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Diagnostic of tractors and agricultural implements in the municipality of Atlacomulco, State of Mexico

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Abstract

The present investigation has like objective, the realization of a diagnostic of the utilization of the park of machines and tractors, as well as the indexes of agricultural mechanization of 24 communities of the municipality of Atlacomulco, give to know the state of these mechanized means, with the purpose that at the level of the State of Mexico the necessary measures are taken to improve the park of machines and tractors in this municipality. The 2014 and 2015 information was supported in a survey; and the sample size had a confidence level of 95% and an error limit of 9%. 140 farmers, owners of tractors were interviewed and 163 tractors were registered in an area of 8 074 ha (49.53 ha tractor^{-1}). The FAO recommends 50 ha tractor^{-1} surface with machinable potential. It is emphasized that the tractor implement relation is quite low (1:3.4), which indicates the non-existence of a full use of the tractor and its implements during the agricultural cycle, since the hectare tractor ratio is 12.4 ha tractor^{-1} cultivated soil, quite low figure, taking into account the average power per agricultural tractor. The index of energy equipment per hectare of cultivated land was 0.89 kW ha^{-1}, a value higher than recommended by other studies. The correlation between the energy index of one hectare (ξha) and the number of tractors per 100 ha ($\ni$N) was r= 0.81**; also $\ni$N and hectares cultivated by tractor (ϕt), had a value of r= -0.63**.

Keywords: agricultural machines, energy equipment, mechanization index, power.

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Introduction

The formation of large cities is a phenomenon that increased over the centuries, as a result of the industrialization process in Europe, United States of America and Australia among others, this situation was due to the mechanization of agriculture that decreased the use of labor in the rural sector, as well as the new activities generated in the industrial and services sector.

During the second half of the twentieth century, the process of urban densification increased in Asia, Africa and Central America, a phenomenon that will continue to increase in the decades of this century, since it is expected that 83% of the world population growth will have its origin in the megalopolis.

Another important trend is the gradual capitalization of large agricultural holdings, called agricultural modernization, which is transforming the traditional hacienda through intensive practices, use of unlimited capital and other industrial inputs, with a growing technification and specialization, both in phases of cultivation as in the preparation, harvest and post-harvest, among others. The agricultural mechanization measured by the number of arable hectares per tractor was very fast in the period from 1965 to 1981, according to the FAO the number of tractors doubled reaching almost one million units. In Venezuela, one tractor for every 399 ha was used in the first five years of the 1960's to one tractor for every 94 ha, in the early 1980's, in 1982 in Mexico there was one tractor for every 148 ha, compared to one tractor for each 346 ha 20 years ago (Gutiérrez, 1990).

Between 1960 and 1970, 15 million tractors were added, but in 1982 this was more than 26 million: for every 100 ha cultivated there were 2.1 tractors, in Africa it has 0.6 tractors 100 ha^{-1}; in Latin America 0.57 tractors 100 ha^{-1} and in Asia 0.11 tractors 100 ha^{-1}. In counterpart in the Federal Republic of Germany until 1960, there were 16 tractors 100 ha^{-1}, logically with an average power in their tractors of 24.2 kW (Gutiérrez, 1990), according to the FAO (2011) in some countries of America, there are some indexes quite high, as are the cases of Brazil which has on this date 460 000 tractors with a ratio of hectares per tractor of 116.3 ha $tractor^{-1}$, Argentine with a tractor park of 280 000 and 91.07 ha $tractor^{-1}$, Canada with 740 000 tractors and a ratio of 61.29 ha $tractor^{-1}$, the United States of North America has 4 800 000 tractors and with a ratio of 36.45 ha $tractor^{-1}$, in Europe France has a tractor park of 1 312 000 and with a ratio of 13.93 ha $tractor^{-1}$ and in the case of the United Kingdom with 500 000 tractors and 12.18 ha $tractor^{-1}$, in the case of the latter two countries, the tractors are of lower power and their cultivation areas are smaller, which is why these minor relationships are.

