the national level, is estimated at 2,339,000 heads in 2016, of which more than half are counted in the north of the country (Houndjo *et* al. 2018; Djenontin *et* al. 2009). Beef production is mainly based on the extensive use of natural pastures, which is only available during the rainy season (Lesse 2016; Houinato 2001). Similarly, the average protein content of these forages, estimated at 15% at the beginning of the rainy season, decreases to 3% by the end of the season (Hishinuma *et* al. 2002; Teka *et* al. 2005; Babatoundé *et* al. 2011; Adjolohoun *et* al. 2013) against a minimum of 7% necessary to ensure suitable activity of microorganisms responsible for the degradation of fodders (Coleman *et* al. 2003). In this context, since the 1980s, many initiatives have been implemented in Benin for the promotion of livestock through the improvement of forage supply, the adequate feeding of animals, reduction of infectious diseases. For example, the Livestock Promotion Project in Atacora (LPPA) aimed at sedentarising pastoralists through the permanent availability of water; feed availability in the dry season and the improvement of customs. The Livestock Development Project in East Borgou (LDPEB) had, meanwhile, worked to remove the constraints related to livestock in its area of intervention. The constraints were: the lack of water for watering animals in the dry season, the lack or irrational use of grazing and the frequency of livestock diseases, which resulted in high mortality rates in the livestock sector of the area. The Borgou Livestock Research and Development Project or FSA_5 project also worked in the same direction. This project used a participatory research approach with the aim of developing appropriate technologies for increasing livestock productivity on farms in north Benin. As such, the forage production component concerned the cropping and extension of several plant species including *Pennisetum purpureum*;

Panicum maximum; *Andropogon gayanus*; *Cajanus cajan*; *Aeshynomene histrix*; *Stylosanthes hamata*; *Leucaena leucocephala*; *Kaya senegalensis*; *Albizia lebbeck*; *Mucuna pruriens* (Schleich *et* al. 1994; De Haan *et* al. 1997; Adjolohoun 2008; Djenontin 2010). However, despite the various convincing results obtained by these projects for the livestock development in Benin, the supply of fodder is still in deficit. On the other hand, the increase in the size of the herd and the conflicts between farmers and pastoralists, partly due to the economic interest granted to cattle breeding and from non-respect of the transition corridors and of the transhumance calendar, imply the research of other alternatives for increasing the available forage for animal feeding in Benin. Also, the adoption of fodder cropping remains ineffective in agro-pastoral farms despite the actions led to promote it (Ehouinsou and Aboh 1998; Djenontin 2009; Adjolohoun *et* al 2013). The lack of adoption of what is clearly well adapted pasture plants would be, in the main, the result of researchers not addressing farmers' requirements. Thus, it is necessary for farmers to be partners in forage research and development so that researchers can understand better the complexities and forage priorities within farming systems. Aim of this work was to identify the factors that influence the adoption of fodder crops in agricultural systems in Benin. Knowledge of these influencing factors would facilitate to fit these crops in agro-pastoral farms in order to increase fodder resources in the dry season.

2. Material and methods

2.1. Study area

This study was conducted from April to June 2016 in North-East Benin in the Tchaourou commune located in the department of Borgou. The commune of Tchaourou is localized between 8 ° 45' and 9 ° 20' of North latitude and 2 ° 10 'and 3 ° 40' of longitude East and belongs to the Soudano-Guinean area. It covers an area of 7256 km² corresponding to 6.5% of the national territory. It has a unimodal climate characterized by one dry season and one rainy season. The rainfall varies between 900 and 1200 mm/year and lasted from six to seven months (April-October) during the year. The relief consists of plains and plateaus surmounted by places of mounds/hills sometimes culminating at more than 300 m of altitude. The soil structure is of the ferruginous tropical type with little concretion. The agricultural sector employs more than 90% of the population. The main crops are maize, sorghum, cowpea, groundnut, yam, cotton, cashew and soy. The rearing of cattle and small ruminants is predominantly dominant (Adjolohoun 2008; INSAE 2015).

2.2. Material

A questionnaire addressed to cattle-breeders enabled to collect relative information's to these: age, marital status, level of education, economic activities, number of years of experience in breeding, whether or not belonging to an association, and to breeding: Herd Size, animal feeding practices, motivations related to the adoption or not of fodder crop, fodder crop Species, land status and size, and difficulties related forage crop.

