


# The role of goat production in smallholder systems in Lao PDR: implications for improving productivity and scaling up production

Eoin Liehr<sup>A,\*</sup> , Joanne Millar<sup>B</sup>, Stephen Walkden-Brown<sup>C</sup>, Malavanh Chittavong<sup>C</sup> and Luisa Olmo<sup>A</sup>

For full list of author affiliations and declarations see end of paper

## \*Correspondence to:

Eoin Liehr  
School of Environmental and Rural Science,  
University of New England, Armidale,  
NSW 2351, Australia  
Email: [eliehr@myune.edu.au](mailto:eliehr@myune.edu.au)

## Handling Editor:

Russell Bush

**Received:** 12 November 2023

**Accepted:** 5 April 2024

**Published:** 29 April 2024

**Cite this:** Liehr E *et al.* (2024)

The role of goat production in smallholder systems in Lao PDR: implications for improving productivity and scaling up production. *Animal Production Science* **64**, AN23368. doi:10.1071/AN23368

© 2024 The Author(s) (or their employer(s)). Published by CSIRO Publishing.

This is an open access article distributed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License ([CC BY-NC-ND](https://creativecommons.org/licenses/by-nc-nd/4.0/)).

OPEN ACCESS

## ABSTRACT

**Context.** Rising demand from Vietnam for Lao goat meat has triggered a rapid increase in goat numbers in Lao Peoples Democratic Republic (Lao PDR). Despite the increased market opportunity for smallholder farmers in Laos, goat production remains low input within free-grazing management systems. **Aims.** Qualitative research was conducted to explore the role that goat production plays in farmers' livelihood strategies and farming systems, including the benefits and associated trade-offs, so as to inform development approaches to improve goat husbandry and productivity. **Methods.** Semi-structured interviews were conducted with 30 smallholder goat farmers across five villages in southern-central Laos. Interview transcripts were analysed using grounded theory methodology with the assistance of the Nvivo 12 software program. **Key results.** The interviews showed that goats were a profitable and liquid asset for farmers. Income from goats was used for small expenses that occurred frequently or at short notice, such as household loans or debts, utility and medical costs and buying food and clothing for family members. Goats had socio-cultural purposes, with some farmers preferring to consume goats during celebratory occasions over other livestock species. Managing goats was easy and benefited the wider farming system by providing goat manure to fertilise crop plantations. **Conclusions.** Goat productivity and goats' unique subsistence and socio-cultural roles can be enhanced by improving goat kid management, goat-house design and cleaning, and by implementing disease management. These activities can be low input. **Implications.** The government policy and future development projects in Laos should focus on increasing goat productivity rather than increasing the scale of farmers' goat enterprises. The majority of farmers may not benefit from significantly increasing the scale of their goat enterprises because of trade-offs associated with free-grazing management, including goats damaging crops or becoming lost or involved in accidents such as dog attacks and car accidents.

**Keywords:** agricultural development, goat production, Lao PDR, livelihood benefits, scaling up, smallholder farming, socio-cultural purposes, trade-offs.

## Introduction

In recent decades, goat numbers have increased rapidly throughout Lao People's Democratic Republic (Laos). Between 2011 and 2022, Laos' goat population increased from 215,600 (Gray *et al.* 2019) to an estimated 682,000 goats (FAOSTAT 2022). This growth is driven by an increased demand for goat meat from Vietnam, where an estimated 90% of Laos' goats are exported (Gray *et al.* 2019). Laos' rural households are benefitting from the expanding goat trade (Millar *et al.* 2022). This is most evident in the southern-central province of Savannakhet, which accounts for the largest proportion of the goat population in Laos (26%; MAF 2014). In Savannakhet, goat raising contributes just under a third of household income and 40.6% of total farm income to rural goat-farming households (Millar *et al.* 2022). Raising goats presents an economic opportunity for rural smallholder farmers in Laos. Two-thirds of Laos' total human population reside in rural villages, where the highest rates of poverty are concentrated

(The World Bank 2020), and 90% of Laos' rural households are farming households engaged in crop, livestock and/or aquaculture production (The World Bank 2022). Raising goats offers a path to poverty reduction and improved livelihood conditions for Laos' rural smallholders.

Increasing goat productivity may assist smallholders in Laos in capitalising on the economic opportunity associated with the growing goat sector. The existence of the strong goat market also presents an opportunity for Laos' farmers to increase the scale of their goat enterprises. However, goat production in Laos remains informal and small scale (3–10 goats per herd), characterised by low inputs and low to moderate productivity (Windsor *et al.* 2018). Laos' farmers have reported that goats typically give birth to their first kid at 12–18 months of age (Gray *et al.* 2019). The mean number of live kids born/doe/year in Laos' smallholder conditions has been reported to range between 1.3 and 1.9 (Colvin *et al.* 2022). The most common management system is free-grazing where goats freely browse leaves and native grasses in forests, fallow land, road sides or rice paddy fields post-harvest (Xaypha 2005; Phengsavanh 2006; Windsor *et al.* 2018). Within these production systems, research has identified the main constraints to increasing goat productivity in Laos as inadequate nutrition and feed availability owing to reliance on natural availability, high prevalence of diseases (Orf disease, diarrhoea, bloat) and internal parasites, and poor management practices (Phengvichith and Preston 2011; Windsor *et al.* 2017, 2018; Millar *et al.* 2022).

Government- and non-government organisation (NGO)-initiated projects have attempted to assist smallholders in increasing their goat productivity by addressing the aforementioned constraints. Despite these efforts and the increased market opportunity, goat production systems in Laos have remained unchanged (Gray *et al.* 2019). It is currently unclear how sociological factors may be contributing to this phenomenon. Sociological factors may be defined as social conditions that affect human behaviour, including socio-economic conditions, environmental circumstances and the customs of an individual's social group (American Psychological Association 2023).

In recent decades, increased significance has been attributed to the impacts that sociological factors have on farmer behaviour and decision-making (Zeweld *et al.* 2017). Research has demonstrated that smallholder farmers may orient their farming activities towards satisfying objectives other than solely increasing yields and meeting market demands (Ayalew *et al.* 2003; Ouma *et al.* 2003; Bettencourt *et al.* 2015). Some of these objectives include security, status, asset diversification, farm integration and socio-cultural relevance (Ayalew *et al.* 2003; Bettencourt *et al.* 2015). Sociological factors such as farmer attitudes, intentions, and their specific purposes for raising particular livestock species can influence smallholder farmers' capacity and willingness to implement 'improved' agricultural practices (Ayalew *et al.* 2003; Bettencourt *et al.* 2015; Zeweld *et al.* 2017). Thus,

the sociological roles that livestock species play within smallholder farmers' livelihood strategies can directly affect productivity outcomes.

Despite this, there has been little sociological research conducted on goat production in Laos. The relative importance goats have across gender and age cohorts is unclear (Gray *et al.* 2019). There are knowledge gaps regarding the extent to which households in Laos rely on goats to cope with economic shocks (Gray *et al.* 2019). There is also limited understanding of the specific roles goats fulfil within the wider farming system, including the productive and non-productive purposes farmers have for raising goats (Gray *et al.* 2019). Little is known about the unique benefits and trade-offs associated with goat management. It is unclear whether goats play a socio-cultural role in farmers' livelihoods. This is despite a precedence of socio-cultural relevance for other livestock species throughout Laos and the surrounding regions. For instance, the involvement of cattle, buffalo and pigs for spiritual rituals, festivals and ceremonies has been previously documented in Laos (Sprenger 2005; Phengsavanh *et al.* 2011; Leuangvilay *et al.* 2017). In some cases, farmers specifically fatten and reserve their livestock for these socio-cultural events (Phengsavanh *et al.* 2011). The majority of these events involve animal sacrifice or slaughter. Such socio-cultural uses can have a direct influence on productivity.