According to the FAO (2011), there are 238 830 tractors in service in Mexico, but 54% have already exceeded their useful average life (SAGARPA, 2010 a). Among the problems facing producers in the Mexican countryside, is the lack of liquidity for the purchase of tractors (the price per tractor varies from $375 000.00 to $800 000.00), the increase in fuel costs and operation of tractors it is expensive (Calva, 1998). These are limitations for the acquisition and maintenance of equipment. On the other hand, imports have increased, since they grew at an average annual rate of 4.32% between 1980 and 2008 (FAO, 2011), with 25 000 units imported from 2006 to 2008.

Mechanized agriculture is attractive to reduce production costs, as well as time and hours of work in priority activities, as it saves resources. The lack of professionalism, the incorrect adjustments of the different implements and agricultural machines, among others, are also aggravated by the use of conventional equipment. Ramírez (2007), commented that, due to the agrarian structure of the country, the modernization of the smallholding through the use of technological packages dependent on an agriculture of unlimited capital is unfeasible; according to him, the agricultural machinery is designed to cultivate large tracts of land and would remain idle for most of the agricultural cycle; the small production units are unable to generate the necessary resources to capitalize.

Pellizi (2000) cited by Negrete (2011), suggested that each country should base its mechanization policy on the following: A definition of the mechanization criteria most in line with technical and economic factors; the creation of the necessary infrastructure for the development of a strong local agro-mechanical industry through alliances with well-established industries in industrialized countries; a definition of the criteria applied to the standardization of production, the establishment of an efficient service network for the repair and maintenance within the country, the promotion of professional training programs, both in the agricultural and manufacturing fields.

Since 1997, the Mexican market is very stable and reports average annual sales of 10 000 to 11 000 tractors (Palacios *et al*., 2003) cited by Ayala *et al*. (2011). However, according to Flores *et al*. (2007) cited by Ayala *et al*. (2011), the total sale of 11 000 tractors represents a deficit, a situation mainly motivated by the crisis facing the sector, since the potential market ranges from 15 000 to 18 000 units. According to Perea (2011) cited by Larque *et al*. (2012), 54% of tractors in the Mexican field exceeded their useful life, since their maintenance and fuel consumption are expensive. According to Larqué *et al*. (2012) this situation has generated that the Mexican field has 78 483 fewer tractors than 20 years ago, in addition the average power of the tractors is 59.9 kW.

Materials and methods

The present work was carried out in the Municipality of Atlacomulco, located northwest of the State of Mexico, Mexico. The municipal seat is located between 19° 43' 37" (minimum) and 19° 43' 67" north latitude and 99° 42' 12" and between 99° 52'48" west longitude of the Greenwich meridian. The town with the highest altitude is San Felipe Pueblo Nuevo (2 720 m) and the lower altitude are the municipal head (2 670 m) and San Jose Toxi (2 640 m). This municipality has the following boundaries: to the north, with the municipalities of Acambay and Temascalcingo; to the northeast, with the municipality of San Andrés Timilpan; to the east, with the municipalities of San Bartolo Morelos and San Andrés Timilpan; to the south and west, with the municipality of Jocotitlan and to the northwest, with the municipalities of Temascalcingo and El Oro. The approximate distance to the capital of Mexiquense is 63 km (INEGI, 1996).

The municipality of Atlacomulco has 258.74 km^2 and represents 1.19% of the state territory (INEGI, 1996). The methodology used was based on conducting a survey directly with farmers, owners of tractors and agricultural machines and for this a questionnaire was constructed as the main work tool. The size of the sample was calculated, based on the number of tractors registered in this municipality; a confidence level of 95% and an error limit of 9% was considered. With the

simple random method, 140 farmers were chosen, who were owners of tractors and agricultural machines. The characterization of the level of mechanization for the municipality of Atlacomulco was made based on the number of agricultural tractors and their different powers, number of implements for each of the tractors surveyed, index of energy equipment, etc.

Table 1. Communities of the municipality of Atlacomulco where the survey was applied.

