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Full Length Research Paper

Influence of modern technology on small family-owned farms in the Brazilian savannah region: A case study of a settlement in Mato Grosso do Sul State

Arcelei Lopes Bambil and Olivier Vilpoux*

Catholic University of Campo Grande (UCDB), Mato Grosso do Sul – Brasil.

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The Savannah region is the second biggest biome in Brazil after the amazon forest. Today, the savannah is Brazil´s largest region responsible for commodity production. Nevertheless, this production is concentrated around large-scale farmers. Most of the small farmers representing the largest group of producers encounter many problems ranging from low levels of production to income difficulties. The objective of the research was to verify the influence of technology in problems encountered by small farmers installed in the Savannah region. The research has been realized with a case study in a cooperative from the settlement São Manoel, in the Mato Grosso do Sul State, Centre of Brazil. Praxeology, knowledge of how to use technology, has been identified as the most important characteristic to explain the cooperative problems. For annual crops, in fertile soils, technologies can be traditional and therefore the use of modern praxeology is not necessary. In poor soils, typical of the Brazilian savannah, the necessity of modern technology requires the domination of more complex praxeologies. Perennial crops and investments in special structures, such as green houses also require modern technologies and adequate praxeologies, which were not available in the cooperative. The results indicate the importance of extension services and training methods adapted to the technologies used. Otherwise, the small producers of the Brazilian savannah are limited to traditional technologies, useful only for crops with good climate and fertile soil, which represent a small part of the biome, mainly near rivers.

Key words: Technology, familiar agriculture, savannah.

INTRODUCTION

The Savannah occupies an area of approximately 2 million km² and is the second largest biome in Brazil (Ribeiro and Walter, 1998). Small parts of the savannah are also found in the Amazon, Caatinga, the dry region of northeastern Brazil, and the Atlantic Forest, which occupies much of the coastal region of the country (Aguiar et al., 2004). The Savannah has provided conditions favorable to human settlement since ancient times. According to Barbosa and Schmitz (1998), the remains found in archeological sites, such as those located in the municipality of Serranópolis, state of Goiás in central Brazil, indicate that the occupation of the biome began some 11 thousand years ago. The first inhabitants were hunters and collectors of fruit, eggs, shellfish and other products of the rich biodiversity, which began to be strongly affected by the arrival of colonizers of European origin. Of these, the most famous characters are the Bandeirantes who penetrate into the hinterland in search of precious minerals and Indians for slavery. Extensive livestock has continued that process of occupation, prevailing as the main economic activity until the advent of modernization, with the introduction of new technologies in agriculture in the decades of 1960/70 (Shiki, 2000).

According to Bourlegat (2003), modernization of agriculture in the Brazilian Savannah is an exogenous process which did not arise from self-evolution of pre-existing models. The introduction of a new pattern of

*Corresponding author. E-mail: vilpoux@ucdb.br.

production is a consequence of external entities, and the Federal Government has been a dynamic element of this process. In the context of public policy, the Federal Government initiative led to the creation of EMBRAPA - Brazilian agricultural Research Agency, and the Brazilian Technical Assistance Agency - EMBRATER and incentive programs to the territorial occupation of the Savannah by agribusiness capital. As mentioned by Silva (2000), citing Shiki (1997) and Salim (1998), the Development Program of the Brazilian Savannah (Polocentro), created in 1975, was the most emblematic and comprehensive Federal Government program to transform the Savannah as a major producer of commodities. The resources of Polocentro intended to research and provide technical assistance to rural credit, to mechanization and soil correction and other benefits. The credit had a low interest rate, no monetary correction and long grace periods. The biggest beneficiaries were the large landowners, contributing to the exclusion of a significant portion of the rural population who suffered an intense process of deterritorialization (Bourlegat, 2003). The rural settlements deployed from the 1980s are a result of this process, which can be interpreted as a form of reterritorialization.

Referring to environmental issues, the modernization of the savannah brought serious problems for biodiversity, soil and water resources. After analyzing the process of deforestation and fragmentation of vegetation which occurred in the decades of 1970/80, Bourlegat (2003) notes that environmental problems began with the selective extraction of timber and continued with the felling and windrowing. In the first operation, the vegetation was removed using a chain or a bulldozer blade. During a second time operation, the plant remains were pushed into a windrow and later burned, leaving the ground without its thin layer of organic matter, as quoted by Coutinho (2000). These new techniques resulted in large-scale deforestation, soil depletion, which favored the emergence of new pests and, most likely, potentiated the effects of existing ones due to the reduction of natural enemies and the introduction of exotic species (Bourlegat, 2003). This set of unfavorable factors in agriculture has created a social and environmental impasse which has limited the development of settlements in the Brazilian savannah.