The qualitative research described in this paper was conducted to explore farmers' reasons for raising goats, including the benefits and associated trade-offs, to inform development approaches to improving goat husbandry and productivity. The research was exploratory, starting with the following two main research questions: (1) what are the benefits and burdens associated with goat raising in Lao PDR; and (2) what socio-cultural uses do Laos' farmers have for their goats? This paper presents findings from farmer responses to semi-structured interviews, describing why Laos' households raise goats and the role that goat production plays within their livelihood strategies. Implications for development attempts to improve goat productivity and increase the scale of goat enterprises in Laos are discussed.

## Methods

This paper presents some of the findings of a qualitative study into the sociological aspects of goat raising in Lao PDR for the improvement of human livelihoods.

The study was conducted as part of the 'Goat Production Systems and Marketing in Lao PDR and Vietnam' (LS-2017/34) research for development project. The LS/2017/34 project was funded by the Australian Centre for International Agricultural Research (ACIAR), and led by the University of New England (UNE), Australia, and the National Agriculture and Forestry Research Institute (NAFRI), Laos. The LS/2017/34 project worked with 70 smallholder goat-farming households, across

seven villages in Savannakhet province (10 households in each village), to trial goat-husbandry improvements. The seven LS/2017/34 villages were located across three districts in Savannakhet province, which holds the largest proportion of Laos' goat population (26%; MAF 2014). The seven villages were randomly selected on the basis of the criteria that (1) villages had many goats (minimum of 80 goats), (2) at least 10% of households within the village owned goats, and (3) the village leader, committee and farmers were willing to participate in the 4-year project. Households were selected on the basis of the criteria that households (1) had at least five goats, (2) were interested in participating and (3) had labour and land to support adoption of selected husbandry interventions. For a more detailed rationale behind the selection of the study site and beneficiaries for the LS/2017/34 projects, refer to Phengvilaysouk *et al.* (2022).

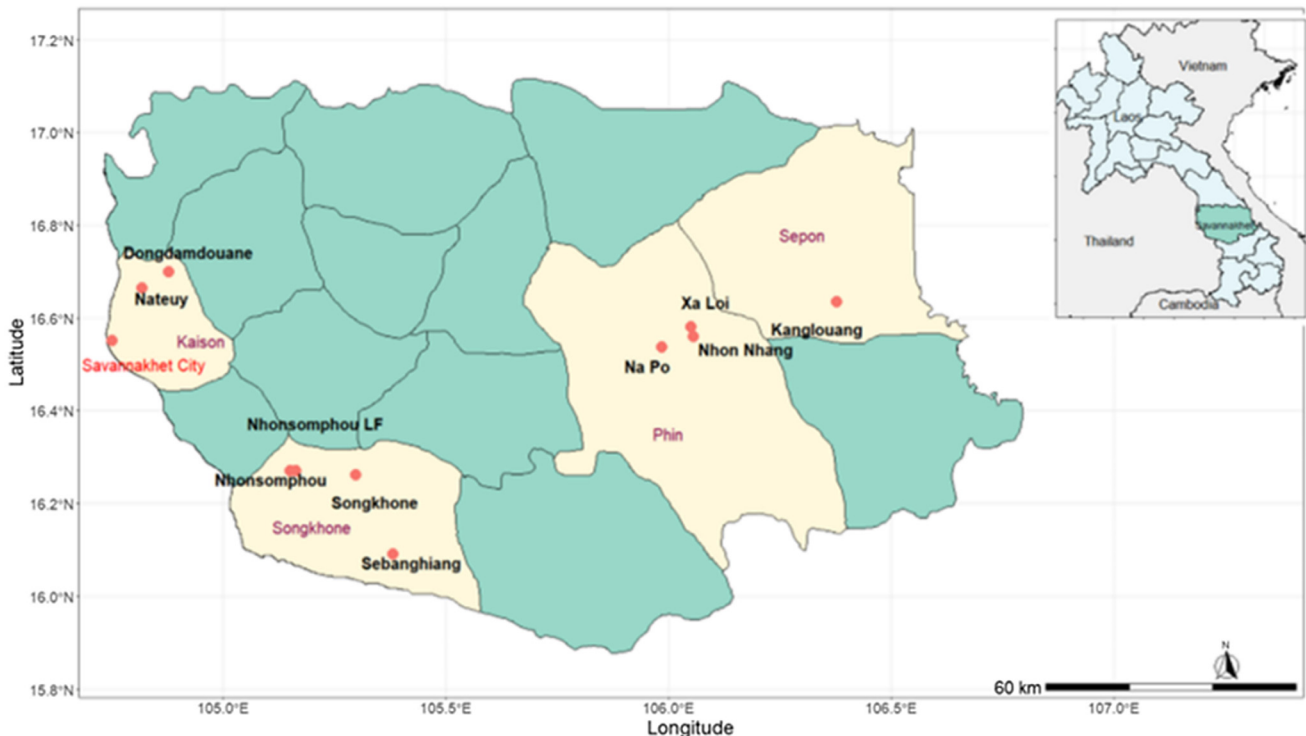
Staff visited households every month and conducted hands-on training in forage-plot establishment to supplement goat nutrition, use of mineral blocks, veterinary treatments, and elevated goat housing with slated flooring to improve hygiene. The project commenced in July 2019 and concluded in December 2023. More information on the project is available at <https://www.aciar.gov.au/project/ls-2017-034>. This study aimed to provide in-depth understanding of the roles goats fulfil in smallholder livelihoods, including the associated benefits, burdens and socio-cultural uses of goats prior to and during the project, so as to inform and improve project approaches.

## Study design and site

Participant households were selected from five of the target villages of the LS-2017/34 project in Savannakhet province (Fig. 1), which holds the largest proportion of Laos' goat population (26%; MAF 2014). These villages were selected on the basis that they collectively provided a wide diversity of village characteristics and social contexts (Supplementary Appendix S1). These data were derived from a prior structured survey of all households at the commencement of the LS-2017/34 project (Olmo *et al.* 2022).

## Household selection

Stratified purposeful sampling was used to select households from the five villages that were (1) goat-raising households that were current beneficiaries of the LS/2017/34 project (project goat-raising households), and (2) goat-raising households that were not registered as beneficiaries of the LS/2017/34 project (non-project goat-raising households). From each stratum, three households were purposively selected from each village. The aim was to explore differences between the cohorts and project influences. Stratified purposive sampling involves the purposive selection of study participants across a number of distinct strata (Palinkas *et al.* 2015). Qualitative researchers may purposively decide on the characteristics that distinguish the different strata from one another, on the basis of the pertinence of these differences to the topic of inquiry (Palinkas *et al.* 2015). Stratified purposeful sampling is a



**Fig. 1.** Location of study villages. Note. Figure copied from Le *et al.* (2024) with permission from author.

valid qualitative research technique for in-depth exploration of differences across groups with significant variation pertinent to the topic of inquiry (Palinkas *et al.* 2015). To ensure that participants had sufficient experience in raising goats and could provide valuable insights, all household members that were selected for interview across both strata were at least 18 years of age, owned at least five goats, and had at least 1 year of experience raising goats.

### Project household selection

The same 2022 structured survey conducted by the LS/2017/34 project (Olmo *et al.* 2022) provided baseline household data on the project goat-raising households such as goat herd sizes, years of experience raising goats, proportion of household income from goats, reported reasons for raising goats, management and grazing strategies, reported constraints and share of goat management among household members. Other features included ethnicities, years lived in the village, number of household members, gender and age ratios, farm areas owned and rented, access to other farm and off-farm resources, rates of labour hire and sources of information and animal health services. These features were used to purposively select a wide range of households to account for as much diversity in social context as possible.

### Non-project goat-raising household selection

Baseline household data were not available for non-project goat-raising households. Therefore, fewer household features were used to purposively select for non-project goat-raising households across as diverse a range of social context as possible. These features included participants' gender, age and ethnicity. Data on participants' number of household members, goat herd size and years of experience raising goats were also collected.

### Ethical approval

This study was granted ethical approval by the University of New England Human Research Ethics Committee (UNE HREC) Chair on 21 June 2022. The ethics approval number is HE22-102. Signed consent to quote and publish participant responses anonymously or using pseudonyms was obtained by participants prior to participating in any audio-recorded interviews. Consent forms were provided in Lao language and were accompanied by a Lao language information sheet that outlined the details and purpose of the study. Participants had to be 18 years of age, or older, to be included in the study.

