Sustainability in Potato Production, According to Crop - Livestock Integration System Approach

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Abstract: *In the southern region of the State of Minas Gerais, Brazil, there is predominance of small farms that cultivate potato and exploit and dairy farming in family business form. These firms are important for the economic activity in the region, although most pasture areas are degraded. In Potato cultivation the intensive use of the area predominates with more than one crop per year, with absence of: technology, conservation and environmental techniques and crop rotation. This predatory system has led to the degradation of soils and natural resources. The purpose of this paper was to propose and disseminate techniques for crop managing and, mainly, the adoption of the crop-livestock integration system with potato as the main crop, providing for family business rationality and sustainable exploitation of its property. These practices can improve the income producers, and ensure the permanence in their properties. The research was carried out in three municipalities in the southern region of the state of Minas Gerais, prioritizing the sequence of rotational occupation and planting time of the potato: a) potato (planting in October), maize + Brachiaria grass (direct grazing and silage), millet (grazing); b) potato (February planting), oats (cutting and grazing), corn (grain); c) potato (October planting), maize; occupational sequence of crop rotation performed respectively in three municipalities. After the crops in succession, the potato planting is again restarted. The results obtained allow us to conclude that the crop-livestock integration system adds positive effects of potato production to those of livestock production, with a great synergistic effect benefiting all these operations.*

Keywords: Sustainability, Potato, Crop-Livestock Integration System Integration.

I. INTRODUCTION

The state of Minas Gerais, is the largest Brazilian producer of potatoes and most part of the production is concentrated in the southern region of the state. This region has an agrarian structure formed by a large number of small farms that cultivate potato and exploit and dairy farming in the form of family business. Family business farming has great social importance, and it is related to the creation of jobs (agricultural and non-agricultural), food production, income and local development (ROCHA, PAULA, 2005). For family farmers it is of fundamental importance the diversification of production and not only reaching high productivities obtained by the monocultures or livestock. This strategy reduces the financial difficulties in periods of low prices for potatoes or milk, which represent the most important sources of income for households in the region. Lesser the oscillations of income, more economic stability of the family is guaranteed. Diversification of production is therefore one of the strategic options in rural development policy, particularly in areas affected by the decline of certain activities or cyclical price fluctuations.

Potato cultivation and dairy farming are important economic activities in this region, although most pasture areas are degraded (MACEDO, 1995). The differentiated conditions of relief, soil and climate allow the cultivation of potatoes throughout the year, which favors the regularity of supply in the market, as well as the economy of the municipalities. In this region, the intensive use of the area with more than one crop per year predominates, with the use of inputs in quantities higher than recommended, but not obtaining higher yields (MESQUITA et al., 2008 b). The potato crop is very susceptible to pests and diseases, mainly bacterial diseases, which is why no more than two consecutive plantations are recommended in the same area. Producers use potatoes as a temporary or nomadic crop in which the farmer is generally not the owner and has no link with the land, so there is no commitment on conservation investments. This fact, over time caused an exodus of large part of producers in the southern region of the State of Minas Gerais, who due to the loss of the sustainability of their lands migrated to other regions of the state. This predatory system of exploitation that still perpetuates has led to the degradation of

soils and natural resources (MESQUITA et al., 2000 a). The causes that contributed to this scenario are associated with several factors, such as the absence of a technology of crop rotation, and the use of conservation and environmental practices.

The adoption of the system of integrating crop and livestock farming, through crop rotation techniques with that of potatoes, can provide the family producer with rational and sustainable exploitation of the property, improving income and ensuring its permanence in property. Possibly, one of the most significant advances in the search for more sustainable technologies for agricultural exploration in Brazil is the evolution of the knowledge of the integrated system of "crop-livestock" production (LOPES, 2008). This system requires a conceptual and operational change of agricultural practices, both for the production of grains and other products such as potatoes in the specific case, and livestock.

Potato and dairy farming are an important socioeconomic feature of agriculture in the state of Minas Gerais. It is a powerful source of employment and income generation. In addition, potato cultivation uses labor intensively when compared to other crops of family farmers, in most cases, activities that are complementary between these farms. The crop-livestock integration has proven to be a viable alternative in the improvement of these areas, reducing the need to "open" new planting areas for potato cultivation, establishing the producer's link with his property and thus reducing the temporary or nomadic migratory process characteristic of the activity, in addition to guaranteeing the rural producers an income improvement.

The objective of this paper is to propose and disseminate management crop techniques in the area and, mainly, the adoption of the System of Integration of the crop with the livestock (ILP) by means of crop rotation, with the potato being the main crop. This practice provides to the family producer rational and sustainable exploitation of the property, improvement of the income, ensuring its permanence in the property.

