Agnote

No: J51

March 2005

Strategies for Improving the Nutrition of Ruminant Livestock Kept by Smallholders in SE Asia

D. Ffoulkes, Ruminant Nutrition Specialist, Darwin

ROLE OF LIVESTOCK

Ruminant livestock have provided mankind with food and a variety of byproducts for 1000s of years. Livestock ownership has also traditionally been a symbol of wealth.

The role of livestock in village agriculture is as follows:

- Large ruminants are used mainly for draught, milk, breeding, and sometimes fattening.
- Small ruminants are used mainly for meat and fibres.
- Additional animals used for financial security - a source of income and cash.

SUSTAINABLE FARMING SYSTEMS

Village agriculture and subsistence farming are usually highly integrated in terms of mixed farming and socio-economic interdependence, and have generally withstood the test of time. They have naturally evolved into low risk agricultural systems that ensure conservation of resources for generations to come. While these systems are sustainable at a certain level of productivity, they are not necessarily efficient. Their stability is particularly susceptible to the pressures of development and need for increased productivity. Thus progress in rural development depends on increasing the efficiency of utilisation of available resources while ensuring that agricultural systems remain sustainable.

PRODUCTIVITY CONSTRAINTS

The performance of livestock under village management is generally low. Cattle and buffalo are slow growing, late maturing breeds, and live weight gains are usually only some 25% or less of their genetic potential for growth (i.e. 150-250 g/d). In Indonesia for example, nearly all female cattle and buffalo over 3 years of age are used for work and bulls are sold for slaughter. Under these conditions, fertility is low due to infrequency of mating and poor body condition. Likewise, the productivity of sheep and goats is poor, ranging from 20-40 g/d, and mortality of offspring can be up to 20%.

Apart from Government programs to control endemic diseases such as foot and mouth, anthrax and haemorrhagic septicaemia, disease control by livestock owners is minimal. Parasite burdens are also high and probably contribute significantly to poor animal performance.

The underlying factor restricting productivity of village livestock is feed quality and its availability. Large ruminants are mostly hand fed on crop residues, with some grazing or gathering of native grasses and tree legumes, but minimal supplementation with cereal bran and other concentrates or minerals. Small ruminants, if not shepherded, are tethered or housed in pens and receive a high proportion of native grasses in their diet. Hand feeding of livestock is time consuming and can occupy the livestock owner and his family a large part of the day in finding, cutting and carrying the forage for their animals. Moreover, there is little planting of improved pastures or cultivation of forage for livestock feed due to a shortage of land and capital, and in the dry season even bulk feed is often in short supply.

Nutrition is evidently a major constraint to livestock productivity at the village level. Small improvements in feed management are likely to substantially improve the efficiency with which available feed resources are used and will result in increased productivity, and better reproductive performance and health.

BASIC PRINCIPALS OF RUMINANT NUTRITION

The main feature that distinguishes the ruminant animal from other herbivores and monogastric animals is that it has a unique pre-gastric digestive system which uses microorganisms to break down grass and other roughages to provide essential nutrients to the animal.

The forestomach, or rumen, contains billions of micro-organisms consisting of bacteria, protozoa and fungi. These micro-organisms breakdown (digest) most of the feed eaten by the animal, into smaller particles, helped by the grinding action of the back teeth when the animal is chewing. Ruminants chew their food twice, once just after eating, and then later when the animal is ruminating, a bolus of food is regurgitated from the rumen for further chewing.

The process of microbial digestion is called fermentation which provides nutrients for the growth and biological functions of the micro-organisms themselves. In turn, the micro-organisms make nutrients available to the host animal by:

- Releasing energy-yielding substances (called volatile fatty acids) in the waste products of fermentation.
- Using nitrogen (mainly from ammonia) to produce microbial protein.

The energy-yielding fatty acids are absorbed through the rumen wall into the blood system and may provide up to 70% of a productive animal's requirements for energy. The microbial cells are continuously washed out of the rumen in the digesta as it flows into the small intestine. Here the components of the cells (i.e. protein, carbohydrate and fat) are digested by gastric juices and the resulting nutrients (viz amino acids, glucose and long-chain fatty acids) are absorbed into the portal vein.