### Data collection and analysis

Data were collected via individual semi-structured interviews with 30 smallholder goat farmers in Laos. All semi-structured interviews were conducted face-to-face in Lao language, with the assistance of an interpreter who was fluent in both the Lao and English language. Interviews were facilitated by a male

researcher from the University of New England, and a female senior researcher from Charles Sturt University. The interviewers were assisted by a male and female interpreters from the NAFRI. The interpreters had previous involvement with the activities of the LS/2017/34 project, including monthly village visits and learning activities, and were familiar to respondents. Interviews were conducted with a single member of the household who consented to be interviewed, in their house. Efforts were made to ensure that interview respondents were equally comprising men and women household members. However, this was constrained by farmer availability at the time of interview. The semi-structured interviews consisted of 20 open-ended questions (Appendix S2) related to the two aforementioned research questions. Interview audio recordings were translated and transcribed into English transcripts, which constituted the dataset of this study. Multiple professional Lao translators were hired to verify that the translations were consistent and accurate.

Data were analysed using a grounded theory methodology, which is exploratory in nature, beginning with open-ended questions and no prior hypotheses. It is an inductive process, whereby findings are grounded in the dataset and emerge during subsequent analysis (Kelle 2007). Interview transcripts were coded and analysed for emergent themes arising from farmer responses to semi-structured interview questions. The NVivo 12 software program (<https://www.une.edu.au/current-students/support/it-services/software>), designed for qualitative analysis of unstructured text, was used to assist this process of coding and analysis. In qualitative research, data collection and analysis stops at the point where emergent themes are considered to have been fully developed (Saunders *et al.* 2018). Repeated identification of the same emergent themes over repeated bouts of analysis, without the identification of any new emergent themes, signifies that saturation has been reached and emergent themes are fully developed (Glaser and Strauss 1999). Sampling as diversely as possible ensures that emergent themes do not require more data collection, because the saturation point will be based on the widest range of data available (Saunders *et al.* 2018). The subheadings in the Results section of this paper represent saturated themes.

Farmers were free to discuss whichever goat-raising benefits, burdens and socio-cultural uses occurred to them at the time of interview. Probing was used to encourage farmers to elaborate on answers they had previously given. To avoid bias, interviewers refrained from directing farmers' answers towards particular features of goat raising that were not raised by the farmers themselves. The Results section of this paper will report the number of farmers that discussed particular benefits, burdens and socio-cultural uses associated with their goats. Because of the non-binary nature of interview questions and farmer responses, readers should not interpret the number of farmers that did not discuss a particular aspect of goat raising as having opposing views

to the cohort of farmers that did discuss that aspect of goat raising.

## Results

### Household demographics

Of the 30 farmers surveyed in total, 16 were males (nine project, seven non-project), whereas 14 were female (six project, eight non-project). The average age of farmers interviewed was 45 years, ranging from 18 to 70 years. The study included farmers from four ethnic backgrounds: Lao Loum (13 farmers), Mong Khong (10 farmers), Phu Tai (5 farmers) and Brou (2 farmers). There was an average of four people per household, with households ranging from two to eight household members. The average goat herd size was 14 goats. Goat herd sizes ranged from 5 to 37 goats. The average number of years farmers had raised goats was 7 years.

### Household benefits from goat raising

#### Goats are profitable liquid assets that are easy to sell

Farmers were asked which factors motivated them to raise goats (Q1 and Q2 in Appendix S2). Twenty-three farmers (77%) reported that the profitability and liquidity of goats as an asset was a main incentive. This was facilitated by frequent goat-trader visits to villages to purchase goats, as reported by 19 farmers (63%). A 32-year-old project farmer from Xaloi village recounted that goat traders visited the village in search of goats every day. There was no notable difference between project and non-project farmers in their level of awareness of the presence of traders visiting their village in search of goats to purchase. The high frequency of trader visits all year round meant that farmers could sell and convert their goats to cash easily and at short notice. Farmers perceived their goats as growing to marketable weight quickly, enabling them to sell them after having raised them only for 6 months. Farmers believed this was a key advantage over larger livestock, such as cattle, which took at least 2 years to reach sale weight. Fourteen farmers (47%; nine men, five women) expressed that goats were easy to sell. These farmers were split evenly across project and non-project cohorts.

Twelve farmers (40%; seven men, five women) elaborated on their interactions with goat traders. This was in response to questions about the delegation of goat-raising responsibilities among household members, including the sale of goats and management of income from goats (Q4, Q5, Q6, Q12 and Q13 in Appendix S2). These farmers explained that the abundance of traders meant that they could refuse offered prices if they believed they were too low. Traders emphasised to farmers that goats received better prices than cattle and buffalo, relative to their size. When asked about the benefits of raising goats (Q11 in Appendix S2), eight farmers (27%; six

project, two non-project) volunteered that the good prices they received for goats was a primary benefit. One farmer explained her approach to bargaining with traders, as follows:

'I am the one who deals with traders... If I wanted to get 1,000,000 kip, I need to ask for 1,100,000 kip. If I said 1,000,000 kip per goat, the trader would bargain to 800,000 kip... Some traders will keep bargaining, but some will walk away... I don't call them because there are many traders. Sometimes they call me. (Thirty-two-year-old female non-project farmer, Xaloi village)

#### Goat raising increased financial security

Twenty-two farmers (73%) reported that their goat ownership had increased their financial security. Farmers volunteered this when asked questions about which benefits motivated them to raise goats (Q1, Q2 and Q11 in Appendix S2). Questions about the use of income from goats and livelihood changes that farmers had experienced since raising goats prompted similar answers (Q12 and Q16 in Appendix S2). Sixteen farmers (53%; 10 project, 6 non-project) reported that income from goats was an important safety net when they had ran out of money or essential household goods, as described in the quote below:

When I don't have enough money, I can sell them to get over my debts. If I don't have money, I will sell one or two goats. Raising goats is very useful for me and it helps me get through some difficulties. Having goats is like having savings in the bank. (Forty-nine-year-old male project farmer, Xaloi village)

This was true for farmers that did not raise goats as their main source of income. Farmers commonly reserved goat sales specifically for alleviating financial stresses on the household. Income from goats was better suited to alleviating financial difficulties than that from larger livestock, which took longer to sell. Four farmers (13%) explained that the safety net that income from goats provided them meant that they no longer had to borrow money from family members, particularly their own adult children. In contrast, four male farmers (13%) reported that goat ownership had actually assisted them in borrowing money from others. These farmers had been able to loan money they otherwise would not have been given had it not been for their goats acting as collateral.

Income goats increased financial security by contributing to household savings for 10 farmers (33%; six project, four non-project). The ownership of goats enabled four of these farmers (13%) from Napo village to deposit their savings from the income they received from goats in village financial systems. This enabled farmers to withdraw their savings from collective village savings funds without having to pay interest because their goats could act as collateral. This

cohort was comprised of both genders as well as project and non-project farmers.

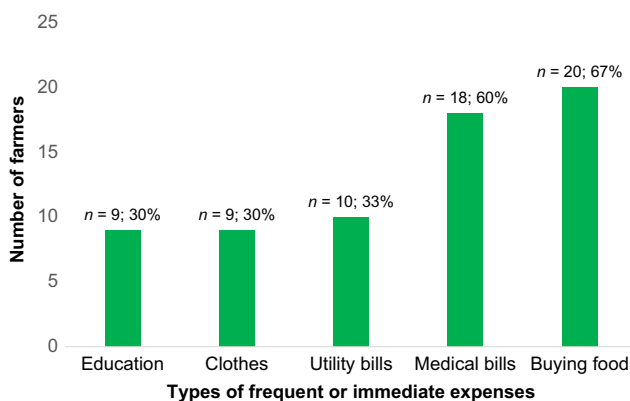
### Income from goats was suited towards expenses that arose frequently

The unique suitability of income from goats towards meeting immediate, or frequently occurring demands on the household was reported by 83% of farmers ( $n = 25$ ). These farmers volunteered this appraisal of income from goats when asked about their motivations to raise goats, the benefits associated with goat raising, and their different uses of this income (Q1, Q2 and Q11 in Appendix S2). These farmers described income from goats as being most commonly used to ensure food security, which was closely followed by the payment of medical bills (Fig. 2).