Community	Num. of producers	Community	Num. of producers
Espejel	5	Santiago Acutzilapan	8
San Luis Boro	3	Manto del Río	2
P.P. Atlacomulco	22	El Manto Ejido	3
San Lorenzo Tlacotepec	8	Cerrito Colorado	2
Rincon de la Candelaria	3	Santa Ma. Tecoac	11
San Francisco Chalchiuapan	13	San Juan de los Jarros	4
Ejido Cuendo Atlacomulco	6	Rincón de la Candelaria	7
San Jose Toxi	6	San José del Tunal	12
Dolores de la Joya	1	San Pablo Atotonilco	1
Diximoxi P. P.	2	El Salto	1
Lagunita Cantashi	3	San Ignacio de Loyola	6
San Antonio Enchisee	5	Las Animas, Atlacomulco La Palma	6

Subsequently, the indexes that help describe the behavior of the level of agricultural mechanization in the reference municipality are related, from which arise the different answers for the proposed indices.

The index of energy equipment of the agricultural producer, can be represented by the relationship that arises from the power in kW (kilowatts) (Garrido, 1984) and the number of agricultural producers in the area, region or agricultural enterprise.

$$\xi p=\frac{\sum Nc}{\sum np}$$

Where: $\sum Nc$= is the power of the engines of agricultural tractors in kW; $\sum np$= are the workers linked to agricultural tasks.

Energy equipment index of one hectare of the elaborated surfaces, it should be taken, into account that the energy equipment per hectare of the elaborated surface is significantly lower than that of an agricultural worker.

They are determined with the formula (Garrido, 1984).

$$\xi ha=\frac{\sum Nc}{\sum Fx}$$

Where: $\sum Nc$= is the power in kW; $\sum Fx$= is the total of hectares of cultivated area.

Quantity of physical tractors per 100 ha (tractors 100 ha^{-1}) of land in artificial production (Karpenko, 1989).

$$ЭN = \frac{ZT}{Fx} = \frac{tract}{100\ ha}$$

Where: ZT= is the number of tractors; Fx= are the hectares in production with mechanized soil preparation.

Tractor implement relation (βrti). Provide of agricultural machines by tractor, is the relation of tractors and agricultural machines in the zone, of investigation, which gives the degree of load of agricultural machines by tractor (Garrido, 1984; Karpenko, 1989).

$$\beta rti = \frac{\sum \lambda_l}{\sum Zt}$$

Where: λ_l = is the number of implements; Zt= is the number of tractors.

Hectares by tractor of cultivated soil (ω): in this aspect, the amount of soil that is cultivated in a mechanized way is taken into account, without taking into account the total of the soil with mechanized working conditions, this relation can be represented by the following formula according to (Mogarianu, 1987).

$$\omega = Fx/\Sigma Zt$$

Where: Fx= total hectares of cultivated area; ΣZt= number of tractors that service mechanized agricultural land.

Producer tractor relationship: according to Garrido (1984), it is the number of tractors among the number of producers in the area that have or do not have tractors for agricultural activities.

$$\Psi tp = \Sigma Zt/P$$

Where: ΣZt= is the number of tractors; P= is the number of producers with tractors.

Average power per tractor (μ): (Iofinov, 1984). It is the power in kW that is held in the municipality and in particular in each of the communities and is calculated as follows.

$$\mu = \sum Nc/\sum Zt$$

Where: Nc= is given in kW.

Hectares by cultivated, mechanized and non-mechanized agricultural soil tractor: (Iofinov, 1984).

$$\phi t = Ft/\Sigma ZT$$

Where: Ft= is the amount of soil cultivated with and without mechanization.

For the analysis and interpretation of the additional data, the SAS program was used (SAS, institute, 2004). With this, a cluster analysis (CA) was performed with the Euclidean distance matrix, the grouping method applied was that of the average distance between groups, this analysis was done with the Cluster procedure. The sample size was calculated according to the methodology proposed by Hernández (2006), as well as the techniques for carrying out the surveys.

