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Mechanization index in agricultural properties of the region of Sinop – MT, Brazil

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Abstract. Agriculture is an activity of great expansion in the state of MatoGrosso (MT), which reflects on the city of Sinop and proximities, and in an intenseway mechanization is intensively applied in these areas. This study aimed to diagnose the level of mechanization (Kw/ha) in relation to thecultivated agricultural area and the total area. To this, a sample of 15 agricultural properties located in the region of Sinop – MTwere analyzed. For the scale representation of the properties, 4 strata were applied in function of the property total agricultural area. The availability of power in the property resulted in significant differencesinthe mechanization index. Stratification was efficient forthe determination of the mechanization indexin the strata, occurring similarities only between strata 2 (3001 – 5000 ha) and 3 (5001 – 9000 ha). The average participation of the areas analyzed was approximately 50%, in which bigger areas presented inferior participation than smaller areas.
Keywords: Agriculture.Agricultural machines. Mechanization index.

Introduction

The first estimation of 2015 for national cereal, leguminous and oleaginous crops totalized 201,3 millions of tons. The crop area estimation is 57,2million hectares, where the Midwest is responsible for 40,58% of this estimated production (IBGE, 2015).

Due to this increaseobserved annually,it's necessary the utilization of efficient techniques, in order to increase the income involved in this process, especially by optimizing theuse of the agricultural machine park and the power available, ever aimingthereduction of costs.

After the land, the mechanized agricultural systemsrepresent the biggest investment for an agricultural property, in which finding the optimal dimensioning is a difficult task because the variables that are changing constantly, and what might be adequate for the moment, may not be viable in a short-term period.

Incatema (1996) affirms that relations of area and power point a fundamentally important parameterfor the knowledge of the productive structure of the agricultural properties, where the real distribution of this informationis only permitted after field data collection.

Based on the necessity of the utilization of agricultural machines for grain production, the relative absent information that allow comparisons about the efficiency of its use, thisstudy aimed to analyze theutilization intensity of power, from agricultural machines andsampled areas, and evaluated the mechanization index (Kw/ha) of the region of Sinop – MT in 15 agricultural properties of the region, which were divided in 4 strata according to its total area.The relation of power and area was established from the cultivated area (HA) and the total area (TA), due to the fact that machineries concentration of use in agricultural activities is concentrated in certain periods of the year.

With the objective to study the intensity of the use of power, from agricultural machines andsampled areas, the mechanized index (kw/ha) was evaluated in 15 agricultural properties of the region of Sinop – MT; these properties were divided in 4 strata according to its total area. The relation of power and area was established from the cultivated area (HA) and the total area (TA), due to the fact that machineries concentration of use in agricultural

activities is concentrated in certain periods of the year.

Methods

The sampling utilized was simple random, in 15 rural properties, that develop agricultural activities, are distributed in the local region and in the proximity of Sinop – MT. Information was obtained with the use of questionnaires, applied directly in the field, where the quantity and specification of the agricultural machines (type, brand, model, year of fabrication, year of acquisition and state of maintenance), owner's name, country to where the property belongs, type of culture cultivated, total and cultivated area.Technical information (power and work hours) was obtained from technical materials available.

To determine the mechanization index of the areas, the power (Kw) of agricultural machines in activity in relation to the declared productive areas (ha) was considered.

For stratification, an important tool for the determination of the mechanization index, the limits were delimited according to the area of the properties. The limits adopted were, from 1000 to 3000, 3001 to 5000, 5001 to 9000, and 9001 to 16000 hectares of the total area, resulting in 4 strata; in which the limits presented a number of samples of 6, 4,3 and 2 strata, respectively.

The average for each strata and the participation, presented in percentage, according to the cultivated area in relation to the property total area,were calculated.

For information analysis, a regression analysiswas appliedwith the use of Microsoft EXCELProgram and forthe contrast statistical analysis of the strata mechanization index averages for the cultivated and total area, the comparative turkey test was applied, at a level of 5% of probability.

Results and discussion

Five tractors per property is the average composition for the agricultural tractor park among the sampled propertieslocated in the north region of MatoGrosso in 2015. However, the average composition of theharvester grain park among the sampled farms, in the north region of MatoGrosso 2015, is 4 grain harvesters per property.

