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Relationship between agroecological practices and work organization in tropical crop-livestock integrated systems

Master thesis

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A farming style is a coherent set of strategic notions about the way in which farming should be practiced. It is therefore a particular cultural repertoire. It is a mode of ordering: a coherent set of strategic notions that guide practical actions and informs farmers' judgments. […] It is a decision-making model; it enables calculation […] it also appears as a particular practice: as an internally consistent, congruous, way of farming. The structure and the internal coherence of this practice are informed ('structured') by the cultural repertoire […]

(Ploeg, Laurent, Blondeau, & Bonnafous, 2009)

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ABBREVIATIONS

Atelage: Activités de travail en exploitation d'élevage (Labor activities in Livestock farming)

AEP: AgroEcological Practices

BG: Basic Group

CAP: Common Agricultural Policy

CLI: Crop Livestock Integration

DA: Daily Activities

FDO: Form of Daily Organisation

GHG: Greenhouse Gases

INRA: National Institute of Research in Agriculture

MCI: Moderate Capital Investment

MCLS: Mixed Crop-Livestock Systems

ME: Medium Extensive

NDA: Non Daily Activities

OBG: Off Basic Group

QuaeWork: Qualification and Evaluation of Work

RW: Routine Work

SLI: Small Labor Intensive

SW: Seasonal Work

UAA: Utilized Agricultural Are

1 INTRODUCTION

Combined with the post war context and its urge to feed the population, the common agricultural policy brought intensification in agriculture through the transformation of farm structures toward specialization and mechanization (Dedieu et al., 2006). This system showed its limits regarding environmental impacts among soil leaching and erosion, decrease of soil nutrient content, loss of biodiversity, pollution of groundwater (Ryschawy, 2012). Moreover, the strong use of chemical inputs in crops and animals products is known to have harmful consequences on human health. The recent raise of consumers' awareness regarding the industrial food system changed their demand toward environment friendly products, emphasized by state policies (Havet et al., 2014).

This global trend brought the Agroecology concept up to date to change sustainably agricultural practices. This holistic approach takes into account environmental, social, economical and ethical dimensions to solve actual challenges of agricultural production (Wezel et al., 2009). At the farm scale; it leads to optimal nutrient cycling and organic matter turnover, soil biological activation, closed energy flows, water and soil conservation and balanced pest-natural enemy population (Nicholls et al., 2016). However, adoption new practices related to the agroecological transition would imply changes in work organization. This requires investigating lived and perceived labor conditions. Farmer's strategies integrate technical and economical aspects, as well as parameters relative to work (productivity, community organization, creating leisure time, including private activities…;(Cournut et al., 2012). These parameters deserve to be taken into account to facilitate the agroecological transition. Indeed, if agroecological practices do not fit with farmers' parameters relative to work mentioned above, their adoption will be difficult or impossible. Researchers and policies must take farmers labor into account to propose new forms of work organization (researchers) or financial compensations (policies).

Zoo-technical researchers from INRA (National Institute of Research in Agriculture) oriented their research interests in tools conception to give a better understanding of work organization in farming systems (Dedieu et al, 2006). Their original approach relied on the quantification of labor schedules and classification of farming styles (see definition Ploeg et al., 2009). Work organization is seen as the contextualized expression of a particular pattern of choices

related to: (i) the dimensioning and combination of activities (ii) the technical management; (iii) the equipment and buildings and (iv) the workforce configuration (Dedieu et al., 2006).

Among the diversity of farming systems, mixed crop-livestock systems (MCLS) are seen as an agricultural system able to connect environmental, economical and sustainable objectives (Ryschawy et al., 2012). First, it enables farmers to integrate different enterprises on the farm: livestock provides draft power to cultivate the land and manure to fertilize the soil, and crop residues to feed livestock. Moreover, incomes from livestock may be able to buffer low crop yields in dry years (Herrero et al., 2010). Second, a study from Stark (2016) show that MCLS farms minimize their external inputs due to crop and livestock integration. Due to their spatial heterogeneity and nutrient cycling they have a better impact on biodiversity and less pollution risks than monoculture farming (Ryschawy, et al., 2012). Finally, MCLS farms are less sensitive to inputs and sales price fluctuation because of their incomes diversification and crop-livestock integration capacity (Stark et al., 2016).

Although a large abandonment of MCLS farms is observed in Europe, due to the lack of successors and the high labor demand among others (Ryschawy et al., 2012), MCLS are still important in tropical areas, often in a context of smallholder agriculture (Stark et al., 2016). For instance, in Guadeloupe 80% of farm territory is based on small MCLS (Stark et al., 2016).

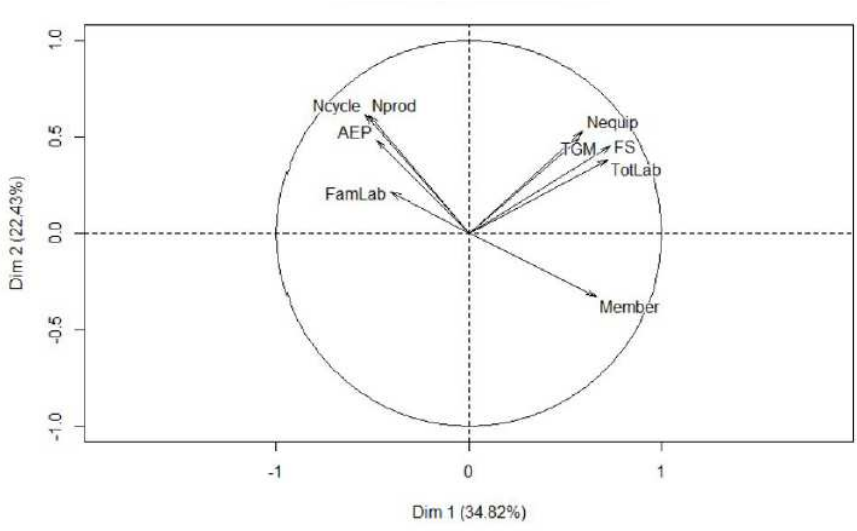
Guadeloupe is a department from the French West Indies where the agricultural sector remains important in terms of social cohesion and landscape maintenance. The rearing of small and large animals such as cattle, pigs, goats, poultry and rabbits is also traditionally widespread in the island and pasture currently accounts for 10 000 ha (31% of utilized agricultural area (UAA)). The number of different products produced by MCLS can vary from 5 to 21 (crop and animal products) and provide a diversity of income, which makes this system more economically resistant to climate and market fluctuations, and also more complex to study than specialized farms.

Until now, very little work has been produced concerning labor in MCLS. Yet, labor can be an obstacle or a lever to MCLS development and AEP implementation.

A recent work conducted in the French West Indies suggests that agroecological practices (AEP) in MCLS are related to family workforce (Figure 1). It means that tasks linked to

agroecological practices are done by the farmer and/or members from his/her family. In the context of agroecological transition, it is important to understand the link between familial work organization and agroecological practices, and why agroecological practices are not related to family and employees whereas components like number of equipment, farm size and total gross margin are.

Correlation circle between production factor variables



Legend: N cycle: Number of production cycles, AEP: Agroecological practices; N prod: Number of production type, FamLab: Family Labor, TotLab: Total Labor (family + hired), N equip: Number of equipement, TGM: Total growth margin, FS: Farm size, Member : Affiliation to distribution channel.

Figure 1: Correlation circle between variables used by Fanchone et al (2017) to discriminate type of farms in Guadeloupe and Martinique (n=215).

It would implies that agroecological practices are rarely delegated to hired workers and the more a farm increases in size, total gross margin and employee number, the less AEP will be applied (Fanchone et al., 2017).This study confirmed the previous results of (Stark et al, 2016) who constructed a farm typology by discriminating farms on the basis crop-livestock integration and production factors. Factors of production are used to produce output. In agriculture, the most important factors of production are: (i) Land (ii) Labor (iii) Capital. In the study, they distinguish land, labor (total and family) and investment (capital) as the main production factors used in tropical

mixed crop-livestock systems. They state that small scale farms are more integrated than intensive farms. According to these works, three farming styles can be defined regarding intensity of production factors and the combination of production:

Small Labor Intensive (SLI) farms with low mechanization; maximum size is 5ha with 1 to 2 family workers. Productions are fruit trees, tubers, market garden and agro-forestry. Simultaneously farmers raise intensively monogastrics such as pigs, poultry or rabbits and extensively ruminants like cattle and/or goats. Crops and livestock are highly integrated.

Medium Extensive (ME) with more UAA (from 10 to 15 ha) for 1 to 2 family workers and low mechanization. Productions are oriented toward exportation and mainly sugarcane. Tubers and market gardens, extensive livestock breeding and semi intensive monogastrics rearing (rarely) were found as second production. Crops and livestock integration is less widespread than in Medium Capital Intensive farms (MCI, see below), as half of the crops by-products are given to the animals, and manure is not valorised back. It seems that this model of development is oriented toward the simplification of farm tasks. However, livestock provide essential complementary incomes.

Medium Capital Intensive (MCI) farms are also managed by 1 to 2 family workers on 10 to 15 ha yet they possess more economic capital which allows them to hire temporary workers and/or enhance their mechanization system. Crops are dedicated to exportation (sugarcane or banana) and seldom forage grasses. Livestock breeding vary in function of the size of productions. This farming style is oriented toward specialization of productions.

2 PROBLEM STATEMENT, OBJECTIVES AND HYPOTHESIS

The context of agro-ecological transition leads farmers to adopt more environmental-friendly practices. These new practices require special work organization which deserves to be analyzed by researchers to match farmers' needs. Mixed crops and livestock farming system are our focus farm type as they support greater biodiversity, better soil quality and water holding capacity, exhibited greater energy output/input ratios, and resilience to climate change (Ryschawy et al., 2012). Moreover, they are highly represented in Guadeloupe and in the world; therefore they present the highest potential for sustainable food production (Herrero et al., 2010).

Objective*: To analyze how the implementation of AEP is organized in terms of types and timing of labor, and how this is affected by the production factors.*

Sub-objective 1: To quantify the labor hours per agroecological practices between family and hired labor resources and the relation with seasonality of production activities (routine work and seasonal work).

Sub-objective 2: To analyze if the labor distribution for agroecological practices differs between farm types differing by production factors.

Hypothesis 1: Agroecological practices are always done by family workers.

Hypothesis 2: Agroecological practices differ in technicality according to the farm's production factors.

Hypothesis 3: Agroecological practices done in farms with small production factors take less time than farms with higher production factors.

My work is part of the AgroEcoDiv project which objective's is to design in an innovative and agroecological approach, efficient and resilient agricultural production systems for Guadeloupe territory. The project brings together the scientific expertise of CIRAD, INRA and the University of the West Indies in multidisciplinary fields ranging from Agronomy, animal production to Humanities and Social Sciences.

3 MATERIALS AND METHODS

3.1 STUDY AREA

3.1.1 GEOMORPHOLOGY

Guadeloupe is a small archipelago situated in the east part of Antilles Islands, 7000 km away from Metropolitan France. Its formation is the result of an oceanic subduction volcanism, which is produced by the sliding of the North Atlantic tectonic plate under the Caribbean plate. From this tectonic structure emerged the two main islands of the archipelago: Grande Terre and Basse-Terre (Sainton, 2012). Despite a common formation, both Islands have distinct geomorphologic settlements. Basse-Terre (848 km^2) is volcanic and is the wettest part of the archipelago whereas Grande Terre (586 km^2) is the driest part with limestone soil.

3.1.2 CLIMATE

Guadeloupe has a tropical humid climate and is characterized by high and constant temperatures (mean annual temperature of 27°C with amplitude of 3°C). Precipitation patterns are observed and related to landform and the position of both islands (Figure 2). Grande Terre Island is relatively plane, small with low altitude which limits the back and fro of important humid air mass. The climate is relatively dry (1500-2000mm/year). Rather, Basse Terre Island has uneven landform. Tradewinds blow water on the mountain part which is called “Côte au vent” (*windward coast*) which receive 3 000mm rainfall/year. The other part of the mountain is called “Côte sous le vent” (*leeward coast*) is warmer and dryer (1500-2000mm of rainfall per year).

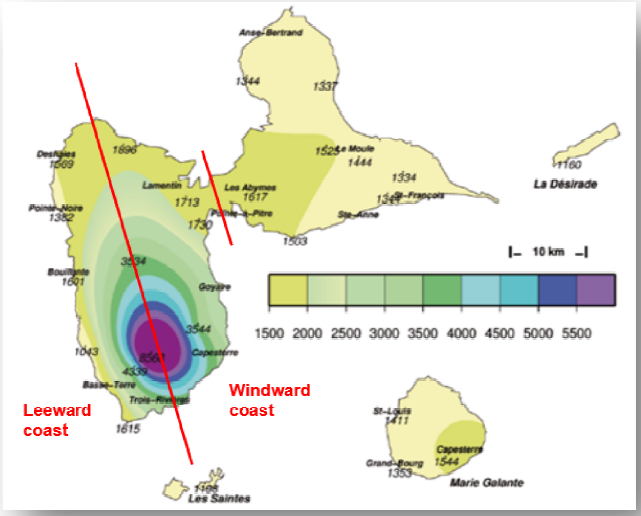


Figure 2 : Mean rainfall in Guadeloupe from 1981 to 2010 (Belfort, 2014)

3.1.3 SHORT HISTORY

French settlers colonized Guadeloupe Island in the XVIIth century with the aim to produce tobacco. After intense land clearing, expulsions, looting and massacres among indigenous Amerindian populations; shipmasters settled on parcels of more than 100 hectares and enriched rapidly together with small independent growers in mixed food crops and tobacco productions (Sainton, 2012). Yet, this pioneer period weakened and crashed since the Great Britain tobacco produced in Virginia arrived on the market with higher value for money than French tobacco (Butel, 2007).

