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Structural Characteristics of Small Ruminant Production in Muş, Türkiye: A Model for Organic Livestock on the Basis of Sustainability

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Abstract: Small ruminant farming enterprises in eastern Türkiye have the potential to establish a sustainable model for organic livestock production but face structural challenges. This study aimed to develop an organic livestock model based on sustainability by examining the socio-demographic characteristics, management practices, and perceptions regarding animal health and the welfare of small ruminant farmers in the eastern province of Muş, Türkiye. A face-to-face survey was conducted with 364 randomly selected farmers, assessing parameters such as animal genotype, pasture conditions, forage cultivation, chemical fertilizer and pesticide use, nutrition, reproduction, health services, and shelter conditions. Results showed that small ruminants in Muş were well adapted to local conditions and were disease-resistant. They were fed with forage grown without chemicals and had unlimited outdoor and pasture access. The production process avoided hormones, antibiotics, and growth promoters, with reproduction occurring through natural mating. Challenges included inadequate pasture productivity, insufficient animal welfare conditions, low record-keeping rates, lack of effective organization, and insufficient awareness of organic practices among farmers. Notably, 81.9% of farmers described their pasture quality as moderate or poor, while 63.2% stated that they had no knowledge of organic practices. In conclusion, the Muş model offered concepts that could aid the transition to organic livestock farming and support sustainable extensive small ruminant farming globally. Farmers should be educated, informed, and organized, with support throughout the supply and marketing processes.

Keywords: small ruminant farming; organic livestock production; sustainability; organic practices

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1. Introduction

The increasing global population and the consequent rise in food demand have led to the widespread adoption of intensive agricultural practices, both in crop and livestock production. Since the Green Revolution in the 1960s, conventional agriculture, characterized by the extensive use of chemical fertilizers and pesticides, has largely replaced environmentally friendly farming techniques. While these practices have significantly increased agricultural productivity, they have also posed serious environmental and health risks [1], including greenhouse gas emissions, soil erosion, water pollution, and threats to food safety [2]. Conventional livestock farming relies on high-yield breeds, modern feeding techniques, veterinary health products, synthetic fertilizers, and pesticides to enhance productivity [3]. While the use of hormones, hormone-like substances, and antibiotics as feed

additives is banned, antibiotics used to treat diseases can still be transmitted to humans through food, posing significant public health risks. These risks include the development of antimicrobial resistance, allergic reactions, and carcinogenic, mutagenic, and teratogenic effects, as well as the disruption of the normal intestinal microbiota [4–9]. In addition to these health concerns, it also contributes 16.5% to anthropogenic greenhouse gas emissions, playing a significant role in climate change [10].

In contrast, organic livestock farming, which is closer to nature and ethics, is based on principles related to animal welfare (low stocking density, the ability to exhibit species-specific behaviors, natural bedding material, and access to the outdoors), feeding (the prohibition of synthetic feed additives), and breeding conditions (breed selection and suckling period) [11]. In organic systems, production is carried out without the use of antibiotics, artificial hormones, GMOs, and their derivatives, and animals are fed with organically grown feed without chemicals, as well as access to pastures [12]. Although organic livestock farming limits the use of antibiotics and synthetic chemicals, alternative strategies ensure productivity. An increasing awareness of the risks associated with antibiotic use and synthetic feed additives has accelerated studies on natural feed alternatives, particularly plant-based additives [13]. Studies have shown that incorporating certain medicinal plants or their extracts into ruminant diets can enhance feed intake, improve feed efficiency and nutrient absorption, stimulate the digestive system, enhance carcass quality and reproductive performance, and reduce disease incidence [14]. Moreover, despite the higher cost and limited availability of organic products compared to conventional ones, consumers increasingly perceive them as more valuable and are willing to pay a premium for them [15]. Thus, the potential for alternative natural solutions, combined with strong consumer demand, can help balance production efficiency and economic viability. In this context, extensive small ruminant farming is considered a production method that is not very different from organic livestock principles and even shows many similarities. However, for products obtained from these animals to be recognized as organic, both the animals and the natural grazing areas they graze on must be certified.

Small ruminant farming is not only an important agricultural activity in Western Asia, North Africa, and Southern Europe, but it also holds economic, social, and environmental value [16,17]. Small ruminants play a crucial role in food security for people living in rural areas, especially landless and poor farmers in arid and semi-arid regions [18–20]. On the other hand, while cattle contribute to 62% of the livestock sector's emissions, small ruminants account for only 7.4% [21]. Grazing small ruminants on pastures helps reduce greenhouse gas emissions and increases soil fertility [22]. Pasture-based livestock farming contributes to carbon sequestration and biodiversity conservation [23].

In Türkiye, the geographical and socio-cultural landscape is highly conducive to the development of small ruminant farming [24] as a sustainable and organic agricultural model. With 76.8% of the ruminant population, amounting to 56.3 million head consisting of small ruminants [25], Türkiye holds significant potential for organic small ruminant production, particularly in regions like Eastern Anatolia and Southeastern Anatolia, where pasture resources are abundant and the use of chemical inputs is minimal [26,27].

Muş province is highlighted as a region where industrialization and urbanization are limited, allowing economic activities to be largely governed by natural conditions. In 2022, over half of its population (51.3%) lived in villages [28], mainly relying on pasture-based livestock farming. The province's meadows and pastures cover 49.7% of the total land area, well above the national average of 18.8% [29,30], providing an advantage for quality forage production. Muş also has a strong potential for forage crops, with 27.7% of cultivated fields dedicated to them compared to the national average of 15.5%. The province ranks fourth in alfalfa and sixth in sainfoin production [31]. Chemical fertilizers and pesticides

used in conventional agriculture have recently caused numerous environmental and water pollution problems [32]. One significant advantage of the province is that the use of chemical fertilizers and pesticides in agricultural areas is well below the national average. While the national average for chemical fertilizer use is 28.2 kg/da, it is only 7.5 kg/da in Muş [33]. Similarly, the national average for pesticide use is 264.9 g/da, whereas in Muş, it is 40.3 g/da [34]. These factors make Muş an ideal location for sustainable agricultural practices, emphasizing natural resource management and organic farming. According to the FAO, sustainable agriculture is built upon five key principles, which include increasing productivity, protecting natural resources, improving livelihoods, strengthening resilience, and ensuring adaptive governance [35]. Muş aligns well with these principles due to its limited industrialization, extensive pasturelands, low chemical input use, and strong forage production. Additionally, sustainable agriculture fosters economic stability by enhancing farmers' resilience to climate change [36] and supporting small-scale producers [37].