Since 2013, a number of 1.4 new acquired tractors is the average composition of wheel dozer market per property among the sampled farms, in the north region of MatoGrosso.

In Table 1, the number of existent wheel dozers in the sampled properties and the area cultivated respectively by the tractors in the applied stratacan be observed above.

Table 1. Number of existent wheel dozers in the sampled properties and the area cultivated respectively by the tractors in the applied strata.

Strata		Average	
N°	Limits (ha)	Tractor per property	Area (ha) per tractor
1	1000 - 3000	4,00	560,64
2	3001 - 5000	5,00	698,45
3	5001 - 9000	5,00	1646,48
4	9001 - 16000	6,00	2415,58

On average, theInferior quantities of tractors per property can be noted in strata with inferior limits of area, in hectares. And in the strata with superior limits of area, in hectares, the average values for the relation area per tractor is superior than in the inferior limits, which results in a betterutilizationof the tractors in these properties.

Table 2 presents the referringnumber of grain harvesters to the cultivated area in the applied strata.

Table 2. Number of existing grain harvesters in the sampled properties and the respective cultivated area in the applied strata.

Strata		Average	
N°	Limits (ha)	Harvester per property	Area (ha) per harvester
1	1000 - 3000	3,00	649,16
2	3001 - 5000	3,00	1074,54
3	5001 - 9000	5,00	1440,67
4	9001 - 16000	7,00	2070,50

Inferior quantities of harvesters per property were observed in strata with inferior limits of area, in hectares. And in the strata with superior limits of area, in hectares, the average values for the relation

of area per harvester is superior to the inferior limits values, which results in a better utilization of harvesters in these properties.

According to the Associação Nacional dos Fabricantes de Veículos Automotores (ANFAVEA) [National Association of Auto Motors Vehicles Manufacturers], the tractors are classified conforming its power. Those tractors with 27 cv of power are classified as small tractors; from 28 to 49 cv are classified as light tractors; from 50 to 58 are classified as medium tractors; from 58 to 100 cv are classified as semi heavy tractors; from 101 to 165 cv are classified as heavy tractors; and those starting with 165 cv are classified as super heavy tractors. The Figure 1 show the data of the sampled values, which represent 13 semi heavy, 19 heavy and 29 super heavy tractors.

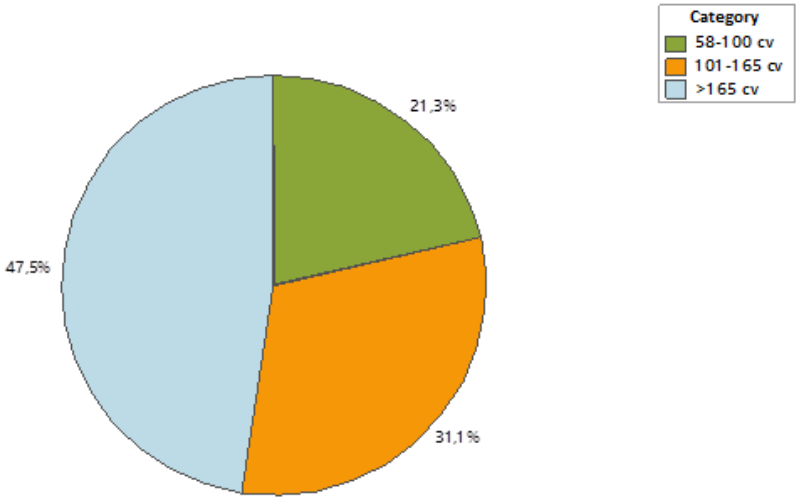

Figure 1. Classification of tractors in relation to the unitary power in cv, following ANFAVEA norms.

Most of the sampled data are found under the classification of super heavy tractors, presenting 29 data; in which 19 and 13 data are classified as heavy and semi heavy tractors, respectively.

For the classification of small, medium and light, none sampled data was detected in this enquiry.

Figure 2 presents tractors and harvesters distributions per area, calculated through the relation of number of wheel dozers and harvesters per hectares.

Figure 3 presents the average power of wheel dozers and the mechanization index for the strata.

