

## Management and work in Crop-livestock-tree integration System in Roraima, Brazilian Amazonia.

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**Abstract:** The increasing population in the Brazilian Amazonia, especially in urban areas, has led to an increasing local demand for food, including meat (Tourrand et al. 2006; Bendahan et al. 2013). High rates of forage production, due to good weather conditions in terms of rainfall and temperature, added to the security and flexibility of cattle ranching are contributing to the rapid expansion of livestock farming in the Amazonia (Veiga et al. 2004). Hence, cattle breeding is considered as one of the main drivers of Amazonia deforestation (Tourrand et al. 2006). More recently, the environmental impact of the associated greenhouse gas emissions have also been highlighted (MAPA and MDA 2011).

In the early 21<sup>st</sup> century, restrictive and repressive measures were enacted in Brazilian Amazonia to reduce deforestation (MMA 2013) and consequently the expansion of livestock farming. An alternative approach supported by EMBRAPA has been focused on sustainable farming systems such as “crop-cattle-tree integration systems”, locally called “Sistema de Integração Lavoura – Pecuária – Floresta” (or SILPF). However, the expansion of SILPF at a large scale is difficult, and the integration is often more an association rather than real integration, at least regarding the tree component (Bendahan, 2015).

The Roraima is a Brazilian State in the Northern Amazonia, at the border of Venezuela and Guyana. Roraima State has also invested in SILPF research as an alternative to pure cattle ranching in forest and savanna biomes. In 2008, the first SILPF were tested at the Experimental Research Station of Embrapa Roraima. Then others were implanted. Our two research hypotheses are: i) SILPF offers better economic and financial results than cattle ranching, especially due to efficient use of resources, and ii) the capacity to manage multi-component and multi-product systems such as SILPF is a constraint to its implementation.

**Keywords:** *labor farm, qualification agriculture, administration agriculture, system integration*

### Introduction

Until the 80s, meat production of Amazonian States did not manage to serve local markets. It was necessary to import meat produced in regions further south in the country, however, this percentage of meat coming from other regions gradually decreased, as the local production increases (Pocard-Chapuis 2004).

The expansion of cattle ranching in the Amazon was based on technical and economic criteria, still because of the dynamics of occupation and organization of the territory (Sayago et al. 2004; Veiga and Tourrand 2004; Tourrand et al. 2006).

In addition to government incentives, ranching proved to be an excellent alternative, especially because of a combination of factors and characteristics inherent in the activity (Veiga et al. 2004), such as: i) favourable weather conditions; ii) ease of structuring the production chain; iii) liquidity; iv) easy activity to manage; v) animals can be stored in their own pasture; and vi) alternative for savings for producers. Factors that demonstrate the flexibility of the activity, not only related to the technique, but also to ease of management.

On the other hand, the actual livestock production systems respond to an economic logic that causes social conflicts and environmental damage, and generally, in the first instance, it is characterized by horizontal expansion of livestock-isolated activities, determining long-term sustainability problems for farms (Dias-Filho 2011).

In Roraima, this dynamic is observed (Melo et al. 2006; Arco-Verde 2008); after the first years, there is a decrease in soil fertility that, in general, is already reduced, causing accelerated degradation (Dias-Filho 2007). The situation is aggravated by poor pasture management, which compromises the sustainability of the farming systems practiced in the region (Bendahan and Veiga 2000).

With pressure to produce more and better and new ways of assessing the systems (social, technical, economic, environmental and landscape), farmers pursue alternatives in the activity and for the activity. Research and development institutions are called upon to answer these questions.

When the scientific community began to promote agricultural systems that incorporate a tree component as an alternative to monocultures and livestock specialization, it was understood that meeting the new

challenges in environmentally friendly production brought major economic and social gains (Veiga et al. 2000; Veiga and Tourrand 2004).

These systems, generating ecosystem benefits and services, meet the challenges posed to farmers and the scientific community seeking production alternatives to traditional extensive livestock farming.

However, these multi-component and multi-product systems did not gain the adoption expected. Even if research on their adoption is scarce (Mercer 2004; Veiga and Tourrand 2004; Brienza Júnior et al. 2010), several authors point to barriers for non-adoption. Among these, less flexibility to modify the arrangements is cited, due to the tree component and the need for greater skills and dedication by those involved. Such barriers suggest the need for improved management and more skilled labor.