While previous studies have generally focused on the fundamental principles of organic livestock farming, this research investigates the suitability of the structural features of extensive small ruminant farming for the transition to organic production. In Türkiye, small ruminant farming in regions where native breeds are used and pastures serve as the primary feed source is conducted under conditions closely aligned with organic principles with minimal chemical input. However, studies assessing the potential and shortcomings of these regions remain limited.

Muş emerges as a promising region for this transition due to its extensive pasturelands, minimal chemical input use, strong transhumance traditions, and the adaptability of local breeds to organic livestock farming. While most research has focused on intensive or semi-intensive organic systems, this study examines how existing practices in extensive small ruminant farming can be aligned with organic principles and integrated into organic production.

Our hypothesis is that the extensive small ruminant farming model implemented in Muş, Türkiye, by utilizing local resources, minimizing chemical inputs, and employing natural breeding methods, can support the transition to organic livestock farming and contribute to sustainability. By examining the management practices and challenges of small-scale enterprises, the study aims to identify key strengths and areas for improvement in compliance with organic standards while also offering a framework applicable to regions with similar conditions.

The transition from conventional to organic livestock farming requires strategic planning, encompassing adjustments in production methods, farm management, farmer awareness, and sustainable resource use. In this context, this study proposes an approach that supports small-scale producers, promotes efficient resource utilization, and contributes to rural development. Beyond regional considerations, this study aims to develop a practical roadmap for farms operating under extensive small ruminant systems, ensuring broader applicability.

The Muş model provides a valuable framework for organic livestock farming; however, its success in other regions depends on factors such as geography, climate, and socio-economic conditions. To evaluate its broader applicability, future research should focus on key variables like pasture productivity, climate resilience, farmer adaptation capacity, and economic feasibility. Comparative studies across different regions with varying agro-ecological and socio-economic conditions will be essential to determine the broader relevance of this framework and to develop region-specific adaptation strategies that address local challenges and opportunities.

2. Materials and Methods

All aspects of this study were approved by the Scientific Research and Publication Ethics Committee of Muş Alparslan University (protocol number: E-10879717-050.01.04-9358, committee decision 5–12, approval date: 7 April 2021).

The research was conducted in Muş Province, located between the 38°28′45″ north latitude and 41°4′51″ east longitude, as well as the 39°33′22″ north latitude and 42°43′26″ east longitude in the eastern region of Türkiye.

Due to the continental climate in the province, winters are harsh, cold, and snowy, while summers are hot and dry. During the period from 1964 to 2023, the average temperature was measured at 9.8 °C, the average maximum temperature at 16.0 °C, and the average minimum temperature was 4.3 °C. In the same period, an average of 112.8 days per year were rainy, with an average annual total precipitation of 759.6 mm [38].

2.1. Data Collection and Sample Selection

The primary data for this study were obtained through face-to-face surveys conducted with small ruminant farmers across the six districts of Muş Province. This allowed for a validation of the consistency between breeders' responses and actual farm conditions, which helped assess the accuracy of the survey answers. Secondary data were sourced from the Food and Agriculture Organization (FAO), the Turkish Statistical Institute (TÜİK), and the Ministry of Agriculture and Forestry statistics. A stratified sampling method based on districts was employed to select the farmers for the survey, which collected information on the socio-demographic characteristics of the farmers and the structural features of their farming operations, including breeding, feeding, grazing, shelter, and health practices. The districts included in the study were selected using a stratified sampling method to ensure a representative sample of the region's agricultural characteristics. After the districts were identified, farmers were selected using a simple random sampling method from registered farmer lists provided by the district agricultural directorates, ensuring an unbiased selection process. The sample size was determined using simple random sampling, and the number of farms surveyed was calculated to be 364, with a 5% sampling error and a 95% confidence interval using the following formula [39]:

$$n = N \cdot t^2 \cdot p \cdot q / d^2 \cdot (N - 1) + t^2 \cdot p \cdot q \quad (1)$$

where n is the sample size, N is the population size, t is the t-table value at a 95% confidence level, p is the occurrence frequency (0.5), q is the non-occurrence frequency (0.5), and d is the sampling error.

2.2. Statistical Assessments

The data collected were analyzed using SPSS version 16 (SPSS Inc., Chicago, IL, USA) to create frequency tables and determine percentage distributions.

3. Results

3.1. Socio-Demographic Characteristics of Farmers

The socio-demographic characteristics of the farmers who participated in the survey are presented in Table 1. Of the farm owners surveyed, 8.5% were women and 91.5% were men. The majority of them (52.7%) were between the ages of 45 and 60, with 36.3% under the age of 45 and 11.0% over the age of 60. In 72.0% of the farmers surveyed, there were more than six family members. Half of the farmers surveyed (49.2%) had completed primary education, while 14.8% had attained education at the high school and university levels. Additionally, 78.8% of the farm owners had been engaged in livestock farming

for more than ten years, and 96.7% considered small ruminant farming their primary source of income. Furthermore, 62.1% reported not engaging in other livestock activities. The majority of farm owners, 64.8%, were members of a producer organization, while 35.2% were not. Additionally, 63.2% of farmers stated that they lacked knowledge about organic farming.

Table 1. Socio-demographic characteristics of farmers.

Variables	Response	Count	Percentage
Gender	Female	31	8.5
	Male	333	91.5
Age	≤30	29	8.0
	31–44	103	28.3
	45–60	192	52.7
	≥61	40	11.0
Number of family members	≤3	8	2.2
	4–6	94	25.8
	7–10	187	51.4
	≥11	75	20.6
Education level	Illiterate	40	11.0
	Literate (no diploma)	91	25.0
	Primary school	179	49.2
	High school	44	12.1
	University	10	2.7
Farming experience (year)	≤10	77	21.2
	11–20	112	30.8
	21–30	81	22.3
	31–40	46	12.6
	≥41	48	13.1
Purpose of small ruminant farming	Main source of income	352	96.7
	Enjoyment	8	2.2
	Additional income	4	1.1
Other livestock activities	Yes	138	37.9
	No	226	62.1
Membership in producer organization	Yes	236	64.8
	No	128	35.2
Level of knowledge about organic farming	Knowledgeable	134	36.8
	Not knowledgeable	230	63.2

3.2. Animal Stock and Management Practices in Farms

The results on animal stock and management practices in the surveyed farms are presented in Table 2. The majority of farms raised sheep and goats together (50.3%), while only 9.3% combined sheep with cattle. Most sheep stocks were in the range of 101–300 heads (50.5%), whereas goat stocks predominantly ranged from 26 to 50 heads (40.1%). There was a significant decrease in animal populations over the last five years (79.4%), primarily due to a decrease in income (57.4%). Among sheep genotypes, Morkaraman was the most common (53.8%), and the Hair Goat was the exclusive goat genotype raised.

Table 2. Animal stock and management practices in farms.

