

*Full Length Research Paper*

## **Agricultural mechanization in small rural properties in the State of Piauí, Brazil**

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**The use of machines in the rural sector increases crop productivity in the field, making it essential to use these technologies for a successful rural enterprise in the market. In this way, this study aimed to analyze the current situation of agricultural mechanization in farms of small producers. The study was conducted in State of Piauí, in Brazil with 30 farmers in the region. This was a quantitative and qualitative research, developed as a questionnaire applied by direct interview. Data were analyzed and represented in graphs using SigmaPlot<sup>®</sup> 12.0. It was concluded that the use of agricultural machinery for cultivation by small producers in the region studied is almost non-existent due to low purchasing power and also because they are small areas. Thus, the own family comprises most of the hand labor, working with crops in the field primarily by hand, leaving only more difficult services to be performed, such as disking, land clearing and threshing for agricultural machinery.**

**Key words:** Mechanization, family farming, production, Brazil.

### **INTRODUCTION**

The planning and rational use of natural resources requires efficient and effective management, since efficient management will promote the preservation and conservation of the environment, benefiting sustainable development, and assisting farmers in decision making (Francisco et al., 2012). Based on this, the industrial revolution favored the advancement of technology in agriculture, using the necessary tools to expand the

acreage, thus inserting agricultural mechanization as a strategic form of rural development and consequently increasing productivity (Francisco, 2010).

These tools (agricultural mechanization) have taken on a large share in agriculture and contribute significantly to the Brazilian gross domestic product (GDP) with steady growth, since it carries out work in a timely manner in relation to the work done manually by the farmers. Thus,

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it is essential and necessary to investment in agricultural mechanization, but it is necessary before that, to make a correct and precise diagnosis as to its use in order to reduce costs in the labor (production) and thereby maximize profit (Pacheco, 2000).

For any producer, whether small, medium or large, its main activity is production with profit maximization and for this the producer must unite the resources that can help the agricultural work with the work in the field thus searching, through the use of machines and inputs, to decrease the cost of production and increase profits (Mochon and Troster, 1994). Caution is required in decision-making with regard to machines because the expense with them may exceed 20% of the cost of the crops, depending on the productive system, thus, the knowledge of these machines and inputs and their correct use is necessary in order to reduce their production costs (Rezende, 2003).

Agricultural mechanization is essential in agriculture, because in addition to raising labor productivity, it reduces labor costs and increases production, yet allows the farmer to carry out planned tasks in a timely manner and according to the demands of quality of services, in the different forms of work (Embrapa, 2006).

The use of agricultural machinery and implements in planting and managing a field crop presents great efficiency and financial return to the producer, besides promoting the reduction of soil compaction, reduction of rural operations and optimization of efficacy through the control of skating (Duarte Júnior et al., 2008). Thus, the use of machines in rural areas is directly related to the improvement of management systems, and better utilization of the productive resources of agriculture, as a consequence of the modernization and technological evolution of agriculture (Santos and Vale, 2012).

Peloia and Milan (2010) point out that in Brazil, expenditures on agricultural mechanization are high, generally being in second larger in spending on agricultural activities, being the first place to land ownership. However, when well applied and organized, mechanization in the medium and long term has a good potential for reducing production costs. The authors also point out that in order to reduce costs with mechanization, it is necessary and urgent to use administrative techniques, focusing on time, movements, mechanization systems, aiming at productivity increase and costs decrease, operations quality, motivation, environment and strategic alignment as a whole.

In this sense, Artuso et al. (2015) emphasize that mechanization must be planned within agriculture, where the correct sizing can be a factor of cost reduction, since rationalization of resources can lead to increased profitability of the activity.

Despite the benefits proposed by agricultural mechanization, the Northeast region has scarce study material in this area and this is a negative point, since the inadequate use and management of the soil has intensified the erosion process, especially in the

northeastern semi-arid region where the climate and soil properties already favor this event (Chaves et al., 2010).

Inserted in this reality is the State of Piauí, which also has little research on the use of machines and agricultural implements by small farmers. The goal of this study was to analyze the use of agricultural mechanization in agricultural properties in the State of Piauí.

