

Results

Three types of feeding systems namely grazing (GS; 86%), partial grazing (PG; 10%) and stall feeding (SF; 4%) were identified in the study area. The farmers who opted for GS also feed their animals with other types of feeds depending on the environment and availability of pasture/range vegetations in the grazing areas. Animals were fed crop residues, non-conventional feed sources (kitchen waste, fruit & vegetable leftovers etc.) and green fodder/forage (cut and carry) during severe hot and cold weather and periods of fodder/forage scarcity (May, June, Dec., & Jan.). Small and large ruminant mixed flock grazing was significantly ($P < 0.01$) higher (52.94%) in the area. Supplemental feeding was significantly ($P < 0.001$) higher in female animals. Weight gain was significantly ($P < 0.01$) higher in lambs after 1 m of age and in kids between 1–2 m of age (Table 1).

Table 1 Weight gain of male kids/lambs in flocks reared under complete grazing system

Weight gain (kg/month)	0–1 month (Mean \pm SE)	1–2 month (Mean \pm SE)	2–3 month (Mean \pm SE)
Goat	3.2 ^b \pm 0.59	3.9 ^a \pm 0.61	3.0 ^b \pm 1.10
Sheep	2.9 ^b \pm 0.90	4.1 ^a \pm 1.01	4.2 ^a \pm 0.84

^{ab}Values with different superscripts in a row differ significantly.

Conclusions

The GS of SR production was common in the area. The little supplemental feeding with grazing resulting in appreciable kid/lamb growth suggests that proper feeding management would enhance the productivity of SR.

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Advances in integrated tree crops-ruminants systems for productivity enhancement and environmental sustainability in Southeast Asia

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Among the prevailing ruminant production systems, the integration of ruminants with tree crops such as coconuts, palm oil and rubber is generally neglected and most underestimated. This is associated with inadequate and inefficient use of the natural resources, which dictates improved land use systems, productivity enhancement, and environmental sustainability. Improved efficiency in natural resource management is justified by serious and inadequate animal protein production throughout Asia, where currently available supplies will need to be doubled to meet projected human requirements in 2050. In this context, integrated tree crops- ruminant production systems merit much more emphasis and expansion. Among the tree crops, palm oil is outstanding in Southeast Asia, with Malaysia and Indonesia together accounting for about 79% of the total world planted area of about 8.3 million hectares, and producing about 87% of the total world production of palm oil. Integrated palm oil-based production systems are therefore important pathways in which ruminants (buffaloes, cattle, goats and sheep) can provide the entry point for development. The stratification of the systems, production options, use of forage legumes, and potential for enhanced productivity are indicated. Productivity enhancing technologies and intensification of production systems that can use the abundant availability of feeds to include herbage undergrowth, palm oil fronds (OPF), palm kernel cake (PKC), palm press fibre (PPF) and palm oil mill effluent (POME).have been shown to significantly enhance animal production being consistent with economic benefits and social

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acceptance. Intensive feeding systems have been developed with *in situ* feeding of OPF and PKC for cattle and goats, often with rice bran or copra cake. The results from 21 case studies over the past three decades showed increased yields of 0.49–3.52 mt of fresh fruit bunches (FFB)/ha/yr; increased income by about 30%; savings in weeding costs by 47–60% equivalent to 21–62 RM/ha/yr; and an internal rate of return of 19% based on the actual field data. The advances highlight demonstrable increased productivity of animals and meat off-takes, value addition to the palm oil crop, environmental sustainability and distinct economic impacts. Additionally, carbon sequestration is enhanced through more widespread use of grasses and tree legumes, and improved forage management practices, with resultant decreased carbon atmospheric emissions and global warming. Concerted future research and development efforts are necessary on the following:

- Measurements of animal performance and crop yields under different nutritional and management regimes
- Assessments of the effects on soil
- Improved understanding of the management of animals under tree crops
- Demonstration of beneficial animal performance
- Sustainability of the production systems
- Economic benefits, and,
- The impact of integrated systems.

The resultant impact provides important socio-economic benefits and food security for resource-poor small farmers. Increasing the adoption rate in the future is associated with promoting greater awareness of the potential of integrated systems, overcoming resistance by the crop-oriented plantation sector, and promotion of wider technology application. These issues are linked directly with defining coherent policy, institutional commitment, increased investments, private sector involvement, and a stimulus package of incentives.

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Organic farming principles related to agro-ecological tropical smallholder livestock systems

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Organic farming is built on a set of principles, e.g. expressed by IFOAM as the principles of health, ecology, fairness and care. These principles are in various ways practiced and implemented in standards and rules for organic farming, some of which is certified, labelled and marketed at a higher price than non-organic produce, typically in countries with privileged consumers who can afford to choose to pay premium price. In other settings, following the principles do not necessarily lead to certification and premium prices, but improves farming, soil fertility and/or production on short and long term basis. This paper will examine the requirements, restrictions and opportunities for organic livestock production across diverse systems of smallholder production in the tropics. We use the term organic and agro-ecological farming, meaning farming in accordance with the organic principles.

Organic livestock is unlikely to gain widespread interest for export. In relation to the local market and local consumers, it will gain interest if it produces high quality products or meets local economic conditions for low inputs or meets local sustainability requirements. The major challenge in agro-ecological and organic livestock production systems is to think the organic principles into widely different and diverse systems under a wide range of conditions and circumstances. This requires a thorough analysis of the problems, opportunities and existing knowledge. One important area which at all times need to be balanced in organic systems is the emphasis on naturalness and at the same time human care in order to ensure that animals are allowed to perform their natural behaviour as far as possible, and at the same time will not suffer as a result of hunger, disease or insufficient living conditions. This means that consideration has to be given to the individual animal (as a sentient being). Furthermore, livestock need to play a role as an integrated element of the whole farm where they produce manure to be used as a crop fertiliser and conditioner and utilise crop residues as sources of feed. Hence, there is a need to consider the role of livestock from a whole farm perspective regardless of whether they are kept in agro-forestry systems, mountain areas, or wet areas. The emphasis should at all times be on creating a basis for sustainable farming systems as part of a sustainable agricultural sector.

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