Results and discussion

The producers surveyed in 24 communities were 140 with a total of 163 tractors of different powers and a total of 528 implements. According to data obtained, the tractor/implement ratio is one (1) tractor for every 1.62 implements, a very low figure according to the different standards of developed countries such as the United States of America, Russia, among others (Negrete, 2012). In the particular case of the quantity of mechanized cultivated soil, there is an amount of 49.53 ha tractor^{-1}, which is close to that proposed by the FAO, on the surface with mechanization potential, which is 50 ha tractor^{-1}. In Table 2, where the energy index by producer (ξp) is presented, the data obtained from the surveys carried out with farmers in the different communities of the Atlacomulco municipality can be observed, which maintains certain characteristics similar to the rest of the communities, except for Dolores la Joya (121 kW producer^{-1}), San Luis Boro (78.3 kW producer^{-1}).

Table 2. Indices obtained by community from those chosen at random in the municipality of Atlacomulco year 2014.

No.	Location	ξp (kW)	ξha (kW)	ƎN (tract 100 ha^{-1})	ω (ha tract^{-1})	Brti	Ψtp	μ(kW)
1a	Espejel	58.8	1.71	2.22	24.5	5	0.6	74.5
2b	San Luis Boro	76	1.38	3.87	25.8	3.4	1.66	34.6
3c	P. P Atlacomulco	60.7	0.71	8.04	12.4	3.06	1.5	41.8
4d	San Lorenzo Tlacotepec	72.6	1.09	2.33	42.8	2.7	1.25	44
5e	Rincón de la Candelaria	56.4	0.7	1.2	83.4	4	1	42.8
6f	San Francisco Chalchiuapan	56	0.93	1.62	61.5	4	1	42.5
7g	Ejido (Cuendo) Atlacomulco	62.5	1.42	2.57	38.8	4.85	1.16	40.7
8h	San Jose Toxi	53.9	0.76	3.26	30.6	3.25	1.33	30.7
9i	Dolores de la Joya	117.6	0.71	1.16	82.5	0.66	2	44.5
10j	Diximoxi P. P.	55.1	0.34	0.61	163.3	4	1	41.8
11k	Lagunita Cantashi	53.9	0.42	1.02	97.5	2.5	1.33	30.6
12L	San Antonio Enchisee	58.8	0.43	0.71	139.8	4	1	44.7
13m	Santiago Acutzilapan	59.7	0.5	0.82	121.5	3.37	1	48.1
14n	Manto del Río	58.8	1.92	3.17	31.5	2	1	44.8

No.	Location	ξp (kW)	ξha (kW)	ƎN (tract 100 ha^{-1})	ω (ha tract^{-1})	Brti	Ψtp	µ(kW)
15o	El Manto Ejido	61.2	2.67	4.22	23.7	2	1	46.6
16p	Cerrito Colorado	62.5	0.58	0.9	110	3.5	1	47.5
17q	Santa Ma. Tecoac	58.7	1.63	2.78	35.9	3.9	1	43.2
18r	San Juan de los Jarros	56.8	0.33	0.52	188.7	3	1	46.7
19s	Rincon de la Candelaria	87.2	2.53	4.01	24.9	3.6	1.42	46.4
20t	San José del Tunal	58.8	2.76	4.54	22	2.8	1	44.7
21v	San Pablo Atotonilco	58.8	0.15	0.25	38.8	4	1	44.8
22w	El Salto	58.8	0.38	0.62	160	2	1	44.8
23x	San Ignacio de Loyola	71	2.1	3.33	30	4.28	1.16	46.2
24y	Las Animas Atlacomulco La Palma	72.3	5.67	8.86	11.3	3.57	1.16	47.1

(ξp)= index of energy equipment of the producer; (ξha)= index of energy equipment of one hectare; (ƎN)= number of tractors per 100 ha; Brti= tractor agricultural implements relation; Ψtp= producer tractor relationship; µ= average power per tractor. Different indices calculated from the inventory, for the different localities of the Municipality of Atlacomulco.