Variables	Response	Count	Percentage
Animal species on the farm	Sheep	123	33.8
	Sheep + Goat	183	50.3
	Sheep + Cattle	34	9.3
	Sheep + Goat + Cattle	24	6.6
Sheep stock (head)	≤100	93	25.5
	101–300	184	50.5
	301–500	57	15.7
	501–1000	30	8.3
Goat stock (head)	≤25	75	36.2
	26–50	83	40.1
	51–75	25	12.1
	76–100	24	11.6
Change in animal stock over the last five years	Increased	75	20.6
	Decreased	289	79.4
Reason for decrease in animal stock	Lack of shepherds	78	27.0
	Decreased income	166	57.4
	Insufficient support	45	15.6
Sheep genotypes raised	Morkaraman	196	53.8
	Akkaraman	75	20.7
	Morkaraman + Akkaraman	93	25.5
Goat genotypes raised	Hair goat	207	100.0
Breeding system	Transhumance	23	6.3
	Sedentary farming	108	29.7
	Sedentary farming + Transhumance	233	64.0
Mating/insemination method applied	Free mating	332	91.2
	Hand mating	32	8.8
Milking duration in sheep (months)	No milking	47	12.9
	1–2 months	50	13.7
	3–5 months	267	73.4
Milking duration in goats (months)	No milking	22	10.6
	1–2 months	28	13.5
	3–5 months	157	75.9
Castration in lambs	Performed	7	1.9
	Not performed	357	98.1
Castration in goats	Performed	7	3.4
	Not performed	200	96.6
Tail docking in lambs	Performed	24	6.6
	Not performed	340	93.4
Tail docking in goats	Performed	5	2.4
	Not performed	202	97.6
Dehorning in lambs	Performed	41	11.3
	Not performed	323	88.7
Dehorning in goats	Performed	18	8.7
	Not performed	189	91.3
Record-keeping in farms	Performed	107	29.4
	Not performed	257	70.6

The most common breeding system was a combination of sedentary farming and transhumance methods, used by 64.0% of the farms. Free mating was overwhelmingly the most common method at 91.2%, indicating a preference for natural breeding processes. Hand mating was less common, used by 8.8% of farms. In sheep, the majority were milked for 3–5 months (73.4%); similarly, goats were predominantly milked for 3–5 months (75.9%). Castration, tail docking, and dehorning practices were generally not widely performed. For instance, castration was performed in only 1.9% of lambs and 3.4% of kids.

Tail docking was performed on 6.6% of lambs and 2.4% of kids. Dehorning was somewhat more common in lambs (11.3%) compared to kids (8.7%). Only 29.4% of enterprises kept records, while 70.6% did not maintain any records.

3.3. Characteristics of Shelters on Farms

The characteristics of shelters on farms are presented in Table 3. On farms, 79.9% of the shelters were constructed independently of the house, and 92.9% were of the closed type. Although 89.0% of the shelters had windows or chimneys, 86.0% were reported to have had inadequate ventilation. Additionally, 50.5% of the shelters had roofs covered with sheet metal, while 34.6% had earthen roofs. The floors of 69.8% of the shelters were made of earth, while 23.6% were concrete. Furthermore, bedding materials were not used in 68.1% of the shelters.

Table 3. Characteristics of shelters on farms.

Variables	Response	Count	Percentage
Shelter's location	Under the house	34	9.4
	Courtyard	39	10.7
	Independent	291	79.9
Shelter type	Open	0	0.0
	Semi-open	26	7.1
	Closed	338	92.9
Shelter with chimney/windows	Present	324	89.0
	Absent	40	11.0
Shelter ventilation	Adequate	51	86.0
	Inadequate	313	14.0
Shelter roof material	Tile	19	5.2
	Metal Sheet	184	50.5
	Wood	25	6.9
	Nylon	10	2.7
	Earthen roof	126	34.6
Shelter floor	Earth	254	69.8
	Stone	24	6.6
	Concrete	86	23.6
Bedding use	Yes	116	31.9
	No	248	68.1

3.4. Pasture Management and Feed Production on Farms

Pasture management and feed production practices on farms are presented in Table 4. The majority of farms, 78.3%, utilized the pasture for more than 5 months annually, with 60.2% of them grazing for 9–16 h daily. A large proportion of farms (87.4%) continuously use the same pasture, and the most common practice (75.0%) is grazing sheep, goats, and cattle together on it. On the other hand, 81.9% of farms described the pasture they used as moderate or poor quality. In contrast, only 20.3% of farms provided supplementary feeding

during the grazing period. Field crop cultivation was practiced by nearly half of the farms (47.8%), and a majority (74.7%) of farms did not use chemical fertilizers and pesticides. In most of the farms (73.9%), forage production was not carried out. The most produced forages were grass hay (37.9%), cereal straws (31.9%), and alfalfa hay (16.5%). Similarly to forages, only 21.7% of the farms produced concentrate feed, with the most produced concentrate feed being barley (54.4%) and wheat (31.9%).

Table 4. Pasture management and feed production on farms.

Variables	Response	Count	Percentage
Grazing duration within the year (months)	≤4	79	21.7
	5–8	269	73.9
	≥9	16	4.4
Daily grazing duration (hours)	≤8	24	6.6
	9–16	219	60.2
	≥17	121	33.2
Use of the same pasture continuously	Yes	318	87.4
	No	46	12.6
Species of animals grazing in the same pasture	Sheep	46	12.6
	Sheep + goat	30	8.3
	Sheep + cattle	15	4.1
	Sheep + goat + cattle	273	75.0
Pasture quality	Poor	106	29.2
	Medium	192	52.7
	Good	66	18.1
Supplementary feeding during grazing period	Provided	74	20.3
	Not provided	290	79.7
Cultivation of field crops	Yes	174	47.8
	No	190	52.2
Use of chemical fertilizers and pesticides	Yes	44	25.3
	No	130	74.7
Forage production	Producing	95	26.1
	Not producing	269	73.9
Most produced forage	Grass hay	36	37.9
	Cereal straw	30	31.9
	Alfalfa	16	16.5
	Other	13	13.7
Concentrate feed production	Producing	79	21,7
	Not producing	285	78.3
Most produced concentrate feed	Barley	43	54.4
	Wheat	25	31.9
	Other	11	13.7

3.5. Feeding Practices on Farms

The results related to feeding practices implemented on farms are given in Table 5. The majority of lambs, at 84.6%, and a significant portion of kids, at 56.0%, received colostrum feeding for 3 days or more. Most lambs and kids experienced milk suckling for more than 3 weeks, with 84.6% of lambs and 87.4% of kids having suckled for this duration, while only a small proportion suckled for 2 weeks or less. Nearly half of the lambs and many of the kids started receiving supplementary feed from the first week of suckling, whereas 38.5% of lambs and 37.2% of kids were not fed supplementary feed during the suckling period at

all. More than half of the ewes were not provided with supplementary concentrate feed, while 38.5% received it after giving birth, and similar practices were observed with goats, where 44.0% received concentrate feed after birth. Most farmers did not use mixed feed or feed additives in their feeding practices. In fact, no use of feed additives was reported at all.

