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Awareness and adoption of a nurse sow management system among small-scale pig farmers in Nakuru County, Kenya

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SUMMARY

This study aimed to assess the level of awareness and adoption of nurse sow management strategies among small-scale pig farmers in Nakuru County, Kenya. The research included a survey of pig farmers who visited the Nakuru Agricultural Show in July 2023. A total of 139 farmers were interviewed within 5 days of the show. The corresponding author interviewed the respondents in a face-to-face engagement, where questions on nurse sow management were initially drafted in English and translated into Kiswahili, i.e. the second language in Kenya. The obtained results indicated that farmers came from two main regions of the county: the northern part (54.7%, 76/139) and the southern part (45.3%, 63/139). Levels of awareness and adoption were insignificant between the two groups (χ^2, $p<0.05$). A major obstacle to the adoption of this strategy was identified as feed challenge at 77.7%; (108/139) and market issue at 59.7%; (83/139). This study identified important aspects and limitations that should be considered when developing sustainable productivity development strategies for Kenyan pig farmers. To assist the sustainable growth of small-scale pig production, the authors suggest government measures that shield farmers against exploitation of feed and marketing components, as well as advocating for effective breeding to increase live born.

Keywords: *pig production; small scale; challenges; Kenya*

INTRODUCTION

Pig farming sustains a significant number of small-scale farmers in Sub-Saharan Africa (Halimani et al., 2012; Mutua et al., 2011). Food and Agriculture Organisation FAO (2012) identified three different pig production systems in Kenya: large-scale systems, small-scale, and traditional indigenous. Improved breeds, commercial concentrates utilized for feeding, suitable housing, and effective biosecurity precautions are characteristics of large-scale commercial systems (Lekule and Kyvsgaard, 2003). Small-scale production systems are characterized by smaller herd sizes of between 2–10 sows (Wabacha et al., 2004). Native breeds raised in the free range are a hallmark of traditional pig systems, primarily in western Kenya (Mutua et al., 2011). Available latest information indicates that, Kenya's sow population is 504,395 (Ministry of Agriculture Livestock and Fisheries, State Department of Livestock MOALFI, 2021), of which most of the farmers are small-scale (Ministry of Livestock Development MOLD, 2006). Family workers care for pigs in small-scale farming operations, and the input costs are low (Kagira et al., 2010). In Kenya, the majority of small-scale farmers raise large white and landrace pig breeds in semi-intensive settings (Kagira et al., 2010). Because feed accounts for 70–85% of the costs associated with raising pigs (FAO, 2012; Verhulst, 1993), farmers resort to feeding their pigs a combination of feeds that are grown on the farm and feeds that they purchase (Mutua et al., 2012). In addition to feed expenses, a farmer's profit margin from raising pigs is affected by the price paid at the market (Levy et al., 2014).

Reproductive management is one of the main factors affecting the success of pigs in a herd. When a sow has more viable live born piglets than functioning teats, management activities are required to nurture the additional piglets effectively (Rutherford et al., 2013). In Kenya, most of the sows have between 10–14 teats, with a possibility of lower number of functional teats from the visible teats. A study by Masembe (1985) on reproductive performance of female pigs in Kenya revealed an average litter size of 10.4±2, while Mutua et al. (2011) study on indigenous pig breeds revealed an average litter size of 8±2.6 with lactation length of 5.4±3.3 weeks. There are variations that can be seen in terms of reproductive performance in all the systems of productions, however, one of the management strategies needed to increase the number of weaned piglets is the nurse-sow strategy. The advantage of this method is that a sow can wean two litters, in a single lactation cycle. Gaining a better understanding of management practices among small scale pig farmers can help direct extension programs and inform policymakers (Madzimure et al., 2012; Mutua et al., 2011). Based on available literature search, no research has been conducted on Kenyan small scale pig farmers' in relation to nurse sow system. Therefore, the purpose of the survey was to determine the level of awareness and adoption of nurse sow management, as well as the production challenges that impede its utilization and provide viable recommendations.