In the XVIIIth century, the discovery of gold resource in Brazil commissioned the French West Indies to access sugarcane demand from the European continent. French merchant gave credits to Guadeloupian settlers to import African slaves for farm hand force in exchange to possess the exclusive rights to purchase sugarcane productions. This slavery production system valued Guadeloupian territory and its market breakthrough (Schnakenbourg, 2005). However, market concurrency and slaves' workforce resistance disrupted this market expansion and lead to bankruptcy and the abolition of slavery in 1848 (Sainton, 2012). In order to remain in the world economical market, banks, traders and administrators modernized the production system; in other

words, they settled sugarcane transformation firms and bought thousands of crops hectares to secure their productions. The fast increase in productivity gains contributed rapidly to the drop of sugar prices and the first world agricultural overproduction happened at the end of the XIXth century. In Guadeloupe, it resulted in deep social and structural issues, as well as indebtedness of industrial sugarcane producers (Schnakenbourg, 2005).

Then, in 1946 with the departmentalization law, French policy for Guadeloupe department evolved toward the development of a “peripheral economy of imported goods” that resulted in import and export trade, mass distribution, building construction and tourism expansion. This economical shift brought agricultural decline due to importation price concurrency and land pressure(Dongal, 2000).

3.1.4 DEMOGRAPHY

411 000 inhabitants are living in Guadeloupe (227 inhabitants/km2); they are spread in 32 municipalities with an overall fairly extensive area (with the notable exception of the towns of Basse-Terre de Pointe-à-Pitre). According to the territorial diagnosis (DDE 971, 2010) the urban framework of Guadeloupe is organized around a hierarchy composed of: the two agglomerations of Pointe-à-Pitre and Basse-Terre; secondary territorial clusters defined by the draft Regional Planning Scheme (SAR) as "poles of balance" and city centers, which supplement this multipolar urban framework. The growing devitalization of most urban centers acted in favor of suburbanization phenomenon with a gradual displacement of urban functions and inhabitants with strong economic power towards the periphery. One consequence is urban sprawl and the decline of arable land devoted to farmers and natural environments.

3.1.5 AGRICULTURE IN GUADELOUPE

Agricultural field encompass 12% of Guadeloupian active population (around 7 800 workers) and covers one third of the island area. There is a total of 31 690 ha of UAA from which 17 036 ha of arable land, 3 404 ha of perennial crops and 10250 ha permanent pastures.

Farms are split within the remaining large mechanized and industrial sugarcane plantation (from 150 to 300 ha), intensive capital crops of desert bananas for export and small and medium-sized specialized or plural-activities farms which benefited from the land reform of the 80s'. **Erreur ! Source du renvoi introuvable.** below protrudes the duality of the Guadeloupian production system.

Table 1: Share of export crops concerning total UAA and subsidies (AGRESTE, 2017).

	Sugarcane	Banana	Total
Share of the total UAA	45%	7%	52%
Share of production subsidies	60%	27%	87%

The number of farms decreased of 35.5 % between 2000 and 2010; from 12099 farms in 2000, the last census from 2010 counted 7804 farms sharing 31 401 ha of UAA. Among those 7804 farms, 4220 (54%) were specialized in large scale cropping system, with mainly sugarcane crops which occupy 13893 ha; 309 farms (4%) were specialized in market garden and orchard cropping system on 1806 of UAA ha and 673 (9%) in fruit for export with mainly desert bananas on 3110 UAA.

The total Guadeloupian livestock unit is 44 509. 1344 farmers specialized in livestock for meat (17%); 217 in off soil breeding system (2%) and 1041 in mixed crops and livestock system (13%) (AGRESTE, 2017).

3.2 DATA COLLECTION

On the basis of the three farms types described in the introduction part, we selected 5 farmers from each type; using the network of farmers followed by Audrey Fanchone from URZ-INRA and Léticia Liméa from Pig Institute IFIP. These farms were retained because they were representative of the type to which they belong and the presence of reference data (Stark et al., 2016). Figure 3 shows the geographical localization of farms within the territory.

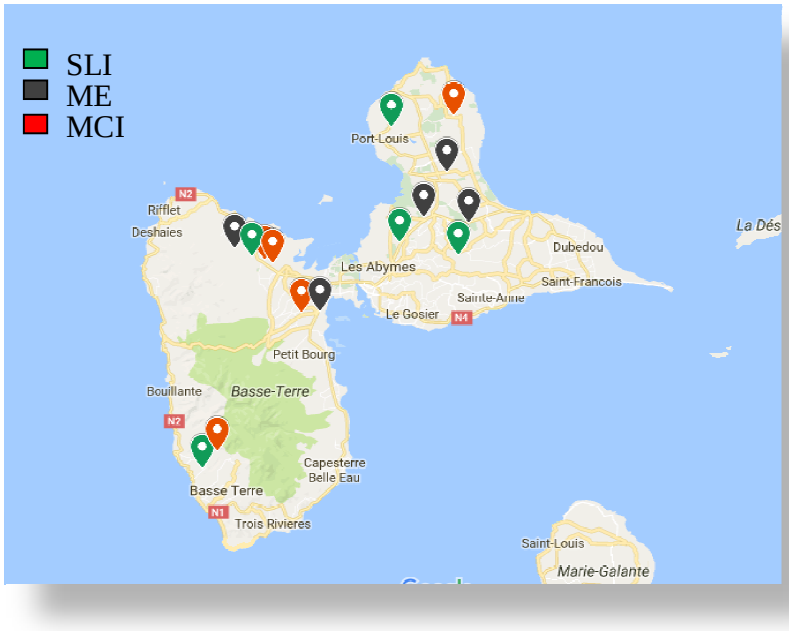


Figure 3 Sample dispersion in Guadeloupe

3.2.1 QUANTIFICATION AND QUALIFICATION OF WORK ORGANIZATION: THE QUAEWORK METHOD

To analyze the farm work organization, we used the Quaework method developed by Hostiou and Dedieu (2011). This method has been tested in several tropical and temperate countries and allows relating the farms' practices to work organization.

This approach is rooted in the combination of the 'Work assessment' model, which represents the work organization and evaluates the duration of activities and time flexibility for farmers (remaining available time in a working day of 8hours), and the 'Atelage' model (Labor Activities in Livestock farming) that describes and qualifies work organization with its various regulations and time scales, integrating the other activities -economic or private- that farmers can

carry out (Malderieux, 2007). Quaework characterizes and qualifies the work organization while taking into account the interaction of farm technical system, workforce and all farm and nonfarm activities. It aims also identifying the reasons underpinning the farm organization (Malderieux et al, 2009).

Besides, the aim of the method is to support farmers in their reflection on the evolution of their operating system and evaluate the consequences of incentives to technical changes on the work organization. The method implies (i) to present the farm as a system with components such as activities, human and material resources, (ii) to define a calendar of activities of permanent and seasonal farm tasks correlated with labor work, (iii) to understand relations between workforces' daily and seasonal activities with quantifying and qualifying daily workload and activities.

The Quaework method assesses work organization by referring to labor input intensities related to ratios (i.e. annual durations divided by farm dimensions like livestock units or hectares of utilized agricultural area; UAA)

It is based on three main principles: (i) all workers are different: tasks require different skills for which workers are not inevitably interchangeable due to their differences in gender, age, aspiration and workforce (Malderieux et al, 2006). Labor force is categorized within **Basic Group (BG)** that is usually family or owners of the farm and workforce **Outside the Basic Group (OBG)**, that are hired workers, internship or volunteers.(ii) Farm tasks are different in time/ rhythm, space and flexibility farm activities are split between the daily **Routine Work (RW)**, which cannot be deferred or concentrated; **Seasonal Work (SW)** which has different degrees of deferability (e.g., weekly for animal handlings, day-by-day according to the weather for work in the field, or over longer periods in the case of land maintenance; Malderieux et al, 2006); **counterpart work** (i.e. reward work for neighbors) and **leisure time**. **Non-farm activities** are also taken into account to calculate the **remaining calculated time.**(iii)The year comprises a sequence of periods, each of them having their specificity of content and duration of work at daily pace. This information is related to time scale with daily, weekly, seasonal and annual rhythms (Malderieux et al, 2007).

QuaeWork method supports the researcher to conduct semi-directive interviews of two to three hours and a half day of data analysis.

In the annex 8.1.1 “Interview Quaework” can be seen all the questions from interviews with farmers. Questions were following three steps: (i)Farm description (size, animals units, crops variety) and farm history; (ii) Workforce available on the farm (Who, when and for which activity?);(iii) Quantification of crops and animal tasks, homogeneous work period in relation to workers type. Data gathered was then inserted in an excel file developed specially for the Quaework method.

3.2.2 ADAPTATION OF THE METHOD TO THE CONTEXT OF STUDY

The QuaeWork method was developed for European Livestock farms with low crops and animal workshops where all farm tasks are described and quantified. Yet, the Guadeloupian farming context is different: farms encompass from 5 to 20 different production activities. The quantification and qualification of farm tasks would be very difficult to recall for the farmer and time taking for the interview. For these reasons, the excel sheet is not going deep in the quantification of farm tasks. To increase the accuracy of the results, farmers were asked to describe day type per period. A day type is characterized by a lapse of time where farm activities are alike and the farmer can estimate seasonal or routine work per day. All crop tasks were grouped by production cycle (short cycle, annual, semi-perennial, perennial) and added to seasonal work excel sheet.

Table 2: Production cycles and main crops produced on guadeloupean farms.

Production cycles	Crop diversity
Short cycle	Market Garden (Zucchinis, watermelon, cucumbers, tomatoes, peppers, chili peppers, eggplant, salad, cabbage, beans, carrot) Rabbits, Poultry, Hogs.
Annual	Tubbers (Yam, sweet potatoes, taro, plantain banana, Malanga) Pineapple, Goats.
Semi perennials	Sugarcane, Bananas
Perennials	Orchard (Bananas, papaya, guava, mangoes, passionfruit, citruses) Bovines, Donkeys.

To estimate crop-livestock integration organization and labor time, we anatomized the practice by tasks type; Gather is the time taken to harvest feed for animals in the farm and prepare it (grind it or cut it); Travel is the time taken to transport the feed from the place it is gathered to animals' workshop and Give is the time taken to give the feed to animals.

For the use of farm based resource as animal feed, one asked the farmer to recall how much time was spent for gathering, bringing the feed to animals, and feeding animals.

In our sample, three types of farm based feed were given to animals:

- Crops by-products which can be crops residues from market garden and tubers, fruits from the farm
- Cut grasses
- Sugarcane under different forms: treacle, stems, leaves.

3.2.3 HOW SURVEYS WERE CARRIED OUT

We realized semi directive surveys using Quaework method which allowed us to gather qualitative and quantitative data.

Among the diversity of agroecological practices and considering our time constraint, we retained solely practices that contributed to the six principles proposed by Nicholls et al (2016; Table 34). Table 5 below shows the relative contribution of AEP to one or more of these principles. Fanchone et al., (2017), suggest that crop-livestock integration, intercropping and crop rotation were the main practices developed in Guadeloupian MCLS. The remaining AEP proposed by Nicholls et al (2016; compost application, cover crop and green manure, mulching, use of microbial/ botanical flowers, …) being marginal or subservient to one specific production were not taken into account. We thus decided to focus on crop-livestock integration, intercropping, and crop rotation.Table 3 Agroecological principles for the design of biodiverse, energy efficient, resource conserving and resilient farming system (Nicholls et al., 2016).

Table 4 Agroecological principles (Nicholls et al, 2016)

1	Enhance the recycling of biomass, with a view to optimize organic matter decomposition and nutrient cycling overtime.
2	Strengthen the "immune system" of agricultural systems through enhancement of functional biodiversity- natural enemies, antagonists etc., by creating appropriate habitats
3	Provide the most favorable soil conditions for plant growth, particularly by managing organic matter and by enhancing soil biological activity
4	Minimize losses of energy, water, nutrients and genetic resources by enhancing conservation and regeneration of soil and water resources and agrobiodiversity
5	Diversify species and genetic resources in the agroecosystem over time and space at the field and landscape level
6	Enhance beneficial biological interactions and synergies among the components of agrobiodiversity, thereby promoting key ecological processes and services

Table 5 Relative contribution of several management practices to one or more agroecological principles (Nicholls et al., 2016).