Table 5. Feeding practices on farms.

Variables	Response	Count	Percentage
Duration of colostrum feeding for lambs (days)	<3	56	15.4
	3	278	76.4
	>3	30	8.2
Duration of colostrum feeding for kids (days)	<3	91	44.0
	3	77	37.2
	>3	39	18.8
Duration of milk suckling for lambs (weeks)	≤2	56	15.4
	3–5	264	72.5
	≥6	44	12.1
Duration of milk suckling for kids (weeks)	≤2	26	12.6
	3–5	169	81.6
	≥6	12	5.8
Supplementary feeding during milk suckling for lambs	Not feeding	140	38.5
	Feeding from first week	174	47.8
	Feeding from second week	22	6.0
	Feeding from third week	21	5.8
	Feeding from fourth week	7	1.9
Supplementary feeding during milk suckling for kids	Not feeding	77	37.2
	Feeding from first week	94	45.4
	Feeding from second week	25	12.1
	Feeding from third week	9	4.3
	Feeding from fourth week	2	1.0
Supplementary concentrate feed for ewes	Not feeding	224	61.5
	Feeding after birth	140	38.5
Supplementary concentrate feed for goats	Not feeding	116	56.0
	Feeding after birth	91	44.0
Use of mixed feed	Using	51	14.0
	Not using	313	86.0
Use of feed additives	Using	0	0.0
	Not using	364	100.0

3.6. Health Care on Farms

The results of health care on farms are given in Table 6. A majority of farms adhered to the government-mandated vaccination schedule, with 79.9% of respondents reporting compliance. Foot baths were not commonly available, as only 17.3% of farms had them; among these, 60.3% provided foot baths for the entire herd, while 39.7% provided them only for sick animals. Bathing animals was largely neglected, with 70.3% of farms not performing it at all, while 15.4% did so before shearing and 14.3% did so after shearing.

Table 6. Health care on farms.

Variables	Response	Count	Percentage
Compliance with vaccination schedule	Compliant	291	79.9
	Non-compliant	73	20.1
Foot bath in the farms	Available	63	17.3
	Not available	301	82.7
Animals receiving foot baths	For the entire herd	38	60.3
	For sick animals	25	39.7
Bath time for animals	Not performed	256	70.3
	Before shearing	56	15.4
	After shearing	52	14.3
Internal and external parasite control	Performed	303	83.2
	Not performed	61	16.8
Season of parasite control	Spring	131	43.2
	Summer	16	5.3
	Autumn	77	25.4
	Winter	24	7.9
	Spring + autumn	55	18.2
Method of parasite control	Medication	83	27.4
	Injection	13	4.3
	Medication + injection	207	68.3
Disinfection practice in shelter	Performed	206	56.6
	Not performed	158	43.4
Frequency of disinfection per year	Once	76	36.9
	Twice	130	63.1
Hoof inspection for the herd	Performed	202	55.5
	Not performed	162	44.5
Lameness problem in the herd	Occurs	299	82.1
	Does not occur	65	17.9
Animals most affected by lameness	Adults	179	59.8
	Young animals	25	8.4
	Adults + young animals	95	31.8
Season lameness occurs most	Spring	130	43.5
	Summer	56	18.7
	Autumn	36	12.0
	Winter	44	14.7
	Spring + autumn	33	11.1
Removal of lame animals from the herd	Not removed	203	67.9
	Removed immediately	96	32.1
Treatment method for foot problems	Antibiotics	135	45.2
	Vaccine	91	30.4
	Antibiotics + vaccine	73	24.4

A high percentage of farms, 83.2%, performed internal and external parasite control. Most parasite control took place in spring (43.2%), with a notable amount also performed in autumn and during a combination of spring and autumn. The most common method for parasite control involved a combination of medication and injection, accounting for 68.3%. Disinfection was carried out by 56.6% of farms, with many performing it twice a year. Slightly more than half of the farms, 55.5%, performed hoof inspections, yet lameness was a common issue, occurring in 82.1% of herds. Lameness was most prevalent

among adult animals, affecting 59.8%, and during the spring season, occurring in 43.5% of cases, but 67.9% of farms did not remove animals experiencing this issue from the herd. Antibiotics were used by 45.2% of farms to treat foot problems, with some using vaccines or a combination of both.

4. Discussion

4.1. Socio-Demographic Characteristics of Farmers

The predominance of male farm owners can be attributed to traditional views that position men as primary breadwinners and the heads of households [40]. Increasing women's participation in agricultural production could promote gender equality and improve the sustainability of the organic livestock sector. To achieve this, educational and entrepreneurship programs specifically targeted at women should be developed.

The age distribution of farmers plays a crucial role in adopting new practices and ensuring the sustainability of agricultural enterprises, particularly in the transition to organic livestock farming. With 52.7% of farmers aged 45–60 and 36.3% under 45, the Muş region exhibits a relatively young farmer profile (Table 1). This demographic composition could facilitate the adoption of innovative practices like organic farming. In comparison to the European Union and the United States, where only 11% of farmers are under 40 [41], Muş stands out with its younger farming population. The younger age profile of farmers in Muş may be advantageous for transitioning to organic livestock farming. Younger farmers generally have better access to information and are more adaptable to new technologies and practices essential for organic farming [42]. This demographic advantage can facilitate the dissemination and adoption of organic farming techniques, thus supporting sustainable agricultural development. Organic farming often requires more labor-intensive practices, such as manual weeding, crop rotations, and organic fertilization. Farmers in the 45–60 age range, while experienced, may face challenges in meeting these physical demands compared to their younger counterparts. Younger farmers are generally better suited to handle physically demanding tasks such as feed preparation, barn cleaning, animal health maintenance, and milking, which are critical for small-scale organic farming operations [43]. The transition of agricultural responsibilities from the aging farmer population to younger generations is crucial for the long-term sustainability of farming enterprises. The capacity of younger farmers to adopt and innovate organic practices supports the continuity and resilience of small-scale farms, which are integral to maintaining ecological balance and biodiversity. While a younger farming population presents opportunities for growth and innovation in organic farming, challenges remain. Access to resources, training, and financial support are essential to enable these farmers to implement organic practices successfully. Policy support is also needed to facilitate this transition, ensuring that young farmers are equipped with the necessary tools and knowledge.