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MATERIALS AND METHODS

(i)Study location

This study was conducted in Nakuru County, Kenya. Nakuru County has a total area of 7,496.5 km^2 (Nakuru County Statistical Report 2015), and is situated in the Rift Valley of Kenya at coordinates of 0° 18' 11.1564' 'S and 36° 4' 48.0900 '' E. The county has 11 sub counties: Kuresoi South, Kuresoi North, Molo, Njoro, Rongai, Nakuru Town West, Nakuru Town East, Bahati, Subukia, Gilgil and Naivasha. According to the 2019 Kenya Population Census, there were 2,162,202 people living in Nakuru County, of whom 50.2% were women and 49.8% were men (Government of Kenya 2019). The County has consistent weather patterns, with temperatures ranging from 10 °C in the colder months of July and August to 20 °C in the warmer months of January through March. The county receives between 700–1200 mm of rain per year, with an average of approximately 950 mm. There are two rainy seasons in Nakuru; October and December (short rains) and April, May, and August (long rains) (Nakuru County Statistical Report, 2015). Agriculture is the mainstay of the county's economy, and has an ideal climate for raising cattle and crops. Livestock production systems include rearing cattle, sheep, goats, poultry, and pigs.

(ii) Study design

Individual questionnaires were administered in a single-stand location. Interviews were conducted to farmers who attended the July 2023 Nakuru Agricultural Show for seven days from 12 July 2023 to 16 July 2023. The livestock stand at the agricultural show drew both exhibitors in various livestock species and attending farmers. While several farmers stated that they raised animals other than pigs, only small-scale pig farmers from Nakuru County were eligible to respond. A total of 139 small scale pig farmers were therefore interviewed. The county was chosen because it was hosting the National Agricultural Show at the time, which regularly draws large numbers of farmers who are interested in learning more about agriculture. Furthermore, because African swine fever being endemic in Kenya (Gallardo et al., 2011; Okoth et al., 2013) and the lower enhancement of farm biosecurity protocols, it was considered prudent not to have individual farm visits to avoid farm contamination. Because the farmers who attended the show were the target audience for the study, their participation in it was perceived by them as an unforeseen event that deviated from their primary goal of simply attending the show. There is always a challenge when conducting an impromptu interview because of the respondent's limited time. As a result, the questions were created broadly to take short time while still accomplishing the intended objective. The following were the questions;

(i) Which sub county do you come from?
(ii) How many sows do you have?
(iii) What is your average sow live born size?
(iv) Do you understand what it means by nurse sow system?
(v) If you understand the system, how often do you practice it in your farm?
(vi) What are the challenges that you face when practicing the nurse sow system?

(iii) Data collection

Following a brief author's self-introduction, farmers were informed that the survey was part of a research project on investigating the use of nurse sows in swine production. Farmers were requested to voluntarily participate in an interview that took five–ten minutes. Structured questions were utilized in the survey design to gather information on location, average live born, size of the sow herd, knowledge of nurse sow system, and challenges associated with implementing the system. The survey questions were written in English, but for farmers' benefit, the author translated them into Kiswahili, the most widely spoken second language in Kenya. To be specific, the term "nurse sow" was not "selling" well to the farmers during the face-to-face interviews, thus a translation into Kiswahili was established in order to make the terminology more understandable. The idea was a straightforward explanation for the need to wean a sow and provide it with other piglets to suckle until weaning. Following the translation, it became evident that the farmers' initial comprehension of what they were doing was nurse-sow management. Throughout the entire process, only four farmers were unable to participate because of time constraints, as they were late in the afternoon. The farmer's willingness to participate entirely in the study was a major boost factor to the overall response. Since the interviews were anonymous, no personal information about the respondent was gathered.