Management practice	Principle to which they contribute*					
	1		3	4	5	6
Compost application	x		x			
Cover crops and/or green manures	x		x	x	x	x
Mulching	x		x	x		
Crop rotation	x		x	x	x	
Use microbial/botanical pesticides						
Use of insectary flowers					x	x
Living fences			x		x	x
Intercropping	x		x	x	x	x
Agroforestry	x		x	x	x	x
Animal integration (use of farm based resources as feed and use of animale manure as fertilizer)	x		x	x	x	x

*Each number refers to an agroecological principle listed in Table 3

3.3 DATA ANALYSIS

One meeting with farmer lasted one whole morning from which half of the time spent was for hand working with the farmer and the second half for questions. This structure allowed a first contact and observation on the farm environment together with balancing the time that the farmer loses with our questions. Data analysis was done just after the interview for one day in average for each farm. After each interview and data analysis, a second interview with the farmer was done to validate the data outcomes and provide additional information to go deeper in the farming system comprehension. We needed in total 4 days per farm to get all necessary information processed.

Data analysis encompassed both quantitative and qualitative data. Quantitative results were added to an excel file where outputs are shown in annex 8.1.2. From these outputs can be assessed seasonal work and routine work time repartition along the year related to workforce type, activity type, and also one can understand how the farmer shares his time between his different activities. Farms' monographs were made to complement the quantitative results and understand better the excel file's outputs. It described the farm history, farming style and the agroecological practices that were applied in the farm. In annex 8.1.3 can be found an example of a monograph realized for farmer R. The monograph encompassed farm characteristics, farm history, farm management and some explanatory information which relates to the farmer state of mind (sociological, political and economical mindset).

At the end of the data analysis, each farms characteristics and labor time were registered in a common excel file which allowed producing graphics and compare labor time and practices among the farms sample. No statistical analysis could be done because of a lack of sample size.

4 RESULTS

4.1 FARMS CHARACTERISTICS

From the 15 farms surveyed, 14 were managed by male farmers. The farm UAA sample mean was 12 ha. 13 farmers were under a mutual agricultural land grouping contract and 2 farmers were farming on their personal land. Distribution channel were diverse: direct selling, producer markets, wholesale markets, ecological and economical interest grouping, and agricultural cooperation for interest society.

There was a mean of 3 production cycles per farm; from which semi-perennial cycles are present in 14 of the 15 farms surveyed; followed by short cycles (12/15), perennials (11/15) and annual cycles (10/15).

4.2 GROUPS CARACTERISTICS

Small labor intensive farms were characterized by smaller surface than ME and MCI with a mean farm size of 6.4ha (Table 6). They were always managed by one or two basic group member and no permanent worker. There was a mean of 3 production cycles diversity. All farmers had more than 10 crops varieties in their field which is higher than in ME and MCI farms. Animals' diversity was also higher for SLI farms than MCI and ME with a mean of 3 animal species per farm, mean animal number of 53, and an average of 7 poly-gastric TLU[1] per farm. Polygastrics were tethered to a pole for farmers 6 and 14. Farmer 7 and 13 did extensive grazing with a stable for the night. The mean monogastric animals TLU was 6. Animals' species encompassed hogs, goats, pigeons, hens and rabbits raised in artisanal buildings/parks.

ME's mean farm size was 16.5ha (higher than SLI and MCI farms). They were always managed by one BG and one or none permanent worker. There was a mean of 3 production cycles diversity per farm and a mean of 6 crops species. Animals' mean diversity was 2. Farms had higher polygastric TLU than SLI and MCI with a mean 16.22 TLU present per farm. Farmer 12 had part of his livestock tethered to a pole and the rest in extensive grazing area. Farmers 1 and 2 did extensive grazing. Monogastrics TLU's mean was 1.8 and encompassed hogs, goats and hens. They were mainly for house consumption and rose in parks. Farmer 9 was peculiar as he was the only one rearing donkeys, 6 in total tethered to a pole; he did organic farming for: tubers and market garden, and conventional sugarcane.

MCI's mean farm size was 12.7ha. They were always managed by one or two BG members and none or one permanent worker. Crops species was much lower than in other farm types (mean=4), with a mean of 3 production cycles. In spite, sugarcane was highly represented in terms of crops surface except for farmer 4 which only grew intensive tomatoes and chayote monocrops. There was a mean of 2 animal species. Mean animal number was much higher than SLI and ME farms with a mean of 350 animals. Polygastrics were less represented than in ME and SLI farms with a mean of 1.05 polygastric TLU. The MCI rearing system was indoor for monogastrics such as hogs, goats, rabbits and hens.

[1] TLU: Tropical Livestock Unit is livestock numbers converted to a common unit.

Table 6 Farm characteristics

	SLI (Small Labor Intensive)			ME (Medium Extensive)			MCI (Medium Capital Intensive)		
Farm code	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Area	6.4	3	10	16.7	12	20	12.7	7	17
Herd (Animal number)	52.6	7	173	37	6	58	347.4	66	811
Family Labor (labor unit)	1	1	1	1.2	1	2	1.2	1	2
Permanent worker (labor unit)	-	-	-	0.4	-	1	0.4	-	1
Polygastrics (cattle TLU)	5.7	-	15.4	16.22	2	29.4	4.4	-	17.6
Monogastrics (pigs, poultry, rabbits, goats/ TLU)	4	-	18.2	1.9	-	6.1	17.4	8.7	44

4.3 WORK DURATION IN THE THREE FARM TYPES

4.3.1 ROUTINE WORK ORGANIZATION WITH FARM TYPES

The routine work per person of the basic group ranged from 45 min to 7.5 hours per day (mean = 2 hours/day). Total routine work tasks encompassed animal feeding, car ride from house to work place and farm products sales. Percentage of routine work spent for animals by the BG ranged widely from 0 to 100 % (mean=66.7%). Tasks encompassed animal feeding, watering animals cleaning shed and moving animals from one grazing place to another. Figure 4 below shows that only three farms (2 MCI and 1 ME) shared their routine work with OBG members. Tasks shared concern only animal management.

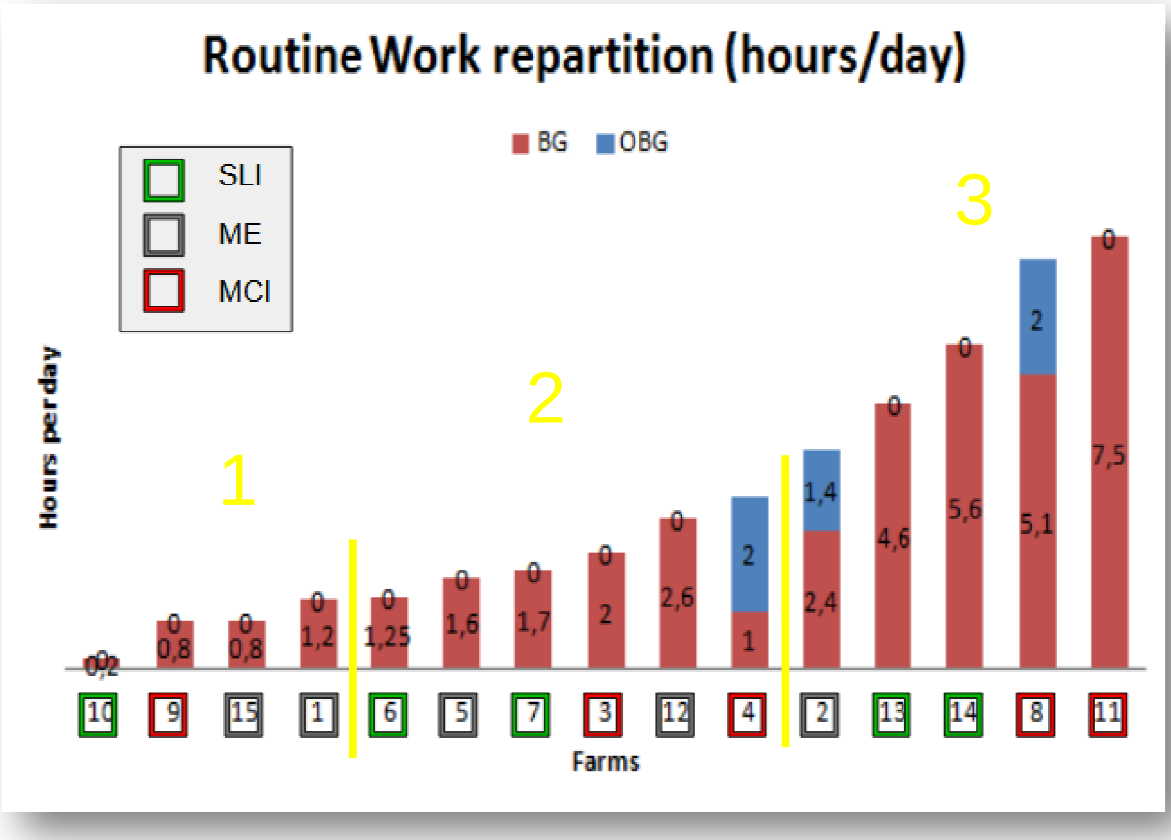


Figure 4 Routine work duration with its worker typer per farm type.

According to Figure 4, routine work varied greatly amongst farming system. Three groups can be formed according to their routine work load and animal management type. From 0.2 to 0.8 routine work hours (group 1), routine work was low and encompassed animal feeding which included giving concentrates for rabbits or changing polygastrics grazing place. Farms 9 and 10 were characterized by a low animal number (4 donkeys tethered to a pole and 20 off soil rabbits) whereas farm 15 raised 440 rabbits in an off soil system, the farmer spent only 45minutes to feed his animals. Then, from 1.2 to 2.6 routine work hours (group 2), routine work increased and is characterized by changing polygastrics grazing place, gathering crops bi-products to feed animals, giving concentrates and watering animals. Farms 1, 6 and 5 were exclusively breeding livestock in extensive grazing system (farms 1 and 5) and pole tethering (farm 6). Farmers 7, 3, 12 had higher routine work since their animals diversity increased to bovine, hogs and poultry which could mean that routine work was increased due production diversification which imply a higher number of

tasks. Finally, from 3 to 7.5 routine work hours (group 3), routine work is high and three farmers shared their tasks wit off-basic group members. Tasks extended to animal care (for intensive hogs breeders), sales and animal feeding. TLU ranged from 11.4 to 44 and production systems are much diversified within farms. Routine work for farmers 2, 13 and 14 was based on animal feeding. Farmer 8 spent 3 hours per day to sell his products which increased greatly his routine work. Farmer 11 with high routine work of 7, 5 had an intensive indoor rearing system with 220 animals he spent most of his time with them.

It seems that no patterns could be seen between routine work and farms type. Routine work increased with animal number and animal diversity, distance between house and farm location, and sale task. We can observe that when the routine work increases, it is most likely to be shared with off-basic group members.

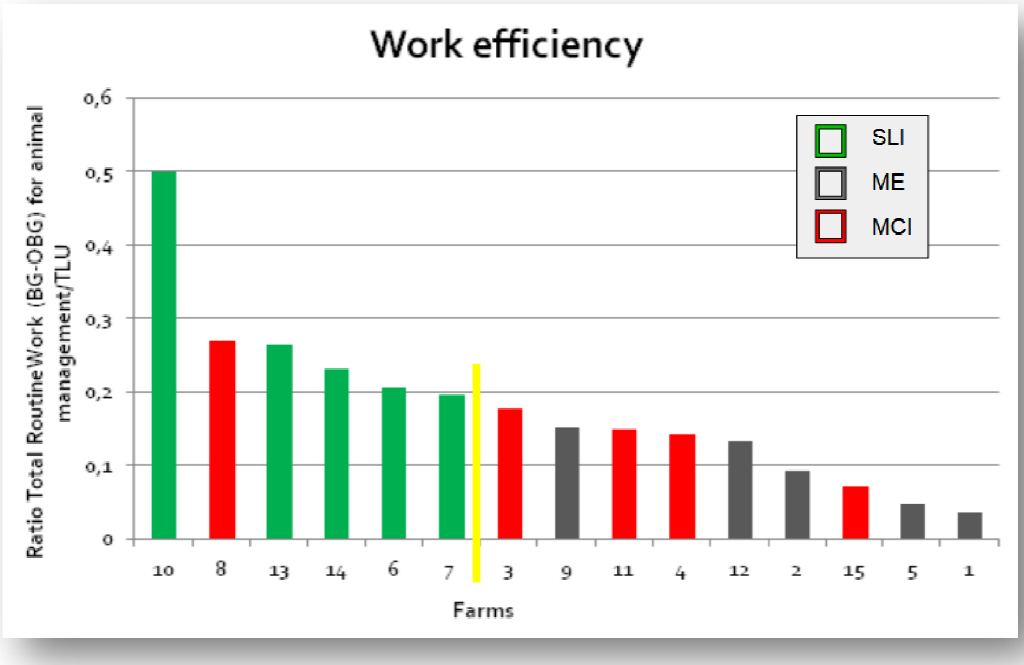


Figure 5 Labor input per production unit with farm type (ratio RW/TLU)

According to Figure 5, the five SLI farms (farms 10, 13, 14, 6 and 7) with one MCI (farm 8) are the six less work efficient farms. They spent more than 0.3 hours of work per TLU per day. This routine work is mainly linked to animal management; farmers 10, 8, 13, 14, 6, 7, 3 and 9 had bovine or donkeys tethered to a pole and needed to move animals every two to three days which is a time taking activity. Even though farmer 8 has an off soil farming system for hogs and donkeys which should be more time efficient due to the optimization of space, the separation of his animals place add consequent travel time to the RW task.