When performing an analysis of the number of tractors per 100 ha of agricultural land with possibilities of machining, it is noted that P.P. Atlacomulco has 8.04 tractors per 100 ha of soil, which is a fairly high amount and the tractor-implement relationship is of 3.06, quite small amount for the amount of tractors, so we have that the ratio of cultivated soil (ω) in a mechanized way by tractor is only 12.4 ha tractor^{-1}, an excessive amount of tractors for such a small amount of cultivated land attended in a mechanized way, when dealing fundamentally with crops where at least 50 ha tractor^{-1} should be according to FAO, mentioned by Larqué (2012), in the case of crops such as corn and beans, among others, this is logical it also depends on the relief of the soil, however the relationship is quite low due to data from Negrete (2006) in the Mexican Republic.

In 2003, there was a ratio of 102.8 ha tractor^{-1}, which figure is above what was found in the municipality of Atlacomulco and according to Flores (2008) cited by Negrete (2006), in the 2007 census, this relationship reached 55.5 ha tractor^{-1} and that according to these authors there are substantial differences between the data of the FAO and the same, but that according to the researched and taking into account the position of the land, there is a close coincidence with that found by Flores (2008), not so with the relation of the surface cultivated in this municipality that is of 12.4 ha tractor^{-1}. According to Masera (1990), to make profitable a medium-sized tractor (≈45.6 kW) it is necessary to have a cultivation area of 25 ha, a fact that is corroborated by Lara (2000), who in a study conducted found that the equilibrium point for a typical tractor armed in Mexico of medium category totally dedicated to the maquila of the agricultural works, the point of balance is of 31 ha.

However, in this area it is stated that there is a 10.96 ha tractor^{-1} ratio, according to the research carried out by Larqué *et al*. (2012), well below what was researched and what the data of the current investigation show. In another order of particular cases worthy of mention, is the community Animas Atlacomulco with 8.86 tractors 100 ha^{-1} of soil (ƎN) and the Manto Ejido with 4.22 tractors 100 ha^{-1}, San José el Tunal with 4.54 tractors 100 ha^{-1} and as an example the latter with a tractor-implement relation (βrti) of 2.8, a very small number, to be able to attend all the mechanized work required in an agricultural cycle. In the same way, it can be observed in Table 2, these items mentioned above in the different communities, with some exceptions, their behavior with higher or lower values is similar.

In this order, mention may be made, by way of example, of the Diximoxi P.P. community which has 0.34 kW ha^{-1}, as an index of energy equipment per hectare (ξha); of 0.61 tractor 100 ha and 163 ha/tractor and an implement tractor ratio equal to 1:4 with average power per tractor of 55 kW, which is a contradictory balance for the mechanized attention of the types of crops that are served in that area; now for tractors with the power previously raised, to have an optimal exploitation, according to what Iofinov (1984), is that each tractor has six implements (1:6), this depends on the type of crop, characteristics of the soil, types of implements, constitution of the same, but it is this region it is necessary to point out that only the community called Espejel reaches a relationship (1:5) all others are well below this proportion, on the other hand according to the agricultural and livestock census of 2007 (INEGI, 2009), it is reported that Mexico has 238 248 tractors of which 95.5% were working and are used in an agricultural area of 29 900 000 ha which gives the figure of 121.72 ha tractor^{-1}, but this does not mean that they are not mechanized and if only cultivated, which, the figure is not correct, in the form in which INEGI shows it.

According to Ayala *et al*. (2011) and INEGI (2009), Mexican producers use tractors in their agricultural activities with a power that fluctuates from 45.6 to 64.6 kW and as shown in Table 2, the power per producer (energy equipment of the producer (ξp), in the case investigated, the average fluctuates from 58.5 to 78.3 kW and in some exceptional cases these values are exceeded In the investigations carried out by Ochoa (2010), it indicates that in recent years the tractor construction companies in Mexico have a demand for tractors of 45.6 kW and above and on average the tractors they buy are approximately 53.2 kW, although it is necessary to note that land tenure is lower than 20 years ago, says this researcher, but because of the research can be seen in Table 2, that there is an underutilization of the tractors, because of the low existing tractor/implement relation.