The stratum 1, which corresponds to the limits of smaller areas, presented a high mechanization index, which results in a higher availability of power in these areas. The stratum 4, which represent the limitsof larger areas, presented a low mechanization index, which results in a lower availability of powerand a good utilization of the machines in the field. The stratum 3 was the stratum that presented higher power average values, which can be explained by the fact that these properties presented a large quantity of wheel dozers than the properties from the other strata.

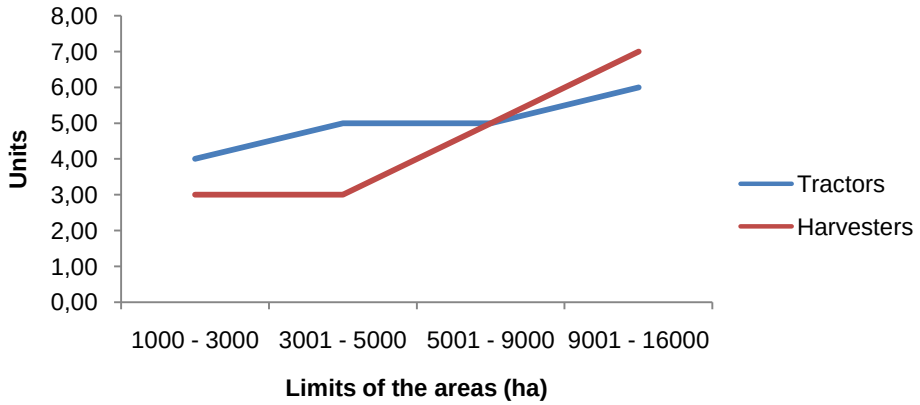

Figure 2.Distribution of wheel dozers and harvesters in units per area.

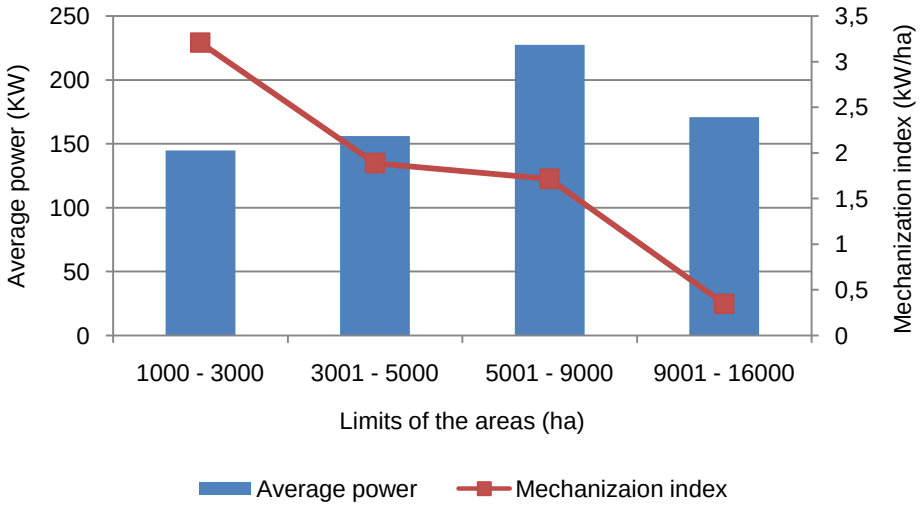

Figure 3. Average power of wheel dozers and mechanization index for the applied strata.

The mechanization index presented a different behavior in relation to the considered stratum, and, according to the scale of the total area, suggesting a higher intensity utilization of power in the smaller agricultural areas (table 3 and image 3). With the increase of the area, a lower mechanization index occurs, as much in the cultivated area analyzed as in the total agricultural area, which represents a better utilization of machineries in the field.However, the higher mechanization index, which occurs with farmers with smaller areas, suggests that they present a higher work capacity; this allow them to work the total area in a shorter period of time, since there is more power available.

According to table 3, the relative average of participation of the cultivated area in relation to the total area is more significant in the limits of the stratum in a smaller scale. While in the areas up to 3000 ha, its participation was of approximately 57% and, for the areas superior to 9000 ha, the participation was approximately of 34%. The study presented an average participation of approximately 50%.

