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EMPOWERING GOAT FARMERS OF KOPERASI AGRO TERNAK MELAYU PERAK BERHAD (KATAM) THROUGH FERMENTED COMPLETE FEED TECHNOLOGY, REPRODUCTIVE MANAGEMENT, AND PARASITIC DISEASE CONTROL IN MANONG, KUALA KANGSAR, PERAK, MALAYSIA

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ABSTRACT

This international community service program aimed to improve the knowledge and technical skills of goat farmers affiliated with Koperasi Agro Ternak Melayu Perak Berhad (KATAM) in Manong, Kuala Kangsar, Perak, Malaysia, in fermented complete feed technology, parasitic disease control, and reproductive management. The program was conducted on October 22, 2026, jointly by the Faculty of Veterinary Medicine, Universitas Airlangga, and the Institute of Tropical Agriculture and Food Security (ITAFoS), Universiti Putra Malaysia. A participatory approach combining education, hands-on practice, and discussion was applied with 20 goat farmers. Participants prepared fermented complete feed from local forages and agricultural by-products using molasses and a probiotic inoculant (BioMC4/EM4) through an anaerobic layered method. Outcomes were evaluated with a one-group pre-test and post-test design using a 15-item dichotomous questionnaire and analyzed descriptively. Mean scores increased from 66.0% to 100% for fermented feed (+34.0 percentage points), from 53.0% to 99.0% for parasitic disease control (+46.0 percentage points), and from 29.0% to 100% for reproductive management (+71.0 percentage points). The largest item-level gains concerned the timing of artificial insemination relative to estrus onset (20.0% to 100%), recognition of estrus signs and the genetic benefits of frozen semen (25.0% to 100%), and the zoonotic nature of scabies (40.0% to 100%). Willingness to isolate goats with scabies rose from 70.0% to 95.0%, limited by a lack of quarantine pens. Integrated participatory training effectively improved farmers' knowledge and skills, providing a basis for sustainable feed management, better herd health, and improved reproductive performance in smallholder goat farming.

Keywords: Fermented Complete Feed; Goat Farmers; Parasitic Disease Control; Reproductive Management; Artificial Insemination; Community Empowerment

1 INTRODUCTION

Goat farming is an important pillar of food security, providing a source of animal protein and improving the welfare of farmers, particularly in rural areas. As small ruminants, goats adapt well to diverse environmental conditions, have relatively high reproductive efficiency, and can make effective use of local feed resources, giving them considerable potential as a sustainable and competitive livestock commodity [1]. In tropical regions, however, smallholder goat farming systems continue to face persistent constraints in feed management, animal health, and reproductive efficiency, which directly result in low productivity and profitability [1,2].

This international community service program was conducted in partnership with Koperasi Agro Ternak Melayu Perak Berhad (KATAM), a community-based agro-livestock cooperative in Manong, Kuala Kangsar District, Perak, Malaysia. The cooperative is engaged in the development of the agricultural and livestock sectors and collaborates with various institutions to build farmers' capacity and develop sustainable agro-livestock enterprises [3]. Perak has abundant forages and oil palm agro-industrial by-products, such as oil palm fronds and palm kernel cake, which can be used as economical alternative feed ingredients [4]. Consistent with this potential, the Institute of Tropical Agriculture and Food Security (ITAFoS), Universiti Putra Malaysia, reported through its capacity-building programs for small ruminant farmers that goat farmers in Perak still face technical constraints requiring science- and technology-based interventions, particularly in nutrition, disease control, and reproduction [5].

The main nutritional constraint at the partner location is the farmers' dependence on daily fresh forage and costly commercial feed, while local agricultural by-products have not been adequately processed using fermented complete feed technology. The use of cellulolytic probiotics and lactic acid bacteria (e.g., BioMC4/EM4) in such feed can improve crude fiber digestibility and extend shelf life [6,7]. In terms of animal health, the humid tropical climate of Perak favors the proliferation of ectoparasites, such as the zoonotic mite *Sarcoptes scabiei*, which causes scabies [8–10], as well as gastrointestinal endoparasites, including the blood-feeding nematode *Haemonchus contortus*, the liver fluke *Fasciola* sp., and the coccidiosis-causing protozoan *Eimeria* sp. These infections often remain subclinical, resembling an “iceberg phenomenon”, and can lead to anemia, emaciation, and an increased risk of antiparasitic drug resistance when treatment is not accompanied by proper disinfection and sanitation of goat housing [8]. Nutritional deficiencies and parasite burdens, in turn, aggravate a third major problem: the low reproductive efficiency of breeding does. Farmers' limited understanding of the relationship between body condition and the estrous cycle, inaccurate detection of the four primary signs of estrus, and underuse of artificial insemination (AI) with frozen semen from superior bucks result in high conception failure rates and prolonged kidding intervals [11,12].