The rest of the sample (five ME and three MCI) spent less than 0.15 hours per TLU per day (farms 9, 11, 3, 4, 12, 2, 15, 5 and 1) mostly for feeding and watering animals. Indeed, their breeding systems were characterized by free-grazing for bovine or off soil breeding for hogs and poultry.

4.3.2 SEASONAL WORK ORGANIZATION WITH FARM TYPES

The seasonal work per person of the basic group ranged widely from 0.6h to 16.7h per day (mean=4.3hours). Seasonal work tasks encompassed crop tasks, external economic activity, veterinary visits, animal care and product sales. 80% of farms were growing sugarcane. This crop was systematically conducted with conventional practices (even for farmers with organic cash crops). It implied a high workload pick during three to four month and no management for the rest of the year. Crops management was done mechanically for all farms. Farmers require the help of a service provider to manage the sugarcane crops with one or two tractors and an average of 6 off-basic group workers.

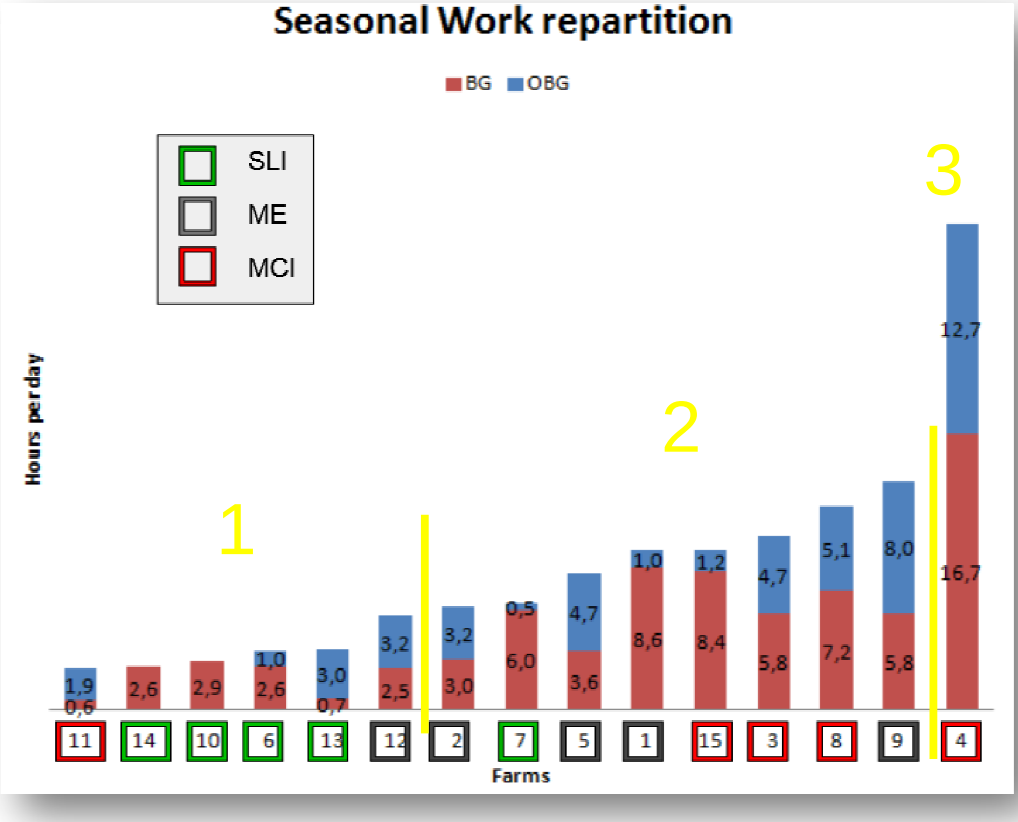


Figure 6 Seasonal work repartition with its worker type and farm type

The repartition of seasonal work delegation within total farm labor is presented in Figure 6. Only two farms (14 and 10) did not hire external workforce, they were also the ones with the smallest surface area of 4 and 3ha, respectively. Three groups of farmers can be formed on the basis of their total seasonal work. From 2.5 to 5.7 seasonal work hours (group 1); seasonal work is low and concerns mostly SLI farms. Three farmers (11, 13 and 12) solely grew sugarcane; which resulted in a high seasonal work period from March to July and no seasonal work for the rest of the year. Farmer 10 was growing trees which are not labor intensive thus seasonal work was low. Farmers 14 and 6 were very diversified yet their crop area were small (respectively 4 and 10ha). Then, from 6.2 to 13.8 seasonal work hours (group 2), seasonal work increases as farmers have more crops cycle diversity such as sugarcane, market garden and tubers. Farmers 7, 1 and 15 do not hire much off-basic group seasonal workers because they either prefer to work alone or with other basic group members. Farmer 3 is peculiar as he grew only sugarcane and 1 ha of tubers. His seasonal work happened during the sugarcane period where he provides services as tractor driver for sugarcane crop management. The farmer with 29.4 seasonal work (group 3) has a high seasonal work as he is doing intensive tomato and chayote on large monocrops. The fields are not reachable by tractors therefore crops are labor intensive.

The seasonal work was linked mainly to both family and seasonal workers. Sugarcane mono crops, orchard or small cropping area results in small seasonal work whereas higher surface area and crop cycle diversification increased seasonal work.

4.4 AGROECOLOGICAL PRACTICES (AEP) AND WORK ORGANIZATION IN THE FARMS

4.4.1 AEP IDENTIFIED IN THE FARMS

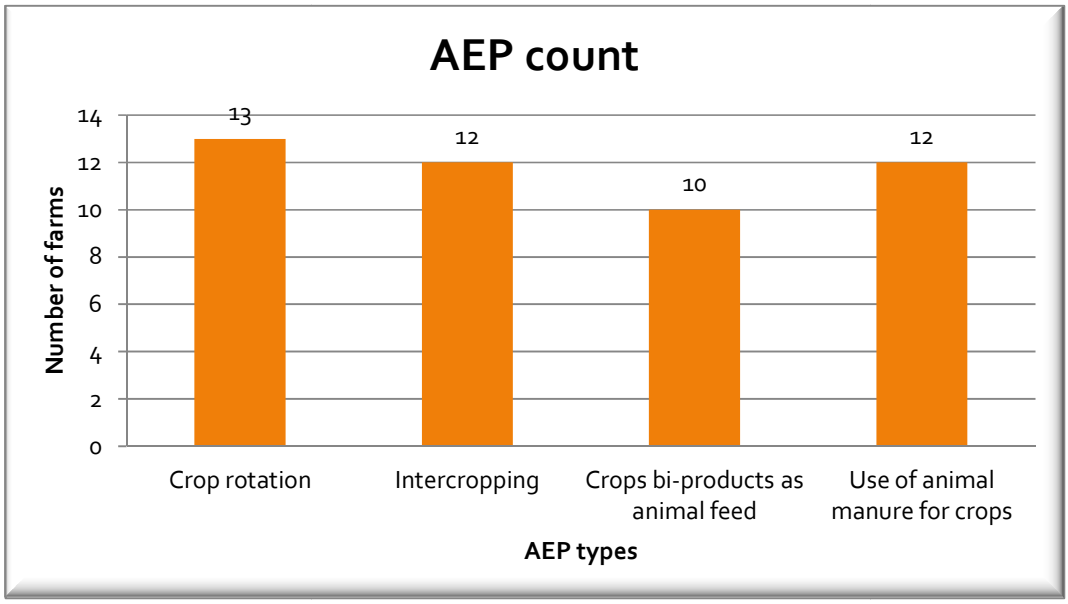


Figure 7 Number of farms per agroecological practices type.

Figure 7 presents the share of agroecological practices per farms; 13 out of 15 farmers were practicing crop rotation and 12 farmers intercropping in at least one of their crops. 10 farmers were using crops residues to feed their animals or complete their feed and 12 valorized animal manure as crop fertilizer. Other marginal practices have been noticed: mulching processed weeds as insecticide, washing animals with sulfuric or sea water for animals against tics, growing hedgerows for animal feed. 93% of farmers were growing trees around or in their parcel either for home consumption or to increase farm value and diversify incomes

We decided to keep the agroecological practices which were the most represented in farmer's practices and contribute to the most agroecological principles mentioned in

Table 5; which are crop rotation, intercropping, use of crops bi-products for animal feed and use of animal manure to fertilize crops.

4.4.2 AEP AND WORKFORCE REPARTITION

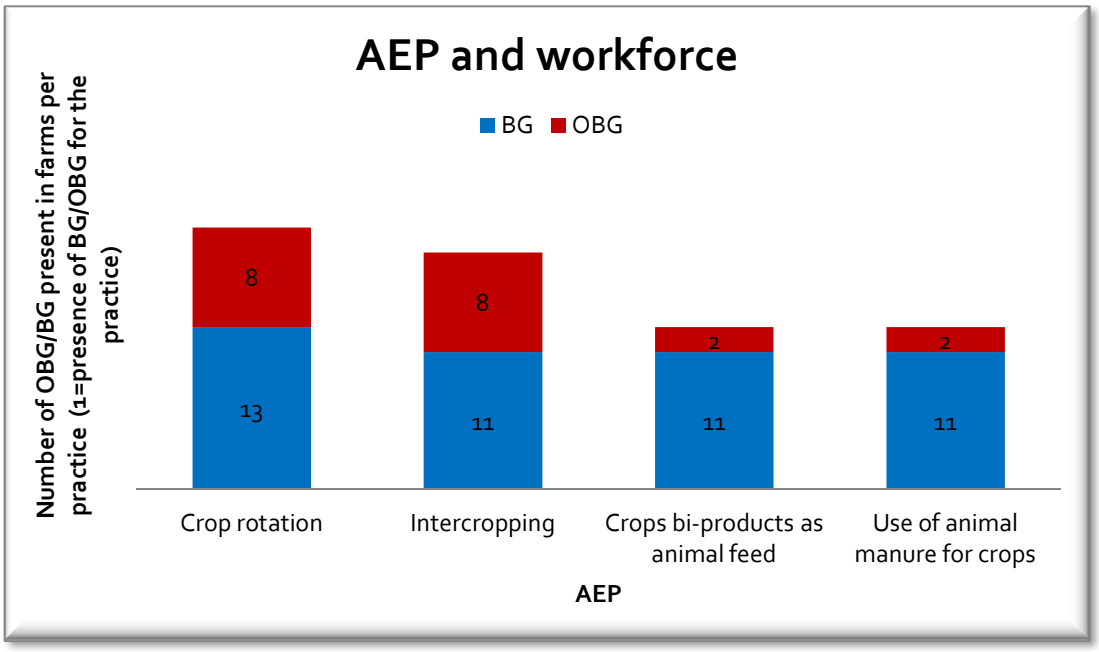


Figure 8: Workers type per agroecological practice

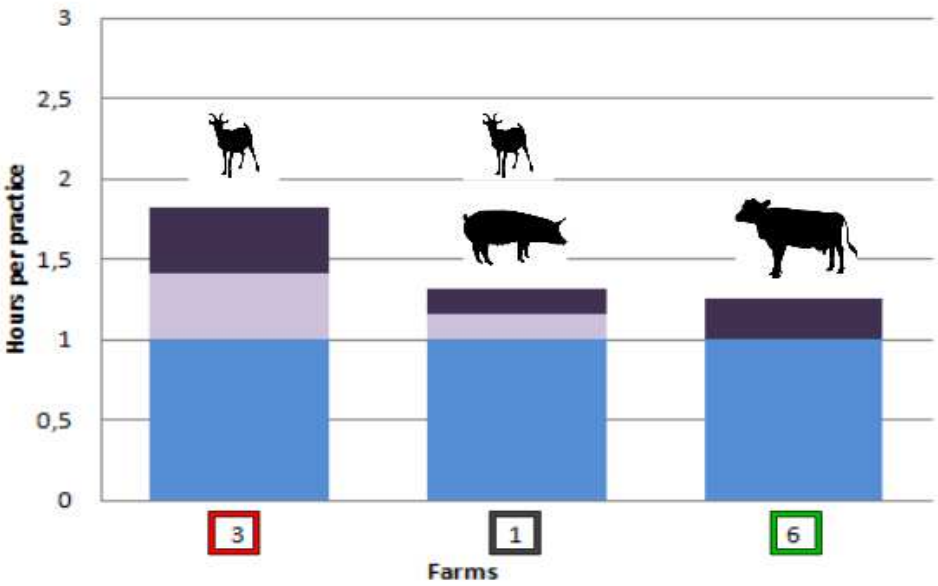
Crop rotation and intercropping practices were shared respectively 38% and 42% with off-basic group members whereas crops bi-products as animal feed and use of animal manure for crops are shared respectively 8% and 15% by off-basic group workers. This pattern clearly indicates that agroecological practices linked to crops are most often shared with off-basic group workers whereas practices linked to animal management are rarely shared with off-basic group workers (Figure 8). Indeed, farmers hired seasonal workers to delegate their farm tasks workload. In the following results we will focus on crops and livestock integration since agroecological practices linked to crops did not interfere with work organization.Indeed, tasks for crops were not referring to a special practice that we could quantify but a whole crop management.