Brazilian producers often give more attention to the technical side than to management, and there is resistance to change their profile of action, even in the face of constant change (Rezende and Zylbersztajn 1999; Queiroz et al. 2008).

It is observed that the management knowledge of the majority of Brazilian producers is deficient (Velooso 1997; Rezende and Zylbersztajn 1999; Batalha et al. 2005; Nagaoka et al. 2011), and that the production and transfer of technologies adapted to different contexts are weak (Batalha et al. 2005; Nagaoka et al. 2011).

In this context, this study aimed to determine the implications for work and property management of the inclusion of crop-livestock-forest integration systems (SILPF<sup>1</sup>) in cattle properties.

## Method

To reach the goal, factors were analysed relating to the qualitative and quantitative characteristics of the labor and management of livestock farms with and without SILPFs.

We used secondary data from the Brazilian Institute of Geography and Statistics (IBGE), National Institute of Colonization and Agrarian Reform (INCRA) and the Department of Agriculture for the State of Roraima (SEAPA), literature research, interviews and workshops with key actors involved and monitoring of private farms.

## Interviews

Twenty-one interviews were conducted in July and August 2013. The method of semi-structured interviews was used with key actors in the chains of grain, livestock and forestry.

This methodology was employed with key actors because of their application in previous research projects and, especially, because of the limitations of traditional forms of interview with closed questionnaires (Chambers 1994; Wood 2015).

In this methodology, the number of interviews has not been previously quantified, since it is based on the principle of redundancy, in other words further interviews were not undertaken when the last one did not produce anything new.

The identification of key actors to interview was taken from (i) knowledge accumulated by the authors over the years, (ii) recommendations made by interviewees during the research, (iii) the emergence of new questions during the interviews that required research for specific information, and therefore specific informants.

The key actors interviewed were farmer cooperatives; cooperatives of annual crops; forestry companies; ranchers and farmers; producers who practice crop-livestock and crop-livestock-forest; small-scale diversified production; representatives of the federal and state governments related to agriculture; a credit representative; and corn, soybean and cowpea buyers and merchants.

In conducting the interviews, a standard was not followed: we always sought to adapt the interviews to the interviewee's characteristics, and the nature of his/her information. With this perspective, a questionnaire was not used. The reference to guide the conversation was to start with an initial open question that was related to the factors assessed, and to use the knowledge gained up until then.

Triangulation was used to verify the information generated with the information already held. Scenario technique was used during the conversation, to put the respondent in unusual situations, in order to check the informant's speech consistency, or that of previous informants.

These intersections between each key player allowed progress to be made in building understanding of the factors related to work and management of properties.

The search for new informants and multiplication of interviews continued until no more new knowledge arose, until the triangulations generated no more doubts. From that moment of relative redundancy, it was considered that enough information was already held to understand the system (Wood 2015).

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<sup>1</sup> Systems that integrate annual crops, livestock and forestry, in the same space, in combination, succession or rotation that seek synergy between these components.

Certainly, another informant would have brought more information, but not of high importance, not of a nature to change the overall vision that was being sought to know and understand. After each interview, reports were produced, in order to secure the information (Wood 2015).

To the labor factor, the initial question to producers was: How do you develop the work (activities) on your property? The technicians were requested, initially, to validate the lists of practices.

Lists of forestry and agriculture practices were validated with producers and technicians, and other practices were included by respondents. Then, grades were asked to be given between 01 and 05, in which 01 was for easy activities to be performed and 05 for the most difficult to perform. Finally, they were requested to indicate needs and the time required to meet them.

Before the end of the interview, they were asked to build a practices calendar. We used two metal plates 0.5 x 01 m in size, with decennial divisions, and magnets with pictures of activities and practices, among others with identification of periods, very dry, dry, slightly damp, wet and very wet. Then the magnets relevant to their activities and practices were placed in the period of the year when they were performed. For the management factor, we sought to identify the farmers' knowledge on property management and production systems. Then, we focused on checking which controls were used, formal and/or informal, in the economic, financial, productive and commercial aspects of their operations.

## Workshop

Present at the workshop were five workers and one producer, who participated in implementing and conducting experiments in experimental stations and properties, members of the IAFP project in Embrapa in the state of Roraima.

This study aimed to identify in the interviews the needs for qualified work required by the adoption of SILPFs. Results from previous items and experience in monitoring systems, between 2008 and 2011, were used in the evaluation of this work to identify training needs.