When asked about the relative importance that goats had in farmers' livelihoods (Q17 in Appendix S2), seven farmers (23%) reported that they were heavily dependent on their goats to maintain their standard of living. Six of these farmers were project farmers. These farmers believed that they could not satisfy household demands without their income from goats, particularly payment of hospital bills. Some household members had chronic conditions that required regular medication that they could afford because of their goats, as described in this quote:

Recently, I spent money [from goat sale] on medical expenses for my wife . . . She fell down and she got injured and it affected her ability to walk. I can withdraw (goat income) whenever I want in case of emergency . . . It helps a lot because I can sell them whenever I want. In addition, I will take my wife to see a doctor for checking up again soon in Savannakhet. A few days ago, I sold 5–6-month goats for about 1.8 million kip. (Fifty-four-year-old male project farmer, Napo village)

A smaller, yet considerable cohort of farmers used their income from goats to pay for household utility bills, as well



**Fig. 2.** Proportion of farmers reporting types of frequent or immediate expenses paid for by income from goats, of all interviewed farmers.

as clothing, particularly for their children (Fig. 2). Nine farmers (30%) spent their goat income on their children's tuition fees as well as stationary, uniforms and school bags. One farmer bought soaps and detergent because his children were required to walk along dirt roads to school. There was no notable difference in spending across gender or project and non-project cohorts.

### Income from goats benefited the overall farming system

When asked about benefits from raising goats and the use of income from goats (Q11 and Q12 in Appendix S2), eight farmers (27%) reinvested their income from goats back into their farming system and facilities, in a variety of ways. Six farmers (20%) used their income from goats to improve the productivity of their crop plantations. Three of these farmers hired extra labour to cultivate their plantations. Two of these farmers bought fuel for their tractor to plough their plantations. Another farmer bought fertiliser with his income from goats.

Five farmers (17%) used their income from goats to improve their livestock enterprises. Two farmers (7%) bought new stock (cows, calves, breeding goat) with this income. Two farmers (7%) used their income from goats to improve their goat houses. One farmer bought rice bran and feed for her pigs and ducks.

### Women were more often responsible for the use of income from goats

When asked about household members' access to, and decision-making concerning, income generated from goat sales (Q13 in Appendix S2), 13 households (43%) reported that women were the sole decision-makers about the use of the income from goats. In 11 other households (37%), this was shared among family members. There were only four households (13%) where males were the sole controllers and decision-makers concerning the use of the income from goats. The reasons for allocating this responsibility varied. The delegation of income decision-making to women was based on beliefs that it was easier to manage income with one person only. In some cases, women were in control because they had been the one to sell the goats. Three farmers (10%) expressed that women were better managers of income and household finances. In households that shared decision-making, discussion between husband and wife premeditated the use of income from goats. One 35-year-old male project farmer from Kanglouang village justified his control of finances relating to raising goats because of his identity as the 'head of the household'. This meant that he was in charge of any decisions that had consequence to household functioning. Another 49-year-old project farmer from Xaloi village justified his role because his wife was illiterate and had received less education than he had.

## Socio-cultural benefits of goat raising

### Goats played a celebratory role

Farmers were asked whether they had any purposes for raising goats outside of income generation (Q14 in Appendix S2). Farmers were also asked about any special occasions or ceremonies that involved goats (Q19 in Appendix S2). In response to these questions, 73% of farmers ( $n = 22$ ) reported that goats were involved in celebratory social events (Fig. 3). These celebratory events usually involved the slaughter of a goat and shared consumption of the goat meat with family, friends and community members. Slaughtering a goat did not represent as large an expenditure as slaughtering a head of cattle or buffalo. The smaller size of goats was more compatible with feeding large groups without meat being left over to spoil without refrigeration.

Two farmers (7%) gifted their married children with goats to raise in their new home. One recently married Mong Khong farmer explained that his parents had provided his brides' family with a goat as a form of dowry. Farmers that reserved slaughtering their goats for special gatherings of their family and friends considered the people they served goat meat to be important. Three farmers (10%) reported using their goat income to contribute to collective village funds used to pay for funeral costs in the case of a community member having died (Fig. 3).

### Goats were involved in ritual ceremonies

Six Mong Khong farmers (20%; three Xaloi village, three Kanglouang village) reported using their goats in ritual ceremonies referred to as 'Jum'. Five of these farmers were male project farmers. These ceremonies occurred when a family member fell sick. Family members of the sick person would consult a spiritual leader within the community to seek guidance from ancestral spirits, which they believed resided in the nearby forest. Farmers explained that any animal could be sacrificed for Jum ceremonies, depending on what the spirit requested. However, goats frequently substituted larger livestock, as explained below:

Actually, buffaloes were preferable for this sacrifice ceremony, but nowadays people use goats instead . . . there are many steps to Jum. Normally we use goat meat to make and offer cooked and raw Laab (meat salad), leaving it at the rice barn. We put Laab in bamboo bowls and make 12 serves. Some textiles and Lao skirts are also offered together with Laab. After finishing the ceremony at the rice barn, we have to do the same at the house of patient as well . . . we use offal, intestines, liver of the goat. We use the head of the goat for the sacrifice as well. Then we eat the rest . . . The seniors will sit around the patient and pray for the patient to get better . . . the goat head is put at the door of the patient's house. Then the seniors use a fishing net to call back a spirit of the patient. (Thirty-two-year-old male project farmer, Xaloi village)

One 31-year-old male project farmer from Kanglouang village explained that the 12 bowls represented their ancestral spirits, which played a guardian role of watching over the sick family member. Farmers believed that Jum ceremonies had contributed to the recovery of sick people in the past, as explained in the following quote:

There was a case that a villager almost died, but when we did the sacrifice ceremony, he recovered from the illness. Sometimes the doctor also advised us to do this ceremony if the patient was not recovered from the modern treatment. (Thirty-two-year-old male project farmer, Xaloi village)

## Management benefits and trade-offs

### Goat manure essential for crop production

In response to questions about goat-raising benefits and purposes of raising goats outside of income generation (Q11 and Q14 in Appendix S2), 77% of farmers ( $n = 23$ ) reported that goat manure was a useful fertiliser. For these farmers, goat manure was so valuable that it could be gifted to family or friends, traded for sacks of rice, or sold for cash (Fig. 4). Farmers reported that manure was most useful during the dry season. Goat manure increased food security indirectly, by fertilising farmers' vegetable gardens and crop plantations. The use of manure did not differ across gender or project and non-project cohorts.

### Ease of management of goats benefited the farming system

When responding to questions concerning the benefits of raising goats (Q11 in Appendix S2), 16 farmers (53%) identified not having to supervise their goats when grazing freely, as a key benefit. This enabled farmers to attend to other livelihood activities, such as planting or harvesting rice fields. Seven (23%) of these farmers expressed that not having to supervise their goats was a comparative advantage over raising other livestock. These farmers believed that goats did not require the close supervision that was needed when managing cattle and buffalo. Four of these farmers explained

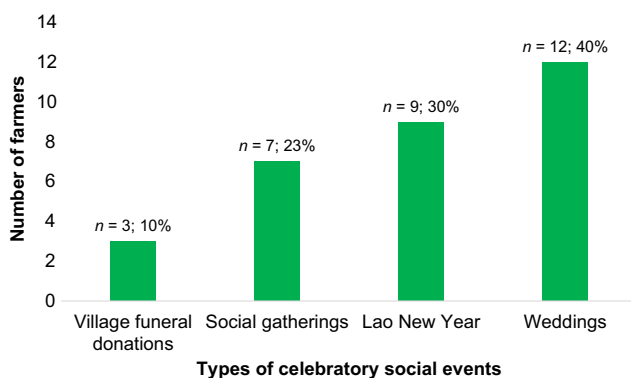
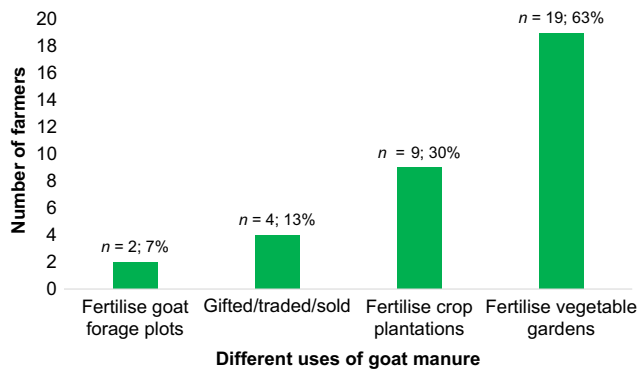


Fig. 3. Proportion of farmers that reported using goats in celebratory social events, of all interviewed farmers.