4.4.3 AEP AND WORK ORGANIZATION FOR ANIMAL MANAGEMENT WITHIN THE THREE FARM TYPES

4.4.3.1 CROPS BI PRODUCTS AS ANIMAL FEED

In

(B) Time spent with giving **cut grasses** to animals with labor, farm and animal type.



(C) Time spent with giving **sugar cane** as animal feed with labor, farm and animal type.

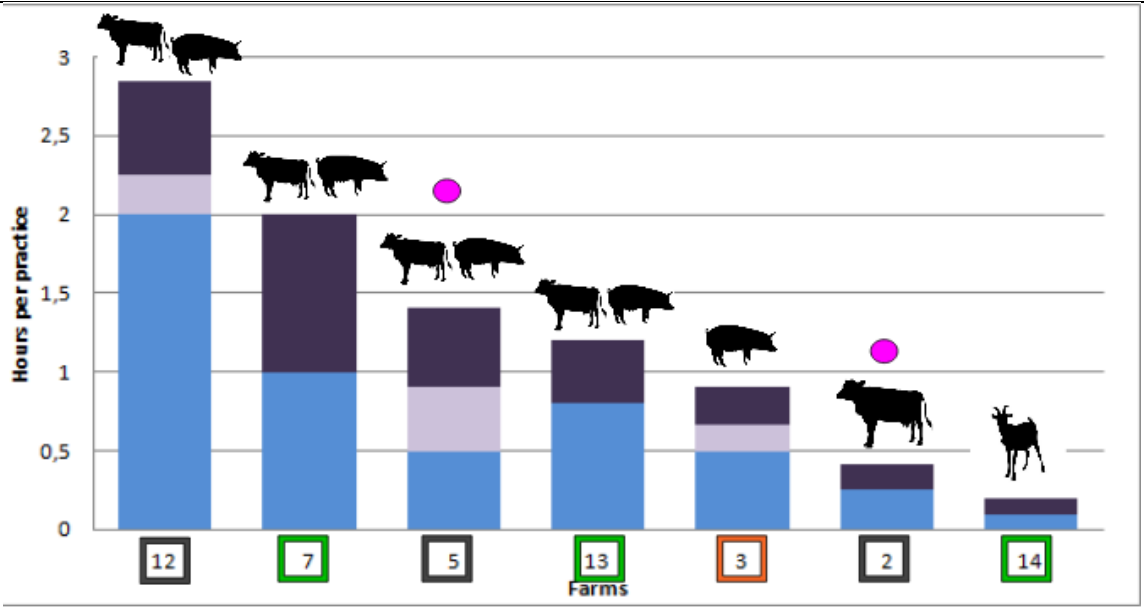
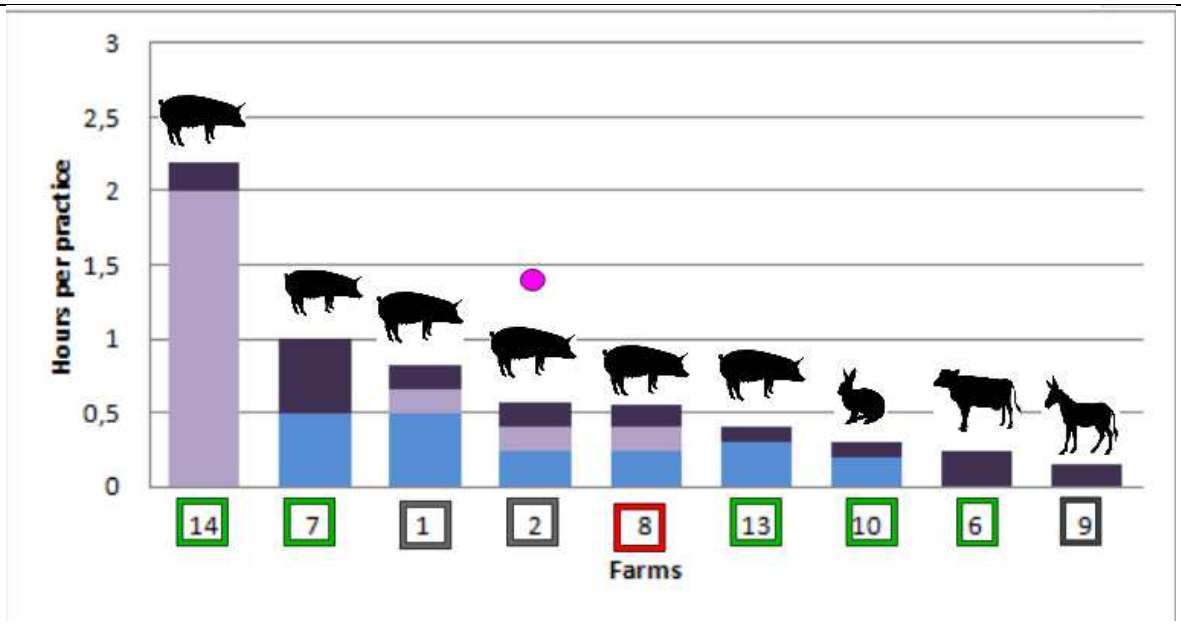


Figure 9 below are presented the different feed types and how farmers organize their working time for giving it as animal feed in function of animal type, farm type, worker type and frequency of the practice per year.

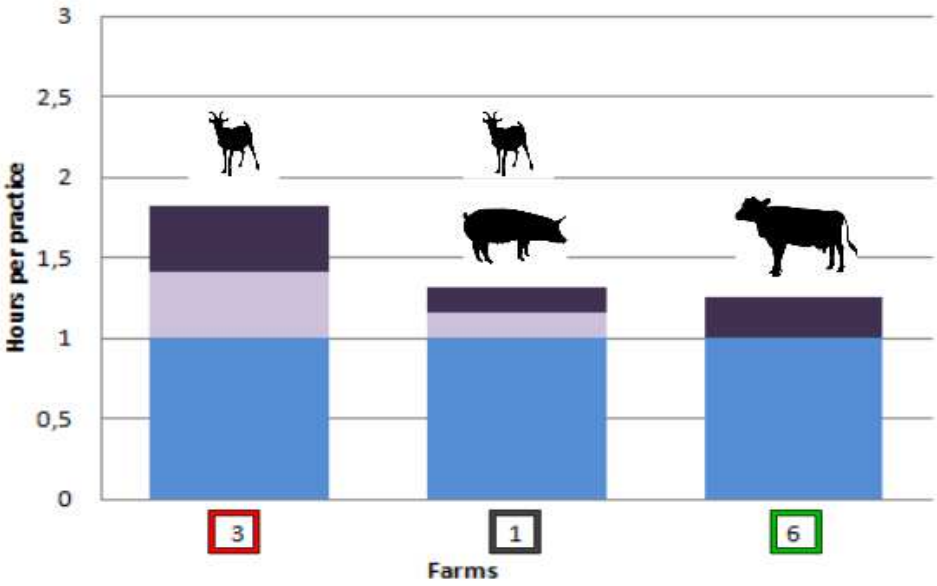
Legend

SLI		Give		Animal type	
ME		Travel		Done by off basic group	
MCI		Gather + prepare			

(A) Time spent with giving residues from market garden and tuber crops as animal feed with labor, farm and animal type.



(B) Time spent with giving **cut grasses** to animals with labor, farm and animal type.



(C) Time spent with giving **sugar cane** as animal feed with labor, farm and animal type.

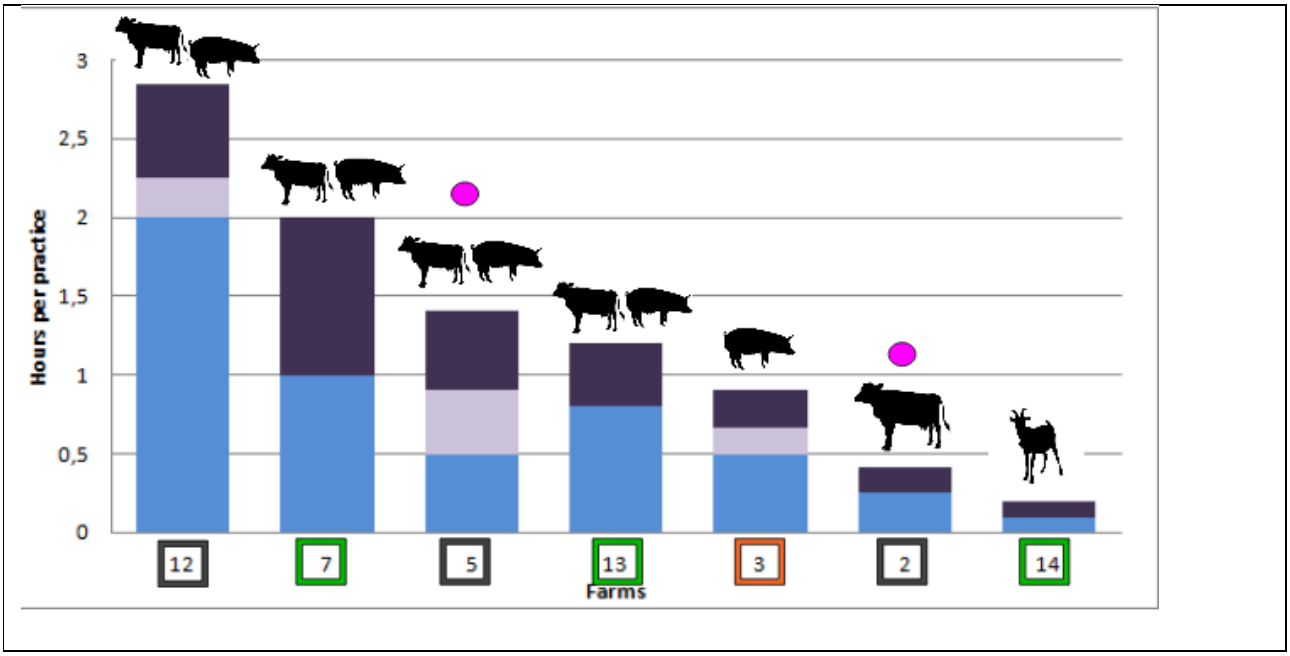


Figure 9 Work organization for using crops by-products as animal feed and farm types

Farmers used mostly market garden, tubers crops residues and sugarcane crops to give to animals. Indeed, the use of residues from market garden and tubers was done in 9 farms about 15 and among them, 7 farms out of 15 for the use of sugarcane as animal feed. Only three farms cut grasses to give to goats. Among these practices management, hogs were used 12 times about 19 to valorize crops by-products followed by bovines (7/19), goats (3/19, donkeys and rabbits (1/19). In the three graphs, gathering time is the task which takes the most time among traveling and giving to animal tasks. Then, small labor intensive farms are represented 9 times about 19 for taking crops by-products as animal feed, whatever the feed. They are followed by medium extensive (7/19) and medium capitals intensive are represented only three times. It does not seem that there is a relation between the time spent per practice and the farm type. There is a relation between taking crops by-products as animal feed and family workers as in 17 times about 19, the practice was done by family workers and only three times by off-basic group.

Time spent with giving residues from market garden and tuber crops as animal feed with labor, farm and animal type (A).

Interestingly, farmer 14 reaches a high level of travel time as he gathered one time per month crops by-products in another farm which was 2hours driving back and fro. Five hogs

breeders were giving crops by-products to their animals almost all days of the year, they could gain travel time when their crops were spatially close to hog's shelters. Two farmers (6 and 9) were very effective in giving crops by products as animal feed as they brought polygastrics directly on the parcel after their crops harvest so the animals gather themselves crops residues and fertilized crops in the meantime with their feces.

Time spent with giving cut grasses to animals with labor, farm and animal type (B).

Thieves' pressure in Guadeloupe is a factor of supplementary workload. Indeed, in order to feed their goats with grazing system or putting them directly on the crops, basic group farmers from each farm type cut grasses every two to three days instead of freeing them up in the pasture where they have more chance to be stolen. Farmers 3 and 1 had 0.2 and 0.1hours of travel because their animals were apart from grasses crops. They offered cut grasses two to three times per week given that goats can get enough grasses for the 2/3 following days. For all farms, farmers took one hour to cut the grasses.