Having more than six family members in 72% of the surveyed farms can provide an advantage for family-run farms, particularly in labor-intensive systems such as organic farming [44,45]. Since organic farming requires more manual labor compared to conventional farming, large family structures can meet this labor demand within the family. Globally, family members actively participate in agricultural activities across many rural areas. In developing countries, utilizing family labor can help reduce operational costs. However, the issue of child labor must be addressed. It is crucial to develop policies that ensure children's access to education and prevent child labor in agricultural contexts worldwide.

Most surveyed farmers had only received primary education, with only a small portion having completed high school or university, indicating a generally low level of formal education (Table 1). Formal education significantly impacts farmers' knowledge and awareness, enhancing their reasoning and critical thinking skills [46]. As education improves the

ability to adopt innovations and new technologies [47], more educated farmers are better prepared to embrace practices such as organic farming. This educational foundation is crucial for evaluating and understanding the standards of organic livestock farming and making informed decisions regarding new technologies and alternative methods [48].

The majority of farm owners had substantial experience in animal husbandry, having been involved in the industry for over a decade (Table 1). This extensive experience positions them well for transitioning to organic livestock farming, which requires a thorough understanding of sustainable practices and animal welfare. Small ruminant farming was the primary source of livelihood for nearly all of these farmers, and a significant portion did not diversify into other livestock activities (Table 1), indicating a focused specialization that may facilitate the implementation of organic standards. According to Andarwati et al. [47], such experience is crucial for business development and income growth, playing a pivotal role in the success of farming operations. Hidayah et al. [49] suggest that experienced farmers can more readily analyze and implement innovations during decision-making processes. Additionally, those with ample experience tend to be more cautious, applying valuable lessons from their past experiences.

The findings indicated that 64.8% of farmers were members of a producer organization (Table 1). While this rate is a positive starting point for transitioning to organic livestock farming, it may be insufficient to achieve broader success on a global scale. The culture of organization is essential in organic livestock farming, as small family farms can only overcome scale-related challenges through effective organization. Farmers who are members of a producer organization have more opportunities for learning and interacting with other farmers. This membership enhances members' skills in developing independent and sustainable enterprises, facilitates problem-solving among members, and eases the provision of training and advisory services [50].

The finding that 63.2% of farmers lacked knowledge about organic farming highlights a significant barrier to the adoption of organic livestock practices. Limited awareness and understanding of organic principles can hinder farmers from transitioning to organic systems, as they may be unaware of certification requirements, sustainable feeding practices, or alternative health management strategies. This knowledge gap underscores the need for comprehensive training programs and extension services tailored to small-scale livestock farmers.

4.2. Animal Stock and Management Practices in Farms

In this study, 66.2% of farms raised different species together, with sheep and goats being the most common combination at 50.3% (Table 2). Raising diverse species on the same farm can enhance biodiversity [51,52] and make use of the natural grazing habits of each species [53], providing cross-protection against certain diseases [54]. This diversity also improves resilience to market and environmental fluctuations, offering farmers diversified income sources. However, managing multiple species requires careful planning to address their distinct nutritional, health, and space needs. García-Dios et al. [55] indicate that managing sheep and goats together can lead to the accumulation of parasites in pastures, which can then spread to other animals. Successfully integrating different species into an organic system may require additional training and infrastructure adjustments to meet organic standards for animal welfare and environmental impact. The complexity of managing diverse species can also complicate organic certification, posing challenges for compliance and auditing processes. The fact that 76.0% of farms had sheep stocks below 300 head and 94.7% had goat stocks below 100 head indicates that small family farming was prevalent (Table 2). Research suggests that small-scale farms often exhibit higher efficiency [56], and organic systems have the potential to provide better livelihoods

and social benefits for farmers with limited resources [45,57]. The decrease in animal stock reported by 79.4% of farms, primarily due to reduced income (57.4%), lack of shepherds (27.0%), and insufficient support (15.6%), highlighted significant challenges. Economic instability and labor shortages are key barriers to adopting organic practices. These findings align with other studies conducted in Eastern Anatolia, which indicate that economic decline, migration, and shepherd shortages were major reasons for abandoning livestock farming [58]. Training and awareness programs on organic livestock farming can help farmers better understand the advantages of organic agriculture and facilitate their transition to these practices. Additionally, increasing government support for organic systems can prevent farmers from abandoning livestock farming and contribute to the development of a sustainable agricultural model.

The widespread use of Morkaraman and Akkaraman breeds, which are well-suited to local conditions, highlights the importance of utilizing indigenous genetic resources. These breeds are highly adapted to long and cold winters and can efficiently utilize pastures with poor vegetation. Additionally, the exclusive use of Hair Goats, which thrive in diverse climatic and terrain conditions, reflects the adaptability of local livestock. In organic livestock farming, it is essential to use breeds that are highly adaptable to local conditions and resistant to diseases [59]. Indigenous breeds generally adapt well to local environments, and consumers tend to prefer products from local breeds. Using indigenous breeds in organic livestock farming also contributes to the preservation of local genetic resources [60]. The study revealed that a significant portion of farms practiced transhumance. Many farms provided flexibility in their livestock systems by combining highland grazing and sedentary farming rather than relying solely on transhumance. The small ruminant herds in the province are taken to cool, grassy highlands at the beginning of summer, when heat and drought become prevalent in the plains. They remain there for about 5–6 months before returning to their villages in the fall as the weather cools down. In organic farming, maintaining soil health and biodiversity is essential [61,62], and these practices contribute to environmental sustainability by promoting the use of natural resources. Furthermore, reducing heat stress and optimizing grazing environments enhances animal welfare and productivity [11], thereby strengthening the core components of organic livestock farming. The practice of natural mating in 91.2% of farms (Table 2) aligns with organic farming principles, which prefer natural reproduction methods. While artificial insemination is permitted, other artificial reproduction methods, such as cloning and embryo transfer, are prohibited in organic systems [59]. Most farms milked their sheep and goats for 3–5 months, aligning with the natural lactation cycles of these animals (Table 2). This practice is significant, as the lactation period for indigenous sheep and goat breeds generally ranges between 3 and 5 months [63]. Supporting these natural processes and ensuring continuity in milk production in organic livestock farming aligns with the principles of animal welfare and naturalness, providing a considerable advantage. The surveyed farms performed procedures such as castration, tail docking, and dehorning only minimally. Organic farming allows such procedures only when they enhance safety, animal health, welfare, and product quality, and they must be performed in a way that minimizes stress and pain [59]. The minimal application of these practices in the region indicated a favorable condition for transitioning to organic livestock farming. However, only 29.4% of farms kept records on reproduction, productivity, and health, which poses a challenge during the transition to organic farming. Organic systems require comprehensive documentation to ensure traceability and compliance with standards [59]. Improving record-keeping practices will be crucial for a successful transition.