**Fig. 4.** Proportion of farmers reporting use of goat manure, of all interviewed farmers.

that goats ate less than pigs, cattle and buffalo. This meant they did not have to provide as much supplementary feed or cut and carry forage grasses as frequently. There was no notable difference across gender or between project and non-project cohorts.

When asked about the unique benefits to goat raising (Q11 in Appendix S2), nine farmers (30%) volunteered that goat raising was not time consuming, spending only 20 min to 1 h on goat management per day. Eight of these farmers were project farmers. The benefits of this free-time were pronounced during the rice-planting season for one farmer, as follows:

I have more time for other activities because I don't need to spend more time taking care of them (goats). Especially during planting season, I have to go to the paddy field early in the morning, I just keep the gate of the pen open and let the goats out whenever they want. And when I come back from the rice field, I just look for them and let them get in the pen. As a result, I have more time to do my own affairs. (Forty-two-year-old female project farmer, Sebanghiang village)

The free-time and lack of supervision led 14 farmers (47%; nine project, five non-project) to describe goat management as 'easy' when discussing goat-raising benefits. This perception of ease of management was a motivating factor for 12 of these farmers to try raising goats initially. Twelve farmers (40%) preferred to raise goats over cattle and buffalo despite larger livestock being perceived as more valuable. Larger livestock required a larger investment of time and labour, which inevitably took away from time spent on other livelihood activities. Goats were also viewed as more practical to manage within the limited space of their land.

### Benefits of goat reproductive capacity and growth rates

When asked about the benefits of raising goats (Q11 in Appendix S2), 14 farmers (47%) emphasised that their

goats' reproductive capacity and growth rates were the most advantageous traits. There was no notable difference between project and non-project cohorts. The capacity of goats to give birth twice a year was an advantage over cattle and buffalo, which give birth only up to once a year. This is described by one farmer in the quote below:

I noticed that goats could reproduce many goats in a year, so I wanted to raise them... In the past, I used to raise cattle, but they did not reproduce many calves. Only one calf was reproduced per year. Then it took 3 years to sell them. On the other hand, goats gave birth twice a year and two kids each time. I found that it's better than raising cattle and I did not want to raise cattle anymore... (70-year-old male project farmer, Sebanghiang village)

Six farmers (20%) expressed that their goats commonly gave birth to twins or triplets. This meant that farmers could increase their herd sizes quickly. Three farmers (10%) explained that their goats grew quickly and were therefore ready for sale much sooner than are larger livestock.

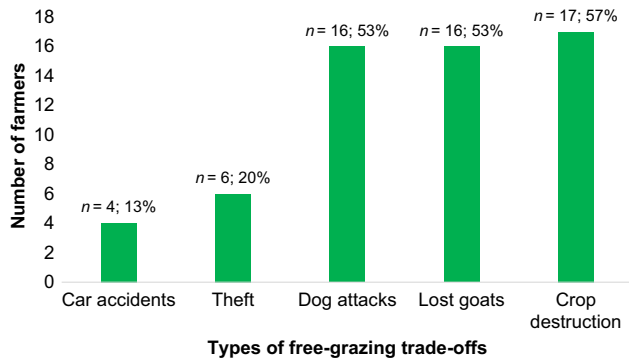
### Free-ranging goats were vulnerable to accidents and destroyed crops

Although unsupervised free-grazing goat management represented valuable time-savings, it also had trade-offs that reduced the productivity of farmers' goat enterprises. Farmers reported trade-offs to free-grazing management, most notably crop destruction (Fig. 5), when responding to questions about burdens associated with goat raising (Q15 in Appendix S2).

Goats destroying crops had caused conflict with their neighbours in the past for 11 respondents (37%). For most farmers, a certain degree of crop damage was an accepted trade-off to free-grazing management. Most farmers that had their crops damaged by goats were aware that their own goats had caused damage to other farmers' crops. Therefore, most farmers simply warned their neighbours when their goats had strayed onto their crop fields. In rarer instances, farmers had to reimburse their neighbours for the crop damage their goats had caused. However, some farmers reported that their goats had been hit or slashed by their neighbours when straying onto their land. This usually injured or killed goats. The most severe neighbour conflict is depicted in the following quote:

They (the neighbour) poisoned six of my goats to death. If it wasn't for that I could make more money. My goats went to their land and they put chemical fertiliser into the water and my goats drank it. The owner of land won't respond or give compensation since my goats went into their place by themselves. So, I don't let them out much. (Sixty-year-old female project farmer, Nhomsomphu village)





**Fig. 5.** Proportion of farmers that reported trade-offs associated with free-grazing goat management, of all interviewed farmers.

Goat theft was a problem for six farmers (20%) (Fig. 5). One farmer had up to four goats stolen and had been forced to supervise his goats more closely as a result. Six farmers (20%) reported that they had lost goats continuously since they had begun raising goats. Most of these farmers lost between one and three goats per year, with 10 goats being the highest number of goats lost in a single year, representing a major economic loss. One farmer tried to avoid losing goats by selling them whenever her herd numbers began to increase too much, as explained below:

When I let them out, I sometimes lost them, some goats never came back... Sometimes, I sell the goats not because I need money, but I have to sell them because some goats like to run with the female goats. I am afraid that they will never come back, so I have to sell them. (Fifty-year-old female non-project farmer, Napo village)

One farmer reported that eight of his goats had died as a result of car accidents since he had begun raising them.

### Attempts to avoid trade-offs of unsupervised free-grazing

Some farmers discussed solutions to free-grazing trade-offs. Four farmers (13%) built fences around their land to prevent their goats from becoming lost, involved in accidents or damaging the crops of others. Two farmers (7%) tethered goats and let them graze in communal areas. One farmer even relocated his goats to his parent's land, which was fenced. His parents lived 10 km away, resulting in only two to three visits by him a month. Another farmer grew forages and trees on his property to entice his goats to remain there. Farmers reported that problems associated with free-grazing were more pronounced during the rice growing season, when their time was the scarcest, as explained below:

It gives more work. I can say I have less time, especially during rice-growing season. It is a hard time. If family members go to plant the seedlings at the rice field, there

is only one person left. I have two rice fields. While I work on the farm during rice seedlings preparation, I have to look after goats at the same time. (Fifty-five-year-old male non-project farmer, Nhomsomphou village)

### Farmer aspirations for their goat enterprises

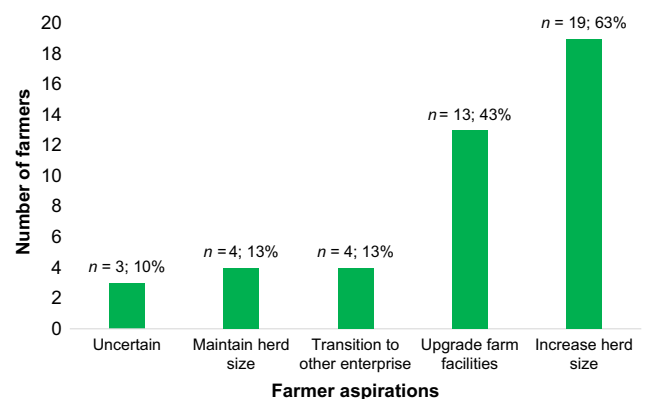
When asked about their plans and goals for the future (Q20 in Appendix S2), farmers discussed the aspirations they had for their goat enterprises. Most farmers ( $n = 19$ ; 63%) aspired to increase their goat herd sizes (Fig. 6). Thirteen of these farmers were men.

