Experiences with urea-molasses multinutrient blocks in buffalo production and reproduction in smallholder dairy farming, Punjab, India

P S Brar[6] and **A S Nanda**[1]

Introduction

Dairy farming plays an important role in the economic development of rural India, and about 80 percent of the trade in this sector is in the hands of small-scale and marginal farmers having 1 to 20 animals each. The ever-increasing shortage of good quality feed and green fodder is one of the major factors limiting profitable dairy farming. Green fodder deficiency increased from 29 percent in 1970 to 32 percent in 2000. In contrast, India produces about 360 million tons of agricultural by-products, which have poor digestibility and little nutritive value without further processing. To put these into effective use there is thus a need to improve their nutritive value.

Use of urea as a non-conventional source of non-protein nitrogen for ruminal micro-organisms is well known. In India, urea has been fed to cows and buffaloes in the form of *uromol* (Chopra *et al*., 1974), urea-molasses liquid supplement (Kaur, 1993) and urea-treated straw (Bakshi, Gupta and Langer, 1986). However, the labour and other costs involved in the preservation, transport and feeding of the end product made some of these methods unpopular and precluded their wider adoption by farmers. Urea-molasses multinutrient blocks (UMMB) are relatively free from these constraints, have the merit of providing nitrogen over a longer period of time than any other urea source, and are generally more widely accepted. This paper considers the development, adoption, merits and limitations of

6 .Department of Animal Reproduction, Gynaecology & Obstetrics, Punjab Agricultural University, Ludhiana-141004, India.
E-mail: <parkashsingh@satyam.net.in> <asnanda@satyam.net.in>

UMMB technology in India. The focus is on the "cold process' of UMMB preparation, and its application in boosting production and reproduction in dairy buffaloes in Punjab, India.

Formulation and Preparation of UMMB

UMMB use in India dates back to its introduction in 1983 by the National Dairy Development Board (NDDB), Anand. Initially, it was produced by a "hot process', using various formulations, equipment and procedures (Ahuja, Makkar and Kakkar, 1986; Gupta and Malik, 1991; Malik, Makkar and Kakkar, 1993; Garg, Mehta and Singh, 1998). Despite the reasonably evident scientific merits of UMMB application from the above studies, the technology did not match the requirements of farmers and its use remained limited to scientific and teaching institutes. The high initial costs, cumbersome procedures, significant labour requirements and poor cost–benefit ratio rendered it an unpopular proposition for field-level adoption. Subsequently, the "cold process' for UMMB preparation was introduced (Tripathi,1997; Garg, Mehta and Singh, 1998), and later modified to be a sustainable, cost-effective and overwhelmingly acceptable procedure, especially for smallholder dairy farmers (Brar and Nanda, 2002, 2003). This later process has the advantages of being simple, inexpensive and easily adopted by farmers.

Comparative evaluation of the "hot" and "cold" processes for UMMB preparation

For some time, controversy prevailed vis-à-vis the usefulness of the two procedures for UMMB production, which warranted their comparative assessment. The authors' laboratory undertook studies on the comparative merits and demerits of both UMMB preparation procedures, from the point of view of their usefulness under smallholder farming system conditions in India.

UMMB preparation by the cold process

Five formulations (I–V) were tested for the production of blocks using locally-available agro-industrial by-products in Punjab, India (Table 1). Urea was added to molasses, stirred and left standing overnight. Next morning, the rest of the ingredients were mixed together on a polythene sheet or in an iron pan. To obtain a uniform distribution in the whole premix, common salt, being the smaller quantity, was mixed with the cement, before mixing with the other dry ingredients. The urea-molasses mixture was poured into this premix and mixed thoroughly by hand or with a spade (for larger quantities). A known amount of this semi-solid mixture (1.0 or 2.0 kg) was put in an iron frame (9×3×3 in (≈23×8×8 cm); Figure 5.1), covered with a wooden sheet tightly fitting the frame and pressed for

20–30 seconds using the foot pressure of one person (Figure 5.2). The iron frame was then removed, leaving a UMMB block on the polythene sheet. These frames are simple to construct, are used routinely for making earthen bricks, and readily available in the local market. The blocks were left at room temperature to air-dry so as to be hard enough for handling, transport and feeding. The time taken to harden off and other physical characteristics of these blocks are shown in Table 5.2.

Table 5.1
Formulations used for preparing UMMB (percentage by weight).

Ingredients (on a percentage basis)	Formulation				
	I	II	III	IV	V
Molasses	40	40	35	35	35
Urea	10	10	10	10	10
De-oiled rice bran	–	26	–	33	17
Oiled rice bran	26	–	33	–	16
Ground-nut cake	10	10	10	10	10
Common salt	4	4	2	2	2
Cement	10	10	10	10	10

Table 5.2
Physical characteristics of UMMBs prepared by the cold process(1)

Characteristics	Formulation				
	I	II	III	IV	V(2)
Hardness	+	+	+++	+++	+++
Days to dry at ambient temperature(3)	–	–	8–10	2–4	3–6
Brittleness	–	–	+	++	+
Cost (Rs./Kg)	–	–	4.22	4.02	4.11
Acceptability to animals	Not tried	Not tried	100%	100%	100%

NOTES: (1) The blocks were prepared during September–October (average daily room temperature = 20–24°C; humidity = 60–70%). (2) Easy to prepare, as it does not stick to pans. (3) The blocks took a little longer to harden on cloudy days with high humidity.