4.3. Characteristics of Shelters on Farms

In the age of climate change and global warming, constructing shelters for small livestock requires a consideration of behavioral and physiological changes in animals, as well as ventilation levels, temperature–humidity ratios, and wind flow speed and direction within the shelter [64]. The majority of shelters on farms were positioned as independent structures rather than being situated under the house or within the courtyard (Table 3). Positioning shelters independently allows for greater flexibility in farm layout and provides opportunities for customization and expansion. As organic farming activities grow, these shelters can be adapted and expanded without disrupting other farm operations. Enclosed shelters were generally preferred on farms to provide better protection against weather conditions. Semi-open shelters were uncommon, while open shelters were not used at all. However, in regions where the climate is suitable for animals to live outdoors, open or semi-open shelters can be viable options for organic farming. Although most shelters had chimneys or windows, many still faced ventilation issues. In organic livestock farming, it is desirable for shelters to allow ample natural ventilation and light [59]. Ventilation plays a crucial role in maintaining the welfare and performance of housed animals by influencing heat exchange between the body surface and the environment, preventing excessive increases in relative humidity, and controlling harmful gas levels [64]. Metal sheets were the most commonly used roofing material in farm shelters due to their durability. However, many shelters used earthen roofs and floors, reflecting a reliance on traditional or locally available materials. Additionally, the lack of bedding materials in many shelters may have negatively impacted animal welfare. In a separate study conducted in Muş, it was determined that the vast majority of shelters were low, poorly ventilated, and had inadequate flooring [65]. Nationwide in Türkiye, a significant portion of shelters are inadequate in terms of animal welfare, with most earthen floors quickly degrading and causing serious health problems [24]. Therefore, the unfavorable shelter conditions identified in this study could negatively impact animal welfare according to the standards defined for organic livestock farming, underscoring the need for improvements in this area.

4.4. Pasture Management and Feed Production on Farms

The efficient use of permanent pastures is crucial for enhancing the profitability of livestock enterprises, as feed expenses constitute around 70% of total production costs [66]. In Muş province, small ruminant farming is generally entirely dependent on pastures, as evidenced by this study's finding that 78.3% of farms grazed their animals on pastures for more than five months (Table 4). Organic livestock farming is primarily based on pasture use. According to the United States National Organic Program (NOP), organically raised animals must remain on pasture during their region's grazing season, which must be at least 120 days [67]. The results of this study indicated that a significant portion of the animal population grazed for extended periods each day, with 60.2% grazing for 9–16 h and 33.2% grazing for 17 h or more. Such extended grazing durations not only promote animal welfare but also align with organic standards, facilitating the transition to organic livestock farming by reducing the need for purchased feed.

According to the results of this study, the majority of farms continuously used the same pasture (Table 4), which can lead to soil degradation and reduced plant diversity, ultimately decreasing the pasture's nutritional quality. Grazing the same pasture continuously can negatively impact sensitive ecosystems and species, making it challenging to manage the intensity and timing of grazing to mitigate these effects [68–70]. Unlike intensive systems, ecological approaches require more grazing land per animal, which can alter land use patterns [71]. However, rotational grazing—moving small ruminants between different paddocks—supports pasture recovery and reduces the risk of overgrazing [72,73]. This

technique enhances grazing efficiency while improving soil health and biodiversity [74,75]. To ensure pasture sustainability, it is essential to adopt rotational grazing systems. In this context, educating farmers on rotational grazing practices and raising awareness about the economic and environmental benefits of these practices is crucial.

The research results indicated that on 87.4% of farms, the most common practice was grazing sheep with goats and cattle. Incorporating goats or sheep with cattle in agricultural systems through rotational grazing can improve pasture biodiversity and enhance the nutritional quality of forage, reducing the risk of parasite and pathogen infestations [76].

The majority of pastures (81.9%) being classified as low to medium quality was a result of intensive grazing (Table 4). Low-quality pastures negatively impact animal health and productivity and increase the need for supplementary feed. However, 79.7% of farms did not provide supplementary feed during the grazing period, highlighting their reliance on pastures. Small ruminants can be raised in feeding systems based on low-cost resources like permanent pastures and rangelands; however, the limitations of pasture-based feeding, such as the need for large areas and variability in feed quantity and quality, should not be overlooked [77]. In developed countries, organic farming regulations increasingly mandate that animals be raised on pastures and impose stricter requirements for pasture quality. For instance, European Union regulations specify that pastures must meet the natural dietary and behavioral needs of specific animal species [78].

One of the fundamental principles of organic animal husbandry is soil-based production [47]. Integrating livestock into crop cultivation systems is an effective approach that enhances environmental sustainability while optimizing natural resource use. Small ruminants can consume residues and byproducts from crop production systems to produce animal protein for human consumption. In this system, animal manure is used to fertilize agricultural lands and pastures, closing the nutrient loop and reducing the need for synthetic fertilizers [79]. Integrated crop–livestock systems also provide additional benefits, such as weed control through grazing, which reduces the need for soil tillage [80]. Approximately half of the surveyed farm owners engaged in both small ruminant husbandry and field crop cultivation, and in line with organic farming principles, the majority did not use chemical fertilizers or pesticides (Table 4). In Muş province, the use of chemicals in agricultural areas is very low, with fertilizer use being one-fourth and pesticide use being one-seventh of the Turkish average. Regions with natural pastures, such as Eastern Anatolia, which remain unpolluted due to the absence of chemicals for improvement and maintenance, hold significant importance for organic livestock farming [27]. In Muş province, animal feeding largely relies on natural pastures, grass hay, and straw, with summer grazing on cereal stubble such as wheat and barley. The majority of farms (73.9%) did not produce forage; among those that did, grass hay, cereal straw, and alfalfa were the most commonly produced forages. Similarly, a large percentage of farms (78.3%) did not produce concentrate feed, with barley and wheat being the most produced concentrates among those that did. The use of farm-produced feed and byproducts in feed recycling for small ruminant systems is an essential aspect of organic agriculture. This method reduces dependence on purchased feed by utilizing farm and local waste as animal feed. As a result, it promotes closed nutrient cycles, reduces waste, and enhances farm efficiency [79]. This approach also lowers costs for farmers and increases resilience to market and climate fluctuations. Additionally, organic livestock regulations mandate that animals must be fed organically produced feed, ideally sourced from the farm itself [81].

Given the limitations of pasture-based feeding in small ruminant farming, sustainable practices like on-farm feed production and rotational grazing are essential. Promoting the cultivation of forage crops on existing agricultural lands can reduce overgrazing and improve animal nutrition, aligning with organic farming principles. Additionally, inte-

grated systems like agroforestry and silvopasture offer additional feed sources, prevent soil erosion, and build resilience against climate change [82,83]. Educating farmers on these sustainable practices and their economic and environmental benefits is crucial.

