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SOCIOECONOMIC AND TECHNOLOGICAL CHARACTERIZATION OF MEAT SHEEP PRODUCTION SYSTEMS IN THE STATE OF PARANÁ, BRAZIL

(*Caracterização socioeconômica e tecnológica de sistemas de produção de ovinos para carne no estado do Paraná, Brasil*)

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ABSTRACT - Sheep farming has shown organizational and development initiatives since the beginning of the 21st century in the State of Paraná. This study identified and characterized the meat sheep production system profile in five mesoregions of the State of Paraná. The study sample was defined and selected by using the rapid appraisal methodology, which was applied in five mesoregions of Paraná State. These mesoregions together account for 65.22% of the sheep population of the State. Data were collected by means of a semi-structured questionnaire applied during visits to these farms with the support of technicians from the Federation of Agriculture of the State of Paraná (FAEP) as well as local technical assistants, addressing the following aspects: (i) farm, farm owner and labor profile, (ii) flock characteristics, (iii) production and feeding systems, (iv) facilities, (v) reproductive and sanitary management, (vi) challenges and future prospects. The results obtained revealed the occurrence of a production system heterogeneity and difficulties in defining standards for the activity development. However, positive prospects were also identified, such as: the use of crop-livestock integrated systems, the farmers' intention to keep their businesses and the importance of cooperative organizations in the production process coordination.

Key words: diagnosis; lamb; production profile; sheep farming.

RESUMO - A ovinocultura paranaense vem mostrando iniciativas de organização e desenvolvimento desde o início do século XXI. Este estudo identificou e caracterizou o perfil de sistemas de produção de ovinos para carne em cinco mesorregiões do Estado do Paraná. A amostra foi definida e selecionada por meio da metodologia *rapid appraisal*, aplicada aos ovinocultores de cinco mesorregiões do Paraná que somadas, compreendem 65,22% do rebanho ovino do Estado. Os dados foram coletados por meio de questionário semiestruturado aplicado durante visitas à estas propriedades e com o apoio de técnicos da Federação da Agricultura do Estado do Paraná (FAEP) e assistentes técnicos locais, abordando os seguintes aspectos: (i) perfil da propriedade, do proprietário e mão de obra; (ii) características do rebanho; (iii) sistemas de produção e alimentação; (iv) instalações e equipamentos; (v) manejo reprodutivo e sanitário; (vi) desafios e perspectivas futuras. Os resultados indicam heterogeneidade nos sistemas de produção e dificuldades na definição de padrões para o desenvolvimento da atividade. No entanto, revelam perspectivas positivas como: o uso de sistemas de integração lavoura-pecuária, a intenção dos produtores em permanecer na atividade e a importância das organizações cooperativas na coordenação dos processos produtivos.

Palavras-chave - cordeiro; diagnóstico; ovinocultura; perfil da propriedade.

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INTRODUCTION

Sheep raising is an expanding business as a source of animal protein production in Brazil. According to IBGE (2020), the Brazilian sheep flock consists of approximately 20.6 million head and has grown significantly, as compared to 14.2 million head in 2002. The Brazilian sheep flock is more relevant in the Northeastern (70.59%) and Southern (18.73%) regions of the country (IBGE, 2020).

Including lamb meat production, the annual cycle of sheep production, which corresponds to approximately one-third of the cycle required for beef production, provides greater liquidity to the activity, being an important alternative for rural property diversification.

In addition, meat production based on pasture systems or crop-livestock integrated systems is a more sustainable alternative to animal production. Crop-livestock integration systems occupy a relevant position when farming feasibility is sought economically wise, mainly by reducing risks through diversification of activities and by attaining a better cash flow balance, apart from allowing more rational input, machinery and labor use on the farm (BRAZ et al., 2012).

In northeastern Brazil, sheep farming is predominantly maintained by low-cost family production systems, thus enhancing sheep social importance to feed the rural population of the Brazilian semi-arid region. Many opportunities for increased sheep production are present in this region, demanding initiatives to make better use of available resources (LÔBO et al., 2011).

In southern Brazil, likewise, there are several possibilities for the development of meat sheep production as an economic activity and a diversification alternative to integrate production with other agricultural activities (VIANA & WAQUIL, 2013).