## METHODOLOGY

This study was developed from a field and bibliographical survey, seeking the interaction, understanding and importance of the same to society. It presents a qualitative nature, where the interpretation and translation of the written text occurs, in a thorough way, with cleverness and scientific competences (Chizzotti, 2003). The objective was to understand the reality of the farmers and the motivation in the use of agricultural machinery that can contribute in a significant economical way and in the production of their crops. In quantitative terms, it was sought to quantify the use of these machines and to make an accurate estimate of their use by the farmers, demonstrating objectivity and emphasizing the reality (Gerhardt and Silveira, 2009).

The study region is located in the semi-arid Piauí, located between the geographical coordinates latitude 07° 04' 37" S, longitude 41° 28' 01" O and altitude of 206 m. According to the climatic classification of Köppen, the climate is semi-arid, very hot, with an annual average air temperature of 27.2°C. The average annual precipitation for the period (1960-2016) is of 684.2 mm concentrated in the months of December to April (PIAUI, 2010).

The daily pluviographic records of the Meteorological Station of the municipality of Picos, PI, were used in the archives of the National Institute of Meteorology (INMET; 3° DISME), in Recife, PE, which were grouped by chronological order, month and years. The mean monthly and annual precipitation of the municipality of Picos, PI corresponding to the 2006 to 2016 (the years 2009, 2010, 2011, and 2015 were excluded) are shown in Table 1. The rainfall index ranged from 311,90 mm in 2012 to 911,2 mm in the year 2006. This interannual variation is the very characteristic of the semi-arid state of Piauí. The temperature varies annually with averages of the minimum 21°C, average of 26.3°C and maximum of 32.5°C. Heat stroke with 3.000 h/year and average evapotranspiration of 2.000 mm/year (IBGE, 2010).

The producers of the region under study produce a great diversity of agricultural and livestock products, however, the most cultivated products are: cashew, mango, coconut, guava, banana, pumpkin, cassava, vegetables, beans, corn, watermelon, and rice, with respect to animal part stands out the raising of hens, cattles, goats, sheeps and pigs.

The field research was carried out in the State of Piauí, in August 2016. A questionnaire of 20 questions was prepared and applied through a direct interview to 30 small producers, which represented a sample of more than 13% of the region's farmers.

For the sample, the statistical method of systematic sampling (Crespo, 2009) was used. Initially, a draw was made using the amount of property (approximately 220) for the sample that was 30 producers, resulting in  $220/30 = 7.33$ , that is, chose by random draw a number between 1 and 7 (inclusive) that would indicate the first farm; the others would be periodically considered 7 in 7 uniformly. This was done to obtain the smallest possible error in the final representation of the probabilities in this work.

For the interview with farmers in the study region, the questionnaire comprised 6 multiple choice questions and 14 subjective questions (Appendix A). The questions were structured in the identification of personal data of the producer; characteristics of the production system used; human resources used in

**Table 1.** Monthly and annual precipitations of Picos, PI from 2006 to 2016.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mm													
2006	65.10	221.80	193.60	190.80	41.20	0.00	0.00	000	10.80	19.80	14.50	153.70	911.30
2007	95.10	202.40	94.90	63.80	46.20	0.00	0.00	0.00	0.00	3.20	32.90	30.10	568.60
2008	88.90	75.00	287.80	138.40	14.20	0.00	0.00	1.10	2.40	0.90	2.90	141.80	753.40
2012	49.50	75.10	47.40	12.70	7.10	1.80	0.00	0.00	0.00	0.60	103.90	13.80	311.90
2013	73.90	8.80	69.90	68.50	67.00	8.60	1.00	0.00	0.00	1.30	16.20	0.00	315.20
2014	28.40	109.60	99.70	64.10	11.20	0.20	23.80	0.00	0.00	43.80	35.60	0.00	416.40
2016	319.30	86.30	97.00	5.90	32.60	0.00	0.00	0.00	7.70	8.80	10.30	0.00	567.90
Media	102.89	111.29	127.19	77.74	31.36	1.51	3.54	0.16	2.99	11.20	30.90	48.49	549.24
CV	0.95	0.68	0.66	0.85	0.70	2.11	2.52	2.65	1.49	1.42	1.11	1.42	0.41

CV: Coefficient of variation.

production; and the mechanized resources for planting and managing the crops in the field. These interviews are objective (concrete facts) and subjective, obtained by the involvement of the actors aiming at a social contribution (Szymanski, 2010). In this regard, the author also emphasizes that the analysis of the interviews (contained in the results and discussion) conventionally implies the way in which the phenomenon under study is inserted in the context of which it is part. The author also emphasizes that when analyzing the interviews, one must remain focused on the objectives of the study.