4.5. Feeding Practices on Farms

Colostrum is a very important and nutritious food due to its rich nutrient content and should be an integral part of the feeding regimen for newborn animals. The relationship between colostrum, which plays a crucial role in the immunity of newborn lambs and kids, and their survival has long been recognized [84]. Additionally, in organic livestock farming, young animals should primarily be fed maternal milk. This period must last at least 45 days for small ruminants [85]. This study determined that all farms provided colostrum to the young animals, with 84.6% of sheep farms and 56.0% of goat farms administering it for three days or more. The milk-suckling period was longer than three months in 84.6% of sheep farms and 87.4% of goat farms (Table 5). These results indicated that the practices of farm owners in raising lambs and kids were compliant with organic livestock standards. The most important physiological factor in lambs and kids is the development of the rumen. Feeding young animals with solid feed at an early age stimulates the morphological development of the rumen, such as muscle formation, papillae growth, and microbial colonization [86]. This is crucial for the healthy growth of animals in organic farming, where animals are primarily fed on roughage after weaning. In line with these principles, this research determined that supplementary feeding during the milk-suckling period generally began early, with 47.8% of lambs and 45.4% of kids starting to be fed from the first week onward. This early feeding likely supports rumen development and facilitates a smoother transition to roughage feeding later on.

Although the proportion of farmers providing supplementary feeding after birth was 38.5% for ewes and 44% for goats, the study found that the majority did not provide supplementary feeding, and that mixed feed was not used on 86% of the farms (Table 5). This suggests that farmers relied heavily on pasture-based feeding. Indigenous breeds such as the Morkaraman, Akkaraman, and Hair Goat, which are common in the region, can generally meet their nutritional needs from the limited resources provided by poor pastures [87]. However, such reliance may limit production during periods of high nutritional demand, such as lactation and growth, leading to nutritional deficiencies [88]. Therefore, feed supplements are necessary during these critical periods. In late pregnancy, the combination of rapidly growing fetuses and the physical bulk of roughage, which limits feed intake, creates a challenge in maintaining nutritional balance for animals in pasture-based organic production systems. Seasonal fluctuations in nutrient availability can also restrict production during periods of high nutritional demand, such as lactation and growth. Developing better feeding strategies to address these challenges can enhance disease resistance, support internal parasite control, and improve reproductive performance. In organic production, legal restrictions, including limitations on concentrates and the requirement that rations be 100% organic, make the production of protein-rich organic roughage unavoidable. At least 60% of the dry matter in daily rations for herbivores must consist of roughage [89,90].

Additionally, none of the farms used feed additives; this may help farms comply with the restrictions on feed additives under organic farming standards. In organic production, the limited use of feed additives should motivate farmers to discover more creative and effective feeding methods. Escribano [91] stated that in organic farming, there is growing interest in proteinated or chelated trace minerals, as well as in various feed additives such as probiotics, dicarboxylic acids, plant extracts, tannins, saponins, essential oils, and

enzymes. In fact, a well-formulated diet reduces dependence on feed additives in organic livestock farming.

4.6. Health Care on Farms

In this study, it was determined that nearly 80% of farms administered mandatory vaccines, which are only allowed under animal disease and pest control programs in organic livestock farming [59]. The government-mandated vaccination program is in compliance with organic farming principles, ensuring that preventive health measures align with certification standards. This reflects a high level of awareness and adherence to preventive health measures by most farmers. However, the limited availability of foot baths, with only 17.3% of farms providing this facility, indicates a significant gap in hoof care management. Moreover, even among farms that have foot baths, only 60.3% administer them to the entire herd, potentially compromising overall herd health. Furthermore, the timing of these baths raises further concerns; on most farms, this practice is not performed at all (Table 6). In general, there is a lack of knowledge among farmers about the direct impact of hoof health on animal performance. Educating farmers about simple yet essential preventive health practices, such as the importance of foot baths, through veterinarians and organizing training sessions on these topics could help raise awareness and make these practices a routine part of herd management.

Parasites are an important factor that can significantly reduce productivity and limit animal welfare, particularly by decreasing feed intake in grazing animals [92]. In organic livestock farming, it is essential to use alternative natural methods for parasite control and to minimize the use of chemical treatments, as the use of synthetic antiparasitic drugs is strictly regulated [93,94]. However, based on this research, it was determined that in the majority of farms, parasite control practices were generally carried out in the spring and autumn, and this control was largely performed using chemical treatments. In organic farming, antiparasitic treatments are only permitted under certain conditions. For instance, when preventive measures fail due to uncontrollable factors such as climatic conditions, a veterinarian conducts the necessary assessments. Additionally, a written protocol is prepared, specifying the product and method to be used, including measures to prevent the development of parasite resistance, such as the rotation of parasiticides. For several reasons, it is more difficult to apply parasite control on organic than on conventional farms. The main reason is that the routine use of antiparasitics is restricted. Moreover, there may be a longer grazing season on organic than on conventional farms. This will diminish possibilities for control through grazing management. In organic small ruminant farming, effective parasite control relies on a combination of strategies. Regular pasture rotation significantly reduces nematode larvae in grazing areas, thereby lowering the parasitic load on the animals [95]. Cabaret et al. [93] reported that the use of uninfected pastures for lambs after weaning is one of the major components of helminth control. Another effective practice is alternating grazing between cattle and small ruminants, which has been shown to reduce gastrointestinal nematode burdens [96]. Additionally, providing access to multispecies forages containing bioactive compounds enables animals to engage in self-medication behavior, enhancing their resilience to parasitic infections [97,98]. Kidane et al. [99] and Marie-Magdeleine et al. [100] reported that the addition of bioactive plants such as chicory or tannin-rich species into the diet has been shown to support animal health and reduce dependency on chemical treatments. Cabaret et al. [95] reported that grazing certain leguminous forages and herbs may reduce parasitic infestation in sheep, because high-protein feed such as legumes enhances immunity and improves the resistance and resilience of hosts against endoparasites and diseases. According to Lu [88], protein intake, legumes, and secondary plant compounds offer effective alternatives to chemotherapy,

which is no longer allowed in organic goat farming. Secondary plant compounds, such as tannins, are associated with the effective prevention, control, and treatment of diseases by bioactive plants [88,101,102]. Particularly for internal parasites, the natural components of these plants have the potential to offer a cheaper and environmentally friendly alternative to chemical anthelmintics. Alternative treatments, such as those based on phytotherapy or homeopathy, are widely recommended in organic farming [93]. Hoste et al. [103] reported a number of bioactive plants, such as sainfoin, (*Onobrychis viciifolia*), sulla (*Hedysarium coronarium*), birdsfoot trefoil (*Lotus corniculatus*), maku (*Lotus pedunculatus*), chicory (*Cichorium intybus*), that could prove useful for disease control and treatment. These plants are commonly found in the pastures where the present study was conducted, and they may be promising in the prevention, control, and treatment of parasites and diseases in organic production. Additionally, shepherds in the region are familiar with and frequently use various anthelmintic herbs for this purpose.