In the State of Paraná, from the year 2000 there has been farmers received incentives to organize the production chain through the establishment of private commercial groups to purchase animals. However, the animals have remained underpriced, considering lamb production costs in this State. As a consequence, some commercial meat production farmers have organized associations / cooperatives as of 2003. Following the Program for the Structuring of the Production Chains of Goat and Sheep Raising (*Programa de Estruturação das Cadeias de Produção de Caprinos e Ovinos*), launched by the Department of Agriculture and Supply of the State of Paraná (*Secretaria da Agricultura e do Abastecimento* – SEAB) in 2004, several producer groups started organizing themselves, scheduling lamb production, thus enabling animal slaughter and marketing, even at a local level. The sheep flock of Paraná State consists of

approximately 574 thousand heads (IBGE, 2020), being the southern State with the highest growth in the last three decades.

According to GUIMARÃES et al. (2022), an increase in the scale of production and regularity of supply will allowto meet the increase in domestic demand and the requirements of the foreign market. However, it is still necessary to raise producer awareness as to the need to optimize environmental resources on each sheep breeding farm or production area in order to determine the best production system that can lead to higher profitability (BARROS et al., 2009) and efficiency.

The aim of this study was to characterize representative farms of sheep production systems in five regions in the State of Paraná, Brazil, seeking to identify their particularities in order to provide information for the promotion and development of the activity.

MATERIALS AND METHODS

According to the Brazilian Institute of Geography and Statistics (IBGE, 2012), a region is defined as an individualized area in a Federation Unit that has types of geographic space organization defined by the following dimensions: the social process as a determinant, the natural setting as a conditioning factor and the network of communication and places as an element of spatial articulation.

The State of Paraná has been divided into ten distinct regions: Curitiba Metropolitan Area, Mid-Eastern Paraná, Southeastern Paraná, Mid Southern Paraná, Mid-Western Paraná, Southwestern Paraná, Western Paraná, Northwestern Paraná, Northern Paraná and Pioneer North Paraná. The most significant regions for sheep production in the State of Paraná were identified by the existence of representative institutions and consolidated organizational structures in the sheep production chain, that is, meat producer cooperatives. Five regions were studied: North Middle (Mid Northern), Eastern Centre (Mid-Eastern), South Centre (Mid Southern), Southwest (Southwestern) and West (Western). Figure 1 illustrates the geographical distribution.

Figure 1 - Regions in the State of Paraná focused on this study.

In order to define representative farms in each region, the rapid appraisal method, also known as Participatory Rapid Diagnosis (PRD), as described by CHAMBERS (1981) and CHAMBERS (1994) and commonly used by European organizations in rural development projects in emerging countries (PEREIRA, 2001), was used. In this method, performance drivers such as the production focus, organizational environment, the use of technologies, market structures and coordination mechanisms are defined. The method also assumes the adoption of three basic concepts: systemic analysis, a multidisciplinary approach and interactive data collection and analysis (BEEBE, 1995).

Mobilization meetings with farmers and other representatives of the sheep farming chain from each region were carried out to discuss the use of the rapid appraisal method between May and July 2015. Due to the methodology used, the information collection process was continuous and not limited to the time of farm visitations.

Five representative farms were chosen for data collection in each region. Initially, a free and informed consent form was given to each producer, which included the conditions for doing the research, guaranteeing their anonymity and data confidentiality, and agreeing to transfer intellectual property researchers the information generated by the research. Next, the farmer's consent and signature were requested in order to start the data collection process.

The data collection tool used was a diagnosis guide composed of a semi-structured questionnaire which contained 20 open questions that addressed the following aspects: (i) farm, owner and workforce profile, (ii) flock characteristics, (iii) production and food systems, (iv) facilities, (v) reproductive and health management, (vi) future challenges and prospects.

It was characterized 25 representative sheep production farms from the five mesoregions, which represents 65% of the Parana state's flock. For data analysis and interpretation, content analysis, in addition to descriptive and inferential statistics, were used with the support of Excel and Windows 2010 software, so as to organize, summarize, and interpret the information. Subsequently, the information was described in a sequential and logical manner.

RESULTS AND DISCUSSION

Farm, owner and workforce profiles

The research revealed that sheep farming was not the main economic activity in any of the properties studied, with agriculture prevailing as the major activity. Table 1 contains information on owner profiles and characteristics of farms.