2.3. Collection of data

A preliminary survey was conducted using a structured questionnaire and was used as a basis for discussions with the farmers. During the survey phase itself, the cattle-breeders were selected according to the following criteria: accessibility and availability for providing information; be a cattle breeder; be an owner of the cattle breeding; have an area of arable land. Thus, with the guidelines of the agents of the Territorial Agency for Rural Development of Atacora Borgou departments, 122 agro-pastoralists were surveyed in total in the study area.

2.4. Data analysis

The data obtained from investigation was entered in to Microsoft Excel 2007© and analyzed using IBM Statistics SPSS 20. For the quantitative data, the means and standard deviations were calculated and compared between the group of producers who adopted the forage crops and the group that did not adopt them. The comparison of the averages was performed using–non-parametric Mann-Whitney U test. For the expression of the distribution of qualitative variables in both groups, cross-tables were performed and the value of the associated Pearson's Chi-square statistic was determined. The significance level considered was 5%.

3. Results

3.1. Socio-economic characteristics of cattle-breeders

Cattle's breeding is a male-led activity (99.2%). The average age of farmers growing forage species is 45.5 ± 6.2 years compared with 53.6 ± 5.5 years for non-producers. Fodder producers are educated with at least primary education level while almost all non-forage producers (96.1%) were not in school ($p < 0.001$) (Table 1). Overall, 25.4% of the interviewed breeders are literate in local languages and those who adopted the forage crop are the majority (78.9% of forage producers) ($p < 0.001$). Livestock is the main economic activity conducted by all the surveyed breeders (76.2%). Thirty six point eight percent of those who adopted the fodder crop are mainly farmers, 31.6% are civil servants, still working in public or private services, 15.8% make livestock their main activity and 10.5% are mainly traders. This trend is not the same in the second category. In fact, farmers who do not cultivate forage species exert livestock as their main economic activity (87.4%). The economic activities carried out differed significantly from one category of breeders to another ($p \leq < 0.001$). However, the main objective of cattle rearing remains the same ($p > 0.05$). Virtually all farmers (99.2%) produce cattle for milk marketing, breeding, traction and saving. Few forage producers belong to breeders' associations (26.3%) whereas no non-forage producer is included ($p < 0.001$) (Table 1).

Table 1: Status of cattle-breeders

		Fodder crop			
Variable	Total (n=122)	Producer (n=19)	Non-Producer (n=103)	x^2	P≤
Gender					
Male	99.2	94.7	100	5.46	0.156
Female	0.8	5.3	0		
Marital status					
Married	100	100	100		
Education level					
Nothingness	81.1	0	96.1		
Primary	4.1	15.8	1.9	112.87	0.001
Secondary	6.6	42.1	0		
More	8.2	42.1	2		
Local language literacy	25.4	78.9	15.5	34.03	0.001
Main economic activity					
Agriculture	8.2	36.8	8.9		
Breeding	76.2	15.8	87.4	93.07	0.001
Trade	5.7	10.5	1.8		
Official	6.6	31.6	1.9		
Crafts	3.3	5.3	0		
Main objective of breeding					
Production and economy*	99.2	94.7	100	5.46	0.156
Social**	0.8	5.3	0		
Belonging to a breeder association	4.1	26.3	0	28.26	0.001

*Milk, reproduction, traction in farm and savings.
** Prestige, gift and marriage.

3.2. Flock, factors of production and fodder crop

The average size in 122 herds surveyed is 43.4 ± 13.1 head of cattle for an average of 52.2± 16.6 head per farmer adopting the forage crop against 41.8 ± 11.7 head per investigated for the second category ($p < 0.05$). The number of active individuals is higher (6.7 ± 1.3) in the category of producers of fodder than in non-producers one (4.7 ± 1.0). The same is true of the area of arable land available to breeders in the first category ($p < 0.001$). However, forage non-producers have, on average, fewer years of breeding experience (9.6 ± 3.4 years) than their counterparts (13.8 ± 5.5 years) ($p < 0.001$). The average forage area is 1.9 ± 0.5 hectares per farmer with an average of 5 years of experience (Table 2).