(iv) Data Analysis

Microsoft Excel was used to enter the responses and the groupings made comprised of the north and the south sub counties. Any possible data entry errors were examined in the files and remedied by comparing the updated files with the original data-collection file. SPSS statistics software version 29 (2022), was used to perform descriptive statistics such as frequency distribution and percentages, and chi-square (χ^2) was used to test for statistical significance and comparisons. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

Herd dynamics in relation to nurse sow system

The nurse sow characteristics of the farmers surveyed, grouped by area, are shown in *Table 1*. According to the data, the majority of small-scale pig farmers were from the county's northern side (54.7%, 76/139), whereas the southern side had (45.3%, 63/139). The northern side consisted of five sub counties (Bahati, Kuresoi north, Molo, Njoro, and Subukia), while the south side had six sub counties (Gilgil, Kuresoi south, Naivasha, Rongai, Nakuru east, and Nakuru west). The Chi-square probability suggests that there is no significant association between the number of sows kept and the respondents in the north

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and south. Nonetheless, the results clearly show that pig farmers in the northern region have higher average sow herd sizes in both the grouping of less than 10 sows (51.4%, 54/105) and more than ten sows (64.7%, 22/34) compared to the south (48.6%, 51/105) and (35.3%,12/34) respectively. During the interview process, farmers understood the concept of litter size as live-born because they were only familiar with recording the total number of piglets born alive at birth. Three farmers did not give live-born figures because they had just started pig farming, and none of their purchased sows had farrowed. The Chi-square probability indicated no significant association between the average number of live born among the groups. From the north 57.1% (48/84) and the south 42.1% (36/84) of the farmers indicated having average live born of less than 12 piglets whereas 51.9% (27/52) and 48.1% (25/52) respectively indicated having an average live born of more than 12 piglets respectively. 45 farmers from the north understood the concept of the nurse sow system compared to 32 farmers from the south. The percentage of farmers in the North and South, who did not comprehend the nurse sow system, was 50 percent. Only Ten farmers of the 45 farmers in the North who understood the nurse sow system practiced it as compared to seven of the 32 farmers from the South.

Table 1. **Herd dynamics in relation to nurse sow system (n=139)**

Factors	Observation	Regions						Chi-square
		North (n)	%	South (n)	%	Total (n)	%	
Sow herd size	<10	54	51.4	51	48.6	105	75.5	1.827
	>10	22	64.7	12	35.3	34	24.5	
Average live born	<12	48	57.1	36	42.1	84	61.8	0.354
	>12	27	51.9	25	48.1	52	38.2	
Level of understanding	Yes	45	58.4	32	41.6	77	55.4	0.988
	No	31	50.0	31	50.0	62	44.6	
Practicing nurse sow system	Yes	10	58.8	7	41.2	17	12.2	0.134
	No	66	54.1	56	45.9	122	87.8	

*(*i)Sow herd size

Pig production in Kenya has remained relatively unexploited, despite agriculture being one of the country's core contributors to Gross Domestic Product. The Agricultural Society of Kenya is a significant player in Kenyan agriculture and is essential for the sharing of trustworthy information and farmer engagement during shows and exhibitions (Ministry of Livestock Development MOLD, 2006). Substantial authors have carried out studies on pig farming practices in Kenya that focuses on certain counties, using information from farmer surveys and in-person interviews, for instance, in Kiambu County by Mbuthia et al. (2015), Busia County by Levy et al. (2014) and Mutua et al. (2012), Tharaka Nithi County by Micheni et al. (2020), and Kakamega County by Mwabonimana et al. (2020). The aforementioned research have all offered valuable recommendations that have played a crucial role in shaping Kenya's small-scale pig industry.