Table 1 - Frequency of occurrence (%) of owner profiles and characteristics of sheep farms in the state of Paraná, Southern Brazil

Owner profiles and characteristics of farms	Mid Southern	Mid-Eastern	Western	Southwestern	Mid Northern	Average of 25 representative farms
Gender: male	60	60	100	100	100	84
Gender: female	40	40	0	0	0	16
Schooling: incomplete high school	0	0	0	20	20	8
Schooling: complete high	80	20	40	10	30	36
Schooling: undergraduate	20	80	60	80	60	56
Hired labor	100	100	80	100	80	92
Family labor only	0	0	20	0	20	8
Crop production	100	80	100	100	100	96
Beef cattle	80	20	60	40	20	44
Dairy cattle	0	0	0	20	40	12
Pig farming	0	60	0	0	0	12
Forestry	0	0	0	0	40	8
Horse farming	0	0	0	0	20	4
Fish farming	0	0	0	0	20	4
Humus	0	0	0	0	20	4

From the total area of each farm, an average of 27% is used for sheep production, and the average sheep occupancy rate in the representative farms for the regions is distributed as follows: Mid Southern (23%), Mid-Eastern (17%), Southwestern (31%), Western (19%) and Mid Northern (47%). It was possible to determine that the smaller the farm area, the higher the sheep occupancy rate. Likewise, the two regions with the highest sheep occupation rate were those with the smallest flocks. Similar information was reported by GALAVIZ-RODRÍGUEZ et al. (2011), SILVA et al. (2013), VIANA & WAQUIL (2013), FARIAS et al. (2014), and RAINERI et al. (2015).

Further corroborating with the above information and taking into account the investments made for the 2015/2016 production cycle, it has been determined that the highest gross revenue expected by farmers comes from agriculture, with an average of 63.46%, followed by cattle raising (15.88%), sheep raising (11.34%), and other activities (12.36%).

Older farmers were found in the Southwestern region with an average age of 54.2 ± 12.5 years, while the youngest were from the Central Eastern region, with an average of 38.4 ± 8.7 years. The predominance of male labor force and the aging of the population in the rural environment can be verified in several characterization studies of sheep production systems in different parts of the world (SAHIN & YILDIRIM, 2002; RIVAS et al., 2004; GELASAKIS et al., 2004; SALCEDO & TRUJILLO, 2006; VALERIO et al., 2009; GALACIZ-RODRÍGUEZ et al., 2011; RIPOLL-BOSCH & BERNUÉS, 2014).

Regarding the period of time these farmers have been engaged in the activity, an average of 13.9 ± 9.3 years was observed. The longest period was found in the Mid-Eastern region, with an average of 24.6 ± 10.8 years, and the shortest in the Mid Northern region with an average of 7.2 ± 5.4 years. In the Mid Southern region, the average time in the activity was 13 ± 6.9 years, in the Western 9.2 ± 1.8 years and in the Southwestern, 15.4 ± 6.8 years. This difference in the period of time is a result probably of the later occupation of the Mid Northern and Western regions with sheep herds.

The sheep production systems under analysis in the State of Paraná have hired labor in 92% of cases and only two farms (8%) relied on family labor solely. Faced with this diversified reality, sharing the workforce activities within the farms is widespread, with 92% of farmers having stated that labor is shared among the different farm activities. Only 12% stated that they had an exclusive worker that cared for sheep and one farmer, and (4%) stated that they had set aside two employees exclusively for sheep farming.

Flock characteristics

There was a wide variation in flock size and composition in the area covered by this study. The average size of the flocks was 472 ± 428 animals, and the average number of matrices was 192 ± 176, whereas the average number of rams per farm was 4 ± 3.

The existence of a production scale is important to render the activity profitable, once economic losses may be higher among small flocks, inasmuch as individual animals will have a greater representation in the economic result of the system. The number of animals in a flock can directly influence the cost of sheep production. According to TORO-MUJICA et al. (2015), smaller flocks have higher production costs and lower income per lamb and per kg body weight.

Table 2 contains information on average flock sizes stratified by animal category in each region.