Objective of the study

The research aimed to investigate the influence of technology on the results achieved by small family-owned farms implanted in the Brazilian savannah. To this end we used the case study.

METHODOLOGY

For Grawitz (2001), this type of research is characterized by the collection of the maximum amount of information about a particular and limited subject. The case study allows the development of hypotheses about an issue without providing scientific evidence, which should be raised later in a more experimental type of research. The case chosen was from settlers, group of small producers which represents a large proportion of family farming in the savannah region. The producers came from the settlement São Manoel, in the Municipality of Anastácio, in the Brazilian State of Mato Grosso do Sul. All had been members of a producers' cooperative, the Cooperative of Agricultural Production Canudos - COPAC, which made several attempts to organize the production of the settlement, using different types of technology and diversified crops. The organization of small producers into a cooperative, which is rare not only in the Midwest of Brazil, but in many parts of the world, as reported by FAO (2009 a, b), conducting experiments with different technologies, from the most traditional to the most modern, with cultivation of different crops, from annual to perennial, can explain the selection of this case.

The Hacienda San Manoel, City of Anastácio, was occupied by landless peasants in October 1989. While waiting for the expropriation of the area, the occupants had installed a camp on the banks of the Criminoso River, where they established small community plantations for subsistence in the fertile soil near the river. Each plantation was under the responsibility of a group consisting of four to five families. Among these groups of families, two are worthy of mention, the group named Padroeira and the one called Bonito. Later, they joined and formed the group that gave rise to the Cooperative of Agricultural Production Canudos – COPAC, founded in October 1993. Data was obtained through structured interviews with all remaining members of the Cooperative, with a total of ten families. The research also included an analysis of documents on the Cooperative available in the State Extension Entity (AGRAER) and the Bank of Brazil, a public bank and main financier of small family-owned farms in Brazil. Visits to settlements allow the realization of direct observations on site, with evaluation of the production processes adopted and the equipment available.

Importance of technology in the development of the Brazilian Savannah

The quasi-stagnation and difficulty in responding to social demands in most of the settlements located in the Savannah of the Brazilian State of Mato Grosso do Sul can be considered a paradox in front of the technological standard of modern agriculture, which reaches high productivity and is located in the same area. After two decades of the early establishment of settlements in the state, most of them are weakened economically and socially and are environmentally devastated as well. Without minimizing the positive aspects of Brazilian agrarian reform, the fact is that in the State of Mato Grosso do Sul the economic and environmental dimensions contradict the expectations created around it. In the period prior to the modernization of agriculture in the Savannah, most of it was occupied by extensive breeding of cattle and the extraction of species of economic interest. Agriculture was practiced mainly in the most fertile soils, near the rivers. There are strong indications that the technology that allowed the Savannah to become viable for agriculture does not fit the model of small family-owned farms. This technological matrix, or modern technology for large scale production, was available for land reform, which may have contributed to the unsustainability and stagnation verified in most of the reformed, or settled areas. The experience of the case study examined in this research is emblematic in this regard. Despite having the basic productive resources - land, organization, credit, technology and technical assistance - the experience was not successful.

According to Santos (1997), farmers who migrated to the Midwest during the modernization of agriculture, mainly from the South, felt displaced in front of an environmental reality different from that in which they lived and grew. They were unaware of the potential of the natural environment such as fruits, medicinal plants, animals, soil characteristics and climate. This statement is consistent with the proposition of the survey, with one exception: it was not only immigrants who felt displaced. Traditional farmers from the savannah region also had the same experience, due to the change of the natural environment of agricultural production. During this period, with the adoption of modern technology such as chemical fertilization, occurred a displacement of cultures from the fertile soils, in the banks of the rivers, located in more sloping area, to the savannah part, with large and flat areas, where the use of mechanization is easier. The technology is developed according to the socio-environmental context. As a result, according to Jequier (1979), technologies developed in the core countries can be effective, but when released in the peripheral countries often cause more problems than solutions. The management of machines and equipment produced in other realities can be simple, which does not mean technological mastery over them in regards to the economic, cultural, environmental and other kinds of differences.

The so-called appropriate technology is presented as a way to overcome the productive deficiencies, without resorting to exogenous technologies. It is often treated as low-cost, intermediate or traditional technology. "The appropriate technology should be, first and foremost, an indigenous creation in developing countries, and the main problem encountered is to form an indigenous capacity to innovate and not to import more technology ..." (Jequier, 1979).