Blocks from formulations I and II, with 40 percent molasses, were too soft to retain their block shape. The blocks prepared from formulations III, IV and V were acceptably hard, although a variable number of days were required for them to reach the desired hardness. The blocks from formulation IV (33 percent de-oiled rice bran) were relatively more brittle and had a high breakage percentage during transport, leading to wastage, while the blocks from formulation III (33 percent oiled rice bran) were sticky, difficult to prepare and took longer to harden off. Blocks from formulation V, with 16 percent oiled and 17 percent de-oiled rice bran, were relatively easier to prepare, sufficiently hard, less brittle and required only a moderate time (3–5 days) to harden. Blocks weighing one kilogram had a greater tendency to break than the two-kilogram blocks, so the latter were chosen for further studies and dissemination.

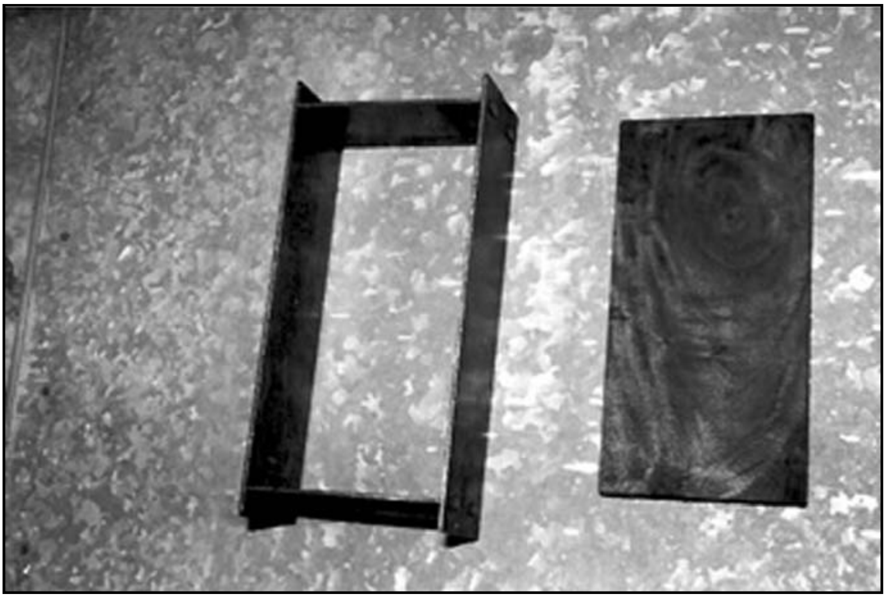

Figure 5.1 Metal mould used to produce UMMBs.

Figure 5.2 Compressing mixture into mould using foot pressure.

UMMB preparation by the hot process

Blocks were prepared using the process of Malik, Makkar and Kakker (1993), using the same five formulations as used in the cold process (Table 5.1). Urea and molasses were mixed together in an iron pan and heated for half an hour while being stirred slowly. Once hot, other ingredients were added and mixed thoroughly. Blocks were prepared by forming this mixture using a hydraulic press. The blocks produced using formulations III, IV and V had the required texture and animal acceptability. However, this method involves heating the ingredients, is labour intensive, takes a longer time and needs costly equipment, such as a hydraulic press. Further, the blocks so produced have been reported to be highly hygroscopic, leading to poor shelf life (Tripathi, 1997; Garg, Mehta and Singh, 1998). As the feed block technology was also being investigated for easy and reliable drug administration for several animal health conditions, the hot method might not be appropriate as it might adversely affect some of the active ingredients. Although the method was adopted by a few commercial firms, the high costs of equipment, infrastructure, additional energy required for heating, and cumbersome procedure militated against its acceptance by small-scale farmers. It could not be extended to the rural masses that own about 75 percent of the dairy buffaloes and contribute about 60 percent of the total milk in the state. The hot process was therefore dropped from further studies on nutrient blocks in the authors' laboratory.

The cold process had the merits of saving time, energy, labour and overall costs in comparison with the hot process. Due to the lower cost, good characteristics of the blocks produced, convenience of their preparation and use in the field, and excellent acceptability in the preliminary trials, this process was selected for further studies at the farmer level.