Table 2 - Average size of flocks (animals) stratified by category in each region of the State of Paraná, Brazil

Animal category	Mid Southern	Mid Western	Western	Sothwestern	Mid Northern	Average of 25 representative farms
Ewes	214±36	407±280	160±101	65±31	114±83	196±179
Rams	6±2	7±5	4±3	2±1	3±2	4±3
Young	126±73	172±90	37±21	16±8	36±23	77±43
Lambs**	446±388	331±119	117±127	44±27	52±22	204±193
Flock	418±150	808±445	286±155	136±12	184±103	467±425

The values represent mean and standard deviation, * Young ewes between six months and one year of age, ** Lambs up to six months old.

Due to the lack of information records by most sheep farmers, it was not possible to identify flock litter size and mortality rates. Some farmers believe that these two indicators are limiting factors for better performance of their production systems, especially neonatal lamb mortality rates. Deficiencies in this management may be related to the lack of training of the workforce. RIET-CORREA et al. (2013) stated that the producers' lack of interest in flock bookkeeping occurs because of the difficulty they have in understanding the importance of registration as a general flock management tool.

Even so, it was possible to establish some relationships using information on flock composition. The average ram: ewe ratio in the breeding season was one ram to 43 ± 18 ewes. The region showing the highest proportion was the Mid-Eastern (1: 61 ± 29), followed by the Western (1: 43 ± 10) Mid Southern (1: 42 ± 23), Mid Northern (1: 39 ± 10) and Southwestern (1: 35 ± 12). The highest proportion ram: ewe is indicative of greater on flock efficiency.

When the average number of matrices was compared to the number of lambs on the farm, it was evident that the litter size rate was probably below the recommended parameters (120%). The average lamb weaned per ewe on the flock was 85%. The great region showing the highest rate for this indicator was again in the Mid-Eastern (94%), followed by the Mid Southern (91%), Southwestern (86%) and Western (69%).

Regarding the culling of adult animals in relation to the number of matrices and rams in the flock, it was observed that the overall average was 0.18 ± 0.11 animal culled per matrix. When the regions were taken into account, the indicator for the Mid Southern region was observed to be 0.24 ± 0.19 culled animal per matrix, Mid-Eastern 0.21 ± 0.09 culled animal per matrix, Southwestern 0.14 ± 0.05 culled animal per matrix, Western 0.12 ± 0.06 culled animal per matrix and Mid Northern, 0.11 ± 0.07.

Individual animal identification by using plastic earrings was found in 19 (76%) flocks, on four farms (20%) only matrices and replacement ewes were identified, one sheep farmer (4%) did not make use of any animal identification. Whereas all representative flocks of the Mid Eastern region had individual identification, 80% of the flocks in the Mid Southern and Mid Northern regions and 60% of the flocks in the Western and Southwestern regions were identified. Again, the Mid Eastern region was highlighted by a greater use of technological tools in this activity.

As for breeds, wool meat production animals prevailed. The use of crosses between breeds was more evident in Mid-Eastern region flocks. Either pure or crossbred, the Texel breed was present in 76% of the properties, followed by Ile de France (48%), Santa Inês (32%), Dorper (12%) and Suffolk (4%). Figure 2 shows breed distribution in the study coverage area.