The degree to which farmers aspired to increase their herd sizes was stifled by resource constraints. The largest proportion of farmers wishing to increase their herd size ( $n = 8$ ) wished to increase it by 5–10 goats, with the upper herd-size limit being 30–50 goats. There was no notable difference between project and non-project farmers. Only two farmers expressed the desire to own 100–200 goats. Three farmers expressed that a lack of available labour was an obstacle to increasing their goat numbers, as expressed in the quote below:

During this season, it is very difficult for me because I have to take care of the cows and my daughter has to look after the goats. In addition, my daughter will start school soon, so no one will take care of the goats... When I have to look after the cows and take them to eat along the road, no one takes care of the goats. (Thirty-three-year-old female project farmer from Nhomsomphou)

Three farmers (10%) believed that increasing their herd sizes would make the herd unmanageable through goats damaging crops, being hit by cars or attacked by dogs. Even farmers aspiring to own 100 goats, were aware of the risks, as explained in the quote below:

I personally want to raise 100 goats, but there are some problems. They often fight each other and get abortion



**Fig. 6.** Proportion of farmers reporting aspirations for their future in goat raising, of all interviewed farmers.

eventually. Based on my observation, if I want to raise many goats, I need to separate them into group of 10, for instance, so that they don't fight. I also found that when a goat panics, he is afraid of eating with other goats, so he is not healthy. Besides, I don't have anyone to help raising goats... If the goats go to eat other farmers' plants, the farmers get angry. And the goats are likely to get in accidents and attacked by dogs. I prefer raising less numbers of goat in order to just sell them when it's necessary. (Sixty-three-year-old male project farmer from Nhomsoiphou village)

Some farmers aspired to upgrade their goat houses, land and forages, as well as machinery for preparing goat feeds. There was no notable difference across gender or between project and non-project cohorts. Some farmers aspired to transition into goat trading or cattle and buffalo raising. Four farmers (13%) were content with the scale of their goat herds. These farmers had an average herd size of 10 goats, with their herds ranging from 5 to 18 goats.

## Discussion

Our study showed that goats occupy a niche in smallholder farmers' livelihoods in Laos. Goats were uniquely suited towards ensuring household financial security and everyday survival because of their liquidity as an asset. This predisposed income from goats towards meeting small but frequent or immediate expenses, including household loans or debts, financing food shortages, or medical and hospital bills. Farmers reported that goats reproduced and reached marketable weight faster than do larger livestock species. This meant that it was easier and more sustainable to sell goats and access goat income frequently. A lack of baseline household demographic data limited our capacity to purposively select non-project households across as many features as those used to purposively select project households. Therefore, non-project households may have been less diverse than project households. However, because there were limited differences between project and non-project households, the impact of this limitation was probably negligible.

Some farmers strategically raised goats over cattle and buffalo, despite larger livestock being perceived as higher-value assets. These findings reflect the observation of [Ayalew \*et al.\* \(2003\)](#) that farmers in low socio-economic, subsistence communities may prioritise biological survival and livelihood security over monetary returns in their production objectives. Similarly, focus group discussions with Zambian farmers ( $n = 112$ ) expressed the quick liquidation to cash being a key reason for keeping goats ([Namonje-Kapembwa \*et al.\* \(2022\)](#)). It lent the income from goats towards meeting short-notice expenses that concerned family and household wellbeing ([Namonje-Kapembwa \*et al.\* \(2022\)](#)). Thus, goat

income may enhance human welfare through its unique capacity towards alleviating expenses related to everyday survival and financial security.

Farmers reported that goats are increasingly substituting cattle and buffalo for use in socio-cultural events. Socio-cultural events often arose without much warning and necessitated the slaughter of a goat, either to provide food for family and friends, or to act as a sacrifice in ritual ceremonies, such as those practised by the Mong Khong ethnic group. The increasing substitution of traditionally used livestock for goats in socio-cultural events has been observed elsewhere ([Coertze 1986](#); [Badenhorst 2002](#); [Aker \*et al.\* \(2016\)](#)). For instance, [Aker \*et al.\* \(2016\)](#) reported that during the Islamic holiday of Tabaski, households in Niger had increasingly begun to slaughter goats instead of traditionally used sheep, because it was cheaper. Farmers in our study reported that goats were the perfect size to feed gatherings of family and friends without wasting meat. This was reflected in Nigeria where farmers ( $n = 135$ ) slaughtered goats for religious festivals and social ceremonies because they could be consumed immediately, circumventing the need for refrigeration ([Hassan \*et al.\* \(2015\)](#)). Pragmatically, goats may be the most appropriate species for socio-cultural events in Laos. Goats allowed households to maintain traditional customs, but at a lower cost, more proportionate to their economic status. Farmers did not express any trait criteria for goats being used in socio-cultural events. Therefore, development projects could recommend that farmers use older or unproductive goats for socio-cultural events, that would normally be culled in commercial systems.

Increasing goat productivity while enhancing, or at least, not interfering with farmers' capacity to remove goats from the herd at irregular intervals, will likely appeal to the widest cohort of farmers. Goat herd numbers fluctuated in response to quick cash needs and socio-cultural obligations. Improving goat kid survival is likely to accelerate the replacement of stock following the sale or slaughter of a goat at short notice. Diarrhoea, presumably caused by coccidiosis and worm burdens, was a major contributor to the morbidity and annual pre-weaning mortality rates of 17.0% in kids in the LS-2017/34 project ([Colvin and Phengvilaysouk 2023](#); [Xaikhue \*et al.\* \(2023\)](#)). A study by [Jalila \*et al.\* \(1998\)](#) found that the intensity of coccidial infection in Malaysian goats, raised in smallholder conditions, was related to goat-house hygiene. Elevated, slatted flooring accompanied by regular cleaning of the goat house can prevent the accumulation of goat faeces, thereby reducing the risk of infection and diarrhoea in goat kids. [Sani \*et al.\* \(2004\)](#) also found that Vietnamese goat farmers ( $n = 18$ ) practicing good goat-house hygiene experienced 20% lower faecal egg counts than did farmers that did not prioritise goat-house hygiene. Thus, improving management of the goat house is a potential low to moderate input means of increasing kid survival and accelerating herd replacement for most farmers in Laos.

Our study showed that goat raising was interdependent with other farm enterprises. For instance, a major benefit of goat raising was its provision of manure and subsequent compatibility with crop production, which is the foundation of food security in Asia (Devendra and Thomas 2002). The benefit of goat manure to smallholder farmers cannot be understated. Mhlanga *et al.* (2018) and McCorkle *et al.* (1989) found that goat manure was a primary reason for raising goats among smallholder farmers in Zimbabwe and Peru. This demonstrates the reliance that farmers have on the integration of their enterprises into a wider farming system that may produce greater benefits than if each component of the system were to operate in isolation from one another (Devendra 2010). Development projects may enhance their capacity to identify and promote methods of increasing farm integration by considering whole farming-system outcomes when assessing the success of goat interventions. For instance, farmers may be incentivised to improve goat-house design and cleaning if it is promoted as increasing manure retention for increased crop productivity.

The free time and resources afforded by goat management allowed farmers to diversify their livelihood activities, thereby mitigating economic risk (Dossa *et al.* 2008). Farmers enjoyed not having to supervise or spend excessive amounts of time on goat management because it enabled them to divert more resources into managing other enterprises. In eastern Ethiopia, an economic evaluation of goat-raising households that had received extension training and support from a Dairy Goat Development Program (DGDP;  $n = 37$ ) and goat-raising households that had not received training or support from any development program ( $n = 37$ ), showed similar patterns of goat management (Ayalew *et al.* 2003). Each unit of labour spent on goat production generated more net household economic benefits per unit of land and labour than did other livelihood activities (Ayalew *et al.* 2003). This led farmers to divert more labour into income-generating opportunities other than goat production, as they required more inputs to derive benefits (Ayalew *et al.* 2003). Resource-limited, risk-averse subsistence farmers must prioritise maximising output across the entire farming system, as opposed to optimising a single enterprise (Ayalew *et al.* 2003). Thus, smallholder farmers in Laos probably accept decreases in goat productivity if it means fewer goat management inputs, which allows higher increases in the productivity of other farm enterprises.