Table 2: Livestock production capacity

		Fodder crop		
Variable	Total (n=122) Mean±SD	Producer (n=19) Mean±SD	Non-producer (n=103) Mean±SD	P≤
Old (year)	52.3 ±6.31	45.5±6.2	53.6± 5.5	0.001
Cattle size (unity)	43.4±13.1	52.2±16.6	41.8±11.7	0.05
Active member (unity)	5.0±1.3	6.7±1.3	4.7±1.0	0.001
Available land area (ha)	6.8±7.9	22.7±6.2	3.1±2.4	0.001
Breeding experience (year)	13.2±5.4	9.6±3.4	13.8±5.5	0.001
Fodder crop experience (year)		4.9±2.1	-	-
Area of fodder crop (ha)		1.9±0.5	-	-

Figure 1 shows the food resources used to feed cattle. All breeders in both categories use herbaceous forage species for spontaneous rangelands in the rainy season. A minority of forage producers (10.5%) use forage crops for animal feed during the rainy season. In the dry season, all farmers use crop residues and aerial grazing. In addition, forage producers use the fodder resources cultivated. These forage species are grasses, herbaceous legumes and ligneous plants. Grasses and woody forage species are dominant. Figure 2 presents them in the order of predominance in all 19 farms surveyed: *Parkia biglobosa* (100%), *Panicum maximum C1* (89.5%), *Leucaena leucocephala* (73.7%), *Andropogon gayanus* (57%), *Pennisetum purpureum* (42.1%), local *Panicum maximum* (42.1%), *Mucuna pruriens* (31.6%), *Brachiaria decumens* (31.6%), *Brachiaria ruziziensis* (26.3%), *Moringa oleifera* (26.3%), *Gliricidia sepium* (26.3%), *Stylosanthes hamata* (10.5%) and *Phyllanthus muellerianus* (10.5%). In the same farm, several forage species are often grown.

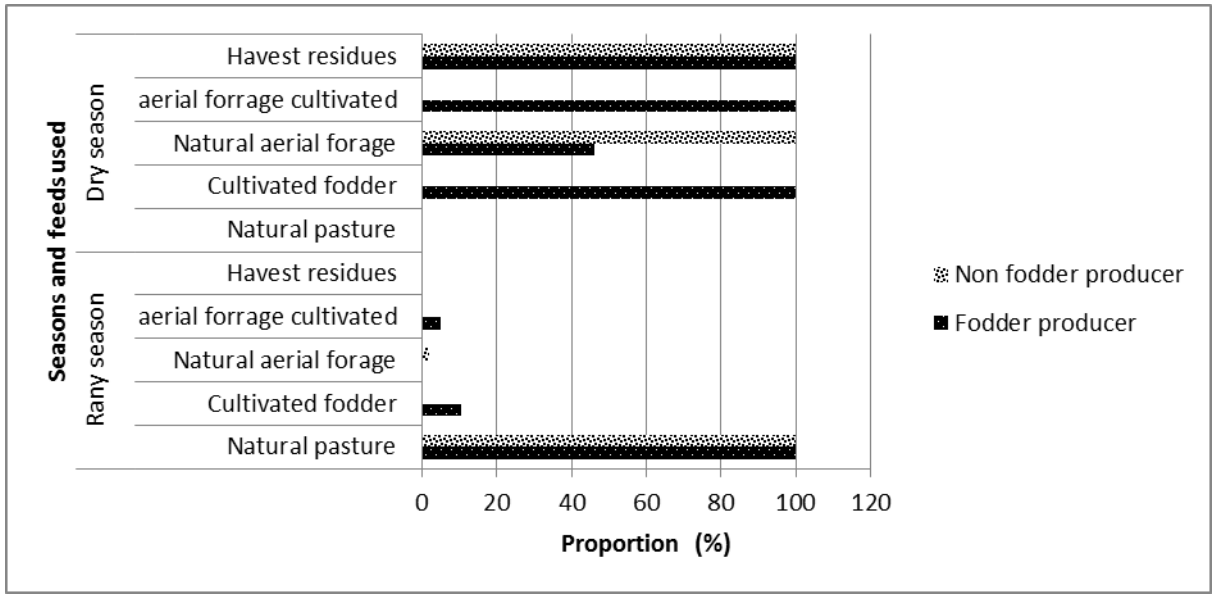
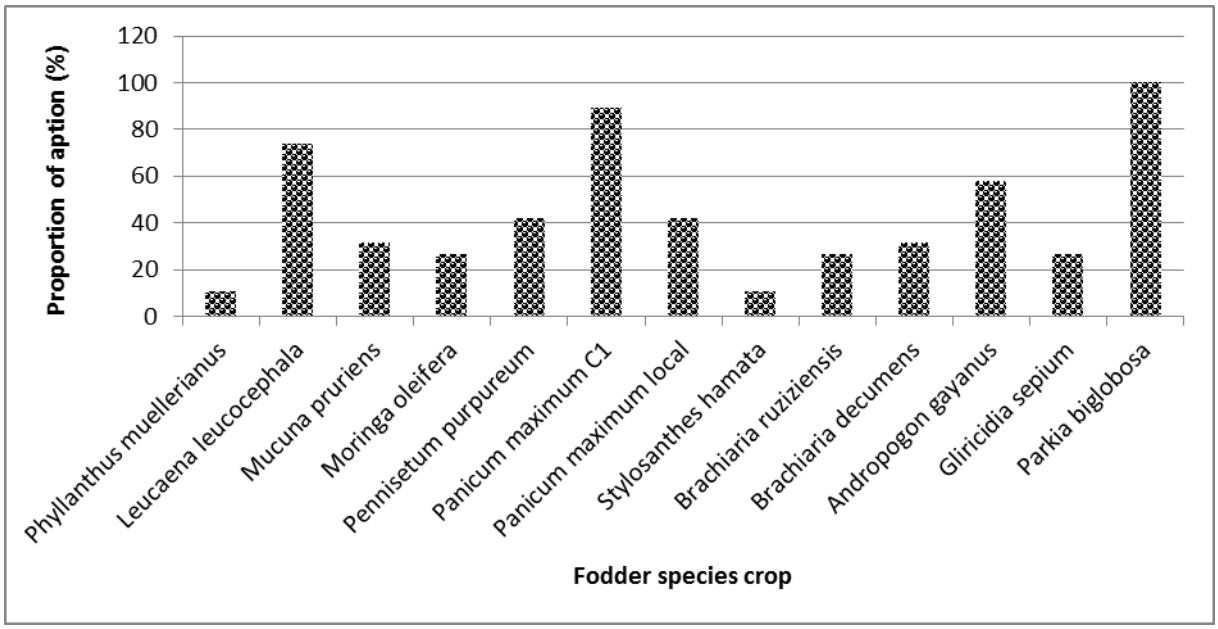