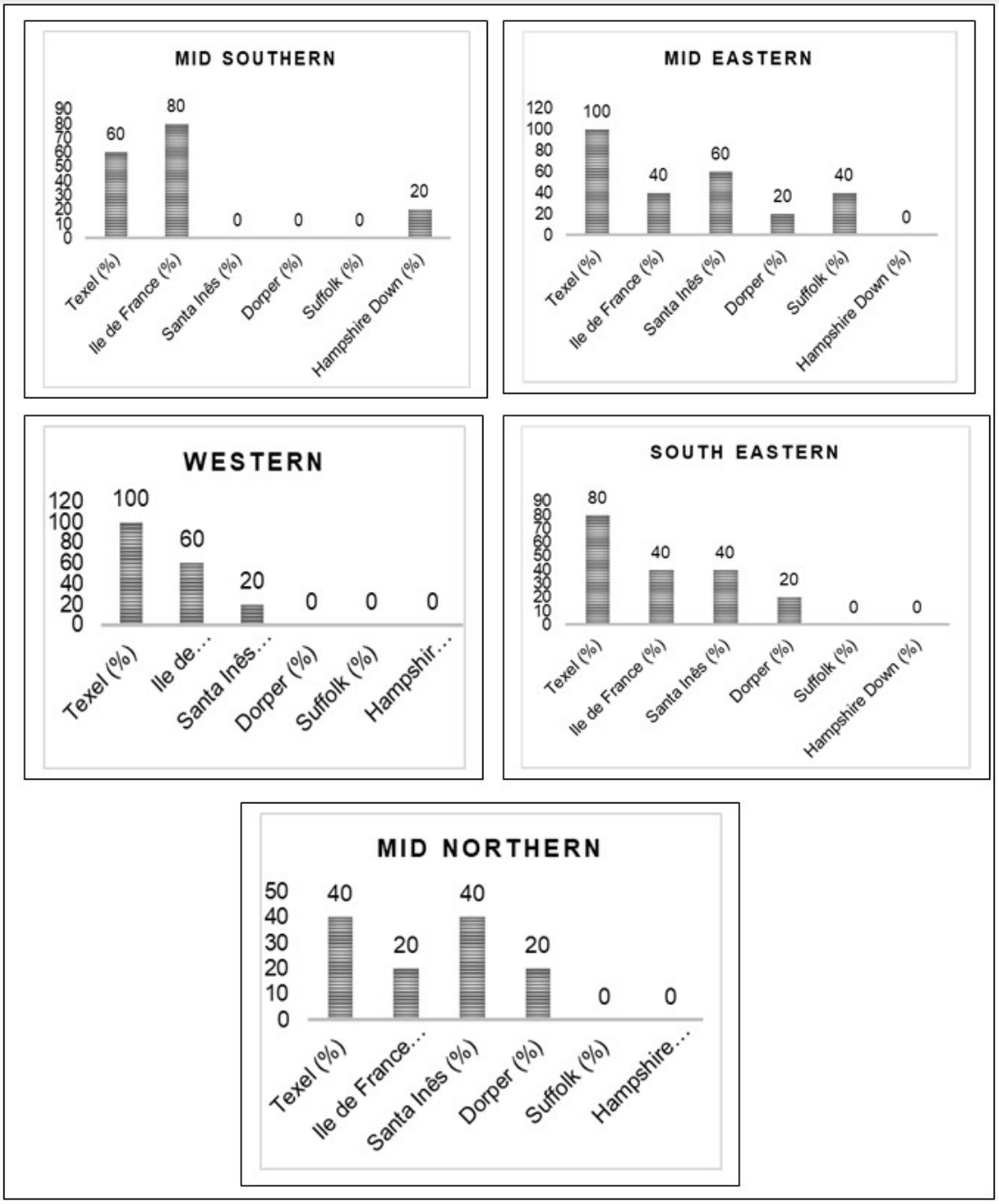

Figure 2 - Relative frequency of sheep breeds on representative farms in each region of the State of Paraná, Brazil

In southern Brazil, wool sheep breeds usually prevail SILVA et al. (2013) found that in the State of Rio Grande do Sul, despite the prevalence of wool breeds, there is a greater trend to expand meat production flocks, as compared to those specialized in wool production. However, it was expected to find a higher frequency of Santa Inês and

Dorper breeds in the northernmost regions of the state and, consequently, with a warmer climate.

Feeding and production systems

It could be observed that production systems were mixed in 80% of the farms, i.e. at least part of the production cycle was either in feedlot or on pasture, 12% developed all productive stages only on pasture, whereas only 8% kept sheep exclusively in feedlot systems. All production systems of the Mid Southern region were mixed, while 60% of the systems were mixed in the Mid-Eastern region and 40% were in feedlots, in the Western, Southwestern and Central Northern regions, 80% of the systems were mixed and 20% were on pasture only.

As for animal feed, the use of cultivated pastures prevails in crop-livestock integrated systems with food supplementation, especially in periods of greater nutritional requirement for the sheep, such as gestation and lactation. Pastures of the genus *Cynodon* spp. (such as Tifton-85) were used as perennial summer forage in 60% of the farms. Other perennial summer species, such as Aruana grass (*Megathyrsus maximus* cv. Aruana) in 48% of the farms, hemarthria (*Hemarthria altissima*) was used in 24% of the farms and, whereas guinea grass (*Megathyrsus maximus* cv. Jacq.) was used in only 4% of the farms.