The Faculty of Veterinary Medicine, Universitas Airlangga (FKH UNAIR), one of the leading veterinary education institutions in Indonesia, is committed to community-oriented and globally minded education and public service. This commitment is realized through its International Community Service Program, which encourages lecturers and students to apply their veterinary competencies for the direct benefit of society. Involving FKH UNAIR postgraduate students alongside the research team from ITAFoS, Universiti Putra Malaysia, accelerates the translation of veterinary research into appropriate technology across borders, develops students' problem-solving skills on complex tropical livestock issues in the field, and strengthens academic collaboration networks across Southeast Asia. The initiative also supports the Sustainable Development Goals (SDGs), particularly Zero Hunger (SDG 2), Quality Education (SDG 4), and Partnerships for the Goals (SDG 17), by promoting sustainable agricultural practices and building institutional networks to address regional food security challenges [13]. This program therefore aimed to empower goat farmers affiliated with KATAM in Manong, Kuala Kangsar, Perak, Malaysia, and to evaluate the improvement in their knowledge and technical skills following integrated training on fermented complete feed preparation, parasitic disease control, and reproductive management.

2 MATERIAL AND METHODS

2.1 Location and participants

This international community service program, entitled "International Knowledge and Technology Transfer Program on Small Ruminant Farming", was conducted on Thursday, October 22, 2026, in Manong, Kuala Kangsar District, Perak, Malaysia. It was an academic collaboration between lecturers and students of the Faculty of Veterinary Medicine, Universitas Airlangga (Surabaya, Indonesia), and the Institute of Tropical Agriculture and Food Security (ITAFoS), Universiti Putra Malaysia (Serdang, Malaysia), with Koperasi Agro Ternak Melayu Perak Berhad (KATAM) as the partner organization. A total of 20 goat farmers (n = 20), all active KATAM members from the Kuala Kangsar area, participated fully in the educational sessions, field practice, and evaluations.

2.2 Design of activities

The program used a participatory learning approach that integrated theoretical knowledge transfer with direct practical demonstrations in the field [14,15]. To measure the effectiveness of the intervention objectively, a quasi-experimental one-group pre-test and post-test design was applied [16]. The activities were carried out in five sequential stages: (1) participant registration and completion of the pre-test questionnaire; (2) delivery of educational material on three main topics (fermented feed technology, parasitic disease control, and reproductive management); (3) training and hands-on practice in preparing fermented complete feed; (4) an interactive discussion and question-and-answer session addressing problems encountered in the farmers' own goat pens; and (5) completion of the post-test questionnaire at the end of the program.

2.3 Educational sessions

The educational sessions were delivered interactively using visual presentations and practical guide modules in Indonesian and Malay that were easily understood by the farmers. The material covered three main pillars of goat productivity, as described below.

2.4 Fermented complete feed

This topic introduced the concept of fermented complete feed (silage), which combines fiber sources and concentrates into a single ration fermented with the aid of cellulolytic probiotics and lactic acid bacteria (BioMC4/EM4) [17]. Farmers were taught to select safe local ingredients (e.g., Napier or dwarf Napier grass, oil palm fronds, rice straw, rice bran, palm kernel cake, and *Indigofera* leaves), to reduce hydrogen cyanide (HCN) in fresh cassava leaves by wilting, and to limit mimosine intake from *Leucaena leucocephala* leaves to a maximum of 20–30% of the ration. Feeding management was also explained, including a daily intake of 3–4% of body weight on a dry matter basis (equivalent to 3–5 kg of fresh feed per head per day) and a 7-day adaptation period when introducing the new feed.

2.5 Parasitic disease control

This topic covered the identification of ectoparasites (the scabies mite *Sarcoptes scabiei*, myiasis-causing flies, lice, and ticks) and endoparasites (gastrointestinal nematodes, particularly *Haemonchus contortus*; the liver fluke *Fasciola* sp.; and protozoa such as *Eimeria* sp., which causes coccidiosis, and *Toxoplasma gondii*) [18,19]. The speakers emphasized the "iceberg phenomenon" of subclinical parasitic infections; the recognition of characteristic clinical signs, such as pale conjunctival mucosa (anemia), submandibular edema ("bottle jaw"), diarrhea, and skin crusts; and the zoonotic potential of scabies. Control strategies were based on the principle that about 95% of the parasite population lives in the housing environment and on pasture rather than in the animal. Disinfection of raised-floor pens, isolation

(quarantine) of sick animals, routine fecal examination, and grazing only after the morning dew has dried must therefore be combined with the rational use of antiparasitic drugs to prevent drug resistance [8].