Figure 1: Feeds used in different seasons by cattle-breeders



Figures 2: Fodder species cultivated by cattle-breeders

3.3. Adoption of fodder crops and difficulties encountered

Several reasons are mentioned by farmers who have not adopted fodder crops to justify their position. The existence of spontaneous pasture in free access is the main reason mentioned by these breeders (46.6%). Then, the fence installation costs of the cultivated pastures (19.4%), the limited area of land (17.5%), the cultivated land not belonging to the farmer (10.7%) and the lack of a local market for plant material (5.8%) (Figure 3). Contrary to these, the main reasons for the practice of forage cultivation were the search for food supplements for animals, the prevention of forage shortage during the dry season, the feeding of sick animals and the solution to conflicts between farmers and ranchers that occur each year. However, they encounter obstacles. A proportion of 38.4% of these producers mentioned the main difficulty, the unavailability of plant material necessary for the installation of pasture. Also, the expensive costs related to the closing of parcels (20.1%), the inexistence of the services of technical supervision (12.5%), the difficulties related to the conservation of the fodder (12%). The expensive costs related to the closing of parcels (20.1%), the inexistence of the services of technical supervision (12.5%), the difficulties related to the conservation of the fodder (12%), the forage course maintenance (9%) and the devastating wildfires of the pastures installed (8%) were cited (Figure 4).