Some of the feed may also reach the small intestine without being completely digested or degraded by the rumen microorganisms. This fraction provides the animal with extra nutrients (sometimes referred to as bypass or escape nutrients) in a more direct form. Figure 1 shows a schematic diagram of the process of digestion in the ruminant.

If the balance and quantities of nutrients in the animal's feed is sufficient to support maximum microbial growth in the rumen, then the end products of fermentation (i.e. volatile fatty acids and microbial protein) alone will supply most of the ruminant animal's requirements to maintain body weight and condition. However, when ruminants are in a productive state (i.e. working, growing, last stage of pregnancy and suckling a calf), they require more nutrients than are supplied in fermentative digestion.

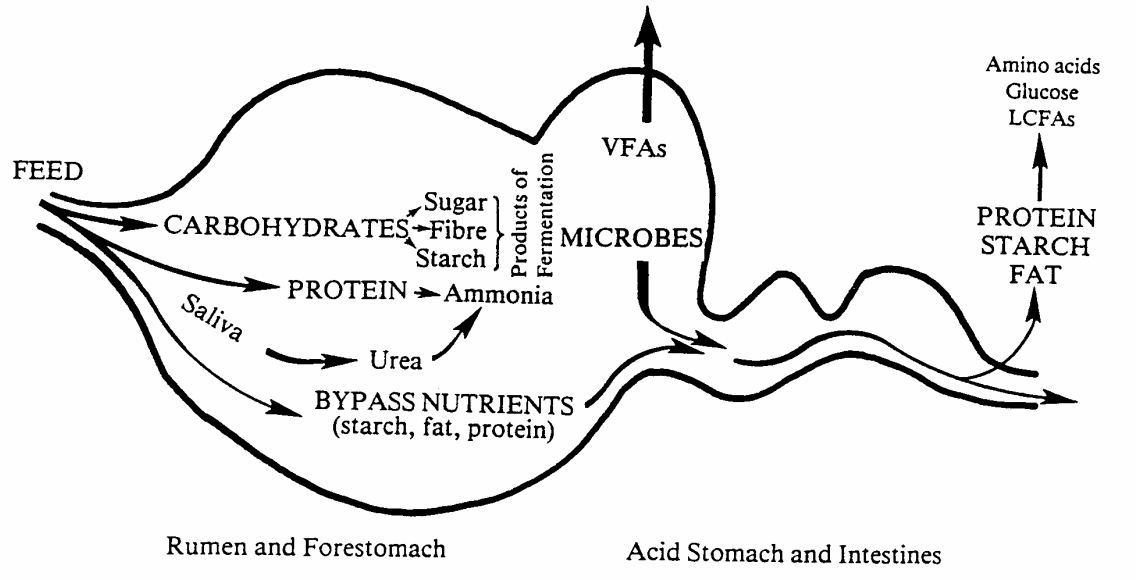

Figure 1. Schematic diagram of the processes of ruminant digestion

The key to formulating efficient rations with available feed resources is therefore knowing the extent to which feeds are fermented in the rumen and provide bypass nutrients for specific productive needs of the animal.

TYPES OF FEEDS

Ration components can be categorised into those that feed the rumen microorganisms and those that provide extra nutrients for the animal, as follows:

- Basal diet provides the bulk of fermentable energy (from cellulose or sugar), nitrogen and minerals required by the rumen micro-organisms.
- Fermentable feed supplements supply extra nutrients to the basal diet to balance the requirements of the rumen micro-organisms.
- Concentrate feed supplements which are mostly resistant to microbial degradation but are digested by the animal in the small intestine. These foodstuffs are very efficient at providing the extra nutrients needed by ruminants for specific productive purposes.

FEED EVALUATION

Feeding standards based on proximate analysis are used in temperate regions to formulated diets, according to the nutrient requirements of ruminant livestock. This can be done because of the highly predictable nature of temperate feeds. In the tropics, feed quality is much more variable and the extent to which nutrients are available in the foregut and the hindgut of the ruminant becomes the critical factor in ration formulation.

