Characterization of the livestock production cooperative systems in the municipality of Caála, Huambo province, Republic of Angola

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For characterizing and evaluating the productive impact of livestock production cooperatives in Caála, Huambo province in the Republic of Angola, an exploratory-descriptive study was carried out. The statistical model of impact measurement (SMIM), based on the combination of multivariate methods was applied. A cohort longitudinal non-experimental design was used. A structured and dynamic survey was directed to eleven cooperatives corresponding to the population of the municipality of Caála, during 2010, 2011 and 2012. Total variance indicated that with four main components there is the possibility of accounting for 85.43 % of the total variance. Cooperatives A, B, C and F showed positive effect, regarding the number of herds, with annual incomes that also increased. Mortality affected the development of cooperatives A, B and D, with values of 12, 8 and 7 %, respectively. However, in F, the number of animals was increased to 80 % and mortality was controlled. Cooperatives G, H, I, J and L had different performance. In the conglomerate five groups were formed: I was characterized by lower mortality and adequate birthrate and the II had higher mortality. Generally, these cooperative systems are characterized by large land extensions, but poor productive.

Key words: *cooperatives, impact, systems, SMIM*

Livestock production is an important element for supporting and guaranteeing food security in any country (Benson and Mugarura 2013). The livestock production activity is one of the main sources of work and sustain for the population at world level (Ramírez 2010). A good exploitation of the livestock production systems will contribute to conserve the environment and to cover the needs of producers and their families.

In Latin America efforts have been made for developing methodologies that will facilitate the application of the approach of systems and production alternatives directed mainly to small farmers. Thus, greater attention is paid to the characterization, farm registration, design of strategies and technological alternatives that will make easier the development of the cattle activity (Escobar and Berdegué 1990).

The cooperative livestock production systems have as purpose to satisfy the requirements of the communities, their maintenance at long-term and the supply of the primary resources for cattle production (Bolaños 1999). It is necessary to learn the functioning of the different productive systems comprising the setting of the population object of study, in order to identify the problems and design strategies and technologies allowing the improvement of the aspects of greater incidence for the development of the livestock production cooperatives.

There was ino characterization of the livestock production cooperatives In the Republic of Angola, according to the production systems applied, although they are identified as the agricultural and cattle production activity. Their properties are considered totally private and the state only grant them the exploitation title. Their members have a quantity of land between 10 and 300 ha. They have low levels of mechanization and fertilization and, generally, the families, in their majority women and elderly persons, are the responsible of carrying out the agricultural labors. The management of these cooperatives is composed of five administrators.

This study was aimed at characterizing and evaluating the productive effect of the livestock production cooperative of the municipality of Caála through the application of the statistical model of impact measurement (SMIM).

Material and Methods

The study was carried out in the municipality of Caála, Huambo, Republic of Angola, during 2010, 2011 and 2012, in eleven cooperatives registered in the administration of the municipality. An empirical research method was applied and a cohort longitudinal non-experimental design was used, with the application of the scientific observation and the survey for securing the information. Variables were: total area (ha), livestock production area (ha), pasture area (ha), pigs (heads), cattle (heads), goats (heads), number of cows (heads), pregnant cows (heads), non-pregnant cows (heads), calf deaths (%), adult deaths (%), birthrate (%), slaughtered cattle (heads), slaughtered pigs (heads), slaughtered goats (heads), quantity of meat sold per year (t) and total

incomes (USD). The analysis of main components was used from the analysis of the correlation matrix between the indicators for the selection of components with own value, greater or equal to the unit ($\lambda \geq I$), as established by SMIM. For selecting the variables of greater weight, the variables in the rotated matrix were considered, with weights higher or equal to 0.59. In the statistical processing the SPSS packages, version 19.0 (2010) and InfoStat, version 2008 were used.

Results and Discussion

The sphericity test of Bartllet was significant ($P < 0.001$), indicating that the matrix of correlation is not a KOM identity matrix (Kaiser-Meyer-Olkin). The sampling sufficiency measurements obtained contributed 0.73, a figure that backs the pertinence of the analysis made and indicates that the sampling is adequate (Hair *et al*. 1999 and 2008). Values of table 1 support the total variance accounted for in the analysis and indicate that with four MC it is possible to account for 85.43 % of the total variability. The variables with weights higher or equal to 0.59 were selected.