Concepts of technology adopted in the research

According to Jequier (1979), technology does not refer only to physical components, such as factories, machines, products or works of infrastructure (roads, warehouses, dams, etc.). These technology components are only the visible aspects of the technology which goes further and includes the logical, or intangibles, components such as information, knowledge, technical skill, education, administration as well as other institutional arrangements. For Vargas (1994), apud Vitorette (2001), technology is defined as the symbiosis of technique with modern science and is therefore a set of human activities. These activities are associated with symbols, instruments and machines aimed at the construction of works and manufacturing of products, according to the theories, methods and processes of modern science. Based on the concepts of productive forces and production relations, Gama (1987) identifies four components that constitute modern technology: "Technology of Work, Materials Technology, Technology of Work Tools, Basic Technology or Praxeology".

The Technology of Work refers to the administration of working times, the division of labor, relations between workers, safety and occupational medicine (GAMA, 1987). The author cites the example of ergonomics (for the design of equipment compatible with comfort and efficiency) and the Rational Organization of Work (the study of time, fatigue, environmental conditions of work, standardization of methods and machinery). The Materials Technology treats the object of work, which is "[...] upon which carries the action of man. [...]. The object of a work stage may be the product of a previous phase: a log of wood is a product of the work of timber, but is the subject of work at the sawmill which provides [...] carpenters and joiners with beams" (GAMA, 1987). This component of modern technology studies the materials, whether natural or synthetic, which will be transformed into products. Always, according to Gama (1987), the Technology of Work Tools refers to tools, implements and machines used. It also includes energy use in its various forms. Basic technology, or Praxeology, is knowledge. According to Gama (1987), the praxeology is "[...] the study of methods to arrive at operational conclusions. It is the logic of rational activity driven by action". Negrão (2000) states that the praxeology "refers to the disciplines and techniques that support the other areas of technology, which may include among them some applied sciences. [...] It is the study of all aspects that affect the action, that is questions of methods, standards, representation, measurement, repertoire and vocabulary, etc., in order to make effective action".

In the case study of COPAC, some modern technology components that characterize the modernization of Brazilian agriculture were considered from the decades of 1960/70 such as: the use of credit, machinery, motor sprayer, chemical inputs, mechanized deforestation, trash blanketing and use of improved seeds. Also considered as modern was the practice of administrative planning, the use of tax accounting and methods and techniques that are not part of the peasant tradition, such as investments in infrastructure (greenhouses, dams). Technology composed by productive tools and procedures that are part of peasant culture since before the modernization of Brazilian agriculture, even if they are industrial products, has been considered as traditional technology. This category shall cover hoe, ax, plow, animal traction, rake, manual sprayer, insecticide use, tree felling, manual harvesting, the use of a community task force between farmers and the practice of a simple accounting or notes. In the cases where there was no clear predominance of one type of technology over the other, indicating balance between the use of traditional and modern technologies, the technology used was considered as mixed.

RESULTS AND DISCUSSION

In its creation in 1993, the Cooperative was composed of 24 persons belonging to 14 families with a total area of 334.48 ha in the settlement São Manoel. In the area there were 44 ha of crops like corn, rice, cassava, banana, cotton, vegetables, and 10 ha of pasture in addition to large areas of savannah. This area consisted of the entire capital of the cooperative members. The production was organized into five productive sectors: 1) vegetable garden, 2) machinery, 3) livestock, 4) beekeeping and 5) farming. In the months following the beginning of activities, the number of cooperative members had reached 30 people, but the participation declined, to be reduced to 10 families in the first years of operation. According to Jequier (1979), one of the difficulties faced by cooperatives in many developing countries is the requirement of a high degree of technical skill needed to manage the organization. It is essential for people responsible for the administration to have deep experience and motivation. For this purpose, some members of COPAC were sent to the states of Parana and Santa Catarina, States in the South of Brazil where cooperatives of small farmers are very strong, to attend technical courses in cooperative development and accounting.

With the legalization of the cooperative, the cooperative members had access to the Special Credit Program for Agrarian Reform - PROCERA. The amount of resources devoted to COPAC, released by the Bank of Brazil, was R$ 41,490.00. This loan was used to purchase dairy breed cattle, wire, a chain saw, deforestation and tillage.

Table 1. Results obtained from annual crops, which do not require an investment in infrastructure, according to the technologies adopted.