A high percentage of farmers 75.5% (105/139) had an average sow herd size of less than ten, suggesting small-scale management. The findings are in agreement with previous studies of (Gichohi et al., 1988; Kithinji et al., 2017; Wabacha et al., 2004; Mutua et al., 2011) who also noted that Kenyan small-scale pig farmers raised only two to ten sows on average. The small herd sizes observed could be attributed to ease of operation, as the required input costs are low (Mutua et al., 2012), and the use of family labor is cheap (Kagira et al., 2010). However, the continued land tenure system of subdivisions for inheritance purposes or for the construction of dwelling homes to accommodate the growing human population hinders small-scale pig production in Kenya. Furthermore, Mbuthia et al. (2015) found that, similar to the farmers in this study, small-scale pig farmers also raised other livestock species, such as cattle, sheep, and goats. Some small-scale pig farmers also grew cash crops for sale (Wabacha et al., 2004). The integration of all these systems cannot suffice to engage in a large sow herd population due to land resource limitations. Nonetheless, 24.5% (34/139) of the farmers in the survey had an average herd size of more than ten sows. A recent study conducted in Kenya by Mutua et al. (2020) with the goal of creating identity and traceability in small scale pig systems, found that the sow herd size among small-scale pig farmers ranged from 10 to 100. Recent findings of more than ten sows kept per herd size in small-scale pig production could be aimed at increasing herd size to benefit from the expected economies of scale of production.

(ii)Average live born piglets

The average live born piglets within sub-county is displayed in *Figure 1*.

It is observed that, in comparison to all other sub-counties, most farmers who were interviewed came from Njoro and Molo and likewise they were the most having average live born of 12 piglets. Unlike in Kuresoi South and Kuresoi North where no farmer reported having average live born of 10 or 11 piglets respectively.

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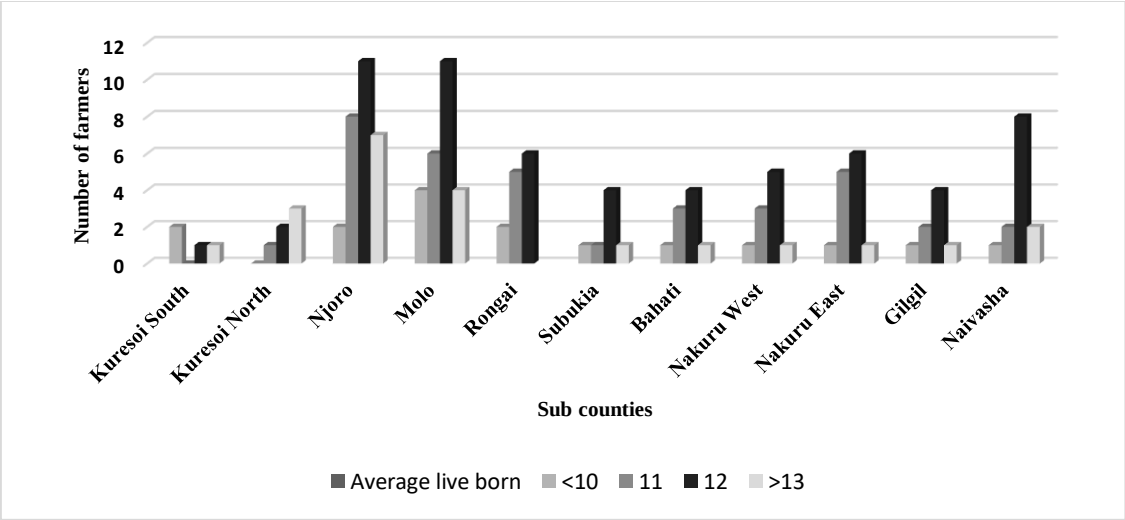
Figure 1. **Average live born piglets**