The first component was the most important that accounted for 53.27 %. Components 2, 3 and 4 decreased in the explanation of the variance, according to the SMIM properties coinciding with what was reported by Lattin *et al*. (2011). On using this same model, Martínez-Melo *et al*. (2011) and La O (2013) established that the first components also accounted for more than 50 % of the variability.

MCI was positively correlated with the variables bulls, cows, pregnant cows, slaughtered bulls, slaughtered pigs, and slaughtered goats, all measured in heads. The production of meat per year and total income were measured in t. The variables cattle and goat slaughtered (heads) had significant importance in other components. These were important in the variability of the system and in the characterization of the cooperative in the municipality of Caála. Rodríguez (2011) in studies realized in Granma province in Cuba, stated that these variables are very important for the establishment of typologies in small-holders farms. The second MC, positively correlated with the total area (ha) variables, cattle area (ha) and pasture area (ha) was labeled as size of the areas. This component accounted for 13.46 % of the total variability. The third component accounted for 10.55 % and was labeled as pig and birthrate. The variables that contributed higher weight were pig (heads) and birthrate (%). The fourth MC was the one accounting the least, with 8.15 % of the variability, was labeled as mortality. The variables of greater interest were calf death (%) and adult death (%). In table 1 are set out the loading matrix of the rotated components and of the total variance explained.

The application of SMIM allowed determining the impact indices of the different cooperatives and their performance from one year to another, depending on the different variables characterizing them. Data represented in figure 1 show that in cooperatives A, B and C the impact was positive by the influence of meat production

Table 1. Loading matrix of the rotated components and of the total variance explained

Variables	Components			
	1	2	3	4
Total area, ha	0.39	0.85	-0.05	0.23
Pasture area, ha	0.37	0.81	-0.07	0.31
Cattle area, ha	-0.03	0.88	0.06	0.03
Pig, heads	0.17	0.18	0.81	0.36
Bovine, heads	0.59	0.56	0.52	0.14
Goats, heads	0.43	0.52	0.49	0.45
Cows, heads	0.63	0.47	0.57	0.00
Pregnant cows, heads	0.62	0.28	0.61	0.14
Non-pregnant cows, heads	0.56	0.53	0.36	-0.15
Calf death, %	-0.02	0.27	0.05	0.89
Adult death, %	0.08	-0.03	0.16	0.91
Birthrate, %	0.06	-0.20	0.70	-0.04
Slaughtered bovines, heads	0.91	0.06	0.19	-0.11
Slaughtered pigs, heads	0.76	0.17	-0.08	0.49
Goats slaughtered, heads	0.59	0.51	0.42	-0.21
Amount of meat, t	0.91	0.19	0.17	0.12
Total income, USD	0.91	0.20	0.16	0.12
Total (eigen value)	9.06	2.29	1.79	1.39
Variance percentage	53.27	13.46	10.55	8.15
Accumulated percentage	53.27	66.73	77.28	85.43

in the three years, especially that from pigs. Impacts increased as years passed, as well as the incomes.

The opposite occurred with cooperatives G, H, I, J and L which exhibited maintained negative impacts in the three years with lower number of animals. Martínez-Melo (2012) applied this same model in Ciego de Ávila province, in Cuba and found in a similar study that only in a reduced number of cooperatives, positive impact indices were shown. In studies of Phiri (2012) it has been demonstrated that the lack of sufficient incomes affects the capacity of the cooperatives. In D, E and F the impacts were negative in the first year and positive in the second and third indicating that these cooperatives attained recovery in these two following years.

Figure 2 shows the impacts of the cooperatives, linked to the size of the areas (MC2).

Cooperatives A, B, F, G and I had positive impacts in the three years and tally with the highest total areas, pasture areas and areas devoted to livestock production. Cooperatives C and J had positive impacts in 2010, but decreased in 2011 and 2012, since as years elapsed some of their members retired. This factor is of great importance, according the criteria of Senra (2011) who stated that the size of the farm constitutes a decisive factor for the number of animals that can be maintained, depending on the biomass production. Cooperatives D, E, H and L presented negative impacts in the three years.

It must be considered that cooperatives with greater amount of hectares have the possibility of having greater number of areas devoted to pasture. This is a very important factor, since in these localities the cattle rearing system is exclusively extensive. Generally, animals are fed native pastures. Parsons *et al*. (2013) in their description of the cattle production systems in the South Vietnam concluded that cooperatives with greater cattle areas, regarding work and land terms, have consequently better incomes.