Time spent with giving sugar cane as animal feed with labor, farm and animal type (C).

Sugar cane crops allow creating a wide range of feed, from whole sugarcane juice, sugar, treacle, straw, bagasse and stems. Whole sugarcane, tops, stems, juice and straw are available on the farm and sugar, treacle and bagasse come from agro industry. Whereas sugarcane was present in 14 farms from the total 15, only 7 farms were giving sugarcane by-products to their animals. Reasons might be a lack of time for the practice.

Farmer 12 was grinding sugarcane trunk for bovines and it this time was added to gathering time. Farmers 7 and 13 had a parcel of sugarcane dedicated only to their animals; this parcel was close to their animal's workshop which reduced travel time to nothing.. Farmer 2 and 14 only used treacle bought at the sugarcane firm to mix either with dry sugarcane leaves or rice flour. This mix aimed to fatten calves and goats and was very fast practice (less than 20 minutes).

Only two farmers (13 and 2) fed their bovine all the year with sugarcane by-products. They both had the objective of cattle fattening. Farmers 12, 7, 5 and 3 were not regular in giving sugarcane to their animals. They cut sugarcane every three days to give enough to their animals for the following days.

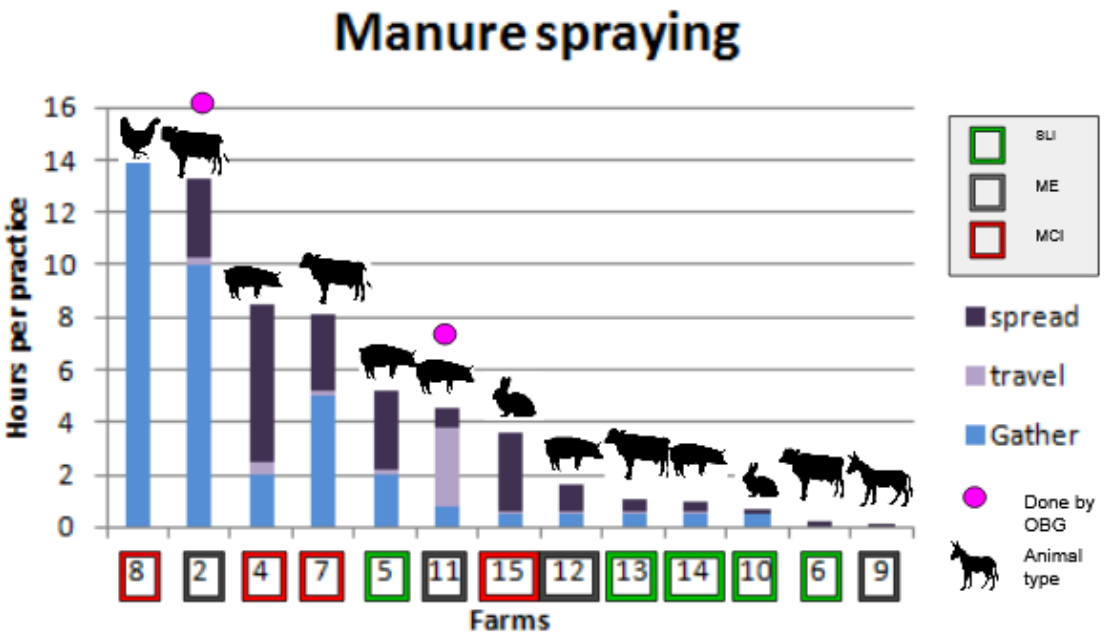


Figure 10: Time spent with using animal manure to fertilize crops

Manure spraying was done in 13 farms about 15 (Figure 10). The time spent with using animal manure to fertilize crops seemed to be linked to the size of animal units and mechanization degree. Interestingly, farmers who spent between 4.2 and 14.1hours with using manure as fertilizers were doing it much less (one to four times per year) than the ones for which the practice took between 3.2 and 0.2 hours. Reasons might be for indoor rearing systems that farmers have more animals units which means more manure from which all need to be spread on arable land, according to French regulation. Whereas farmers with smaller production factors are not follow regulations and are able to use manure when they need it for smaller parcels.

Farmers 8 and 2 were the ones with the higher time spent per practice (respectively 14.5 and 13.3). Gathering manure is done manually. Farmer 8 spent two to three mornings per year to gather chicken manure. He gathered all the manure and let it for one year on the parcel before using it. Two times per year farmer 2, with the off-basic group permanent worker gathered manure in the stable from bovine, fill it in bags to bring it to his market garden crops.

Farmers 11 and 4 were intensive hogs breeders. They gathered manure with a slurry tanker. Gathering is fast (less than 30min) yet spreading takes time. Farmer 11 relies upon an off-basic group worker to do it and farmer 4 is doing it himself but take more time as his parcel was hilly and harder to access. Farmer 7 took as much time as intensive medium capital intensive hogs breeders although he belongs to the small labor intensive type and uses the manure of 7 bovine. He took manure from the stable that is already mixed with straw during one morning.

Farmers 5, 12, 13, 14 and 10 were taking rarely their bovine and hogs animal manure to spray it in their Market Garden parcel.

Farmer 15 was doing vermicompost, it means that when he emptied his rabbits manure boxes, a part of it is added in the vermicompost bath. Then he used it for his market garden crops. This was the less time constraining practice and very appreciated by the farmer.

Manure spraying is linked to family labor except for two farms, and the time spent per practice is linked to farm type.

5 DISCUSSION

On-field surveys with farmers enabled me to characterize agroecological organization within 15 diverse crop-livestock farming systems from small labor intensive, medium extensive and medium capital intensive farms.

In our study, we hypothesized that agroecological practices were done systematically by basic group members. To understand this relation, we looked at each agroecological practice and its work organization. It seemed that agroecological practices were linked to basic group workers only for crop and livestock integration whereas practices linked to crops (intercropping and crop rotation) were linked to both basic group and off-basic group labor.

Crops and livestock integration implies to put into interaction two farms activities (crops and livestock). In most cases, these activities were spatially separated. It means that farmers were more likely to do it alone to reduce their labor cost as they would not pay off basic group members to travel from one activity to another. It is most likely the case when tasks do not take lot of time and are not labor intensive; which means that they are manageable by one basic group worker. For instance, concerning the practice to give crops residues as animal feed, farmers did it at the end of their day of work; once they had finish their crops tasks with off-basic group member, they gathered crops residues and went alone to feed their animals. Moreover, the practice of giving crops by-products as animal feed is part of the routine work tasks which is also linked to basic group workers. Reasons could be animal welfare (animals are less stressed when they know the people who take care of them (Boval et al., 2012); or health monitoring via frequent observations (which means that basic group members are responsible of animals because they know their animals and see their evolution throughout time). Besides, the practice also implies to know well animals' diet to adapt the feed quantities to animals' requirements. Therefore basic group and off-basic group members were able to operate animals' tasks when they were working permanently on the farm.

Then, seasonal work was linked to crop management, and done by family and hired workers; agroecological practices linked to crops were also done by both family and hired workers. In all farms, farmers hired seasonal workforce to delegate their seasonal work that they couldn't do alone. Seasonal work tasks included also intercropping and crop rotation. The reason that agroecological practices linked to crops could be delegated to off basic group worker might be that they do not

demand more technicality than regular farming. Indeed, it is of the farmer responsibility to decide which crops will be planted and where. Seasonal workers were responsible to apply the scheme decided by farmers.

This organization type could imply for researchers to go deeper in the comprehension of the relation between farmers and task delegation to off-basic group members. Indeed, the fact that practices linked to crop-livestock integration is rarely delegated to off basic group workers could mean that the practice will be done less often because of farmers' time constraint. Contrariwise, we can hypothesize that the integration of crop-livestock will be stronger if they hire someone to share their task.

Then, we hypothesized that agroecological practices differed technically according to the farm's production factors. Indeed we could see many management differences between small labor intensive, medium extensive and medium capital intensive farms concerning crop-livestock integration, but no relations were found concerning intercropping and crop rotation with production factors.

In a first hand, livestock tethered to a pole was relevant only for small labor intensive farms. In all cases it was done by basic group members and implied to tether animal to a pole at different places were grass was available, every two to three days. Yet it was a time taking activity compared to free range grazing. A possible optimization could be to let the poles directly in the field to create a grazing channel (Boval, 2015) which was not observed in our sample. Moreover, from an agroecological point of view, tethered animals are said to optimize pasture management together with providing ecosystem services that improve carbon fixation, soil conservation, water regulation and water quality, pollination, landscape conservation and pest control. However, the animal welfare can be questioned as bovines cannot move freely. Then, pole tethering is known to be too time-consuming over 30 animals units (Boval et al., 2012).

Therefore, farmers with large cattle units were either totally free ranged in fenced pasture or combining both practices. Indeed, the most work efficient farmers of our sample had a mean of 42 cattle in fenced pasture grazing system. This means that whenever they wanted to move animal's place of grazing, they just had to open a gate. This animal management could be delegated to off-

basic group member in one farm. Three farmers got a stable for animals to sleep at night or for fattening. It allowed for two of them to gather manure more easily.

In a second hand, crops and livestock integration practices within medium capital intensive farms concerned only the use of animal manure for crops fertilization in 3 medium capital intensive farms; in 1/3 farm, off-basic group worker was responsible to spray hogs manure. According to (Aubron, 2016) herd growth led to a focus on less labor demanding feed resources that are purchased feed. Indeed, farmers were asked by cooperatives to reach their production objectives which implied to offer feed complements. When farmers in intensive breeding systems were questioned about feed complements they all said that taking farm resources as animal feed implies to search which other feed can balance the animal diet, which they had no time for.

Finally, we wanted to look whether agroecological practices done in farms with small production factors took less time than farms with higher production factors. This seems true for manure spraying and farm type where small labor intensive farms took less time than medium extensive and medium capital intensive farms. No other relation was found for giving crops by-products to animals and farm type.

Indeed, in our sample, strategies to decrease workload differed among agroecological practices and farms' production factor. It confirm a study of Hostiou, (2015) saying that the high variability of farmer's workloads is linked to the available workforce, technical choices and the delegation of farm tasks to external workforce. For instance, for practices linked to animals, farmers mostly chose to optimize their technical choices (animal tethering, stable or indoor rearing) whereas labor workload linked to crops was decreased first by hiring off-basic group workers no matter the farms' production factors.

A very efficient practice to feed animals with crops residues was pole tethering and concerned small labor intensive and medium extensive farms. Indeed, by moving animals for direct free grazing upon crop residues, animals fed themselves and fertilized crops with their feces in the meantime. This practice was done only for bovines. Yet, INRA researchers carried out an experiment to evaluate foraging behavior of Creole pigs in sweet potato field. Their results show that this practice could be suitable to implement low input hogs production system in mixed farming system. Further studies needs to be done to evaluate animals' growth, economic gain and meat taste

to develop a niche market with local pigs reared outdoors (Burel, 2013). Moreover, hogs were highly valorizing crops residues in small scale systems (between one and 10 animals). Farmers were giving crops residues regularly which allowed them to reduce the amount of feed concentrates. It confirms the study of (F Stark et al., 2010) that hogs are animals the most integrated in crop-livestock integration practices. We hypothesize that animals foraging crops residues are time saving because they just need to be placed in the crop. However, for hogs foraging, the time taken to install fences around the crop deserve to be taken into account in the task time analysis.

Then, intensive indoor rearing systems seemed more efficient in routine work tasks linked to animals. Yet they had the lowest agroecological practice count. It relates to a study of Hostiou & Dedieu (2011) showing that breeders decrease their routine work thanks to mechanization.

Further analysis in the effectiveness of agroecological practices linked to production factor and work organisation could help farmer to choose practices adapted to their farming system and time constraints.

5.1.1 CONTEXTUALIZATION OF THE RESULTS

Guadeloupian context is of importance to understand our results. Indeed, specific factors from the region can influence farmer's mindsets by providing obstacles or lever to agroecological practices adoption.

When stating that technical choices highly impact work (Dedieu, 2015), one should take into account available information for farmers. Agroecological practices are not taught in Guadeloupian agricultural schools. It does not seem that formal agricultural education was a factor of AEP adoption but medias, pairs and personal experiments were factors of agroecological practices adoption. A better knowledge of agroecological practices can trigger farmers to change their practices either by technical optimization or hiring off-basic group members. Farmers with the most integrated practices were the ones which were already convinced by sustainable agriculture. Yet, two of them did not seem that they were overloaded with farm labor since one had time to carry political and economical off farm activities, and farmer the other came solely in the morning, and rarely in the afternoon. Yet they both claim to be organized and have a clear management of their

productions cycle. One farmer had more difficulties from an economical perspective, but seemed to be very organized in his production practices.

During surveys, all farmers referred to the disorganization of the Guadeloupian distribution channel, the illegal grocers present in the market, and their sales instability. Two farmers decided to stop their diversification because of the important time spent in sales. Then, due to the high concurrency from Dominican fruits and vegetable; farmers are driven to use chemicals to produce faster and quantitatively. A suitable solution to face the concurrency is to protect Guadeloupian's products origin and quality with a label. One supermarket and a fruit and vegetable cooperative are already working on it.