## Monitoring

Monitoring was carried out during all the years of experimentation in private properties, through weekly visits during the cropping season and monthly visits in the off seasons.

Table 1: Items monitored in the properties and experimental stations relating to the analyzed factors.

Monitored items
Time spent on manual activities and with tractors
Time spent on management of dairy cattle during days of dairy control
Annotated non-ordinary events that influenced management of the systems
Which component (tree, grain and animal) was infrastructure used for
Financial cash flow

## Quantification of additional labor

Quantitative data of manual and mechanized services performed on farms monitored over three years, that adopted SILPFs, served for calculations on the quantitative increase (man days year<sup>-1</sup>) in labor in three typical models of farms in the state of Roraima.

## Results

### Characteristics of the rural context of the State in Roraima

Ranching is dispersed throughout all the municipalities of the State of Roraima. It is based on native grasslands, in a region of savanna that in 2006 amounted to 404,385 ha (IBGE 2006), and cultivated pastures in forests, which in 2012 was 353,624 ha (INPE and Embrapa 2014). The first estimates of ADERR in 2016 consist of a herd of 850,000 head spread over 6,896 properties.

As for the origin of those in charge of management of the farms, in which the livestock activity is a part, about 52% come from the Northeast of Brazil, where the state of Maranhao stands out with 36% of all property managers, and another 17% were born in other states in the North-eastern region (IBGE 2006). Roraima contributes with the origin of 24% of managers and other states in the northern region with 11%. The regions of the Midwest, Southeast and South each added 04% of the total of all managers (Figure Figure-1a). About 88% of these managers live on the property itself, 05% in rural areas, 05% in an urban area and 02% in other municipalities (Figure Figure-1b) (IBGE 2006).

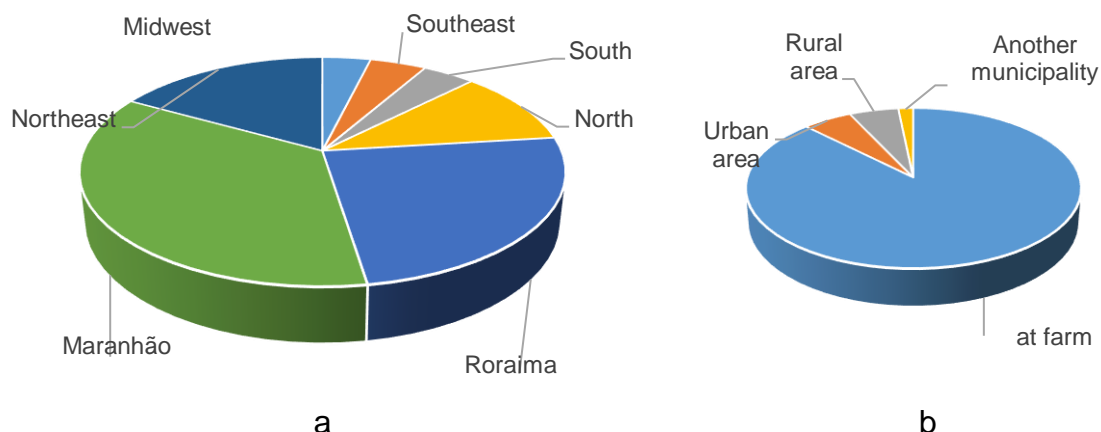


Figure 1: Origin (a) and place of residence (b) of the person responsible for management of the properties in the State of Roraima (IBGE 2006)

On one hand, the indicators of the quality of primary and secondary education show that education in rural areas is deficient (INEP 2014); on the other hand, it appears there has been an increase in the number of places offered in higher education and vocational courses in recent years. Rural income is low in the state of Roraima and many producers settled there are below the poverty line (INCRA 2015).