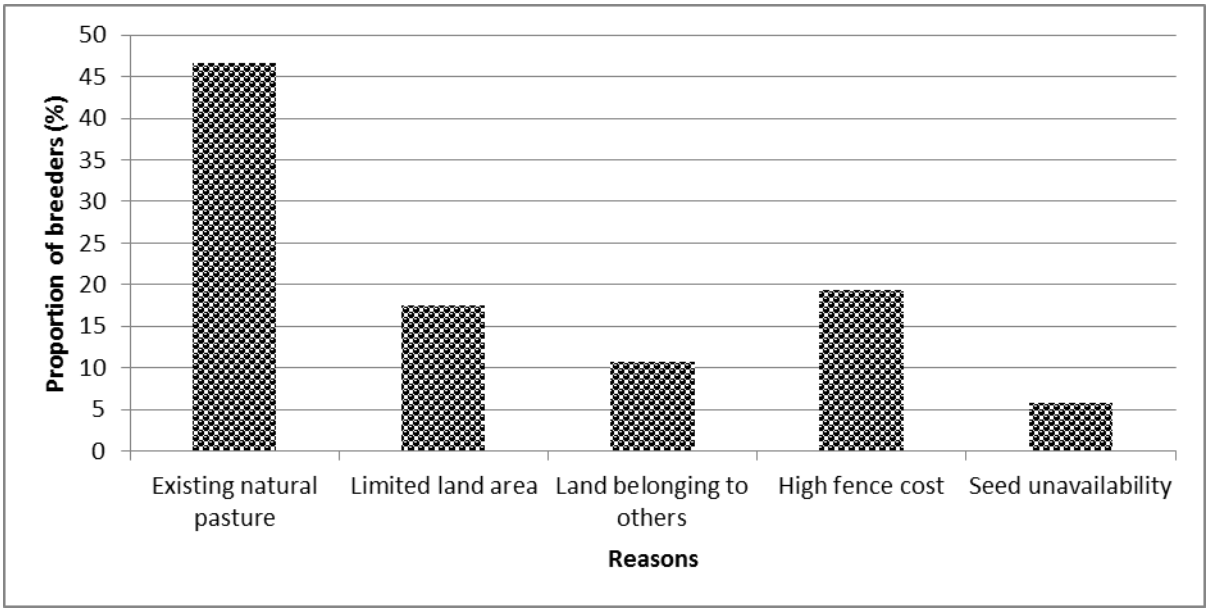


Figure 3: Reasons for not adopting fodder crops

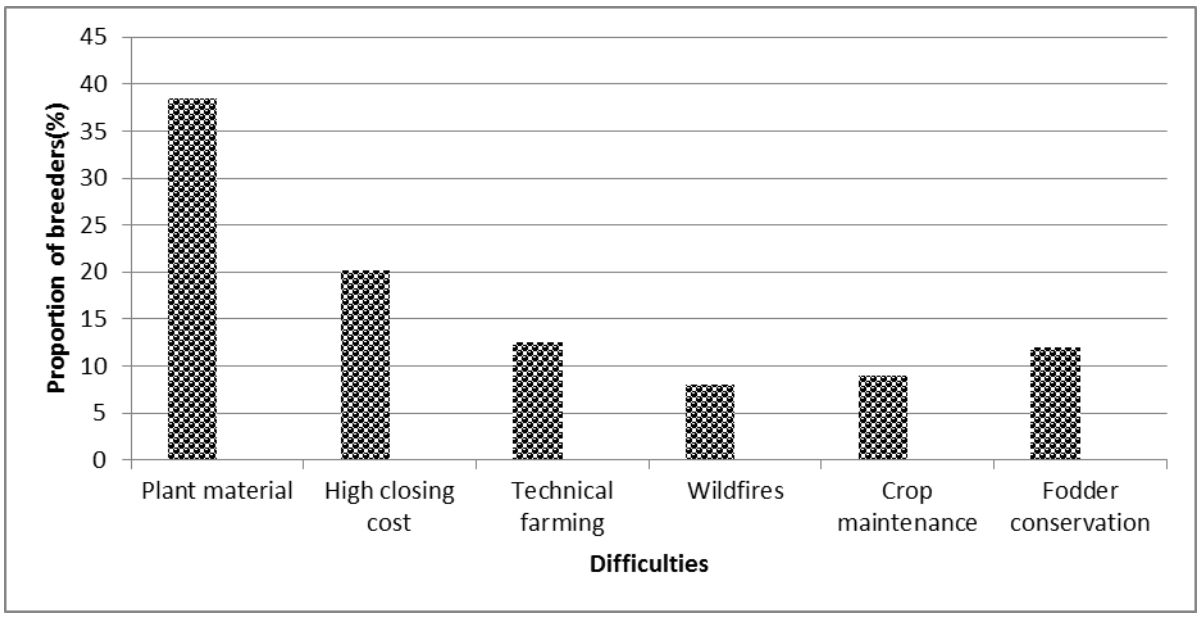


Figure 4: Difficulties about fodder crops

4. Discussion

Forage farming in north of Benin remains an activity that receives little attention. However, with the upsurge of conflicts between farmers and breeders and the economic interest that livestock represents for the populations who practice it, fodder crop is developing better today than it was a decade ago. The adoption of fodder crops is low and is carried out by a new category of breeders designated "agro-pastoralists" (Kate 2001; Djenontin *et* al. 2005). These represent 15.6% of all the breeders surveyed. Such observation is consistent with the rate obtained (18.9%) by Hamadou *et* al. (2005) in the peri-urban farms of Bobo-Dioulasso. These are farmers who have integrated cattle herds. The integration of forage crops allows better feeding of animals during dry season when forage resources are scarce, better management of health and improved growth performance and reproduction of animals. It also avoids conflicts between different users of environment resources.