5.1.2 LIMITS OF THE STUDY

Quaework method is very heavy (two to three hours). One cannot cross check information as it may take too much time. Yet, information's from interviews are very subjective when it is done with only with one person. Some of the questions I asked might have been superfluous. It might have been accurate to decrease surveys time to crosscheck information with another farm worker.

Moreover, farmers sample was not homogenous, there was only one woman. Yet, is is known that in agriculture, men and women do have different practices (Nelson & Chaudhury, 2012) and gender is barely taken into account in the Quaework scientific literature. Beside, most of farmers were at the end of their career, whereas agroecological transition targets tomorrow's farming population meaning the young farmers.

In my surveys, AE practices have not been quantified. It means that AEP counts are not representative in terms of nutrients integration, i.e. Intercropping can occur in a farm but remains limited to one parcel about ten, which means that in the end, the farmer does not apply systematically the practice.

5.1.3 PRACTICAL AND THEORETICAL IMPLICATIONS OF THE STUDY

Literature gap have been observed about labor in the tropics and this study is the first work assessment realized in the Caribbean islands. It could be a first work to create references of AEP

work organization which farmers are asking for, in relation to their work force and farm type (Cournut, Chauvat, 2012)

The next logical steps for the thematic of work organization and agroecological practices could be to investigate which practices are the most efficient in labour input and ecological impact.

A study of (Koura et al., 2015) stated that The decision by a farmer to choose the total integration type significantly depends ($p < 0.001$) on the size of his cattle herd, his membership in farmers' association, the weight of his agricultural experience and his equipment value. It could be relevant to carry out the same study in Guadeloupe with integrating the routine work and seasonal work variables, with the hypothesis that farmers with higher working time are the most integrated.

6 CONCLUSION

This study was able to continue the work of (Fanchone et al., 2017) which found a link between family labor and agroecological practices. We understood deeper how agroecological practices were implemented regarding workers type and production factors. We could also quantify time concerning crops and livestock management practices and assess their diversity of implementation. Our results suggest that there is a relationship between work organization and AEP implementation but only for animal management. This relationship linked family labor with crop-livestock integration practices. AEP were also linked to seasonal work organization. Indeed, crop-livestock integration was done during routine work mainly by basic group members whereas crop rotation and intercropping was done during seasonal work with basic and off-basic group members. No patterns could be assessed between AEP and farms' production factors except for manure spraying; where the practice is done seldomely in farms with high production factors and regularly in farms with small production factors. However, our study sample needs to be increased to make significant conclusions regarding the relation between AEP, work organization and production factors.

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8 ANNEXES

8.1.1 INTERVIEW QUAEWORK

FARM DESCRIPTION

Farms' name	
Legal status	
Name	
Address	
Phone number	
Date	
Name of the researcher	

Farm activities

Farm productions

ANIMALS

OVINE	
Number of animals	
Number of units produced per year	
CATTLE	
Number of livestock	
Number of units produced per year	

GOATS	
Number of animals	
Number of units produced per year	
RABBITS	
Number of animals	
Number of units produced per year	
PIGS	
Number of animals	
Number of units produced per year	
POULTRY	
Number of animals	
Number of units produced per year	

Remarks:

Market garden

Crop name	ha	Crop number in the sketch

Tuber

Crop name	ha	Crop number in the sketch

Orchard

Tree name	ha	Crop number in the sketch

Agroforestry

Crop name	ha	Crop number in the sketch

Is there any production agreement?

Others

Type	ha

Is there any production agreement?

Plots

Type of plots	
Plots grouped around the farm buildings	
Plots away from the building	
Group of plots away from the building	
Distance between forage pastures which are away from the farm	
Transhumance	

RESSOURCES

Farm buildings

Number of farm site and distance between each	

Building typology

Building	Use	Characteristics

Are they operational enough to work efficiently in good conditions?

FARM ASSETS

Animal care assets

More precisions concerning reproduction equipment, feeding concentrates, forage,

Assets	Use	Characteristics, functionalities?

Material for surfaces operations

(Soil preparation, treatments, spraying, harvest, landscape maintenance…)

Farm property, co- property or CUMA farmers organization (if there is a machinery cooperative, is there a (driver)) ?

Assets for surfaces	Use	Characteristics, functionalities	Property status

OFF FARM ACTIVITIES

Type of activities
Diversification and services activities (farm hostel, bed and breakfast, productions transformation in the farm, sales in the farm or in the market, direct seling, slurry spraying for the city, etc.)
Professional mandates (in cooperatives, in a trade union, in the breeding network …)
Non extra farm activities (paid work, communality responsibilities…)

Activity type	Dimensionnement Hours/week	Who?	Rhythm (all the year, some periods of the year)

WORKFORCE AVAILABLE ON THE FARM

Name
Status Basic Group Outside basic group : Occasionally interventions (internship, children, mutual aid, firm in agriculture workforce…) Is not responsible of work organization of the whole exploitation (part-time employee or employers ‘alliance…) From which the salary is not directly reliant of the farm (retired relatives, Spouse full-time outside, replacement service ...)
Work periods and holidays,

Attendance rhythms
Affinities and skills, responsibilities,

Name , surname	Age	tatus	Work period and holidays ; attendance	off farm activities: employee, professional responsibilities, + time spent?

WORK ORGANIZATION

Communication meeting: Where? When? What?
Ways to communicate on the management
Activities for which workers are interchangeable or not

HISTORY:

(Tell the farm history)

Which were the drivers of change in the work organization?

What were the consequences on the work force, production quality, marketing etc...? ?

Events	Consequences

Did you always have this livestock management? Why did you change?

QUANTIFICATION OF CROPS AND ANIMAL TASKS

The aim is to understand and highlight the yearly evolution of the work process, farming activity and the combination of other activities: it means to recreate a general calendar before coming back to the details of what were described. One gathers and qualifies also the amount of seasonal work linked with activity types.

Production system : rhythms and activities quantification

Animal,Farm Task/Month												

Tasks related to livestock: preparation of the mating, mating duration, lambing, suckling, fattening, dates of grazing.

LIVESTOCK: Quantification of seasonal work with the livestock

Seasonal work type	Period (fortnight)	Number of days	Basic group number of workers	Non basic group number of workers

Bovine feeding

Date of grazing and returning to the sheepfold (complementation with the pasture)

System: grazing livestock

Main events of the bovine management:

Sorting and allotment, weighing, re-composition of batches, manure cleaning, treatment (Parasitism), prophylaxis, vaccination, flooring, mowing

SURFACES: Identify seasonal work and articulate tasks type with the farms calendar

+ Counterpart work following common joint workshops or delegated

Market garden

Seasonal work type	Period(fortnight)	Number of days	Basic group number of workers	Non basic group number of workers

Soil preparation: Plowing, spade, furrowing, irrigation installation, Disposable sheaths

Plantation: weeding, buying seed beds, planting

Crop management : fertilizer, fungicide , insecticide, irrigation, weeding, tutoring, buying tutors, transplanting

Harvest: harvesting, sorting harvest + post harvest

Orchards

Seasonal work type	Period(fortnight)	Number of days	Basic group number of workers	Non basic group number of workers

Soil preparation: plowing, spading, furrowing, Background fertilization (manure), trellising, charging and discharging

Plantation: plants, Installation of the grid, holes, refill holes, tutoring + planting, irrigating system

1st year tasks: weeding, fertilizing, manure, insecticides, fungicides, cutting (taille) ,

2nd year: weeding, chemicals spraying, cutting, management.

3d year: harvesting, sorting harvest, washing, calibration, packaging, selling

Tubers

Seasonal work type	Period(fortnight)	Number of days	Basic group number of workers	Non basic group number of workers

Soil preparation: Plowing, spading, Ridging, irrigation system installation, disposable sheaths.

Plantation: weeding, buing seeds, transport of cuttings, dressing plants, planting,

Crop management: fertilization, water irrigation,tutoring, hoeing, floor covering

Harvest: first harvest, topkiling, second harvest putting out the irrigating system, manual harrowing, packaging

Work in parallel of the production

Add to the calendar and quantify the main work linked to work and done in parallel of the farm production

Paperwork
Savings
Treasury
accounting

Maintenance of fix fences
Hedgerows, wood

Seasonal work type	Period(fortnight)	Number of days	Basic group number of workers	Non basic group number of workers

Paperwork
Savings
Treasury
accounting

Maintenance of fix fences
Hedgerows, wood

Off-farm activities

Add to the calendar and quantify the main works linked to nonfarm activities

Examples of works linked to off-farm activities

Diversification and services activities (farm hostel, productions transformation inside the farm, sales in the farm or in the market, direct seling, spraying for external agents, etc.)
Professional mandates (in cooperatives, in a trade union, in the breeding network…)
Non extra farm activities (paid work, communality responsibilities…)

Seasonal work type	Period(fortnight)	Number of days	Basic group number of workers	Non basic group number of workers

Identification of work periods

The aim is to synthesize the work organization of one year with highlighting periods where work is homogeneous.

Starting from the calendar described before, we reformulate with the farmer the yearly work organization and we split the year within periods considering:

Workforce attendance on the farm (herdsmen in the summer, brother during hay making period …). Evolution of daily routine work (summer / winter, births,) ; interventions of seasonal work have an impact on the day-type ; evolution of the combination of economic and private activities implemented during the year (ski resort activity in winter, summer vacation …).

Discuss and validate identified periods with the farmer

Identify day type and quantify the daily routine work

To define a day type, we need the following elements:

What is the daily routine work?

Who carry it?

In which order and how much time?

Origin of the time schedule:

Labor force: children in holidays, internships, occasional help…
Free time requirement: holidays of a colleague, Sunday…
Other activity : market day, meeting day …

Take note with the following table:

Period n°	Starting date

Workers	Moment of the day	Tasks	Number of hours
Total (h/j) :			

Breeding cases with one or more herbivorous workshops

To start:

The easiest is often to start early in the winter, when the animals are in the stabling (animal housing). We ask to the farmer to describe precisely a day with a question such as "can you describe the work with animals for a winter day, when the animals are in the stabling and when you are present on the farm? « One assesses the permanent work while the farmer describes his day:

- Nature of tasks (feeding, monitoring, youth care, mulching, milking ...),

- Duration,

- Worker (s) involved.

To identify the variations of the Day Type:

Then, on the basis of the timetable established above, one assess the variations likely to modify the standard day within the period considered (labor involved, or one Week end day, or a priority work site in season or a meeting day ...). The farmer is questioned about the changes that have occurred. This is done through questions such as "How are Harvest Days? "Or" how do you go to a meeting at this time? "Or" can you detail your day when a trainee is there? ".

For each Day type, one informs:

- Nature of tasks (feeding, monitoring, youth care, mulching, milking ...),

- Duration,

- Worker (s) involved.

To identify the duration of the Day Type:

Then we ask the breeder until which month this typical day is valid.

Is there a period among the others that is harder?

Why is it more difficult?

What do you mean by difficult?

Is there a period among the others that is easier?

(Possible question to restart the discussion,

Is your job stressful? Time constraints? Penalty?

Do you have examples in mind of large scale farms with CLI practices ? do you know some in Guadeloupe ?

Who are you talking with for farm management advices ?

In an ideal farm without time and money constraint ? what would be your farm management ? CLI practices or more chemicals intrants ?