### Profile of ranches and farms of Roraima

- ✓ The rancher is "traditional." Doesn't easily incorporate new technologies;
- ✓ Is "intuitive." Property management is intuitive and prioritisation of activities is deficient;
- ✓ It is "diverse". Few farmers have livestock as their only source of income, even though, for some, livestock is the most important;
- ✓ The activity seems to need other, rural or urban activities, mainly due to the need of owners and their families for continuous cash flow for everyday expenses;
- ✓ They can be used to compliment other activities, in this case, livestock occupies areas already open in the property, but idle;
- ✓ Is well connected. The network of relationships is useful to them for marketing, procurement of supplies, to aid in sporadic services, recommendations for the health of the herd and the incorporation of technologies into the system;
- ✓ Is aging. A significant number of the farmers, especially with small farms, are getting older and their sons are migrating to the city;
- ✓ Livestock production appears to represent the farmers of Roraima, an activity that is "autonomous, not needing to be accompanied daily," without great difficulty in conducting;
- ✓ Activity involving low use of technology;
- ✓ Inexistent structure for economic and financial management;
- ✓ When other rural or urban activities thrive, profits are invested in livestock, otherwise, this is the first source of funds which the farmer uses, even if it hampers;
- ✓ There is virtually no formal education in management;
- ✓ Many have low schooling or are illiterate;
- ✓ Do not adopt controls for zootechnical reasons;
- ✓ Planning and strategic analysis are inexistent and those for economic and financial are rare, so that they cannot use information sources for use in decision making.

### Activities and farming practices

Livestock systems, including the most flexible, feature significant numbers of functions, practices and activities. On farms with large herds and more structured, as a rule, the division of work is carried out at management level, officer and cowboys and their assistants. Still it happens that a specific service may be hired, such as for maintenance of infrastructure and invasive plants.

In farms with a low production scale, family members or employees accumulate functions. In the example, the owner goes on to operate as a manager, or as an officer who mingles with the cowboys. On a smaller scale farms, especially where there is no hiring of work, these functions are all performed by one or two people. This means that some practices and activities are not carried out, or that they are in some way lacking. It is emphasized that this fact, sometimes also occurs in properties where work is hired.

Moreover, there is the perception that, in general, farming practices are considered easy to perform, and there is a degree of flexibility as to when they are performed.

### Practices to be incorporated into farming properties adopting SILPFs

To better understand the results, practices are divided into 4 groups that should be incorporated with the adoption of ILPF systems in livestock properties.

Table 21: Groups of annual crops and forestry practices.

Group 01	Group 02	Other groups	Forestry group	
Soil sampling	Soil improvement	Driving machines and equipment	Preparing seedlings	Using a chainsaw
Stump removal	Planting of grain	Equipment calibration	Preparation of pits	Sickle mowing
Ploughing	Fertilizer application	Choosing areas	Acclimatisation	Machine mowing
Harrowing	Pests/diseases	Drying and storage	Planting seedlings	Tractor mowing
Levelling	Invasive species	Operation planning	Thinning of crowns	Measurement
Harvesting	Dessication	Marketing	Lopping	
	Inoculation	Acquisition of supplies		
		No-till farming		

The interviewers consider that the practices that need knowledge of machine operation and of simpler equipment control belong to group 01, are of intermediate difficulty and the skills can be acquired through training and practice, over one year of cultivation.

In another respect, the practice of grain harvest, also said to be of intermediate difficulty, requires greater attention because it involves a more refined level of regulation and equipment operation and more experience to establish the best time to carry out, in order to reduce waste.

Practices of group 02 (Table 21-Table 2), (apart from inoculations of soybean and cowpea, which were considered low difficulty, and the skill can be acquired in the first year), were labelled as high difficulty, involve learning knowledge and need years of practice. However, it is a difficult area, because new things always occur, both in relation to pests that arise as well as new defensives.

The analyses of the interviews show that some factors were predominant, so that this difficulty was considered one of the most impactful to the agronomic success of crops:

- ✓ The producer does not have the right product at the right time to practically implement, for lack of inventory planning, or for lack of availability in the local market;
- ✓ In the same way, not having the appropriate equipment, either it is out of use, or not available in sufficient quantities to manage to do at the right time;
- ✓ Lack of sufficient and/or trained personnel;
- ✓ Finally, some do not have the technical expertise to identify the ideal time to carry out the practice, mainly pest controls.

The grain planting differs from the other group practices, as it requires more attention than years of experience. In this practice, many variables interrelate to achieve the desired distribution, plus of course the quality of seeds.

The tillage system, which involves the use of herbicides in desiccation and making straw, means this system requires not only more training, but also more years of experience.

The acquisition of inputs and activities like marketing of production were considered by all respondents as high difficulty and grasping the necessary skills difficult.

For input acquisition, all respondents established that understanding the need for more time to obtain experience and a higher degree of difficulty was crucial: there was a lack of formal knowledge of negotiation techniques, or perception of the lack of marketing channels and lack of the free flow of information on prices, demand and product' supply.

Finally, it was shown that more time for planning is necessary, despite it not being formalised and with little flexibility in the implementation period.