II. METHODOLOGY

The sequence of occupation of the rotating crops with the potato crop were defined in order to allow the variation of nutrient absorption, root exploitation, soil management and emphasis on good agricultural practices, to optimize the sustainability of the system. The experiments were installed in rural properties in the municipalities of the southern region of Minas Gerais; SenadorAmaral, Munhoz and Pouso Alegre, respectively:

- Potato (October planting); corn + brachiaria (grazing + silage); millet (grazing).
- Potato (February planting.); oats; corn.
- Potato (October planting); corn.

After the crops in succession, it restarts again with the planting of potato because it is the main crop. The choice of methodology was defined in agreement with the activities developed by the producers, mainly in relation to the management developed in dairy cattle.

III. RESULT AND DISCUSSION

The yield and forage yield of the rotation and / or succession crops are shown in Tables 1 and 2.

TABLE 1
YIELD, PRODUCTION AND ROTATIONAL OCCUPATION.

Variable	Rotational Occupation			
	Corn + Brachiaria+ millet	Oats	Corn (grain)	Potato
Green matter (t/ha)	49,60	16,0	-	-
[(1)] Dry matter (% DM)	30,35	16,39	-	-
Crude protein (%DM)	10,0	15,04	-	-
Ethereal extract (%DM)	2,50	3,33	-	-
Production t/ha	-	16[(2)]	7,2[(2)]	35[(2)]

[(1)] Percent dry matter (%DM).
[(2)] Average yield of 02 crops.

These results showed a good yield of green mass (49.6 t / ha), significant if compared to corn yield for silage that is close to these values. However the producer will have the pasture formed after the removal of the silage material, that is, it has the formation of grasses at a much reduced costs for the rest period of the area until a new planting of potatoes.

TABLE 2
PRODUCTION AND FORAGE YIELD (t / ha) OF THE BRACHIARIA-CORN CONSORTIUM.

Forage	Production
Brachiariagrass	33,60
[(1)]Corn	16,00
Total greenmass	49,60
Total in area (4,8 ha)	240,00
[(2)]Total in drymatter	57,60

[(1)] Estimated 1/3 of the normal production of corn silage
[(2)] % of dry matter (DM) = 24,23%

The forage produced in the form of silage in 4.8 ha (57.6 t DM) is sufficient to treat 64 dairy cows weighing 500 kg for 120 days, or 80 steers weighing 360 kg for 120 days , or 180 calves weaned for 120 days.

It should be emphasized that the production of crops in succession is carried out with the residual use of fertilizers, mainly phosphorus (P), from the areas with potato cultivation.

Oats for animal feed can be carried out in different ways: green directly in the trough, grazing and hay, in this case specifically, was used green directly in the trough and in direct grazing by the animals. In addition to its high food value as forage, it is used as organic matter (OM) addition by the incorporation of vegetable residues, continued by the succession of crops, favoring the reduction of soil resistance to root penetration in the arable layer; the reduction of the acidity, increase of the base saturation index and significant changes in relation to soil preparation, cultivation and soil quality maintenance.

Crop rotation among potatoes, oats, maize and pasture proved to be an excellent option for the producer, since one crop benefits the other through nutrient recycling, resulting in increased productivity (figure 1). One of the great benefits of planting corn after potato cultivation is the residual fertilizer utilization in areas cultivated with potatoes, which allowed:

a) Strengthening the linkages of crop-livestock activities with a crop rotation program that has the potato as the main activity, aiming at the sustainability of the family producer;
b) Reduce environmental impact through the use of crop rotation practices, soil and water management, integrated pest and disease management with an emphasis on good practices.

A. Potato Crop

B. milhet + brachiaria.Pictures : Hugo A. Mesquita.

FIGURE 1. ROTATION CROPS

In order to evaluate the beneficial effects of the crop-livestock integration system (ILP), no maize or pasture was used in the planting of maize and pasture, simply using the residues from the previous crop (potato) and without the need for preparation of the soil (plowing and harvesting), since the soil rotation for the potato harvest did not require the operation, which, besides promoting soil and water conservation, reduced production costs with soil preparation and management, contributing significantly for the sustainability of the potato-corn -pasture system (Cattle-Raising).

The integration of these activities has shown that diversification reduces the risks of producers by providing alternative income. An activity covering the risks of the other, the management of the property, especially at the moment that the potato presents low seasonal prices.

The integration demonstrated the need for diversification of activities in the property. The search for cost reduction is essential and other cultures are promising the alternatives to this integration with dairy farming, among several possibilities (figure 2).

A. Corn + Brachiaria grass Mesquita

B. Oats crop after potato. Picture: Hugo A.

FIGURE 2. ROTATION CROPS

IV. CONCLUSION

Diversification has proven to be one of the strategic options in rural development policy, particularly in areas that are more affected by the decline of certain activities or cyclical price fluctuations such as potatoes and dairy farming.

The results show that the crop-livestock integration (ILP), allows adding positive effects to potato production, with those of livestock production, with a great synergistic effect benefiting all these operations.

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