Average litter size in pig production is used as a productivity benchmark (Koketsu et al., 2017). In relation to average live born, 61.8% (84/136) of the surveyed farmers had an average live born of less than 12 piglets. Even though current information regarding the average live born among small-scale pig farmers in Kenya is unpublished, evidence of low-prolific breeds in small-scale pig production witnessed by Kagira et al. (2010) and Wabacha (2001) could affect the number of live born. There is no Kenyan pig breed characterized and domiciled to Kenya as what is seen with Mangalitsa pig breed of Hungary. The local large white (phenotypically characterized by: white in colour, large and long body size, standing ears and straight face) and land race (phenotypically characterized by, white in colour, long body size, drooping ears and a dished face) are the most preferred breeds (Wabacha et al., 2004), however crossbreeds are also reared (Chege et al., 2023).These breeds, whether exotic or crossbred, are limited by inbreeding and crossbreeding, which results in fewer live born observed in both groups and restricts the use of nurse sows. A staggering 38.2% (52/136) of the respondents said that they had, on average, more than 12 live born. This is made feasible by the advent of small-scale pig producers using Artificial Insemination (A.I) for increased prolificacy and prompt heat detection to enhance herd reproductive performance. Due to financial concerns, small-scale pig farmers have not given pig A.I sufficient consideration; however, even in the event of timely heat detection, natural mating may still lead to a larger live born. Compared to other sub-counties, farmers in Njoro and Molo sub-counties reported higher average live born on their farms. This can be explained by the possibility that these farmers could use improved pig breeds in conjunction with good husbandry techniques, which would result in greater average live born. Additionally, according to the Nakuru County statistical report (2015) Njoro and Molo are two distinct sub-counties in Nakuru that have agronomic weather conditions that are favorable for growing animal feed. Good nutrition profiles in the herd, especially for feeding livestock, results in elevated levels of reproductive performance, witnessed through high prolificacy.

(iii)Level of understanding

Figure 2 shows the level of understanding within the sub counties. Compared to farmers in the other sub-counties, the majority of farmers in the Njoro and Molo sub-counties exhibited the highest level of knowledge regarding the nurse sow method. Nonetheless, it's noted that there are somewhat more farmers in the same sub-counties who are unaware of the system. In the sub-counties of Kuresoi North and Kuresoi South, there was relatively little awareness.

The two groups' levels of understanding of nurse sow management were not significant, but 55.4% (77/139) of the farmers said that they were familiar with the method. Nurse sow method is related to fostering and it was clear that farmers associate themselves with knowing the fostering aspects. One possible explanation for the slightly above-average knowledge of nurse sow management among farmer groups could be the fact that they are acquiring information through radio, shows, and exhibitions, among other channels. A famous example is the popular radio station Inooro FM 88.9FM, whose broadcasting reaches Nakuru County and regularly broadcasts an episode titled "The voice of the farmer," which is loosely translated from Kikuyu language to English language and teaches farmers about numerous aspects of farming. A platform like this could reach a large audience based in Nakuru County, where most of the farmers are of the Kikuyu ethnic tribe (author observations). Every year, the Rift Valley Institute of Science and Technology hosts the annual Farmer Open Day in Nakuru County, drawing large numbers of farmers, much like the annual Nakuru Agricultural Show. According to Micheni et al. (2020) and Mutua et al. (2011), pig farmers can obtain information from government extension service providers. However, Wabacha et al. (2004) discovered that the majority of small-scale pig farmers 78%