For cattle-breeders who have not adopted fodder crops, several reasons are also mentioned to justify this choice. These were: existence of natural pasturage, necessary high costs for fodder fields' fence establishment, unavailability of seeds and small area of arable land. This study indicated as Irungu *et* al. (1998) that level of education, years of experience, farm size, membership of a cooperative organization and income were some of the key factors influencing adoption of forage crops. Cattle size of breeders who didn't practice the fodder crop is lower than that of the breeders who do it. Thus, cattle-breeders who have not adopted this practice could therefore move more easily to other soils in search of fodder. The reduction in herd size is a way of resources available managing on the natural pastures of the village soil (Jung and Allen 1995; Djenontin *et* al. 2009). Among those breeders who didn't do the fodder crop, some entrust their flocks to herdsmen who are usually the Fulani ethnic group. These are responsible for leading the animals to pasture on average twice per day. Their

women take care of the milk milking. The cowherd receives also a monthly remuneration. Thus, the owners of the animals explain that the feeding of the cattle is the herdsman task. Therefore, the option of a fodder crop is an additional activity that requires a surplus of financial investment. Also, the main activity of these is agriculture. However, forage production requires space. Thus, livestock and crop activities may become competitive for land resources. Although the demand for feed may increase under these conditions, competition with food crops is unfavorable to forage adoption, particularly because farmers tend to be unwilling to sacrifice food production to produce fodder for animals (Gebremedhin *et* al. 2003; Hamadou et al. 2005). In addition, Thomas and Sumberg (1995) attributed some part of this reluctance to grow forages to producers being unfamiliar with the concept of investing labour and capital in forages rather than staple crops. Farmers have not been accustomed to considering forage production as a part of subsistence agriculture. There is also a lack of appreciation of the value of forage. Many livestock farmers of this category do not consider forage as a valuable crop; accordingly, they would rather take care of a maize crop than a pasture crop. They nevertheless make the crop residues available to the animals. These residues are exploited with aerial pasture in the dry season (Djenontin *et* al. 2004). Cattle-breeders who mentioned the problems of seed availability and who didn't start the fodder crop are those who understood the importance of integrating this crop into production systems but who do not know how to acquire seeds and where they can to receive the training necessary for materialization of their desire. On the other hand, cattle owners who emphasize the existence of a natural pasture and that it is not appropriate to initiate a forage crop are mainly Fulani. Movement with herds in search of water and forage is a cultural reality of these (Crane *et* al. 2011). Increasing grazing frequencies and changing travel schedules (transhumance) are strategies for adapting these to the shortage of feed (Wittig *et* al. 2007). Households in these systems are typically subsistence-oriented and based on seasonal milk production. The livestock herders are dependent on natural pastures and grazing areas, and to some extent the grazing of crop residues in crop systems after harvest. In these systems, adoption of improved forages is unlikely since livestock owners do not usually own the great land area. (Gebremedhin *et* al. 2003). The main residues used were cereal straw (maize and sorghum), crop residues of groundnut and cowpea. The fields thus receive an organic fertilizer through the manure while providing a feed supplement which helps to make the welding during dry season when the natural pastures begin to become scarce (Lesse 2016; Djenotin 2010).

On the other hand, cattle-breeders who have adopted fodder crops have several difficulties. These difficulties related to the adoption of forage crops are technical (management), environmental (wildfires), financial (fence cost of plots) and hardware (availability of seeds). Seed availability affects grasses and forage legumes crop. Certified sources of supply for these seeds are almost non-existent. As a result, farmers are sourcing from other producers, in the wild or at some agricultural training centers. A marketing and distribution system for forage seeds does not yet exist in Benin.