The free-grazing system had some trade-offs, including goat accidents, crop destruction and neighbour conflict (Fig. 5). These issues had negative implications for goat health, the productivity of crop plantations as well as interpersonal relationships between farmers and other members of their community. Other studies have reported similar issues arising as a result of goats grazing unsupervised (Bello 2013; Oyama 2014; Mhlanga *et al.* 2018; Namonje-Kapembwa *et al.* 2022). Ayalew *et al.* (2003) found that farmers operating traditional free-grazing management systems lost twice the number of

goats to disease, predation and accidents than did those that had goats that were tethered or supervised close to the homestead. Namonje-Kapembwa *et al.* (2022) also found that goat herd sizes were restricted by free-grazing burdens, particularly goat theft, in Zimbabwe. Our study has shown that goat theft has been a recurring problem for farmers. Most farmers accepted trade-offs to free-grazing in exchange for the benefits associated with low-input goat management. Thus, off-setting trade-offs by increasing goat productivity in areas that will not interfere with free-grazing benefits, will likely appeal to the largest cohort of farmers. For instance, improved disease management may be an effective, low-input strategy to reduce goat mortalities and morbidities, thereby partially off-setting losses resulting from goat accidents.

Significantly scaling up goat production in free-grazing systems will likely increase the frequency and severity of crop destruction, neighbour conflict and goat losses. Only a small cohort of farmers aspired to own large goat herds (>100 goats). Herds of this size are well above the average herd size of 14 goats reported in this study. This study strongly suggests that farmers must augment their management systems to own large goat herds. Large goat herds will require fodder cultivation and concentrate feeding as farmers, on average, own 3.6 ha of land. The higher investments of capital, land and labour required of these activities is likely to be prohibitive to most farmers. Many of the unique benefits associated with raising goats were not related to the scale of the goat enterprise. For instance, the ease with which farmers could access goat income was more important for financial security and livelihood benefits than was the total amount of income generated by their goat enterprises. Farmers were less concerned with significantly increasing their herd numbers. Instead, they valued their goat's prolificacy to maintain their herd numbers following short notice removal of goats from the herd. This explains why some farmers were content with maintaining their goat numbers, despite only operating small herds (average 10 goats).

Most farmers were aware that large goat herds would not be sustainable in free-grazing systems. However, most farmers still aspired to modest increases in their goat enterprises. As the scale of goat enterprises increases from small to medium, free-grazing trade-offs and low feed availability are likely to amplify. Higher input methods of improving goat health and reducing free-grazing trade-offs may become more justifiable as farmers transition from small- to medium-scale goat herds. For example, forage plots are likely to have higher returns on investment to farmers as herds become larger (Ashley *et al.* 2018), particularly during Laos' long dry season (November–April) which is characterised by low feed availability. Providing forages may reduce the occurrence of crop damage, thereby benefitting the wider farming system.

Development projects should provide farmers with a suite of different options for increasing goat productivity as farmers transition through varying scales of the goat enterprise. The inputs required to successfully implement each option must

be clearly communicated to farmers. This way, farmers may select or abandon improvements on the basis of their individual aspirations and constraints, as well as the appropriateness of the intervention to the scale of the goat enterprise.

## Conclusions

Our study has found that goats occupy interdependent and distinct roles within smallholder farming systems and livelihood strategies, which include cultural rituals. Goats' unique suitability to these roles is likely to further embed them in financial, livelihood or socio-cultural roles in Laos in the future. Increased goat productivity stands to benefit the existing niche that goats occupy within farmers' livelihoods. However, particular methods of doing so are likely to be more compatible with goats' unique roles than others, and therefore will appeal to larger cohorts of farmers. The suitability of less widely compatible methods of increasing goat productivity will be dependent on farmers' individual contexts and constraints, aspirations and scale of their goat enterprise. Development projects should characterise these factors, as well as the unique roles that goats fulfil, prior to devising intervention packages to enhance their ability to promote relevant methods of increasing goat productivity to the largest cohorts of farmers as possible.

## Supplementary material

Supplementary material is available [online](#).

## References

- Aker JC, Sawyer M, Goldstein M, O'Sullivan M, McConnell M (2016) Get your goat: planning, saving, and ceremonial spending. Working Paper. Available at <https://www.povertyactionlab.org/evaluation>
- American Psychological Association (2023) Sociological factors – APA dictionary of psychology. Available at <https://dictionary.apa.org/sociological-factors> [accessed 20 September 2023]
- Ashley K, Young JR, Kea P, Suon S, Windsor PA, Bush RD (2018) Socioeconomic impact of forage-technology adoption by smallholder cattle farmers in Cambodia. *Animal Production Science* 58, 393–402. doi:10.1071/AN16164
- Ayalew W, King JM, Bruns E, Rischkowsky B (2003) Economic evaluation of smallholder subsistence livestock production: lessons from an Ethiopian goat development program. *Ecological Economics* 45, 473–485. doi:10.1016/S0921-8009(03)00098-3
- Badenhorst S (2002) The ethnography, archaeology, rock art and history of goats (*Capra hircus*) in southern Africa: an overview. *Anthropology Southern Africa* 25, 96–103.
- Bello AU (2013) Herdsmen and farmers conflicts in north-eastern Nigeria: causes, repercussions and resolutions. *Academic Journal of Interdisciplinary Studies* 2, 129.
- Bettencourt EMV, Tilman M, Narciso V, Carvalho MLdS, Henriques PDdS (2015) The livestock roles in the wellbeing of rural communities of Timor-Leste. *Revista de Economia e Sociologia Rural* 53, 63–80. doi:10.1590/1234-56781806-94790053s01005
- Coertze RD (1986) Livestock in the social and cultural life of African communities. *South African Journal of Ethnology* 9, 129–135.
- Colvin FA, Phengvilaysouk A (2023) Monthly farm visits: key findings' presentation at LS-2017/34 project final review. University of New England, Armidale, NSW, Australia.
- Colvin FA, Olmo L, Phengvilaysouk A, Millar J, Gray D, Phengsavanh P, Walkden-Brown S (2022) Smallholder goat production systems in Lao PDR: assessing production efficiency. In 'Proceedings of the Australian Association of Animal Sciences', Cairns, Qld, Australia. (CSIRO Publishing)
- Devendra C (2010) Concluding synthesis and the future for sustainable goat production. *Small Ruminant Research* 89, 125–130. doi:10.1016/j.smallrumres.2009.12.034
- Devendra C, Thomas D (2002) Crop–animal systems in Asia: importance of livestock and characterisation of agro-ecological zones. *Agricultural Systems* 71, 5–15. doi:10.1016/S0308-521X(01)00032-4
- Dossa LH, Rischkowsky B, Birner R, Wollny C (2008) Socio-economic determinants of keeping goats and sheep by rural people in southern Benin. *Agriculture and Human Values* 25, 581–592. doi:10.1007/s10460-008-9138-9
- FAOSTAT (2022) Food and Agriculture data Food and Agriculture Organization of the United Nations. Available at <https://www.fao.org/faostat/en/#data/QCL> [accessed 9 September 2023]
- Glaser BG, Strauss AL (1999) 'Discovery of grounded theory: strategies for qualitative research.' (Routledge: New York, NY, USA)
- Gray D, Walkden-Brown S, Phengsavanh P, Patrick I, Hergenhan R, Hoang N, Phengvilaysouk A, Carnegie M, Millar J, Hu Văn N (2019) Assessing goat production and marketing systems in Lao PDR and market linkages into Vietnam. Australian Centre for International Agricultural Research, Canberra, ACT, Australia. Available at <https://www.aciar.gov.au/publication/technical-publications/assessing-goat-production-and-marketing-systems-lao-pdr-and-market-linkages-vietnam> [accessed 6 March 2022]
- Hassan DI, Mbap ST, Naibi SA (2015) Socio-economic characteristics of Yankasa sheep and West African Dwarf goat's farmers and their production constraints in Lafia, Nigeria. *International Journal of Food, Agriculture and Veterinary Sciences* 5, 82–93.
- Jalila A, Dorny P, Sani R, Salim NB, Verduyck J (1998) Coccidial infections of goats in Selangor, peninsular Malaysia. *Veterinary Parasitology* 74, 165–172. doi:10.1016/S0304-4017(97)00133-7
- Kelle U (2007) The development of categories: different approaches in grounded theory. In 'The Sage handbook of grounded theory'. (Eds A Bryant, K Charmaz) pp. 191–213. (SAGE Publications)
- Le SV, de Las Heras-Saldana S, Alexandri P, Olmo L, Walkden-Brown SW, van der Werf JHJ (2024) Genetic diversity, population structure and origin of the native goats in central Laos. *Journal of Animal Breeding and Genetics* 141, 1–19. doi:10.1111/jbg.12862
- Leuangvilay P, Chapman RS, Siriwong W (2017) Associated environmental factors and past practices regarding to anthrax infection in human in Salavan district, Salavan Province, Lao PDR: case-control study. *Journal of Health Research* 26, 335–339.
- MAF (2014) Lao census of agriculture 2010/11: analysis of selected themes. Ministry of Agriculture and Forestry, Vientiane, Lao PDR. Available at [https://www.researchgate.net/publication/340332818\\_LAO\\_CENSUS\\_OF\\_AGRICULTURE\\_201011\\_ANALYSIS\\_OF\\_SELECTED\\_THEMES](https://www.researchgate.net/publication/340332818_LAO_CENSUS_OF_AGRICULTURE_201011_ANALYSIS_OF_SELECTED_THEMES) [accessed 14 December 2022]
- McCorkle CM, Nolan MF, Jamtgaard K, Gilles JL (1989) Social research in international agricultural R&D: lessons from the small ruminant CRSP. *Agriculture and Human Values* 6, 42–51. doi:10.1007/BF02217668
- Mhlanga TT, Mutibvu T, Mbiriri DT (2018) Goat flock productivity under smallholder farmer management in Zimbabwe. *Small Ruminant Research* 164, 105–109. doi:10.1016/j.smallrumres.2018.05.010
- Millar J, Colvin AF, Phengvilaysouk A, Phengsavanh P, Olmo L, Walkden-Brown SW (2022) Smallholder goat raising in Lao PDR: is there potential to improve management and productivity? *The Lao Journal of Agriculture and Forestry* 46, 20–34.
- Namonje-Kapembwa T, Chiwawa H, Sitko N (2022) Analysis of goat production and marketing among smallholder farmers Zambia. *Small Ruminant Research* 208, 106620. doi:10.1016/j.smallrumres.2022.106620
- Olmo L, Phengvilaysouk A, Colvin AF, Phengsavanh P, Millar J, Walkden-Brown S (2022) Improving Lao goat production when resources are limited. In 'Australian Association of Animal Sciences Conference', Cairns, Qld, Australia. (Australian Association of Animal Sciences)