Data collected in the interview were quantified, analyzed and represented in graphs elaborated in SigmaPlot® 12.0 and later discussed.

## RESULTS AND DISCUSSION

The results analyzed showed that 90% of the interviewees were male and only 10% were female, showing that the majority of the producers in the State of Piauí are men. The participation of women in agriculture in the present times has taken positive courses because they have and/or had their work as domestic activities or helping men in various activities. The other study was found that, in family farming, men are responsible for 87.32% of the total and women account for 12.68% of the total (IBGE, 2009).

From the farms surveyed, all are from family farmers and their families actively participate in rural activities, including women. Family farmers are those who are in accordance with the law no. 11.326 of 24 of July 2006, that in his article, 3° stands out: "the family farmer is one who practices activities in rural areas, simultaneously meeting the following requirements: (I) does not hold, in any capacity, an area greater than 4 fiscal modules; (II) predominantly use the labor force of the family itself in the economic activities of its establishment or enterprise; (III) have family income predominantly from economic activities linked to the establishment or enterprise; (IV) direct your establishment or venture with your family" (Oliveira, 2018).

All farmers have the aptitude statement to pronaf

(ASP). Therefore, studies on the use of mechanization are of the utmost importance, since these farmers can acquire agricultural machines and implements through Pronaf. The Pronaf is a government program to help family farmers acquire machinery, implements, irrigation, greenhouses for the production of food products with a credit line of up to 100,000 reais to be paid in up to 10 years, with three years of grace and interest below the market at 2% per year (Revista Rural, 2018).

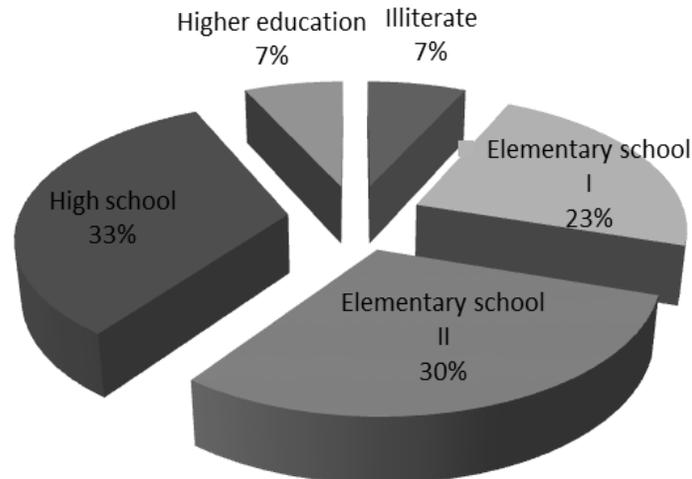
Thus, it is evident that all of the family work in the production either with planting of crops or with breeding and rearing of animals. In this respect, it is well known in this research that women perform activities related to production (crops) and reproduction (animals) contributing financially, albeit indirectly, to family farming (Mesquita and Mendes, 2012).

Another important factor to be discussed is the schooling of these farmers, since the techniques for a good development in agriculture require a minimum of knowledge or at least the search for it. Thus, according to the collected samples, it can be seen that the level of education of rural owners is quite diverse, as shown in Figure 1.

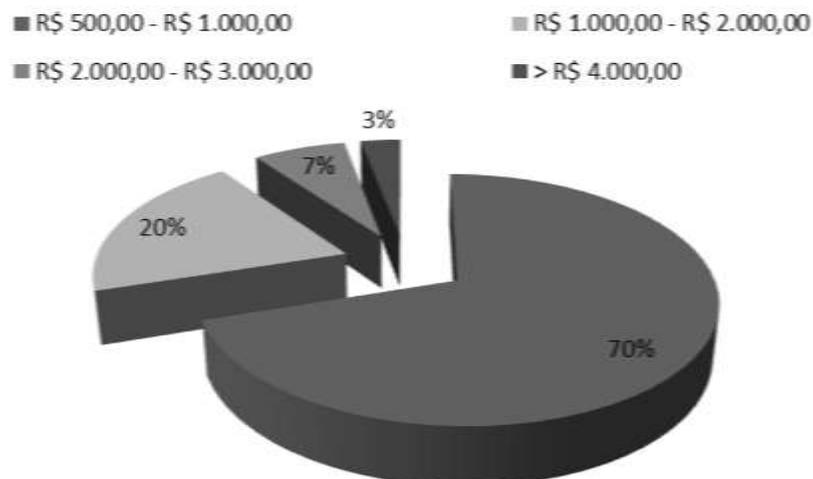
The educational level of most of the farmers is concentrated in the completion of High School and Elementary Education II, which means that most of them have basic knowledge of the study, and this is positive, since access to scientific and technological knowledge benefits in the management of field crops (Abebe et al., 2013).