A systematic method of evaluating tropical feeds is described as follows:

STEP 1: Identify potentially useful nutrients by chemical analysis of major components (eg organic matter, fibre, fat, nitrogen, calcium, phosphorus, sodium and sulphur).

STEP 2: Categorise into potential ration components (see below) by measuring digestibility using *in vitro* or preferably, intra-ruminal bag (*in sacco*) methods.

STEP 3: Test the quality of a foodstuff as a ration component, ie basal diet, fermentable feed supplement, or un-degraded concentrate feed supplement. For foodstuffs likely to be fermented in the rumen, carry out *in vivo* digestibility trials and measure voluntary consumption and rumen fluid metabolites. For foodstuffs likely to be un-degraded in the rumen, conduct growth trials to obtain response curves (i.e. $\pm$ supplements).

DAILY FEED MANAGEMENT

Composition of diet

The association of foodstuffs with a particular ration component provides the basis for daily formulations of a more balanced diet and better utilisation of available feed resources. For example, rice straw which is commonly used as a basal diet and is fed *ad libitum* is low in nitrogen content and requires supplementary fermentable nitrogen. This could be provided in the form of sweet potato leaves or fresh grasses. Fertiliser urea is also a good source of fermentable nitrogen (see section below). Mixtures of the better quality fermentable supplements can generally be used to replace most of the basal diet to raise the level of animal productivity, and local knowledge of sources of the rumen-un-degraded concentrates enables farmers to provide extra nutrients for specific productive states, such as work, lactation, and fattening.

Table 1 shows the likely proportions of each ration component and categories of foodstuffs, and can be used as a guide to formulate rations.

Feeding urea

Fertiliser urea is a concentrated source of fermentable nitrogen which can be used in small quantities to supplement basal diets fed to older ruminant livestock. However, urea must be administered properly to avoid poisoning. The correct method is to dissolve 75 g of urea (per head) in 100 mL or more of water or diluted molasses and thoroughly mix the solution into the ration.

Mineral supplementation

Certain mineral elements which are essential for normal body functions are often deficient in the feeds offered to ruminant livestock. Sodium deficiency is probably the most common and salt should be provided as a matter of routine. Other important minerals are calcium and phosphorus, sources of which are limestone (calcium only) and dicalcium phosphate. Molasses is a good source of a wide range of minerals particularly sulfur. Blanket supplementation with salt and mineral blocks is recommended where these are available.

Supplementing the productive animal
This is the provision of extra nutrients in the ration to meet the specific requirements of an animal's productive state.

Draught. Prior to the working season adequate fermentable supplements need to be fed to maximise the efficiency of the basal diet in supplying sufficient energy to restore body fat reserves. When animals are being subjected to hard work and are losing weight and body condition, then supplements of rumen-un-degraded concentrates need to be added to the ration.

Late Pregnancy. Ensure adequate nutrient supply to the animal from microbial digestion by adding fermentable feed supplements to the basal diet or replacing the basal diet with a mix of better quality fermentable feeds.

Early lactation. The health and growth rate of a suckling calf depends on a good supply of milk from the dam over the first few months of lactation. Ensure that there are adequate quantities of basal diet and fermentable feed supplements, and in addition, provide a mix of concentrates containing high levels of protein and fat, eg cotton seed meal, rice or maize grain, copra and palm kernel cake.

Fast growth/fattening. Ensure that there are adequate quantities of basal diet and fermentable feed supplements, and provide young animals with high protein concentrates (eg. soya bean or cotton seed meals) and older animals with high energy concentrates (eg. kapok or cotton seed meal, copra cake or good quality rice bran).

Inconsistency of diets
Different types of feed and rumen conditions favour the predominance of different populations of microbial species in the rumen. If the composition of the diet constantly changes, conditions in the rumen remain unstable and prevent the establishment of a balance of microbial populations. This results in an inefficient fermentation process. Ideally, dietary ingredients should be changed as little as possible, or gradually over a period of time to allow the microbial populations to adapt slowly to new foodstuffs.