The development of cattle production is essential for the intensification and diversification of forage cultures. Specifically in the municipality of Caála, this represents a great limitation, since cooperationists only supply natural pastures to the animals. Ramírez (2010) refers that the lack of forage species of good quality, adapted to the environmental conditions of different livestock production zones, is indicated as one of the problems limiting the development of the livestock production activity.

Figure 3 is represents the pig impact index and birthrate in the cooperative systems.

In the three years of study, cooperative A showed the highest positive impacts which increased as time went by. The same occurred with E, F and L, but with different magnitudes. On the contrary, cooperatives B, C, D, G and H had maintained negative effects during the three years. Cooperative C, in 2010, did not exploit the pig breed, but in 2011 and 2012 these animals were incorporated to the system, although in small amounts. However, its impact continues to be negative. Cooperative D had negative impact in 2010 which increased until 2012.

Halimani and Muchadeyi (2012) stated that the number of adult pigs contributes to the production efficiency of the cooperative system. Carter *et al*. (2013) pointed out that the growth rate of pigs can be improved, if the available feeds are used in the locality, so that it can be made an efficient use of resources.

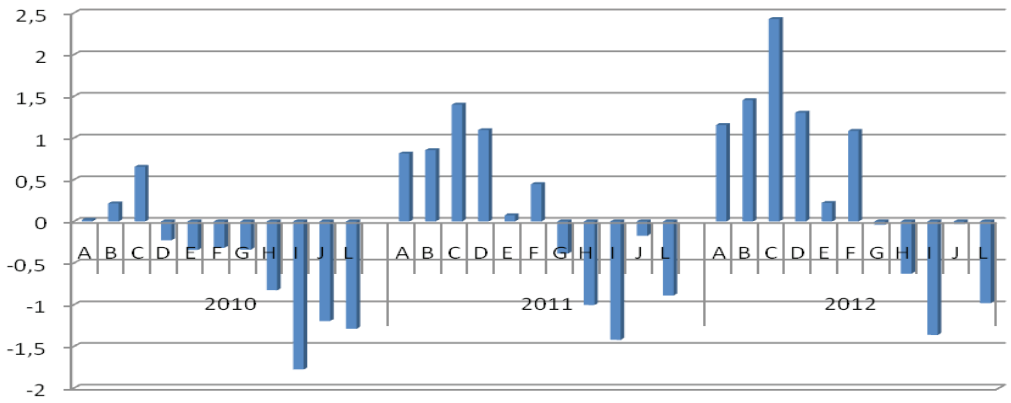


Figure 1. Income impact and meat production in the cooperative systems

Figure 2. Impact of area sizes on the cooperative systems

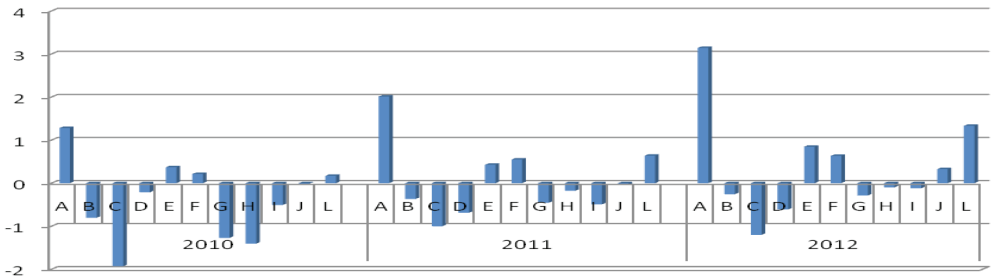


Figure 3. Pig impact and birthrate on the cooperative systems

In this study, only in few farms were attained favorable results on the reproductive performance of the herds. Research reports realized in Tanzania by Karimuribo *et al*. (2011) coincide in recognizing the pig cattle as important income source, above all in rural areas. However, another limitation is the reproductive inefficiency of the sowing. On characterizing the cattle activity, Belkheir *et al*. (2011) indicated that the control of reproduction is a determinant factor. The presence of animals that are not reproduced increases the load of the cattleman and hinders the correct herd renewal.

Figure 4 shows the impact of mortality in the cooperative systems.