The annual ryegrass (*Lolium multiflorum*) and oat (*Avena* spp.) combination is the major winter pasture alternative and was present in 60% of the farms. This consortium was used in 100% of the representative farms of the Mid Southern, 80% of the Southwestern, 60% of the Mid Eastern, 40% of the Western and 20% of the Mid Northern region. Pearl millet (*Pennisetum americanum* l.), an annual summer forage, was used in 24% of the farms. It was found that farms had greater animal grazing or forage production area availability during the autumn/winter period, while in spring/summer there was a greater area competition because of soybean (*Glycine max* l.) and maize (*Zea mays*) production. Since the prevailing system is crop-livestock integration, grain production is prioritized in arable areas at this time of year.

All production systems use concentrate (feed) in sheep supplementation, including 12% that keep animals exclusively on pasture systems, and 40% and 32% of the systems use corn silage and hay, respectively. Corn silage is performed on the farm in 96% of cases, while 100% hay is produced by the sheep farmers themselves. Food supplementation strategies for sheep constitutes an important tool for improve production, especially on the end of the gestation and the onset of lactation, period that metabolic diseases can affect animal production performance (BRONDANI et al., 2022).

Facilities and equipment

Among the sheep production facilities in the State of Paraná, the existence of shelters (sheepfolds or sheds) on all farms stands out. Even in the extensive and semi-intensive systems, there is a need to drive the flock to these facilities at night, mainly due to predator attacks. Most herd management activities are carried out in the sheepfolds. Some farms use pre-existing management facilities for cattle and pigs adapted for sheep management activities.

The use of facilities was observed in 15 (60%) of the 25 farms included in the study. Old swine facilities have been adapted for sheep production, thus keeping a low initial facility investment for the development of the activity. When the different regions in the State of Paraná were analyzed, facility use frequency corresponded to 80% in the Mid-Eastern and Mid Northern, 60% in the Mid Southern and 40% in the Western and Southwestern regions.

In 22 (88%) of the farms there was at least one available tractor, with an average of 1.2 tractors per farm. In the Mid Southern and Mid-Eastern regions, the average was 1.6 tractors per farm, in the Western, 1.4, in the Southwestern, 0.8 and in the Mid Northern, 0.6. In 20 (80%) of the farms the tractor was shared with other activities, 30% of its time on average being employed in sheep raising. In five farms (20%), there was a tractor for exclusive sheep farming use. These exclusive tractors have power equal to or less than 75 hp and over 10 years of use. As for the tractors shared with other activities, power is directly related to the agricultural activities developed on the farm which proportionally occupy this equipment more often. The three (12%) farms with no tractors had an average flock size of 107 ± 51 sheep. This are grassland-based family production systems.

Reproductive and health management

Regarding the reproductive management, it was observed that rams were maintained throughout the year with the flock in 40% of the farms, showing limited reproductive management organization and efficiency, whereas in 24% of the farms a mating season was carried out during the cycle, 20% of the farms adopted an accelerated calving system (for the purpose of obtaining three deliveries in two years) and 16% performed induction and estrus synchronization. None of the 25 production systems performed artificial insemination.

The practice of keeping the ram throughout the year in the flock was identified on farms with low technological levels, which is technically not recommended. However,

some farms that used the Santa Inês breed for crossings, seeking to reduce reproductive seasonality, even being in the south of Brazil where the photoperiodism is more accentuated.

PARDOS et al. (2008) reported that sheep production systems in Spain that use different reproductive management strategies so as to obtain three lambs per ewe had a litter size rate 13.45% as high as those with seasonal reproductive management. This leads us to reflect on the fact that the adoption of better organized reproductive systems could reduce the limited litter size results on Paraná farms, which was 0.85 ± 0.22 lamb per ewe.

As for health management, one of the main concerns of sheep farmers is the control of parasites. In this sense, the use of the FAMACHA® method as a sanitary management strategy regarding parasitic diseases was observed in 68% of the farms. When analyzed by region, this management practice is performed in 80% of the farms of the Mid Southern and Mid-Eastern regions, 60% of the farms of the Western and Mid Northern, and 40% of the farms of the Southwestern regions, which were quite satisfactory results, once parasitic diseases affect sheep productivity and are thought to be a constant challenge to sheep production systems (SALGADO et al., 2018).