2.6 Reproductive management and artificial insemination

This topic addressed the relationship between the body condition score (BCS) of breeding does, whether too thin or too fat, and estrous cycle disorders; the four primary signs of estrus in does (a swollen, reddened, and warm vulva with clear mucus discharge; restlessness and tail wagging; and standing to be mounted); and the optimal timing of AI based on the onset of estrus [20]. Farmers were also introduced to the advantages of frozen semen from superior bucks, which improves the genetic quality of the offspring while reducing the cost of keeping breeding bucks.

2.7 Hands-on preparation of fermented complete feed

After the classroom sessions, all participants prepared fermented complete feed at a 100 kg mixing scale. The formulation consisted of 70% fiber sources (forage grass and oil palm fronds) and 30% local concentrates and supplements (rice bran, ground corn, and palm kernel or coconut cake, with 1 kg of mineral premix and salt). The procedure followed eight stages: (1) chopping the forage and agricultural by-products into 2–5 cm pieces with a chopper to facilitate compaction; (2) spreading the chopped forage on a clean tarpaulin to a thickness of about 15–20 cm; (3) evenly spreading the concentrate ingredients over the forage layer; (4) preparing the inoculant solution by mixing 100–200 mL of probiotic (BioMC4/EM4) and 1–2 L of sugarcane molasses into 5–10 L of clean water, then leaving it for 15 minutes to activate the microbes; (5) spraying the solution gradually while mixing the ingredients until homogeneous; (6) checking the moisture content of the mixture (target 30–40%) with the hand-squeeze test, in which the feed is considered ideal if it forms a compact ball without dripping water when squeezed firmly; (7) loading and compacting the feed layer by layer into an airtight 200 L plastic drum, trampling it firmly to expel air and create anaerobic conditions; and (8) sealing the drum with an inner plastic liner and a metal locking ring and storing it in a shaded place for 14–21 days [4,6]. Farmers were also trained to assess the organoleptic quality of well-fermented silage: a fresh, sour aroma resembling fermented cassava (*tapai*), a brownish-green color, a soft and loose texture, and the absence of white or black mold and putrid odors [21–23]. The hands-on session, including the preparation of the probiotic–molasses solution and the sealing of the fermented feed in airtight plastic containers, is shown in Figure 1.



Figure 1: KATAM goat farmers practicing the preparation of fermented complete feed with the FKH UNAIR and ITAFoS UPM team: mixing the molasses–probiotic (BioMC4/EM4) inoculant solution, with packed and sealed fermented feed in the background

2.8 Evaluation and data analysis

Knowledge improvement was evaluated by comparing participants' responses to the same structured questionnaire administered before (pre-test) and at the end (post-test) of the program. The questionnaire comprised a section on demographic characteristics (age, sex, education level, farming experience, and herd size by age and physiological group) and 15 dichotomous items answered “Yes” (have done/know/willing) or “No” (have not done/do not know/not willing). The items were evenly distributed across three domains: fermented feed (items 1–5), parasitic disease prevention and control (items 6–10), and reproductive management and AI (items 11–15). Data from all 20 respondents

were tabulated and analyzed descriptively as frequencies (*n*) and percentages (%). The change for each item and domain was expressed as the difference between the post-test and pre-test percentages (percentage points). Brief discussions were also held at the end of the session to capture participants' feedback on the feasibility of applying the introduced technologies in their daily farming practices.

3 RESULTS AND DISCUSSION

3.1 Profile of participants

The demographic characteristics of the 20 participating KATAM goat farmers are presented in Table 1. Most participants were male (15; 75.0%), while 5 (25.0%) were female. The participation of women, who made up one-quarter of the group, indicates that women are also actively involved in daily goat husbandry in the Kuala Kangsar area of Perak.