As far as farmer income is concerned, almost all respondents stated that they earn about 600 reais per month (Figure 2), which is considered a very low value, mainly because 50% of families have 6 to 10 people in the same family and 47% below 6 people. This is mainly due to the climatic disparity, such as low rainfall, excessive heat, and low fertility soils, which raises poverty in the Northeast, especially in the Brazilian semi-arid region (Buainain and Garcia, 2013).

Much of what is planted by these farmers are consumed



**Figure 1.** Schooling of the agricultural producers surveyed.



**Figure 2.** Monthly income of the interviewees.

by them, since their families are large, marketing only what is left from their subsistence. In this context, Lima et al. (2015) highlight that gross monthly income ranges from less than a minimum wage up to two wages, evidencing rural poverty and the consequent history of rural exodus in Brazil.

Another important factor is that due to the small areas that they have (Figure 3), together with the low income, which has been a limiting factor in the acquisition of agricultural machines and/or implements, since it has a high value.

The knowledge of these family farmers about Pronaf is important since they can improve their production and consequently their quality of life. Farmers should know that they are important in the production chain, since they are, according to IBGE, responsible for 38% of Brazil's gross value of production (GVP) (IBGE, 2009).

Since the largest number of farmers has little area for cultivation, the amount of labor employed is small and usually hired in the rainy season, which lasts around 3 to 4 months. They are used for cleaning, planting and harvesting the product. However, a large part of the workforce is owned by the family members who live in the property, because since the income is low, there is not much money available to pay the daily employment services, since these costs about R\$ 35.00 to R\$ 50.00. This context is justified because family agriculture is characterized precisely by the family's participation in agriculture and must be understood from studies and research focused on its socioeconomic specificities and differentiation (Silva, 2015).

Nevertheless, even the area being small is still necessary to hire people for the most important operations of the crop, because there are cultures that

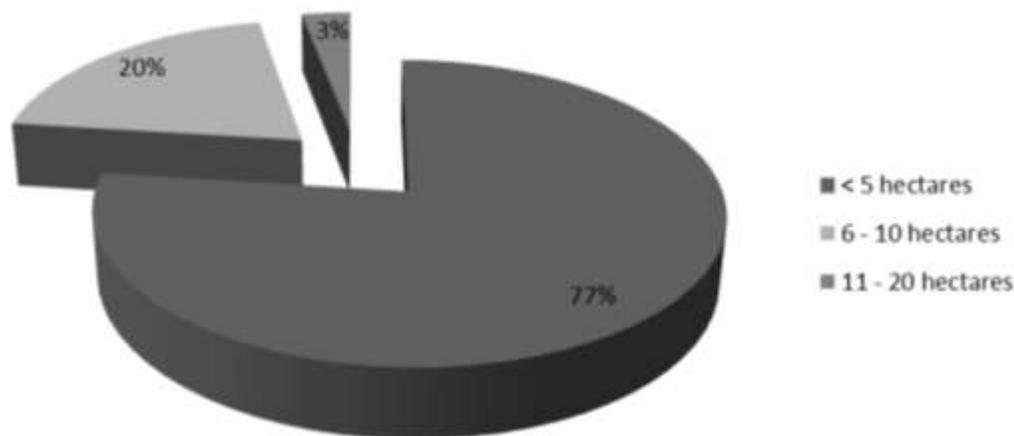


Figure 3. Acreage of small farmers.