- Ouma EA, Obare GA, Staal SJ (2003) Cattle as assets: assessment of non-market benefits from cattle in smallholder Kenyan crop-livestock systems. In 'Proceedings of the 25th International Conference of Agricultural Economists (IAAE)', Durban, South Africa. (International Association of Agricultural Economists)
- Oyama S (2014) Farmer-herder conflict, land rehabilitation, and conflict prevention in the Sahel region of West Africa. *African Study Monographs. Supplementary Issue* 50, 103–122.
- Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N, Hoagwood K (2015) Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research* 42, 533–544. doi:10.1007/s10488-013-0528-y
- Phengsavanh P (2006) Goat production in Lao PDR. Potential, limitations and approaches of forage development, Goats: undervalued assets in Asia. In 'Proceedings of the APHCA-ILRI regional workshop on goat production systems and markets', 24–25 October, Luang Prabang, Lao PDR. (International Livestock Research Institute)
- Phengsavanh P, Ogle B, Stür W, Frankow-Lindberg BE, Lindberg JE (2011) Smallholder pig rearing systems in northern Lao PDR. *Asian-Australasian Journal of Animal Sciences* 24, 867–874. doi:10.5713/ajas.2011.10289
- Phengvichith V, Preston TR (2011) Effect of feeding processed cassava foliage on growth performance and nematode parasite infestation of local goats in Laos. *Livestock Research for Rural Development* 23, 1–8.
- Phengvilaysouk A, Colvin AF, Olmo L, Phengsavanh P, Millar J, Walkden-Brown SW (2022) Smallholder goat herd production characteristics and constraints in Lao PDR. *The Lao Journal of Agriculture and Forestry* 46, 3–19.
- Sani RA, Binh DV, Ly ND, San S, Phimpachanhvongsod V (2004) Chapter 12: Goat production, parasites and testing of control options in Lao, Cambodia and Vietnam. In 'Worm control for small ruminants in Tropical Asia'. (Eds RA Sani, DG Gray, RL Baker) pp. 211–218. (Australian Centre for International Agricultural Research: Canberra, ACT, Australia)
- Saunders B, Sim J, Kingstone T, Baker S, Waterfield J, Bartlam B, Burroughs H, Jinks C (2018) Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & Quantity* 52, 1893–1907. doi:10.1007/s11135-017-0574-8
- Sprenger G (2005) The way of the buffaloes: trade and sacrifice in northern Laos. *Ethnology* 44, 291–312. doi:10.2307/3774092
- The World Bank (2020) Rural population (% of total population) – Lao PDR. Available at <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=LA> [accessed 7 June 2022]
- The World Bank (2022) Lao rural livelihoods in times of crisis. Available at <https://thedocs.worldbank.org/en/doc/0540059f3d8e2a7bac78b780c428eba4-0070062022/related/LaoPDRCommunitySurveyReportMay-Nov22Final.pdf> [accessed 7 June 2023]
- Windsor PA, Nampanya S, Tagger A, Keonam K, Gerasimova M, Putthana V, Bush RD, Khounsy S (2017) Is orf infection a risk to expanding goat production in developing countries? A study from Lao PDR. *Small Ruminant Research* 154, 123–128. doi:10.1016/j.smallrumres.2017.08.003
- Windsor PA, Nampanya S, Putthana V, Keonam K, Johnson K, Bush RD, Khounsy S (2018) The endoparasitism challenge in developing countries as goat raising develops from smallholder to commercial production systems: a study from Laos. *Veterinary Parasitology* 251, 95–100. doi:10.1016/j.vetpar.2017.12.025
- Yaikhue T, Olmo L, Colvin FA, Walkden-Brown S (2023) 'Main goat health problems observed and managed', presentation at LS-2017/34 project final review. University of New England, Armidale, NSW, Australia.
- Xaypha S (2005) Goat production in small holder farming systems in low lands Lao PDR and an evaluation of different forages for growing goats. MSc thesis, Swedish University of Agricultural Sciences.
- Zeweld W, Van Huylbroeck G, Tesfay G, Speelman S (2017) Smallholder farmers' behavioural intentions towards sustainable agricultural practices. *Journal of Environmental Management* 187, 71–81. doi:10.1016/j.jenvman.2016.11.014

**Data availability.** The data that support the findings of this study are available on request from the corresponding author, E. L. The data are not publicly available owing to their containing information that could compromise the privacy of research participants.

**Conflicts of interest.** Stephen Walkden-Brown is an Associate Editor of Animal Production Science. To mitigate this potential conflict of interest they were blinded from the review process. The authors state that there are no other conflicts of interests to declare.

**Declaration of funding.** This work was supported by the Australian Centre for International Agricultural Research (ACIAR) under Grant LS-2017-34.

#### Author affiliations

<sup>A</sup>School of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia.

<sup>B</sup>Gulbali Institute, Charles Sturt University, PO Box 789, Albury, NSW, Australia.

<sup>C</sup>Department of Livestock and Fisheries, Faculty of Agriculture, National University of Laos, PO Box 7322, Vientiane, Lao People's Democratic Republic.