With regard to the preventive control of diseases, it was found that 88% of sheep farmers provided vaccination against clostridiosis, following the technical recommendations of dosage and reinforcements. There was one sheep breeder in each of the Western, Southwestern and Mid Northern regions that did not carry out preventive vaccination against clostridiosis. Other preventive vaccinations against keratoconjunctivitis, pododermatitis and contagious ecthyma were found in two (8%) farms for each disease. At this point, there is a need for greater awareness among farmers about the importance of preventive sanitary management.

Social aspects

Farm management was performed by the sheep farmer himself in 17 (68%) farms and in eight (32%) the sheep producer had the assistance of a hired professional. In the Mid Southern and Mid-Eastern regions, 60% of the farms had technical management support, in the Mid-Northern region this frequency was 40%, whereas the Western and Southwestern regions did not make use of this service on their farms.

Family succession on the farm is described as having been planned on 15 (60%) farms. The succession proceedings frequency by region that have been identified were: 100% in Mid-Eastern, 80% in Mid Southern, 60% in Western and Mid Northern, and 40%

in Southwestern. Inheritance proceedings are decisive for the adoption of technologies and productive planning in the long run.

Cooperatives are an obvious feature in meat sheep production organization in the State of Paraná. Concerning the importance of cooperatives for the development of their activities, 16 (64%) farmers described them as very important, six (24%) farmers considered them important, and three (12%) farmers thought them of little importance. When analyzing this characteristic by region, it was found that the highest appreciation occurred among farmers from the Mid Southern region, followed by the Western, Mid-Eastern, Southwestern and Mid Northern regions. It was found that the presence of cooperatives increases the chances of success in sheep production development. Similar information was reported by LARA et al. (2006), MARÍN-BERNAL & NAVARRO-RÍOS (2014), RAINERI et al. (2015).

Challenges and future prospects

Several challenges need to be faced by the sheep industry in the State of Paraná. Genetics and facilities were found to be the features most often mentioned as positive by sheep farmers. Conversely, food production (48%) and labor quality and availability (40%) obtained the same indication frequency, both as a positive feature and as one to be improved.

The flock zootechnical control was mentioned as a positive feature by 4% of the interviewees, precisely because it is rarely performed by sheep farmers (20%). However, only 24% of the respondents recognized zootechnical control as an important factor to improve their production systems. In this aspect, it is necessary to increase the awareness of farmers to record events in the management on the flock.

Technical assistance was considered a positive feature on only 8% of the farms, and just 20% of sheep farmers cited technical assistance as a feature to be improved. A similar situation was found with the managerial control of the activity: mentioned as a positive feature by 4% of sheep farmers and as a feature to be improved by 8%. Sheep farmers who have technical assistance, mainly that provided by cooperatives, in addition to approving of this service, were able to identify benefits in the improvement of their production indicators.

The need to improve the efficiency of production systems becomes increasingly important for the economic viability of any activities, especially those directly linked to complex biological processes and dependent on uncertain factors.

Future prospects of the interviewed sheep farmers, comparing the current flock with the intention of expanding flocks on each farm within five to ten years identify that only two of the 25 sheep farmers (one from the Western region and another from the Southwestern) stated that their flocks were stable, that is, they would keep the same number of matrices and rams. It was also possible to observe that the farmers with the largest flocks were those with the highest expansion expectations.

CONCLUSION

The sheep farming focus in the state of Paraná is on the production of lambs for slaughter, with the adoption of more intensive systems, showing better performance in regions where there is greater influence of cooperative organizations in the coordination of production processes.

The sheep farmer's interest in increasing their flocks is a positive perspective for the activity, indicating that this organizational system is adequate to the reality of Paraná (sheep farming with focus on lamb meat production). In spite of not being the main activity on the farms, sheep raising is seen as an economic activity, a source of income and an alternative for diversification.

Thus, the evolution of the Paraná sheep industry relies on improvements in the management and control of information as well as on production and zootechnical indicators of flocks.

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