Crops	Working material	Predominant technology of work tools	Predominant technology of work	More complex praxeology	Final results
Community crop	Fertile soil	Traditional	Traditional	Absente	Good productivity
Cotton plantation	Poor soil	Mix	Mix	Absente	Low productivity
Slash-and-burn cotton plantation	Fertile soil	Traditional	Mix	Absente	Good productivity
Cotton plantation	Poor soil	Modern	Modern	Precarious	Low productivity
Cotton plantation	Poor soil	Modern	Modern	Absente	Loss of plantation

In the same period, two additional credits were also released, totaling R$ 19,037.00, for the drilling of a semi-artesian well. Thus, COPAC has contracted a total investment credit equal to R$ 60,527.75 (equivalent to R$ 100,000 in 2011 values, or around US$ 55,000.00). Beyond the resources described, each of the ten families had the right to an individual credit of R$ 3,192.00, totaling R$ 31,920.00. These financial resources were used to buy a medium sized tractor and implements, and fund the construction of dams, a reservoir, expansion of deforestation, acquisition of lime and phosphorus fertilizers, as well as to purchase cotton and corn seeds and poisons for the 1994/95 harvest. Table 1 shows the results achieved from annual crops, depending on the adopted technologies.

While still at the stage of community crop, with predominance of traditional technology such as that used in the exploitation of the lowlands, the most fertile soils of Brazilian savannah, or with the “slash-and-burn technology”, without mechanical removal of organic matter, farmers have been successful in production. With regard to cotton fields, the difference is flagrante between the results achieved between areas deforested with a bulldozer blade and those deforested with “slash-and-burn technology”, utilizing manual labor. The result of the latter exceeded the regional average of productivity, while the other areas have comparatively low yields, including fields where soil analysis, correction and fertilization have been conducted. The information collected in the survey indicates that farmers who were members of COPAC produced satisfactorily with small surfaces where the soil is more fertile, in an area which represents less than 20% of the total area belonging to the Cooperative. This area was used for subsistence crops, repeating the peasant tradition of exploiting these kind of land existing in the Savannah mainly for consumption and sale of any surplus in local trade. On the other hand, the farming introduced by COPAC in other parts of the Savannah, with poor soil was traditionally reserved for livestock but today it is used for large modern soybeans, cotton and corn plantations, were barely able to produce to pay for inputs, except for cases in which a low of technology has been used, such as “slash-and-burn”. In these cases, the mechanization process responsible for the removal of the topsoil, where the organic matter is located, is not realized, maintaining natural soil fertility for a longer period.

Table 1 indicates some factors that may have had great importance for the production performance for the COPAC cooperative. In the case of the most fertile land, the adopted work and work tools technologies were more traditional. It can be considered that for cultivation in high fertility soils, the traditional method is sufficient and there is no need for more complex praxeology in order to obtain good productivity. In the lands of lower fertility, traditional technologies are inadequate, making necessary the use of more modern technologies. In this case, the control of more complex praxeology becomes a necessity, which was not observed with the members of COPAC, as indicated in Table 1. In this case, low productivity is primarily due to a lack of suitable praxeology, not allowing for the proper use of work and work tools technologies. Table 2 presents the results for perennial crops and other specific enterprises, requiring additional investments, such as greenhouses and a dam. The construction of the dam is a case that attracted attention because it is not an activity typically peasant. As it has been planned and executed by inexperienced people, without technical expertise, it can be assumed that there was malpractice during the construction. We can cite the absence of studies of the micro water basin upstream from the work being done, of the characteristics of the damming and of the construction planning. These aspects are part of the technology (praxeology) required for the construction of a dam technology, that members of COPAC did not dominate, even if a small one.

The search for alternatives to traditional crops, driven by the need to produce for market commercialization, led COPAC to opt for enterprises which required greater investments, with necessities of modern works and work tools technologies. These agricultural enterprises relied on poor professional technical assistance and suffered from technological setbacks, some of which should have been predictable and manageable with existing technology. In the case of greenhouses, the building model was imported from Rio Grande do Sul, a Southern Brazilian State. In this region, climate is very different, and the building project did not make any adaptation for the Mato Grosso do Sul region, mainly concerning the occurrence of strong winds. The sensitivity of plastic

Table 2. Results achieved in perennial crops and enterprises that need investment in infrastructure, according to the technologies adopted.