As an element to ponder very strongly is the high index of energy equipment of the worker and the low ratio ha tractor^{-1}, which is in agreement with what was raised by Negrete *et al*. (2006 and 2012), also in the investigations carried out by Larqué *et al*., (2012); Sánchez *et al*. (2014). Regarding the tractor power index per hectare of cultivated soil, the research yields 0.89 kW ha^{-1}, which is above 0.76 kW ha^{-1} raised by Gaytan (2007) cited by Sánchez (2014) and 71% of the surveyed communities are above 0.76 kW ha^{-1} and in some cases over 1.52 kW ha^{-1}, which indicates that there is a great energy potential in the investigated area.

It is necessary to highlight the existing dispersion among farmers, the energy equipment index/hectare and the number of tractors used per 100 ha of cultivated land and very close to the producer tractor relation, the same thing happens with the total ratio of tractors and agricultural machines.

In the correlation analysis between pairs of standardized variables of the different coefficients (Table 3), the most important ones were selected; of them those that it is necessary to take as employers.

Table 3. Pearson correlation coefficients, among the different analyzed indices of the different communities of the Atlacomulco municipality 2015.

Variables	ξha	ƎN	Ψrtp	βrti	μ	ϕt	Ωn
p	0.203	0.13	0.749**	0.435*	0.054	-0.193	0.44*
ξha		0.811**	-0.01	0.064	0.245	-0.589*	0.1
ƎN			0.245	-0.016	-0.161	-0.638**	-0.02
Ψrtp				-0.503*	-0.574*	-0.2352	0.106
βrti					0.282	0.063	-0.766**
μ						0.063	0.36
ϕt							-0.043

(φt)= hectares per tractor of mechanized and non-mechanized cultivated soil; (Ωn)= power by agricultural machine, including tractors and agricultural implements.

And those that need to be corrected and taken to higher levels, when correlating the energy index of the producer with the producer tractor relationship, it is positive and highly significant with a value of 0.749**, this indicates that with the exception of few producers most have at least one tractor, in the correlation index equipment per producer with the tractor -implement ratio, it is negative with a value of -0.43, which shows the small proportion between tractors and implements owned by producers. Another pair of important variables is the tractor-implement relationship and the power per agricultural machine, which shows a negative and highly significant value of -0.766**.

The power per agricultural machine (Ωn) and the index of energy equipment of the producer (ξp), which is 0.44 and significant, this indicates that both indices have a positive behavior, where the ideal would be to stabilize ξp, so that this way the value of this correlation was greater. Due to the high number of tractors per 100 ha (ƎN) and its correlation with the energy equipment index of one hectare (ξha), this value is 0.81 and highly significant; however, at this high value it is necessary to point out that both one index and the other do not agree with what is currently considered optimal at the international level. Finally, it is necessary to point out the correlation between the number of tractors per 100 ha of land and the number of hectares per tractor of cultivated soil, which is negative, with a value of -0.638** and highly significant.

With the use of the SAS program and using the Proc Cluster is shown in Table 4, how the groups are grouped according to similar characteristics in quantities of tractors and agricultural machines and in which seven groups appear, which is well explained in the dendrogram that appears in Figure 1.

Table 4. Agglomeration of groups according to the similar characteristics in quantities of tractors by localities.