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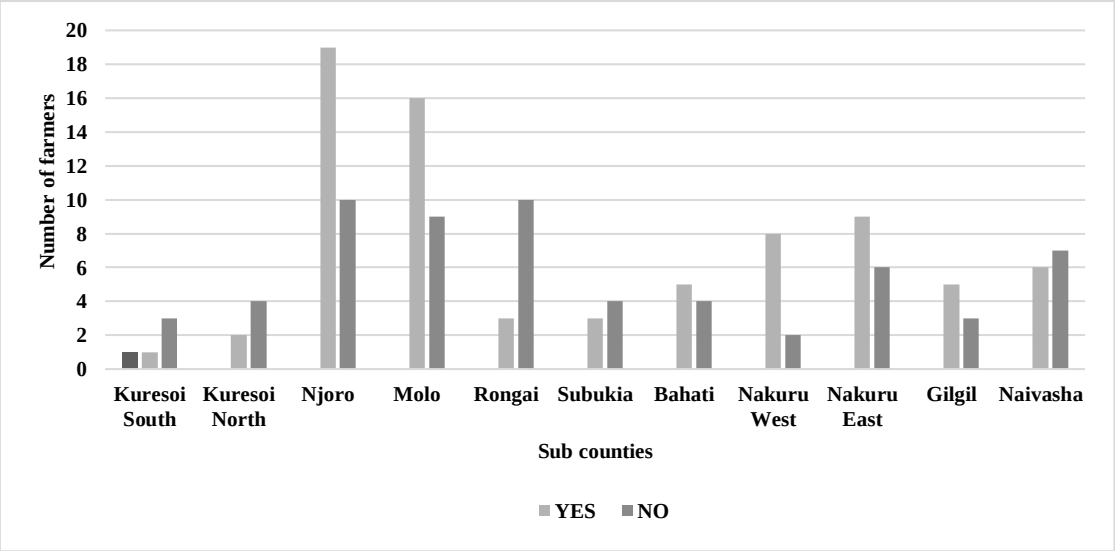
(68/87) did not request extension information from government service providers, leading to poor pig management. Farmers in the sub counties of Molo and Njoro are more knowledgeable about nurse sow management. The sole rationale for this finding is that farmers with higher litter numbers are compelled to attempt managing the large number of piglets in order to improve weaning survival rates. According to the study, the majority of Molo and Njoro farmers reported litter averages of more than 12 piglets.

Figure 2. **Level of understanding within sub counties**

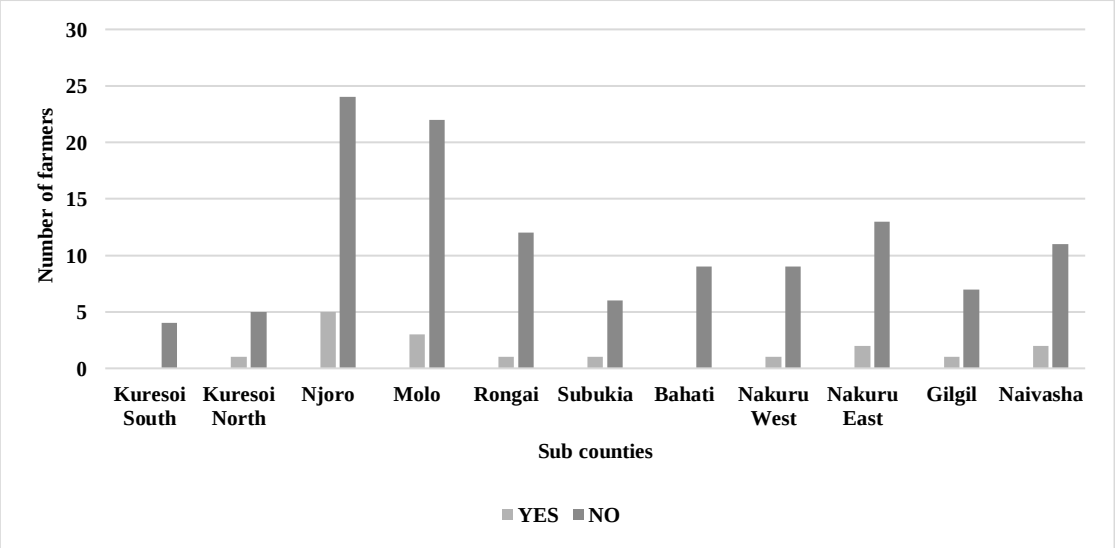


(iv) Level of practicing nurse sow system

Figure 3 shows the level of practicing nurse sow within sub-counties. The sub-counties Njoro and Molo show a noticeable level of adoption, but they also show a higher percentage of non-adopters. Of the farmers surveyed, none in the sub-counties of Bahati and Kuresoi south used this method.