Disinfection practices and hoof inspections were carried out on over half of the farms, but the varying frequency of disinfection may have reduced its effectiveness. The disinfection of shelters across Turkey generally takes place at the beginning and end of the grazing season, which depends on climate conditions and when the animals are not present in the shelters. Similarly, in organic livestock farming, disinfection is also carried out when the shelters are empty, and the disinfectants used, as well as the duration of shelter closure, must comply with regulations [59]. Foot diseases are a common issue in small ruminant farming, leading to decreased productivity and significant economic losses. Hoof abscess is an inflammatory lameness condition that affects one or more parts of the hoof in animals [104]. Lameness was a common issue, particularly affecting adult animals, and was most frequent in the spring. This emphasizes the need for improved seasonal interventions and hoof care strategies. Despite the prevalence of lameness, the study found that many affected animals were not immediately removed from the herd. When treatment was administered, antibiotics were most commonly used, often combined with vaccines. In organic livestock farming, the reduction in antibiotic use is a key principle. Organic farming regulations emphasize preventive health management to minimize the incidence of lameness through non-chemical approaches. These include proper pasture management to reduce muddy conditions, rotational grazing to limit prolonged exposure to wet areas, and maintaining dry and clean housing environments. Additionally, regular hoof inspections and natural treatments such as herbal foot baths and essential oils are recommended as alternatives to conventional antibiotics. This necessitates the development of more effective and targeted alternative or supportive treatments for bacterial diseases. Traditional and alternative medicine approaches show promise in preventing and treating animal diseases within this context. The study highlights a gap in the implementation of these organic management strategies, as only 17.3% of farms had foot baths and routine hoof inspections were not consistently conducted. The data suggest that more consistent and comprehensive practices are needed across farms to address hoof health and lameness issues. Developing these practices in line with organic production standards could significantly improve animal welfare and productivity.

In organic livestock farming, unlike conventional systems, chemical treatments (chemotherapy) cannot be used for the prevention, control, and treatment of health issues. Instead, natural substances or the animal's innate immune system are employed to combat parasite infestations and diseases. Nutritional manipulation is one of the most effective methods to reduce reliance on traditional chemotherapy for disease control. For example, incorporating legumes, with their high protein content, anthelmintic properties due to secondary compounds, and suitability for grazing, in management strategies plays a crucial role in controlling internal parasites and diseases. Lu et al. [88] defined these strate-

gies as prevention (moving parasite-free animals to clean pastures), avoidance (moving animals from infested pastures to clean ones to avoid the threat of worms), and dilution (reducing the pasture infection level to mitigate the threat of worms).

5. Conclusions

This study identified several important practices and challenges in managing extensive small ruminants on farms, highlighting both strengths and areas needing improvement regarding compliance with organic livestock standards. The findings suggest that the Muş model provides a strong foundation for transitioning to organic small ruminant farming and offers a framework that could be applied in similar regions.

Small ruminant farming in Muş province holds significant potential for facilitating this transition, particularly due to the use of locally adapted resources such as indigenous sheep and goat breeds and the reliance on natural grazing lands free from chemical inputs like fertilizers and pesticides. Furthermore, the region's practice of using natural reproduction methods and avoiding interventions such as dehorning or tail docking aligns with organic farming principles. However, several challenges remain, including the low productivity of pasturelands, suboptimal animal welfare conditions—especially in terms of shelters—insufficient record-keeping practices, and a lack of effective farmer organization. Other significant issues include inadequate on-farm feed production, reliance on pasture-based feeding despite poor pasture quality, overdependence on antibiotics for treating common health issues like lameness, and the lack of supplementary feeding during critical periods such as lactation.

Addressing these challenges will require future research and policy efforts focused on improving sustainable pasture management, increasing farmer awareness of organic practices, and developing more robust record-keeping systems for small-scale farms to meet organic certification requirements. Additionally, exploring on-farm feed production strategies, reducing reliance on external feed sources, and investigating natural alternatives to antibiotics for animal health are essential steps. Research in these areas, combined with appropriate education and support programs for farmers, will be crucial to ensuring the long-term sustainability of organic small ruminant farming systems.

To strengthen the Muş model as a framework for organic small ruminant farming, several key variables should be considered. Sustainable pasture improvement strategies, such as rotational grazing and reseeding, must be prioritized to ensure adequate forage availability. Improving shelter conditions and water access will enhance animal welfare and meet organic certification standards. On-farm feed production should be encouraged to reduce external dependency, while natural health management strategies, such as herbal medicine and probiotics, can help minimize antibiotic use. Effective record-keeping and farmer cooperatives will play a crucial role in ensuring compliance with organic standards and facilitating knowledge exchange among farmers.

These variables are interdependent and influence one another in several ways. Poor pasture quality increases reliance on external feed, raising production costs and complicating organic certification efforts. Limited feed production affects animal health, requiring increased veterinary interventions, which may include antibiotic use—something restricted in organic farming. Inadequate farmer organization leads to difficulties in accessing organic certification and limits knowledge transfer, which is necessary for the adoption of sustainable practices. Improvements in animal welfare conditions can reduce disease prevalence, thus decreasing the need for antibiotics and aligning with organic standards.

To ensure a smooth transition to organic small ruminant farming, specific strategic approaches should be adopted. Government incentives such as subsidies for organic feed production and pasture restoration projects would support farmers in making the transition.

Educational programs focusing on organic livestock management, sustainable feeding strategies, and natural disease prevention should be implemented. Additionally, research into region-specific organic feed alternatives and low-cost health management solutions will further facilitate the process. Strengthening farmer cooperatives can help streamline certification procedures and improve market access for organic products. Developing a more sustainable supply chain through organic feed networks and processing facilities will also be essential for long-term success. These measures directly address the key challenges identified in this study. For example, pasture improvement projects and rotational grazing systems can enhance forage availability, improve pasture quality, and provide better grazing conditions for livestock. Training programs on organic disease management can help reduce antibiotic dependency by promoting natural health strategies. Similarly, strengthening farmer cooperatives can facilitate access to organic certification, encourage knowledge-sharing, and help address issues related to weak farmer organization and record-keeping.

In conclusion, the Muş model presents a viable foundation for transitioning to organic small ruminant farming, offering a pathway to more sustainable, resilient, and profitable agricultural practices. Expanding this model to similar regions worldwide could help meet growing global demand for organic products, improve rural livelihoods, and contribute to more sustainable food systems. Future research and policy measures should focus on strengthening these key variables and facilitating farmers' access to organic certification to ensure the long-term viability of organic livestock production.

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