There exist little or no strategy from extension workers to (**i**) inform farmers about available technologies, and (**ii**) increase farmers' capacity to evaluate, adopt, and adapt the most appropriate technologies for their situation from a pool of available ones (Kelly 2006). Thus, only the livestock herders who belong to breeders' associations or those who have knowledge of the training centers can then obtain forage seeds and some technical knowledge on forage production. The level of education, training, information and consequently membership of a breeder' association are therefore determining factors in the integration of forage crops into agricultural systems. The low availability of the seed is also a real limit for the promotion of forage crops. Pasture seed research in Benin must aim to increase seed production and quality through the use of low fertilizer input, improved crop management, harvesting methods, drying, threshing and seed storage. In the initial stage, Government or non-Government Livestock Development Project will encouraged farmers to produce forage seed particularly legumes forage seed which have ability to increase soil nutrients mainly nitrogen which is the main factor that limit plant production. Farmers can be encouraged to produce pasture seed because a higher income can be derived from pasture seeds compared to that of cassava and rice production. Satjipanon (1989) reported that, the income from the sale of pasture seed was US$ 9241/ha for ruzi grass (*Brachiaria ruziziensis*) while incomes from cassava or rice production is US$ 370/ha. During last decades the ruminant population increased markedly (Houndjo *et* al. 2018). Thus, large amounts of pasture seed were required to increase fodder land. Those seeds can be used for pasture establishment in communal grazing land, back yard or under plantation crops. However, the young age of pastoralists adopting forage crops is a hope sign. Indeed, when the adoption of a new technology is more important among young people, it augurs better prospects in the medium and long term (Bultena and Hoiberg 1983). Other influencing factors, such as wildfires and lack of knowledge's over forage conservation methods, are crucial for the perpetuation of forage crops. In fact, forage species don't maintain the same nutritional values throughout the production cycle (Babatoundé *et* al. 2011). Fodder producers must then know when to make fodder cuts and how to preserve these forages during the lean season. It is therefore important that extension services, development projects and non-governmental organizations (NGOs) working in the agricultural sector come into contact with livestock farmers for technology awareness and dissemination. Thus, there grouping of breeders into associations is essential for new technologies adoption and their diffusion (Houndonougbo *et* al. 2012; Kiki *et* al. 2018). The cost of installing fences was mentioned as another limit for the adoption of forage crops. According to the cattle-breeders surveyed in this study, the average cost per hectare of fodder crop establishment was US$ 344 and varied according to the plant material used. Grimaud and Touré (1998) estimated that approximately 365 US $ is required for the establishment of one hectare of the following fodder species: *Panicum maximum, Brachiaria ruziziensis, Stylosanthes hamata, Stylosanthes guyanensis* and *Aeschynomene histrix*. These costs do not take into account the installation of fences (Hamadou *et* al. 2005). In our case, during the survey, the cattle-breeders mainly estimated that the closing establishment costs at three to six

times that of installing grasses and forage legumes. Because of the difficulty of mobilizing this financial capital, the producers are limited to the installation of woody forage species that are both used to feed animals but also used in logging. This is the case of *Phyllanthus muellerianus, Leucaena leucocephala* and *Khaya senegalensis*. Thus, like Pengelly *et* al. (2004) asserted it, the fodder resources are not a commodity in themselves but a means to providing livestock products. As such, they are not usually high on a farmer's list of priorities. It is now time that forage researchers place more emphasis on providing evidence to farmers of the economic benefits and costs of forages.

5. Conclusion

Fodders crop introduction on farms or agro-pastoral practices are hampered by the unavailability of fodder seeds, the lack of producers framing engaged in this activity, the destruction of range lands installed by wild fires, high costs of the fence of fodder plots. However, the adoption of fodder crops is an opportunity because they presuppose, first of all, a decrease in the pressure on natural pasture using. Then, the interest of these forage crops will be mainly to ensure welding fodder, rich in nitrogen for the dry season. Finally, fodder crop is essential to reduce transhumance and, by extension, to settle inter-community or inter-professional conflicts that cause loss of life. Adoption of crop forages can result in increased incomes for smallholders and benefit natural resources management. However, to promote the adoption of forage-based technologies by small- and medium scale farmers in Benin, there is a need for sustained funding of strategic research on forages, for linking on-station with on-farm research, and for farmer-driven research and development. Thus, studies on the selection of high-performance, drought-resistant forage species and the practices of best seed production of these species are to be considered as a result of this study for successful of pasture establishment in agro-pastoral systems. Afterwards, efforts by both government and non-governmental organisations to diffuse pasture seed-multiplication programs and the dissemination of pasture research results to the livestock farming community are necessary.

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