Frequency of feeding
Stability of rumen conditions is also maintained by offering fresh feed to the animal several times a day. This is especially important in the situation where feed is scarce and the amount of feed offered is less than the animal's voluntary consumption. When animals are fed only once daily, the nutrients available to the rumen micro-organisms become exhausted in the period before the next feed. These conditions may be aggravated by the animal's ability to select the choicest parts of the diet and leave less digestible plant material in anticipation of receiving fresh feed the following day.

Water
Small ruminants can generally obtain their daily water requirements from diets of fresh green forages and indeed it is rare to fine farmers providing water to sheep and goats in the rainy season. Cattle under these conditions require periodic access to water while buffalo are much less tolerant to periods without water, especially in hot weather and after working. In drier regions and seasons, the moisture content of foodstuffs is lower and fresh water should be regularly available to all ruminants.

LONG-TERM FEEDING STRATEGIES

Seasonal fluctuations of forage resources and agricultural by-products mean that livestock owners are rarely able to offer sufficient quantities of feed to meet the full nutritional requirements of their ruminant animals. The formulation of balanced diets and strategic supplementation of animals at times of greatest productive and physiological need will increase the efficiency of utilisation of these limited feed resources. The challenge for Government Extension Services is to get farmers to adopt these practices.

As a first step, Government Extension Services need to document the regional availability and category of foodstuffs on a seasonal basis to produce a calendar map of feed resources for each village area. The calendar map can then used as a guide by the Government Extension Officer in conjunction with smallholders of each village to develop annual feeding strategies. The identification of livestock feeds as one (or more) of three ration components, and knowledge of the quantities to use (see Table 1), will enable local rations to be formulated simply to meet the demand for critical nutrients, according to the animal's productive state and level of performance desired by the farmer.

Furthermore, periodic surveys of the calendar map of livestock feed resources in a region will enable the sustainability of the local agricultural system to be monitored.

Table 1. Categories of feed as ration components

FEED CATEGORY	PROTEIN (% dry matter)	ENERGY (MJ/kg dry matter)	FEEDING INSTRUCTIONS (as fed basis)
Basal Diets:			*Ad libitum* feeding
Straws (rice, maize, sorghum)	4-8	5-9	
Grasses/hay (native, elephant)	6-12	6.5-7.5	
Pineapple residue	3	11	
Banana pseudo-stems (chopped)	3	-	
Bagasse	1	8	
Molasses	5	8	
Fermentable feed supplements:			1. Feed one or a mixture of foodstuffs at a rate up to 1 kg/kg of the basal diet. 2. A mixture of foodstuffs can replace up to 90% of the basal diet.
Cereal bran (rice, maize)	10-11	9-13	
Tapioca waste	2	15	
Whole bananas	5	12	
Green forage (banana and sweet potato leaves, sugar cane tops, fresh grasses)	6-13	11-12	
Rumen-Undegraded Concentrates:			Feed at a rate up to 0.5 kg per 5 kg of basal diet.
Cereal grains (rice, maize)	10-13	9-13	
Seed meals (cotton, kapok, soya, peanut)	31-55	11-15	
Cakes (copra, palm kernel)	19-22	13-15	
Leaf meals (leucaena, glyricidia, cassava)	20-29	11-13	

FURTHER READING

FFOULKES D (1986) Research and development of nutrition strategies for Indonesian ruminant livestock.Indonesian Agricultural Research and Development Journal 8, 76-82.

FFOULKES D and BAMUALIM A (1989) Improving the nutrition level of draught animals using available feeds. In `Draught Animals in Rural Development', pp.135-145 [D Hoffmann, J Nari and R J Petheram, editors] Canberra: ACIAR.

MORAN J B (1981) Beef and buffalo production by smallholders in Indonesia. World Review of Animal Production 17, 55-64.

PRESTON T R and LENG R A (1987) Matching Ruminant Production Systems with Available Resources in the Tropics and Sub-Tropics. Armidale: Penambul Books.

Please visit us at our website:

www.nt.gov.au/dpifm

Department of Primary Industry, Fisheries and Mines

ISSN 0157-8243
Serial No. 545
Agdex No. 400/50