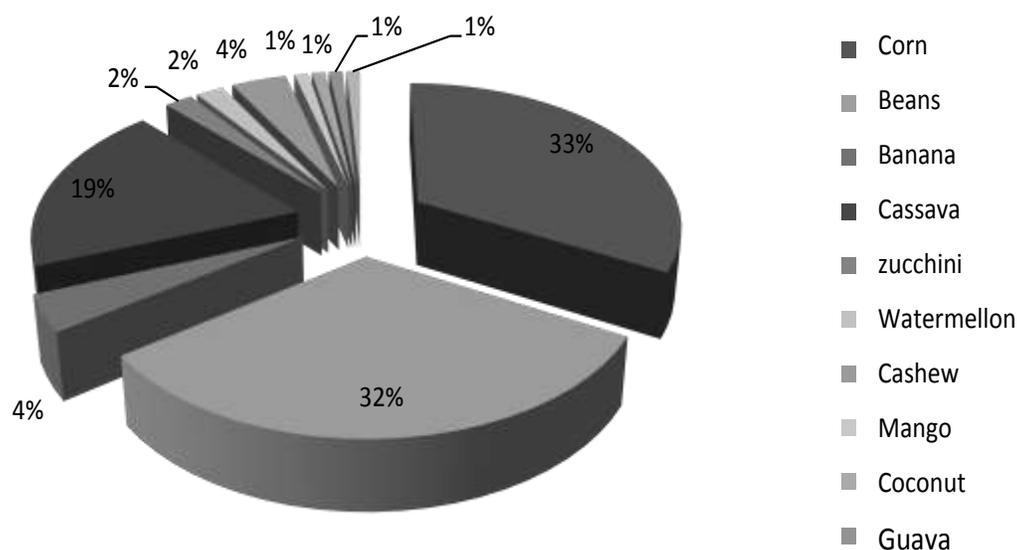


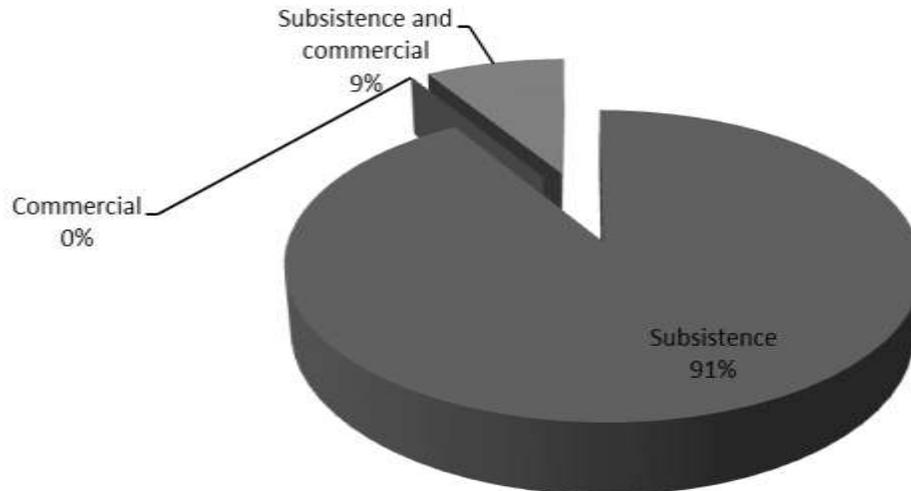
Figure 4. Cultures grown in the properties of small producers.

are exhausting to be accompanied, so that there is a good production. According to the results of this study, of the plants cultivated in the semiarid region of Piauí, the ones that stand out most in the production of these farmers are as shown in Figure 4.

Corn and beans are the most cultivated crops in the region, followed by cassava. In the Northeastern region of Brazil, crop cultivations stand out per region, being beans in the North-Center regions of Piauí, Agreste and Northeastern of Paraíba, South of Ceará, Agreste of Rio Grande do Norte, Agreste of Pernambuco and backwoods of Sergipe. Corn stands out in the South and Center South of Ceará, backwoods of Ceará, backwoods of Pernambuco, and cassava is concentrated in north and east of Maranhão, Agreste of Rio Grande do Norte and Sergipe (Buainain et al., 2016).

As for the temporary crops per agricultural mesoregions (average participation in planted area (2011-2014)), Freitas and Maciente (2016) pointed out that, in the Southwest of the State of Piauí, corn (20.73% grain) and beans (8.67% grain) are in the 2nd and 3rd place, respectively, losing only to the soybean crop (60.38% grains) considered the leading crop in production.