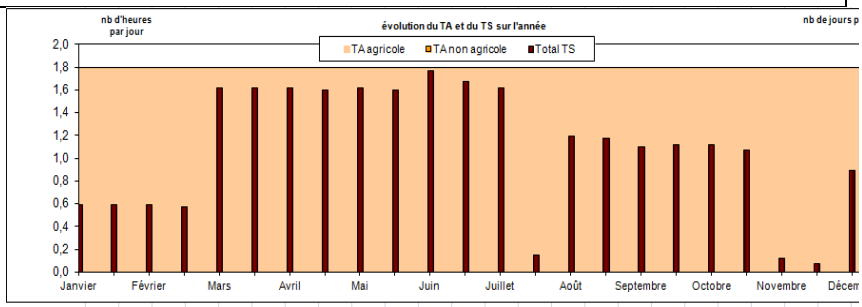
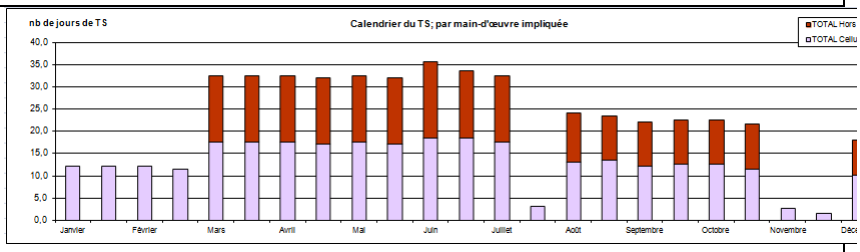
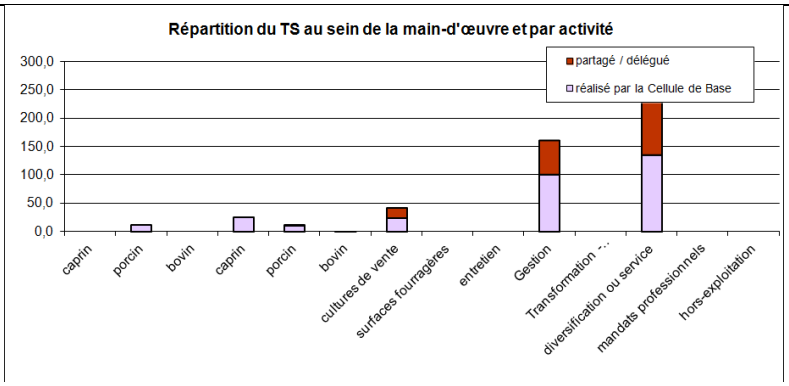
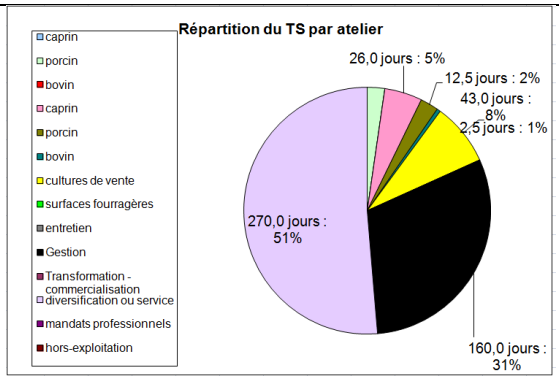
Which tools would you need to CLI ?

Do you have enough information about this practice ?

What do you like the best in your job ? which moments ? which practices ?

What do you are you reluctant to in your practices ?

8.1.2 QUAEWORK GRAPHICAL OUTPUTS

Graph Title	Output
Routine work and seasonal work evolution along the year	
Calendar of seasonal work per workforce type.	
Share of seasonal work per activity and workforce type.	
Share of seasonal work per workshop.	

8.1.3 MONOGRAPH EXAMPLE PER FARM

Interview with: Mr R.

Crop variety	Area	Destination
Sugar Cane	15ha	Market, house consumption + export firm
Orchard	0,40 ha	Market, house consumption + export firm, animal feed
Tubber	1ha	
Pasture	0,9	Animal grazing

Table 1 : Surfaces and crops actually present on the farm.

Animals type	number	Destination
Goats	40	Individuals, market, reseller, home consumption
Porc	24	Individuals, market, reseller, home consumption
Cows	2	Individuals, market, reseller, home consumption

Table 2 : Livestock diversity and quantity actually present on the farm.

Farm history and main evolution, drivers of change

Mr Ramassamy followed his heart when he chose to be farmer. Despite the disapproval of his parents' will, he knew that farming was his life path. He studied firm management during high school, and after doing his military service he graduated for the BPA degree (Brevet Professionel Agricole- *Professional Agricultural Certificate*) adding to this, he followed two years courses of commercial initiation and firm creation. He started his farm activity in 1986, he could benefit from installation premiums. He defines his farm as polyculture small livestock farm and distinguishes it from specialized farms which he rejects the productions models. He thinks that diversified farms are more resilient

and sustainable than specialized ones.

Since very young he has political ideas and he tries to apply them at every level in the agricultural field. Indeed, he was involved in the Guadeloupian peasant confederation, he became mayor consultant of the city in 2002 in the minority part. In 2008 until 2012 he was elected with the suffrage majority and could design agricultural and urban project to promote local agriculture. Concretely, he elaborated a market day in Lamentin city for producers to meet their consumers and create new market opportunities, he created UDCAG (Union pour le Développement de la Canne et de l'Agriculture Guadeloupéenne- *Guadeloupian Union for Sugarcane and Agriculture Development*). He had lots of stories to tell about his political campaign, how politics are corrupted and manage to covert agricultural land into construction land. Therefore his land contract is a GFA(Groupement Foncier Agricole- *Mutual Agricultural Land Grouping*) which means he owns 40% of the land but he is shareholder of the GFA which means that he is also landowner of his farm area. This choice was very important to him as he thinks that GFA systems do not protect enough agricultural land. Land areas are owned by the state which can decide or not to keep them as such (because of corruption problems). He thinks that it is important to always improve the farming system however " *it is important to always remember where we come from and what we have. Some farmers have big farm assets, they have lots of subsidies, yet they are not resilient enough to absorb risks*".

He got sometimes into troubles with corruptions as he tries to fight against it as much as possible. His daughter might have been influenced by it as she studied law and she is now working in Lamentin's city house.

Untill 2004, his farm was vandalized several times where hogs, free range chickens and goats got killed or stolen. Therefore he stopped poultry production and he keeps goats in his garden.

When we ask him if twenty years ago he will do exactly the same thing he did, his answer is: "Yes I will, but I will be more adventurous in his choices, meaning that I would do more credits to have butchery. I never wanted to do credits to bank. I think that farmers are too much assisted and they don't want to do any new activities if they do not get help from the government, it is not my case. I did everything myself, with my own farms incomes". He would like to do in the future free range chickens, a butchery and use pork manure to fertilize his crops. He is also thinking to have four milking cows to diversify his productions. "I am sure that with four milking cows I could have a daily income".

Farm presentation

Mr Ramassamy is from Indian sub culture, and has Hinduism beliefs. He is married and has two children. He works every day on the farm and all the year. Sometimes in high workload period he is hiring service providers or workforce from Haiti. There are sometimes neighbors which come to help him for precise works that does not necessitate much time. He is going as well to help his neighbors' occasionally. He often takes students to work on his

farm. There use to be some family workforce but it is decreasing because they all have economic occupations.

Main productions on the farm are tubers, sugarcane, bovine, porcine and caprine. He sells life weight animals, and in the festivities period like Easter or Christmas, regular customers come to his house to buy him pork meat.

Beside farm work, he is working in two different Agricultural Work firms. He owns two tractors that are used by him and his employee to work on other farmer's exploitation. The counterpart of his work is that the two firms are harvesting each 50% of his sugarcane crops.

He likes to take the time for his friends, his family and his duty in the field of politics. He didn't embrace the logic of intensive production only for profit, rather, he claims to be an agroecologist farmer which diversify his productions and care for nature. He tries also to promote local and terroir products as he organized in Lamentin a local market for producers. He wanted the consumers to meet their producers personally. He thought to be a good idea to have new customers for farmers which come to their farm to buy their farm products.

The allocation of land is for crop production, he needs labor at key times in the year for soil preparation, planting and driving sugar cane tractor?. Pastures is sufficient for his 2 productions. The unsold and rotten fruits are distributed to the Large white croisé petrain pigs.

The farm is not irrigated but mechanizable. He uses rainwater to water his animals and crops.

Farm management
Management of the exploitation
Workforce

There are lots of different people which come to work on his farm:

Students for internship
Service providers for sugar cane
Neighbors and friends for volunteering
Part time workers that he calls when he needs their help

"I could not exist if there was no Haitian workforce"

Crops

His farm is situated along a DPL (Domaine Public lacustre-*Lacustrine Public Area*) there are sugarcane crops around but he let 25 meters of pasture to valorize the zone and care that the sugar cane chemicals do not end in the

public water. He wanted to get subsidies for this project but the administrative folder was never actualized.

Sugar cane

He has 15ha of sugar cane crops. He starts with other employee to prepare the soil from June to September with plowing, spraying, furrowing and weeding with the tractor or manually. Harvest is taking place with specialized firm from March to June. Earth is rather muddy and difficult to access for mechanical equipment in case of heavy rain. However, harvests are quite satisfying.

Tubers

He has two parcells of 5 000m2 so he is harvesting one ha of crops every year. He starts with other employee to prepare the soil in September with plowing, spraying, furrowing with the tractor or manually. The plantation occurs in june every year and the harvest happens in December/ January. He manages well to sell the production. He chose to plant yam because it is the traditional Guadeloupian dishes that is eaten with pork. Therefore when he sells porks in Christmas he can sell yam with it.

Pasture

Control erosion and fertilizer runoff, serves as a buffer before the canal. There is no particular management. Pasture is used 100% for animal grazing.

Animals

Animals takes him less than two hours of work every day and he manage it alone "*It is the only activity where I invest 100% of myself*".

Goats

He has a herd of 40 to 50 goats that he keeps at home away from thieves. He knows that it is not the best solution because of the neighbors that might complain and sanitary reasons, but he can't let them alone in the farm. Goats are fed with a mix of concentrates and maize. He manages well to sell them in celebration periods. Sometimes he cut grasses when it is dry to feed the goats. He is doing phytosanitary treatments Bains 4 times per year and it takes him one whole day.

Porcine

He manages well to sell them in celebration periods. Porks are fed with concentrates, crops bi products like bananas, sugar cane, breadfruit… They are separated in parks and he cleans their shed one time per week (it takes 15minutes). The pork manure is stocked in a natural basin 10 meters away from their park. Now a friend of the farmer

is using it to fertilize his crops. He wants in the future to use it to fertilize his own crops but he didn't found the time yet to incorporate this activity to his schedule. He is fattening hogs from February to December. He has between 20 and 25 animals. It takes 3 hours per animal for slaughtering and cutting the meat. He is doing natural reproduction, and he does not do tail or teeth docking because of animal welfare. He is doing this activity to have complementary incomes.

Bovine

Cows stays in the pasture and he needs to move them every two days. They are fed only with grasses. He is doing phytosanitary treatments (baths) 4 times per year and it takes him two hours.

Agroecological practices

Cows valorize the pasture in between sugarcane and DPL. Pork are fed with crop bi products, goats are fed sometimes with grass from the pasture. He is using rainwater to water the porks.

Sociological, economical, and political mind set

Access to land

He explained that GFA are not protecting the future of agricultural lands. Therefore he is shareholder of the GFA which means that he is owner of his land.

Access to information

He used to have a consultant for sugar cane and animals but not anymore because he does not like the way they think. He always tries to have ecological practices.

Access to subsidies

He has some subsidies but never did bank credits. He is doing aloe his paperworked and say that he spents a mean of one hour per day for this task.

ABSTRACT

Mixed Crops and Livestock farming Systems (MCLS) provide a relevant alternative to intensive monoculture farming which impacts negatively ecosystems and human health. Indeed, MCLS farms can potentially integrate crops and livestock workshops to increase nutrient cycling together with remaining productive. Yet in Guadeloupe, crops and livestock are not systematically integrated and a study from Fanchone et al., (2017) stated that agroecological practices are often linked to family workers and small scale farming. In this study, 15 surveys were done to understand the relationship between agroecological practices, workers type, work organization and workshops size. We used the Qualification and Evaluation of Work (Quaework) method to qualify and quantify work organization of each farmer throughout the year in three farms type: Small Labor Intensive (SLI), Medium Extensive (ME) and Medium Capital Intensive (MCI). Results show that Agroecological practices (AEP) and workforce type relation differ according workshop type and size. AEP linked to animals were mainly managed by family workers whereas AEP linked to crops encompassed both family and hired workers. Then, agroecological practices were mainly linked to routine work and seasonal work organization. This study was the first work conducted in the French west indies concerning work organization and further researches could help farmers to decide which practices fit the best to their production factors and time they want to invest.

RESUME

Les systèmes en polyculture élevage (SPE) sont des alternatives intéressantes face à l'intensification et la spécialisation agricole, qui ont un impact négatif sur l'environnement et la santé humaine. Effectivement, Les SPE peuvent potentiellement intégrer les ateliers végétaux et animaux afin de fermer leur cycle de nutriments tout en restant productifs. Pourtant, en Guadeloupe, les ateliers végétaux et animaux ne sont pas systématiquement intégrés et une étude de Fanchone et al., (2017) établi une relation entre pratique agroécologique, travail familial et faible facteur de production. Durant ce stage de six mois, 15 enquêtes ont été réalisées afin de comprendre les relations entre pratiques agroécologiques, organisation du travail et facteurs de production. Nous avons utilisé la méthode Bilan Travail Atelage (BTA) pour quantifier et qualifier l'organisation du travail de chaque agriculteur sur l'année, au sein de trois types de fermes: petites intensives en main d'œuvre, moyennes extensives et moyennes intensives en capital. Les résultats montrent que les pratiques agroécologiques et l'organisation du travail diffère en fonction de la taille et le type d'ateliers. Les pratiques agroécologiques telles que l'intégration des ateliers animaux et végétaux sont liées au travail familial, alors que les pratiques telles que les rotations et associations de culures sont liées au travail familial et salarié. Il y a une forte relation entre l'organisation du travail saisonnier et l'organisation des pratiques agroécologiques. Cette étude est pionnière dans l'analyse du facteur travail aux Antilles, de plus amples recherches pourraient aider les agriculteurs à choisir des pratiques plus efficaces en terme de temps de travail.