According to the criteria of Torres *et al*. (2013), the highest mortality values indicate animal losses in the herd, thus, high and positive values of this index are unfavorable for the activity. It could be convenient in future studies to evaluate this variable by the index and not by heads. For this reason, in this study, the values of the impact indices on the mortality component were multiplied by -1.

Cooperatives A, B, D and H presented negative impact during the three years, with mortality percentages of 22, 21, 20 and 20, respectively in adults and calves. Mortality affected the development of the system in the mentioned cooperatives. Nonetheless, in C, E and F, the number of animals was increased but mortality was controlled, which justifies the positive impact of these during the three experimental years. According to criteria of Martínez-Melo *et al*. (2011) the knowledge of the proportion between animals born and deaths is very important for determining the growth in herds of the different cooperative sectors. As stated by Bernal (2010) in the characterization of agricultural systems multiple factors are related influencing on their efficiency.

As per the SMIM procedures, the impact indices were employed for grouping the cooperatives and then, realize the characterization of the groups formed and their typification. Castaldo *et al*. (2003) reported that the high degree of heterogeneity existing between exploitations that form a population hinders the adoption of decisions. In this sense, on grouping exploitations according to their main differences and relationships, it was search for maximum homogeneity and heterogeneity in the groups and among them.

The cut for stopping the fusion process of the groups was practiced in the dendrogram, at a distance of 12.50 %. This allowed to form five groups of units by means of the hierarchical conglomerates (figure 5), as indicated by the inter-group linking method and the measurement of square Euclidean distance interval.

Results from table 2 characterize the cooperative system in the municipality of Caála. Similar procedures were utilized by Benítez *et al*. (2003 and 2008), Ramírez (2010) and Torres *et al*. (2010 and 2013) for characterizing agricultural production systems in Cuba.

Group I was characterized by lower mortality and adequate birthrate. Group II attained higher mortality, livestock and pasture production areas and higher number of herds and, as consequence, better total incomes. However, it was the one with higher birthrate percentage. Group III grouped more cooperatives in the experimental time and was characterized by smaller areas, lower number of bovine cattle and lower total incomes. Group IV presented lower total and cattle areas. Finally, group V had lower number of pigs, a category

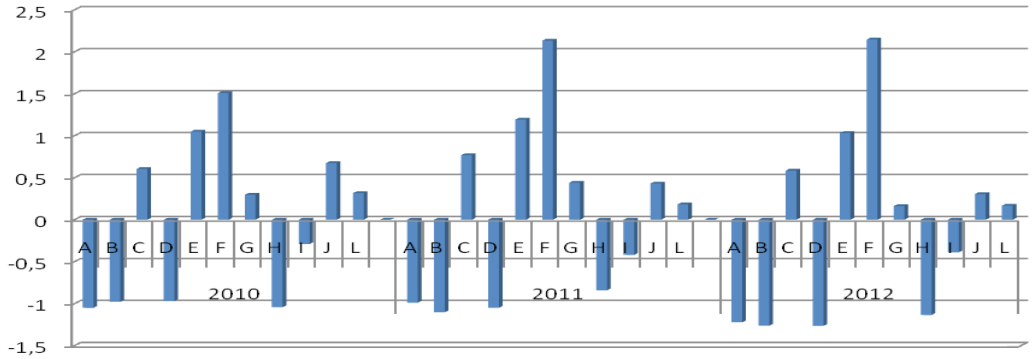
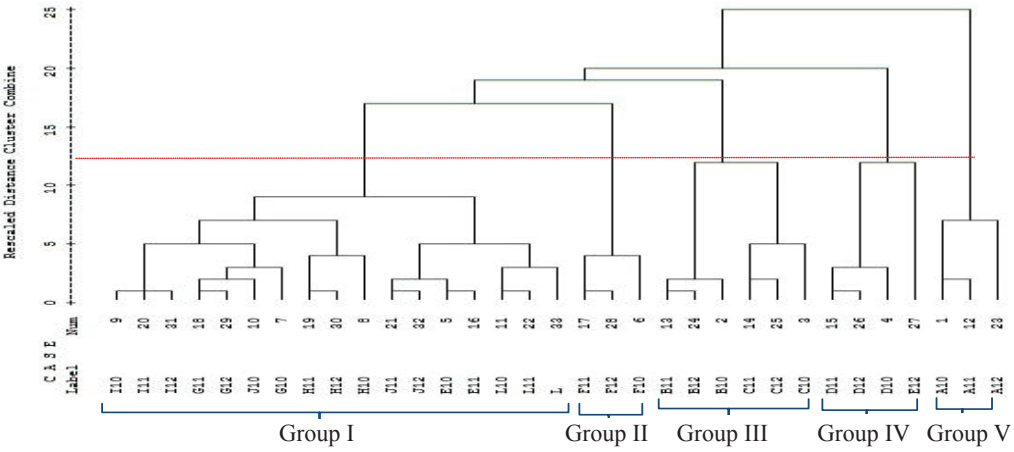