An important point to consider is that family farming is responsible for 70% of the beans we eat, 60% of the cheeses we consume, among others and that are produced in up to four fiscal modules, placing food on the table of Brazilians (Oliveira, 2018). Oliveira also points out that the majority of family farmers are located in the Northeastern region of Brazil, which justifies the need for more research for this region as well as the dissemination of the results in electronic media and with the farmers



**Figure 5.** Purpose of the production of small farmers.

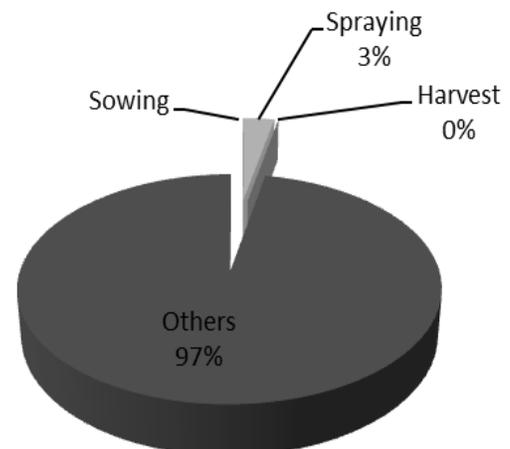
themselves so that they will value themselves and seek to use modern equipment on their properties and thus improve their quality of life.

With the constant growth of the population, the look at family agriculture has changed course by two important characteristics. On one hand, is the quality of the food, since family farmers take care of their lands with the minimum use of pesticides seeking environmental sustainability and socioeconomic development (FAO, 2014; Smith and Haddad, 2015); on the other hand, family farmers are no longer seen as problems by the elite class, placing the responsibility of hunger on small producers, and in the current context the solution to world hunger (McIntyre et al., 2009; Silva, 2014)

Almost all production of farmers in the State of Piauí is used for subsistence (Figure 5) and many of these are retirees not depending entirely on agriculture to survive. On the other hand, 9% of the mentioned farmers sell part of their production (small, by the way) for the acquisition of belongings they need like clothes, shoes, etc. and to pay the daily labor costs, which they will need during the plantation. Thus, sales of fruits, vegetables, flours, gums among others in fairs in the region where they live are justified (Menezes et al., 2016).

Of the 30 interviewees in this survey, only one person claimed the use of tractor. Its use was in soil preparation, with plowing and spraying, stating that the tractor was rented. None farmer used tractor for sowing or harvesting. Almost all of them pointed out that they use other types of manual equipment and animal traction, which shows the need to use the family labor force due to low purchasing power (Figure 6).

However, only 10% of the interviewees are aware of the operation of agricultural machinery and this is because 100% of producers do not have such equipment. In addition, the tractors used for cultivation aid are rented from third parties that are often not trained and have not

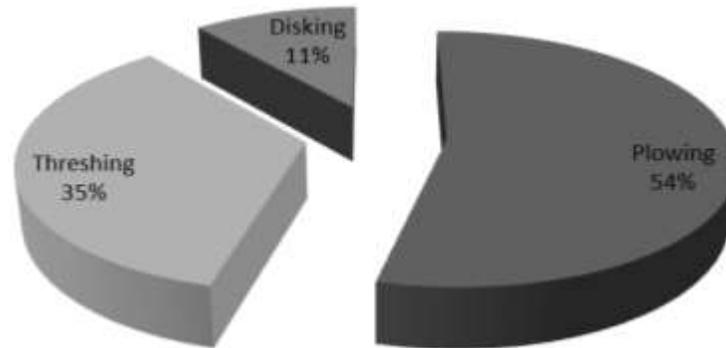


**Figure 6.** Operations carried out with the use of agricultural machinery during the work with the crop in the field.

undergone any training to use the machines. This is a cause of great concern, since the tractor is a machine that is among the main causes of accidents occurring in the rural context, reaching about 65% of reported incidents (Monteiro, 2010).

The values of the rent of tractors vary according to the purpose and number of hours that will be used. According to the interviewees, prices can vary from R\$ 50.00 to R\$ 120.00, the most common being R\$ 100.00 and R\$ 120.00 and are used in the most difficult operations to be performed (Figure 7).

Thus, the agricultural tractor must be able to do as many operations as possible in the rural property (Machado et al., 2010). However, it should be handled by trained personnel so that there is no poor management of the activity, harming people, the environment or even the



**Figure 7.** Operations carried out with the use of agricultural machinery.

product itself. For this, it is necessary that the tasks are executed in a rational and planned way, thus promoting the time and financial savings for the small farmers (Silva, 2009).