Enterprise	Working material	Predominant technology of work tools	Predominant technology of work	Praxeology	Final results
Dam construction	Land, water (heavy rain)	Modern	Modern	Precarious	Destroyed by flood
Greenhouses construction	Local, weather (strong wind)	Modern	Modern	Precarious	Destruction of greenhouses by wind
1.st harvest of tomatoes	Greenhouse, good climate	Modern	Modern	Precarious	Good production
2.nd harvest of tomatoes	Greenhouse, warm climate, pests	Modern	Modern	Precarious	Low production
1.st harvest of passion fruits	Fertile soil, good climate	Modern	Modern	Precarious	Good production
2nd harvest of passion fruits	Fertile soil, pests	Modern	Modern	Precarious	Low production
Banana crop	Fertile soil, contaminated plants	Modern	Modern	Precarious	Plantation lost

greenhouses to climate variables is well known, and climate conditions should have been analyzed very carefully. The first tomato crop benefited from a favorable climate, allowing for good production. In the second crop, held in the summer, excess temperatures inside the greenhouses damaged the crop. Besides this problem, the lack of proper care during the first crop has facilitated the development of pests, particularly of the whitefly. The period of the attack of the whitefly coincides with the entry of this pest in the Mato Grosso do Sul State. In this period, the pest was new in the region and there were not many technological control resources. Its occurrence was considered as a major problem for local agriculture.

The first crop of passion fruit provided a good yield for the Cooperative. The second year, however, saw the appearance of pests and diseases in this crop, due to lack of proper care in the first year. Despite awareness to the fact that the banana chosen by COPAC producers, the banana-maçã, is susceptible to Panama disease, which was already present in the region, the prevention measure was limited to disinfecting of the plants with bleach, which proved to be insufficient to prevent contamination by the fungus. The choice of pest-resistant varieties with good market acceptance would have been more appropriate. The results of Table 2 identify the need for the use of technologies qualified as modern, in works and tools of work. However, the proper use of these technologies requires adequate praxeology. In the event of severe weather (heat, excessive rain, strong winds), or the appearance of pests, the results of the projects have always been negative. In this case, as for Table 1, the lack of praxeology was of great importance. The adoption of modern technologies of works and work tools does not respond positively, if the use of these technologies is not combined with appropriate praxeology.

Conclusion

COPAC technological setbacks did not happen due to differences between the environmental conditions, before and after the settlement. Although most farmers had been born in other regions of the state and country, outside of the Savannah, at the time of deployment of the settlement all Cooperative members were already adapted to this biome. The data indicates that farmers did not stop to produce, according to tradition, in favor of modern technologies. They instead tried to associate both technologies. Initially, at the phase of collective and community crops, there was a predominance of traditional technology. Little by little, as the farmers tried to commercialize more and more of their production, greater weight was given to modern technologies, which occurred mainly from the release of credit. This did not imply the abandonment of traditional technological

resources nor the increase of productivity. What really happened was a failure to comply with the requirements for the application of modern technology, causing successive negative economic impacts which exhausted the resources and discouraged the producers.

The praxeology proved to be the most important point to explain the problems encountered by the Cooperative. In annual crops, soil quality was a major factor. In fertile soils, the use of more modern praxeology is not necessary, as the work and work tools technologies may be traditional. In poorer soils, typical of the savannah, the use of modern technologies is essential, making necessary the domination of appropriate praxeology, which was not dominated by the members of the Cooperative. Perennial crops and investments in a more complex infrastructure, like greenhouses, also need modern technology and appropriate praxeology; praxeology not dominated by farmers in the cooperative, despite participating several training sessions. In this case, the first year of crops, characterized by adequate working material, gives good results. However, the lack of appropriate practices to maintain the working material of the following years, favored the appearance of pests and diseases, affecting incomes. As in the case of annual crops on poor soils, modern technology is indispensable for production with unfavorable working materials, but a praxeology able to dominate the technological needs is also required.

This conclusion does not mean that availability of modern technology with appropriate praxeology would necessarily lead to the sustainability of the productive system. It is important to pay attention to the fact that small family-owned farms are subject to the market laws, including consumer demand, competition, capital intensive use and the need for technological innovation. The use of appropriate technologies with the necessary praxeology is useless without the existence of a market demand. The producers of COPAC participated in several training sessions for management and production technology (labor), but these sessions were not enough to meet the requirements of material production (climate, soil, crops), works and work tools technologies. In this case, the adopted praxeology can be characterized as inadequate to the socio-environment and therefore did not lead to the expected results. The results of the research indicate the importance of rural extension and training adapted to the used technologies. Without adequate knowledge, small producers of the savannah are limited to the use of traditional technologies, suited only for annual crops, favorable climate, fertile soil and the lack of pests and diseases.

Even if research on other settlements and cooperatives of small farmers is required to extend the results obtained in this study, as outlined in earlier in the description of the goals of the case study, it is possible to estimate that the praxeology limitations can be a barrier to the development of the small family-owned farming in the Brazilian savannah region. This result could partially explain the difficulties encountered in numerous settlements in the region, where the soil is not very fertile and the level of producers praxeology is inadequate.

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