Figure 4. Mortality impact on the cooperative systems



Letters represetn cooperatives. The numbers with each letter inform the last two figures of the corresponding year: A10 year 2010; A11 year 2011; A12 year 2012.

Figure 5. Dendrograme according to cattle indicators

Table 2. Descriptive for the characterization of the groups

Variables	Group I		Group II		Group III		Group IV		Group V	
	Mean	Dev. typ	Mean	Dev. typ	Mean	Dev. typ	Mean	Dev. typ	Mean	Dev. typ
No. of cases	3		3		17		4		6	
Total area, ha	7000.00		8333.33	288.68	4258.82	2008.44	2875.00	1108.68	8916.67	917.42
Pasture area, ha	3000.00		3333.33	288.68	1705.88	999.67	1375.00	750.00	4250.00	1214.50
Cattle area, ha	3000.00		3000.00		1988.24	1078.70	900.00	200.00	2500.00	547.72
Pig, u	32.00	17.00	269.00	76.00	38.00	24.00	32.00	15.00	19.00	19.00
Bovines, u	234.00	35.00	413.00	61.00	103.00	35.00	121.00	36.00	254.00	71.00
Goats, u	62.00	19.00	307.00	40.00	54.00	23.00	42.00	26.00	181.00	115.00
Cows, u	147.00	25.00	207.00	31.00	50.00	21.00	71.00	28.00	123.00	33.00
Pregnant cows, u	42.00	8.00	76.00	33.00	24.00	10.00	35.00	20.00	47.00	19.00
Non-pregnant cows, u	104.00	21.00	111.00	33.00	26.00	15.00	36.00	9.00	76.00	18.00
Calf death, %	3.00		10.00		6.00	2.00	8.00	4.00	7.00	4.00
Adult death, %	2.00		12.00		6.00	3.00	8.00	4.00	7.00	3.00
Birthrate, %	80.00		82.00	8.00	74.00	10.00	79.00	3.00	68.00	11.00
Slaughtered cattle, u	7.00	3.00	6.00	2.00	3.00	1.00	6.00	1.00	7.00	2.00
Slaughtered pigs, u	4.00	0.00	13.00	2.00	5.00	1.00	11.00	4.00	17.00	2.00
Slaughtered goats, u	10.00	3.00	10.00	3.00	5.00	1.00	5.00	1.00	9.00	1.00
Quantity of meat, t	3.00	1.00	3.00	1.00	1.00	1.00	2.00	1.00	3.00	1.00
Total income, USD	12500.00	2500.00	16166.67	3752.78	6970.59	3023.19	10250.00	3570.71	14166.67	3816.63

which was not included in this productive systems, as well as higher total areas.

These indicators must be used as criterion for grouping the cooperative sectors. They have also been considered in the analysis made by Macedo *et al*. (2003) and Valerio *et al*. (2004) who also typified the agricultural production systems. These authors demonstrated that there is heterogeneity among producers, which was verified on establishing in the analysis five production groups.

It is necessary to encourage producers of the Caála region to include pig rearing in their systems, since it adapts well to the conditions of the municipality, according to the reports of MINADER and FAO (2003). In Angola the consumption of this meat is very high and according to Chivangulula *et al*. (2013) the Angolan government directs part of its activities to the strengthening of this economical item. It must be considered that meat production has a positive impact on family incomes and the reduction of poverty. In table 2 are set out the descriptive values typifying the cooperative sectors.

Results referred demonstrate that there is great diversity in the agricultural cooperative systems. Cooperatives were characterized as per their mortality, total areas, cattle areas, and pasture areas, as well as number of herds, total incomes and birthrate.

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