## Conclusion

The use of agricultural machinery for cultivation in farms in the region studied is almost non-existent due to the low purchasing power and also because they are small areas. In this way, the family comprises most of the labor force, working with crops in the field primarily by hand.

More research is recommended in the different regions of Brazil, regarding the use or not of agricultural machinery, inputs, equipment, etc., in order to obtain more information about the real situation of the production of small and medium farmers and their participation in agribusiness.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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## APPENDIX A

### DIAGNOSIS OF AGRICULTURAL MECHANIZATION FORM FOR DATA COLLECTION

#### Who should respond to this interview?

Person responsible for the administration of the property, owner or person having knowledge of the production system and the equipment used in the place.

#### Restrictions

Data should not be collected from properties where the focus is not on agriculture.

#### 1. IDENTIFICATION

1.1 SEX: \_\_\_\_\_

1.2 SCHOOLING LEVEL: \_\_\_\_\_

1.3 MONTHLY INCOME: ( ) 500-1000 ( ) 1000-2000 ( ) 2000-3000 ( ) 3000 – 4000  
( ) 4000 – 5000

1.4 PURPOSE OF AGRICULTURAL PRODUCTION  
SUBSISTENCE ( ) COMMERCIALIZATION ( )

1.5 CULTIVATION AREA \_\_\_\_\_ ha  
OWN \_\_\_\_\_ ha  
LEASED \_\_\_\_\_ ha

THIS QUESTION CAN BE SUMMARIZED, IF NECESSARY, IN: WHAT IS THE SIZE OF YOUR AREA AND WHAT IS THE SIZE OF THE CULTIVATED AREA?

#### 2. HUMAN RESOURCES

2.1 TOTAL NUMBER OF PEOPLE (FAMILY MEMBERS, EMPLOYEES...)

2.2 NUMBER OF PEOPLE OPERATING AGRICULTURAL MACHINES

2.3 MAXIMUM NUMBER OF TEMPORARY JOBS IN THE YEAR

2.4 INTENSITY OF USE OF TEMPORARY WORKFORCE

2.5 IN WHICH OPERATION IS THE TEMPORARY WORKFORCE USED IN? AND WHAT IS THE COST PER HOUR WORKED?

2.6 ARE THE PEOPLE OPERATING AGRICULTURAL MACHINES SPECIALIZED, THAT IS, THIS TYPE OF OPERATION IS ALWAYS WORKED BY THEM?

PULVERIZATION YES ( ) NO ( )

SOWING YES ( ) NO ( )

HARVEST YES ( ) NO ( )

2.7 DO PEOPLE OPERATING AGRICULTURAL MACHINES RECEIVE TRAINING FOR THE OPERATION? HOW OFTEN? WHAT TYPE OF TRAINING? WHAT IS THE TRAINING APPROACH?

#### 3. CHARACTERISTICS OF THE PRODUCTION SYSTEM

3.1 CULTIVATION PERFORMED (CROPS PLANTED ON THE PROPERTY)

3.2 AVERAGE PRODUCTIVITY (IDENTIFY THE AVERAGE PRODUCTIVITY OF EACH CROP PLANTED ON THE PROPERTY IN t/ha)

3.3 CULTURE PARTICIPATION IN THE AREA (%)

3.4 AGRICULTURAL OPERATIONS MADE WITH MACHINERY

- 3.4.1 SOWING ( )
- 3.4.2 PULVERIZATION ( )
- 3.4.3 HARVST ( )
- 3.4.4 OTHERS ( ) \_\_\_\_\_

**4. MECHANIZED RESOURCES**

**RELATE THE TRACTORS USED IN THE PROPERTY WITH THE CHARACTERISTICS USED**

- 4.1 NEW PURCHASE ON RESALE ( )  
PURCHASE USED IN THE RESALE ( ) RENTED ( )
- 4.2 IF RENTED, WHAT THE VALUE COLLECTED BY THE RENT (PER HOUR):
- 4.3 IF THE HOROMETER WORKS, WHAT IS THE NUMBER OF HOURS WORKED:
- 4.4 THE TRACTOR IS INTENDED TO PERFORM WHICH OPERATIONS? RELATE IN ORDER OF IMPORTANCE:
  - 1) \_\_\_\_\_
  - 2) \_\_\_\_\_
  - 3) \_\_\_\_\_
  - 4) \_\_\_\_\_
  - 5) ALL ( ) \_\_\_\_\_