Número	Integrantes
1	A
2	U
3	X
4	Y
5	B S C
6	D N O T V
7	E F Q G W J L M P R H K

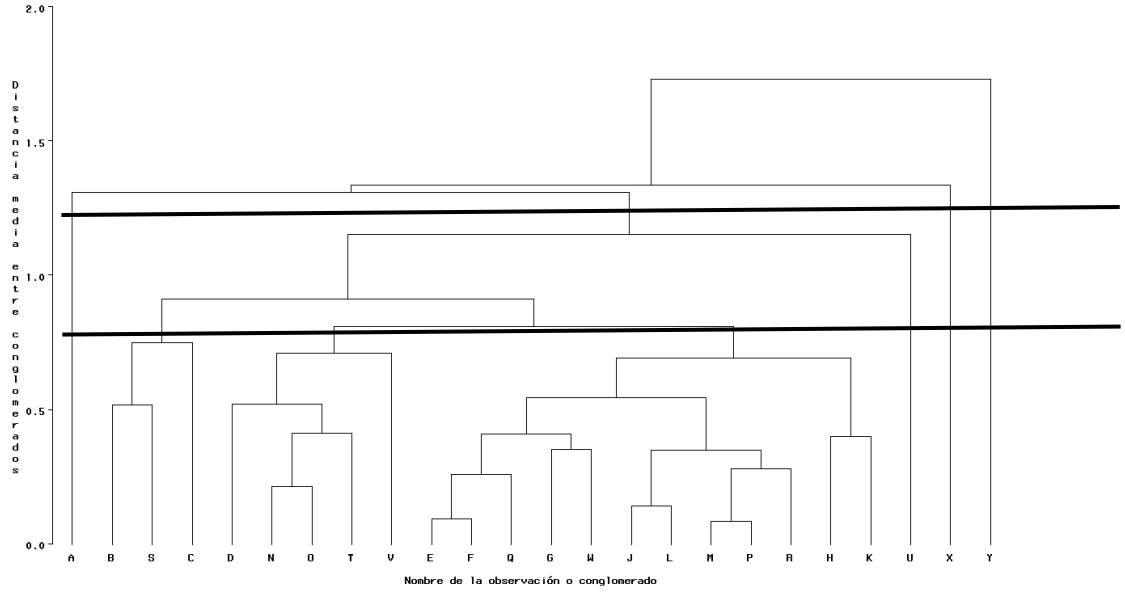

Figure 1. Dendrogram of cluster analysis on the 24 communities that own tractors and agricultural machines in the municipality of Atlacomulco, State of Mexico, 2015.

In Figure 1, at the beginning of the output of the result was obtained the history of the agglomerate of producers with tractors and agricultural machines surveyed in which the behavior of the different rates of mechanization in that municipality was determined. On the X axis the different communities were placed and on the Y axis the different average distances between conglomerates. Placing in the dendrogram a first horizontal line to the X axis and above the 1.2 value approximately on the Y axis; we obtain a first criterion in which five agglomerates appear, placing a second line below the first and at a height of approximately 0.8 of distance between agglomerates, we can distinguish seven groups of communities according to the chosen height and that this second one was drawn line. With these two lines, we can distinguish that there are two groups of communities, in the first there are communities that are scattered, such as Animas Atlacomulco (X), Espejel (A); San Pablo Atotonilco (U) and Dolores la Joya (Y), which show different positions of tractors and agricultural machines and as a reference can be referred to Table 2. As a second criterion, we must refer to the bottom line

where you can clearly see seven agglomerates of communities, taking into account the indexes analyzed above. Finally, it can be stated that the groups not mentioned above have very similar characteristics or indices in the aspects of agricultural mechanization and their indices in each of their communities surveyed.

Finally, it can be stated that the groups not mentioned above have very similar characteristics or indices in the aspects of agricultural mechanization in each of their surveyed communities. In this aspect, the most accurate analysis depends a lot on the experience that the researcher has to define the agglomerates and the characteristics of each of them due to their relevance.

Conclusions

Based on the data obtained from the surveys carried out, it was calculated that the mechanization index for all the communities in the Municipality of Atlacomulco is 49.53 ha tractor^{-1}, taking into account the cultivated and non-cultivated area.

The tractor-implement relation (βrti), 90% of the cases does not exceed four implements per tractor, which limits full use of the tractor in an agricultural cycle such as: corn, wheat, oats, etc., without taking into account that many times this also depends on the relief of the lands where the properties of these farmers are located.

At the municipality level, there are 12.4 ha per tractor (ω), which is quite low, taking into account the average power of the tractors, which exceed 58 kW in most of the communities and between them there are abysmal differences, which is necessary correct with tractors whose powers do not exceed 50 kW and that have the possibility of having universality in agricultural work.

The majority of the investigated communities have a higher average power per hectare than that proposed by some authors and their work is limited by the number of implements and the limited possibilities of land for agricultural mechanization. In the analysis of the cluster seven conglomerates can be observed, which shows us that there are well-marked differences between them.

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