Table 1: Characteristics of the participating goat farmers (n = 20)

Characteristic	Category	Number of participants (n)	Percentage (%)
Sex	Male	15	75.0
	Female	5	25.0
Age (years)	20–35	7	35.0
	36–45	3	15.0
	≥ 46	10	50.0
Education	SMR	2	10.0
	SPM	10	50.0
	Sarjana Muda	8	40.0
Farming experience (years)	1–5	11	55.0
	6–10	4	20.0
	> 10	5	25.0
Herd size (head)	≤ 20	4	20.0
	21–50	10	50.0
	≥ 51	6	30.0

SMR = *Sijil Menengah Rendah* (lower secondary certificate); SPM = *Sijil Pelajaran Malaysia* (Malaysian Certificate of Education, upper secondary); *Sarjana Muda* = bachelor's degree. The 20 respondents managed a total of 805 goats, comprising 159 adult bucks, 428 adult does, and 218 kids.

All participants were of productive age (23–53 years; mean 41.2 years). Half (50.0%) were older than 45 years (46–53 years), 35.0% were young farmers aged 20–35 years, and 15.0% were aged 36–45 years. The formal education level of KATAM members was relatively high: half of the participants (50.0%) held the *Sijil Pelajaran Malaysia* (SPM, upper secondary), 40.0% held a *Sarjana Muda* (bachelor's degree), and only 10.0% held the *Sijil Menengah Rendah* (SMR, lower secondary). The predominance of secondary and tertiary education (90.0%), together with the presence of younger farmers, represents valuable social capital, as farmers with higher literacy tend to be more open, critical, and quick to adopt new livestock technologies.

Regarding farming experience, most participants (55.0%) were relatively new farmers with 1–5 years of experience, followed by those with more than 10 years (25.0%) and 6–10 years (20.0%), with a mean of 7.3 years. Despite this limited experience, herd sizes already indicate a shift toward semi-commercial enterprises, with a mean of 40.3 head per farmer (805 goats in total). Half of the farmers (50.0%) kept 21–50 goats, 30.0% kept more than 50 goats (up to 95 head), and 20.0% kept 20 goats or fewer. The predominance of productive does (428 head; 53.2% of the total population) and kids (218 head; 27.1%) underlines the urgent need for KATAM members to improve feed, reproductive, and parasitic disease management to optimize the productivity of their breeding stock.

3.2 Knowledge and skills in fermented complete feed technology

The pre-test and post-test results for fermented complete feed technology are presented in Table 2. The farmers' mean level of knowledge and practical experience in this domain increased by 34.0 percentage points, from 66.0% in the pre-test to 100% in the post-test.

Table 2: Farmers' knowledge and experience of fermented complete feed before and after training (n = 20)

No.	Questionnaire item	Pre-test		Post-test		Change (pp)
		Yes, n (%)	No, n (%)	Yes, n (%)	No, n (%)	
1	Practical experience in making fermented feed for goats	11 (55.0)	9 (45.0)	20 (100.0)	0 (0.0)	+45.0
2	Knows that grass, straw, or agricultural by-products can be used as goat feed	15 (75.0)	5 (25.0)	20 (100.0)	0 (0.0)	+25.0
3	Knows that fermentation makes feed more palatable and digestible for goats	13 (65.0)	7 (35.0)	20 (100.0)	0 (0.0)	+35.0
4	Knows that using fermented feed can reduce daily feed costs	14 (70.0)	6 (30.0)	20 (100.0)	0 (0.0)	+30.0
5	Knows that fermented feed can be stored as a feed reserve for the dry season or periods of feed scarcity	13 (65.0)	7 (35.0)	20 (100.0)	0 (0.0)	+35.0
Mean, fermented feed domain		66.0	34.0	100.0	0.0	+34.0

pp = percentage points (post-test % minus pre-test %).

The largest gain in this domain was for item 1, practical experience in making fermented feed, which increased by 45.0 percentage points (from 55.0% to 100%). Before the training, 9 farmers (45.0%) had never made silage or fermented feed, and 35.0% did not know that fermentation improves feed digestibility and allows feed to be stored as a reserve (feed bank) for the dry season. Through demonstration and hands-on practice, all 20 farmers (100%) directly practiced chopping, mixing concentrates with the probiotic and molasses, testing moisture content with the hand-squeeze method, and anaerobic compaction in plastic drums [23].