The highest availability of power of the agricultural machines in the properties with smaller areas, highlighted by high mechanization indexes, shows smaller distribution of utilization of the area, requiring, nevertheless, greater attention at work and a shorter period for the performance of agricultural operations.

The lowest availability of power of the agricultural machines in the properties with larger areas, characterized by lower mechanization indexes, shows a better utilization of the investment in the agricultural machineries, which can result in a high economic profitability.

The dispersion of the data of the mechanization indexin relation to the applied strata presented a polynomial trend line, as much for the cultivated area as for the total area.

The polynomial equation adopted explains well the data trendbecause in both parameters, R2 is superior to 90%; this occurs by the fact that the strata were efficient and that the mechanization index diminishes with the increase of the area.

Table 3. Number of samples, average area and mechanization index of the cultivated area and the total function of the strata.

Strata		Number	Harvested area			Total Area	
N°	Limits (ha)	of samples	Average area (ha)	Participation (%)*	Mac. Index (KW/ha)**	Average area (ha)	Mac. Index (KW/ha)**
1	1000 - 3000	6	1142,33	56,96	5,77 a	2055,67	3,21 a
2	3001 - 5000	4	1752,75	50,89	3,76 b	3492,25	1,89 b
3	5001 - 9000	3	4400,00	56,73	3,00 b	7683,56	1,72 b
4	9001 - 16000	2	4820,80	33,76	1,05 c	14493,50	0,35 c
Total		15	3028,97	49,58	3,39	6931,24	1,79

* Relative participation of the cultivated area in relation to total area of the stratum.
** Averages followed by the same letter don'tdiffer with the Turkey comparison test, in a level of 5% of probability.

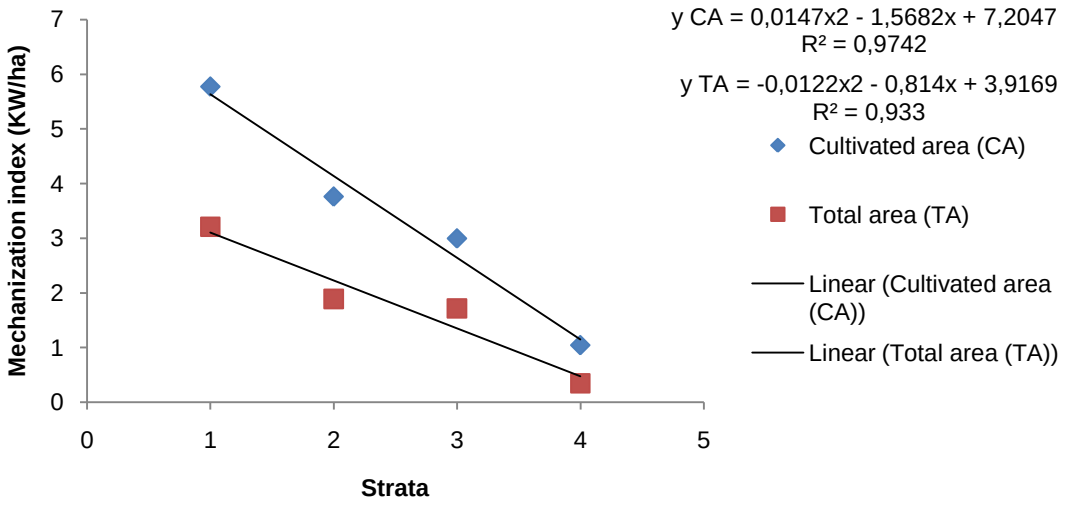

Figure 4. Mechanization index in relation to the cultivated and total area.

Final considerations

The availability of power in the property resulted in significant differences in mechanization index;

Stratification showed efficiency for the determination of the mechanization index in the strata, occurring similarities only between stratum 2 (3001 – 5000 ha) and 3 (5001 – 9000 ha).

Index of mechanization was lower for properties with larger areas and higher for properties with smaller areas; this occurred as much for the cultivated area as for the total area.

Smaller areas presented bigger relative participation of the area than larger areas.

The average participation of the areas analyzed was of approximately 50%,in whichlarger areas presentedan inferior participation to the smaller areas.

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