Of all the farmers interviewed, only 12.2% (17/139) used the nurse-sow strategy. The reason for the high percentage of non-practicing farmers could be that they did not have many live born piglets as seen in *Table 1* to justify the use of the system. Thus, intrinsic (live-born) and extrinsic (lack of information) factors restrict one's capacity for practice. Substantial number of farmers from Njoro and Molo who had more live born were aware of the nurse sow method and subsequently put it into practice. Mutua et al. (2010) reported that small-scale pig producers who had access to sufficient knowledge were better able to understand issues related to pig production and the potential to sell their pigs than those who were unaware. Therefore, knowledge could help the farmer make the right judgments and see those decisions through to satisfaction.

Figure 3. **Level of practicing nurse sow system**



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Challenges associated with adoption of nurse sow system

Table 2 presents the results of challenges associated with adoption of nurse sow system. The data indicate that feed issue is the biggest challenge among the pig farmers rated at 77.7% (108/139). The Chi-square probability suggests that there was no significant association between the feed issue challenge and regions, however the rating of feed issue was at 55.6% (60/108) and 44.4% (48/108) to the north and south respectively. Farmers responded by ranking market issue as the second biggest challenge at overall 59.7% (83/139), rated at 55.4% (46/83) from the north and 44.6% (37/83) to the north. Sow herd size, live born and disease challenges were rated minimal at overall 12.9% (18/139), 4.4% (6/136) and 13.7 (19/139) respectively.

Table 2. **Challenges associated with adoption of nurse sow system**

Challenge	Observation	Regions						Chi-square
		North (n)	%	South (n)	%	Total (n)	%	
Feed issues	Yes	60	55.6	48	44.4	108	77.7	0.151
	No	16	51.6	15	48.4	31	22.3	
Market Issue	Yes	46	55.4	37	44.6	83	59.7	0.046
	No	30	53.6	26	46.4	56	40.3	
Sow herd size	Yes	12	66.7	6	33.3	18	12.9	1.200
	No	64	52.9	57	47.1	121	87.1	
Less live born	Yes	5	83.3	1	16.7	6	4.4	2.078
	No	71	53.4	59	6.6	133	95.6	
Diseases	Yes	11	57.9	8	42.1	19	13.7	0.092
	No	65	54.2	55	45.8	120	86.3	

Feed challenge was the highest for adopting the nurse sow system. Notwithstanding the fact that there was no significant difference between the two groups, 77.7% (108/139) of the farmers pointed out feed challenges as a major issue compared to the other challenges. According to the Food and Agriculture Organisation FAO (2012) study on the pig industry in Kenya, 70–85% of pig production costs are related to feed expenditure. Survey research on small-scale pig production conducted in Kenya showed that feed costs are a major challenge, exceeding 70% of production expenses, as reported by Wabacha et al. (2004) in Kiambu County, Mutua et al. (2011) in Kakamega County, Micheni et al. (2020) in Tharaka Nithi County, and Kagira et al. (2010) in Busia County. Pig production faces feed challenges owing to several factors, including cost, quantity, quality, and availability. The nurse sow system in pig production entails sows feeding for a longer period of time during the lactation period than during the normal conventional period. The typical weaning age of piglets raised on small farms in Kenya varies depending on the farm but can range between six and eight weeks of age (Kagira et al., 2010). Farmers indicated that any additional stay in lactation is disadvantageous, as sows continue consuming feeds that would have been used by other sows or at a different stage of production. The most common type of sow feed in Kenya is sow and weaner meal, which is given to sows during all stages of lactation, weaning, and gestation. Any additional stay in lactation for sows nursing other piglets could mean an additional requirement, which becomes a costly venture. Various companies sell sow and weaner feed at varied prices, and there has been a noticeable increase in the price of a 70 kg bag, which retailed at USD 14 prior to the pandemic and USD 26 post pandemic (author observation). The solution to the feed challenge in small-scale pig production in Kenya similar to what this study would recommend, has been emphasized by some authors (Levy et al., 2014; Micheni et al., 2020; Mutua et al., 2010) as a requirement for farmers to formulate their own feed or the incorporation of additional feeds to reduce the overdependence on feed purchased from the market.