In the group belonging specifically to forestry practices, preparation of seedlings and pits, acclimatization and planting of seedlings, are performed in the first year, but cannot be neglected. Regardless of the size of the business, monitoring by experienced people must be provided.

In maintenance practices, weeding, mowing and pruning, it was not considered to be difficult to grasp the necessary skills.

Both chainsaw use and measurement of height and circumference at chest height were considered of medium difficulty. Respondents believe that competence in the use of chainsaws can be gained in the

first year. Evaluation measurements such as pruning were suggested to be a more detailed practice, but with relative ease of implementation.

As with livestock practices, there is a certain flexibility with the time of the operations, during the year.

### **Quantitative work**

The additional labor (men day<sup>-1</sup> year<sup>-1</sup>) due to the inclusion of SILPFs in subsistence dairy farms in the forest region, with 10ha in area and a herd of 5 cows, was 80% higher than the 91 men days<sup>-1</sup> year<sup>-1</sup> calculated for this type of property without SILPFs.

For fattening beef cattle farms, in forest regions, with 200ha area of usable pastures and 238 head, it was estimated that 480 men days<sup>-1</sup> year<sup>-1</sup>, are needed. With the inclusion of SILPFs there was an increase of 21%, so 885 men day<sup>-1</sup> year<sup>-1</sup>.

Finally, the increase in labor in farms in the savanna region of Roraima with 1000 ha of pasture and 200 cows, because of the inclusion of SILPFs, was 30%, thus, 1,152 men days<sup>-1</sup> year<sup>-1</sup>.

### **Qualitative labor**

The SILPFs require the inclusion of new practices and increased work in operations in a property's production system.

The new practices incorporated are not restricted to those related to new components, grain and forestry; they include those regarding livestock and management, which is necessarily improved with the implementation of tools adapted to the different contexts.

The farms of Roraima do not possess the skilled technical labor to meet the demands generated by the inclusion of grain and tree components. Therefore, continuous training plans in techniques must be incorporated into the daily running of the property.

In addition to training in the implementation techniques and conducting of SILPFs, training should also be included in financial and accounting management, prioritisation and focus, marketing and trading, human resource management and planning for the short, medium and long term.

### **Property management for SILPFs**

It is understood that the intensification of a property due to SILPFs requires adjustments that exceed the inclusion of new components to the property's production system, given that the entire operation of the property is changed.

The increase in components, activities and practices complicate the management of the property. Other contributing factors are new legislation, increased funding, new markets and different logistical elements for new supplies and products.

These multi-component and multi-product systems are more complex than livestock farming, so understanding or improving the producer's systemic vision, in which the results come not only from the sum of their harvests but also from interactions between components that arise from relationships: cause and effect; temporal; nonlinear; retroactions or "feedback"; even indirect interactions, produce other less visible results that contribute to future earnings and the sustainability of the entire production system, thus their business.

### **Operational management of the production system**

Intensification of farming properties by SILPFs, especially agro-forestry-pastoral farms, based on the increased use of supplies and technology, different from the norm in livestock systems, demands a revolution in the daily running of a property;

the numbers of practices, activities and technologies that are incorporated need new knowledge and constant updating and management control.

In complex management, when the results that emerge from interactions between components (complexity) are not taken into account, it is possible to overcome this in the context of State livestock properties, with management tools such as the creation of an annual calendar that serves for planning and monitoring practices and activities; a calendar which must contain the agricultural practices and management activities, marketing and supplies acquisition.

The management of complexity, understood as the income, is not only in the end product of the components, but also originates from the interaction between all components of SILPFs.

### **Conclusion**

The adoption of SILPFs to replace exclusive livestock activity gives the loss of temporal flexibility in the implementation of practices.

The key factors relevant to work management are to improve the distribution and coordination of tasks and the constant qualification of those involved.

The availability of qualified rural work in Roraima is a barrier to large-scale expansion of SILPFs in the State.

Management models most commonly used by farmers on the State cannot enable the SILPFs, meaning that this discipline is forced to combine qualification plans. Management is fundamental to the success of SILPF, more than traditional systems based on slash and burn, which are characterised by less developed management. The success of SILPF requires strict management of timing and work. Regardless of the scale of production, the more components in SILPFs there are: i) the greater differentiation in activities; ii) the further the diversification of knowledge and work; iii) the greater the complexity; and iv) the more complicated the management.

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