Fermented complete feed technology is highly relevant to the agricultural setting of Perak, Malaysia, where oil palm plantation by-products (such as oil palm fronds and palm kernel cake) and local forages are abundant. The direct use of high-fiber feedstuffs without processing is often limited by lignocellulosic bonds that restrict rumen digestibility. Adding a probiotic inoculant (such as BioMC4/EM4, which contains lactic acid bacteria and cellulolytic microbes) together with molasses as a source of water-soluble carbohydrates accelerates the drop in pH to below 4.2 under anaerobic conditions. Ensiling not only inhibits spoilage bacteria and fungi but also breaks down crude fiber into simpler fractions, increases crude protein digestibility, and produces a pleasant lactic acid aroma that improves palatability for goats. Furthermore, combining forages and concentrates into a single complete feed prevents selective feeding, saves the time farmers would otherwise spend on daily forage collection or grazing, and can reduce feed costs by up to 20–30% [21–23].

3.3 Knowledge of parasitic disease prevention and control

Farmers' knowledge of the prevention, diagnosis, and control of parasitic diseases in goats is presented in Table 3. The mean score in this domain increased by 46.0 percentage points, from 53.0% before to 99.0% after the educational session.

As shown in Table 3, before the intervention more than half of the farmers were unaware that scabies in goats can be transmitted to humans (60.0%) or that fecal examination can detect worm and protozoan infections (55.0%), and half (50.0%) were unaware of the role of overcrowded pens in parasitic disease outbreaks. After the session, awareness of the zoonotic potential of scabies increased by 60.0 percentage points (to 100%), understanding of the importance of fecal examination by 55.0 percentage points (to 100%), understanding of the effects of overcrowding and poor sanitation by 50.0 percentage points, and recognition of the importance of pen disinfection by 40.0 percentage points.

This improvement is important because gastrointestinal parasites (particularly the blood-feeding nematode *Haemonchus contortus* and the protozoan *Eimeria* sp.) and ectoparasites (*Sarcoptes scabiei*) remain major constraints in smallholder ruminant farming in Southeast Asia [24]. In humid tropical areas such as Kuala Kangsar, dirty, damp, and overcrowded pens accelerate the sporulation of *Eimeria* oocysts and facilitate the transmission of *S. scabiei* mites through direct contact between animals and from animals to farmers [10,25]. By understanding the "iceberg" concept, in which about 95% of the infective parasite population resides in the environment (pen bedding and pasture) and only about 5% in the animal, farmers recognized that anthelmintic or antiparasitic treatment (such as albendazole or ivermectin) will be ineffective unless it is combined with disinfection of raised-floor pens, periodic fecal examination, and rotational grazing [26].

Table 3: Farmers' knowledge of the prevention and control of parasitic diseases in goats before and after training (n = 20)

No.	Questionnaire item	Pre-test		Post-test		Change (pp)
		Yes, n (%)	No, n (%)	Yes, n (%)	No, n (%)	
6	Knows that pen disinfection helps reduce the risk of parasite transmission	12 (60.0)	8 (40.0)	20 (100.0)	0 (0.0)	+40.0
7	Knows that fecal examination can detect worm or other gastrointestinal parasite infections	9 (45.0)	11 (55.0)	20 (100.0)	0 (0.0)	+55.0
8	Knows that overcrowding and poor pen sanitation favor the occurrence of parasitic diseases	10 (50.0)	10 (50.0)	20 (100.0)	0 (0.0)	+50.0
9	Knows that scabies in goats is zoonotic (transmissible to humans)	8 (40.0)	12 (60.0)	20 (100.0)	0 (0.0)	+60.0
10	Willing to isolate goats with skin disease (scabies) from the healthy herd	14 (70.0)	6 (30.0)	19 (95.0)	1 (5.0)	+25.0
Mean, parasitic disease domain		53.0	47.0	99.0	1.0	+46.0

pp = percentage points (post-test % minus pre-test %).

A notable finding concerned item 10 (willingness to isolate goats with scabies from healthy animals), which increased from 70.0% (14 farmers) in the pre-test to 95.0% (19 farmers) in the post-test, with one respondent (5.0%) still answering "No". Field discussions indicated that the main barrier for this farmer was not a lack of knowledge about transmission, since all respondents (100%) understood that scabies is contagious and zoonotic (item 9), but the lack of separate quarantine pens on the farm. This finding provides useful input for the KATAM management and future programs to design simple, low-cost isolation partitions within communal pens.

3.4 Knowledge of reproductive management and artificial insemination

Farmers' understanding of reproductive management and AI technology is presented in Table 4. Of the three training domains, reproductive management had the lowest pre-test score (mean 29.0%) but reached 100% in the post-test, giving the largest improvement of 71.0 percentage points.