At 59.7% (83/139) farmers considered market issues as their second greatest challenge. These findings were consistent with those reported by (Micheni et al., 2020; Mutua et al., 2010; Wabacha et al., 2004), who found that in small-scale pig production, market concerns rank second when selling pigs and pig products. Market challenges are mostly caused by low pig prices, inadequate market knowledge, and middleman involvement. Owing to the high cost of feed used in production, farmers said it was very difficult to achieve a fair price for their pigs in the market, given that they would want to break even. Pigs are only supposed to be slaughtered in government-designated facilities in Kenya; thus, farmers would prefer to sell their pigs cheaply to middlemen, who will transport them to the slaughterhouse and cover the associated costs. Disposing the pig to middlemen denies the farmer higher bargaining power, as the middlemen involved in the value chain would also capitalize on making profits from their business activities. At the moment, majority of middlemen in Nakuru county purchase pigs from farmers at between USD 1.57 to USD 1.96 per kilogram of slaughtered pork. Later, the retail price of this pork is between USD 3.26–3.92 per kilogram (author observations). The farmer is, therefore, deprived of the full value of having to allow pigs to stay longer in the nurse sow section and grow up to become fatteners only to fetch a small output. To address this challenge, policy interventions from various government stakeholders must be enacted

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to help streamline the pig marketing sector, as similar recommendations have been made by Micheni et al. (2020).

Sow herd size and live born were not regarded as major challenges at 12.9% (18/139) and 4.4% (6/136) respectively in adoption of the nurse sow system. The majority of small-scale pig farmers keep large white and landrace breeds (Wabacha et al., 2004), which have been greatly impacted by cross breeding and have decreased prolificacy, which is largely responsible for minimal live born. Reduced prolificacy does not warrant the use of nurse sows, as the nurse sow system is well-designed for managing large litters. According to a recent study in Kenya by Mutua et al. (2020), small-scale pig farmers currently own 10–100 pigs. The observed rise in sow herd numbers could suggest that small-scale pig farmers are prioritizing the optimization of economies of scale in their operations.

In small-scale pig production, diseases in the nurse-sow system could have substantial economic consequences. Nevertheless, only 13.7% (19/139) of the farmers cited disease as a concern, and there was no significant difference between the two groups. Disease concerns seem to be minimal even though African swine fever is endemic in Kenya (Gallardo et al., 2011; Okoth et al., 2013). In Kenya, worm infestations are thought to be the main cause of disease among small-scale pig farmers (Mwabonimana et al., 2020), however Wabacha et al. (2004) study showed that mange parasites are also considered the most common cause of animal health associated problems among small scale pig farmers. Concerns about animal health in pig farming can be addressed through control measures such as good animal husbandry techniques and sufficient biosecurity protocols.

CONCLUSIONS

Small-scale pig production system undoubtedly plays a crucial role in Kenya's overall pig farming. The study's descriptive conclusions were based on the recollections and reporting of pig farmers. However, this study has brought to light a number of difficulties that can serve as opportunity points for improvements in small-scale pig production. The lack of differences between the north and south groups may be due to common pig production techniques among the county's numerous small-scale pig farmers. Low average herd sizes and litter live born are still common among small-scale pig farmers, which may be a barrier to higher productivity. Farmers have a reasonable understanding of the concept of nurse sow management, but there are still issues with its adoption rate due to live born to support its implementation. The current large white and landrace sows kept by small-scale pig farmers are still feasible for realizing increased prolificacy if controlled breeding can be practiced to prevent inbreeding. The county administration can implement policies like subsidizing ingredient costs for feed companies in an effort to encourage them produce quality and affordable feeds to pig farmers. Furthermore, streamlining market channels to enable farmers to access the market for knowledge about the prices of pigs and pig products could help them have a voice on the final value of their pigs and avoid middlemen exploitation. The survey played a critical role in revealing information that lay the groundwork for stakeholder education to close the knowledge and practice gap by encouraging pig farmers to raise their herd and litter sizes in order to increase productivity.

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