Table 4: Farmers' knowledge of reproductive management and artificial insemination (AI) in goats before and after training (n = 20)

No.	Questionnaire item	Pre-test		Post-test		Change (pp)
		Yes, n (%)	No, n (%)	Yes, n (%)	No, n (%)	
11	Knows that does that are too thin or too fat may develop estrous disorders	9 (45.0)	11 (55.0)	20 (100.0)	0 (0.0)	+55.0
12	Knows the four clinical and behavioral signs of estrus in does	5 (25.0)	15 (75.0)	20 (100.0)	0 (0.0)	+75.0
13	Knows that AI must be timed according to the onset of estrus signs	4 (20.0)	16 (80.0)	20 (100.0)	0 (0.0)	+80.0
14	Knows that frozen semen from superior bucks used in AI can improve the genetic quality of offspring	5 (25.0)	15 (75.0)	20 (100.0)	0 (0.0)	+75.0
15	Knows that using frozen semen (AI) improves efficiency because farmers do not need to keep their own bucks	6 (30.0)	14 (70.0)	20 (100.0)	0 (0.0)	+70.0
Mean, reproductive management and AI domain		29.0	71.0	100.0	0.0	+71.0

pp = percentage points (post-test % minus pre-test %).

Table 4 shows that before the training most farmers still relied on natural mating without systematic recording of reproductive cycles. This was reflected in low pre-test scores for the correct timing of AI relative to the onset of estrus (known by only 4 farmers; 20.0%), recognition of the four primary signs of estrus in does (25.0%), the benefits of frozen

semen for improving the genetic quality of offspring (25.0%), and the cost savings of not having to keep breeding bucks (30.0%). In addition, 55.0% of the farmers did not understand the relationship between nutritional status (a body condition that is too thin due to malnutrition or parasitic infection, or too fat due to excess energy intake) and estrous cycle failure (anestrus) [27].

After the interactive sessions, understanding increased by 80.0 percentage points for the timing of AI, 75.0 percentage points for both the detection of the four estrus signs and the genetic benefits of frozen semen, 70.0 percentage points for the efficiency of not keeping breeding bucks, and 55.0 percentage points for the relationship between body condition and estrous disorders. Reproductive success in small ruminants depends heavily on the farmer's ability to detect estrus accurately, including changes in the vulva (swollen, reddened, warm, with clear mucus discharge) and in behavior (restlessness, frequent bleating, tail wagging, and standing to be mounted), because estrus in goats is relatively short (approximately 24–36 hours) and ovulation occurs toward the end of estrus [28]. Inaccurate detection of estrus onset leads to conception failure after AI, prolonging the kidding interval and causing economic losses for farmers.

Overall, the three topics delivered in this program form a coherent and mutually reinforcing management system. Fermented complete feed ensures an adequate year-round supply of protein and energy, enabling breeding does to reach the body condition needed for normal estrous cycles. At the same time, parasitic disease control prevents the nutrient loss and anemia caused by blood-feeding worms and the stress caused by scabies, so that dietary energy can be directed toward pregnancy and the growth of kids produced by AI [11,20]. The collaboration between the Faculty of Veterinary Medicine, Universitas Airlangga, and ITAFoS, Universiti Putra Malaysia, therefore addressed fundamental problems faced by KATAM goat farmers in Manong, Kuala Kangsar, Perak.

This evaluation has several limitations. The one-group design without a control group, the small sample, the use of dichotomous items, and the administration of the post-test at the end of a single-day program mean that the results reflect short-term knowledge gains and may be influenced by recall and ceiling effects. Follow-up visits are recommended to assess the long-term adoption of fermented feed technology and its effects on herd performance indicators, such as body condition, parasite burden, conception rate, and kidding interval.

4 CONCLUSION

Integrated participatory training on fermented complete feed technology, parasitic disease control, and reproductive management substantially improved the knowledge and technical skills of KATAM goat farmers in Manong, Kuala Kangsar, Perak, Malaysia. Mean scores increased by 34.0, 46.0, and 71.0 percentage points in the fermented feed, parasitic disease, and reproductive management domains, respectively, with reproductive management showing the lowest baseline and the greatest improvement. Combining education, hands-on practice, and discussion proved effective for transferring appropriate technology to smallholder farmers. Continued mentoring, the provision of simple isolation pens, and access to AI services are recommended to support the adoption of these practices and their translation into improved herd productivity.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

This community service program did not involve any experimental procedures on animals. Human participation was limited to a voluntary knowledge questionnaire completed by adult farmers, and no personally identifiable or sensitive data were collected or reported; therefore, formal ethical approval was not required.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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