Nutritive value and block storage quality

The nutritive value (see Table 5.3 for proximate analysis) and keeping quality (shelf life) of formulations III, IV and V were observed over a period of 14 months. The nutritive value in terms of crude protein, neutral detergent fibre, cellulose, ether extract and ash were similar in all the formulations tested and did not vary much during storage (Table 5.3). Marginal differences in components, if any, could be the effect of the type and quantity of ingredients used by different workers (Kakkar and Makkar, 1995; Chauhan *et al.,* 1997). Further, no deterioration in colour, odour or texture was observed in storage, nor any apparent contamination with mould. Of the several lots of the blocks produced, only one lot developed surface mould within one month of storage. This could be due to improper drying or high water content, or both, or prior contamination of the molasses used. Malik, Makkar and Kakkar (1993) had suggested wrapping blocks in polythene sheets to avoid moisture contamination, especially during the rainy season. Based on these observations, it was inferred that the UMMB so prepared could be preserved in a dry environment at room temperature for a reasonable period.

Table 5.3
Proximate analysis of fresh and stored UMMB prepared using formulations III, IV and V (percentage of dry matter)

Components	Freshly prepared UMMB			14-month-old UMMB		
	III	IV	V	III	IV	V
Dry Matter (percent of UMMB)	85.0	84.0	86.5	84.4	81.8	83.5
Crude Protein	42.4	43.0	41.8	40.9	40.8	41.3
Neutral Detergent Fibre	26.7	25.9	26.5	26.0	26.0	27.0
Acid Detergent Fibre	–	–	–	21.0	14.5	17.5
Cellulose	3.6	6.4	4.1	5.0	7.0	5.5
Ether extract	1.4	0.5	0.8	2.5	0.5	1.0
Ash	28.3	26.4	27.5	35.1	22.8	26.5

Acceptance of the blocks by buffaloes

All the animals offered UMMBs accepted them readily. In the first week of the trial, more buffaloes (46 percent) tended to bite the blocks, but this decreased to 26 percent in the second and to about 5 percent in the third and fourth weeks of supplementation. The daily average UMMB consumption by each animal was calculated to be 627 ±34 g. In earlier studies, where bentonite was used as a binder, adult cows and buffaloes consumed 400–500 g of UMMB (Makkar and Saijpaul, 1996). The use of cement as a binder in the present study did not affect the intake of the blocks. The intake of UMMB also depended upon the basic diet being fed to the animals, and the quality and texture of the blocks. Calves kept on lower amounts of concentrate consumed more UMMB (695 vs 559 g/day; Kakkar, Malik and Makkar, 1997).

Studies on the Effect of UMMB Supplementary Feeding – Field trials

Several field studies were undertaken on boosting reproductive performance and milk production through UMMB supplementary feeding in buffaloes.

Effect of UMMB supplementation on reproduction

An efficient reproductive process is a prerequisite for profitable dairy farming. However, delayed onset of postpartum ovarian activity (90–180 days) and high incidence of deep anoestrus, especially during summer (50–75 percent) lead to prolonged inter-calving intervals (15–25 months) in Indian dairy cows and buffaloes, causing huge economic losses to the Indian dairy industry. The major limiting factor is a lack of sufficient good quality feed and fodder, coupled with the limited purchase capacity of smallholder and landless farmers. Several pilot projects were initiated to study the reproductive performance of buffaloes following UMMB supplementation at various stages of reproduction, the results of which are presented below.

Effect of pre-partum UMMB supplementation on postpartum reproduction in buffaloes

High milk production, and therefore excessive drainage of body reserves, in the immediate postpartum period leads to excessive weight loss, which, in turn, suppresses ovarian activity. It is therefore preferable that a dairy animal should have appropriate body reserves before parturition, and sufficient feed intake after parturition to meet its energy demands (Gearhart *et al.*, 1990; Staples, Thatcher and Clark, 1990). The animals are, however, unable to increase dry matter intake, owing to limited rumen capacity and delayed ruminal microfloral adjustment to new, energy-rich diets that are fed conventionally (Goff and Horst, 1997; Roche, Mackey and Diskin, 2000). Hence, good quality feeding pre-partum is needed to develop sufficient body reserves and also to attain timely adjustment of ruminal microflora to the probable postpartum diet (Domecq *et al.*, 1997; Goff and Horst, 1997). The study reported here was undertaken to assess the effect of pre-partum UMMB supplementary feeding on postpartum reproductive performance in water buffaloes.

Thirty-two closely observed buffaloes were provided with UMMB during the last trimester of gestation, and their postpartum onset of ovarian activity was compared with that of unsupplemented controls. Buffaloes in both the groups exhibited first behavioural oestrus between 15 and 45 days (average 24) postpartum. However, plasma progesterone concentrations studied in a limited number of animals revealed that none had ovulated (absence of a rise >1.0 ng/ml). UMMB supplementation did not appear to affect the onset of first behavioural oestrus, which could probably be related to factors other than nutritional status of an animal (Beam and Butler, 1997; Butler, 2000). Ovulatory heat was recorded (plasma progesterone concentration >1.0 ng/ml) in 90 percent of the supplemented and 80 percent of the control buffaloes on average at 48 (range: 34–57) and 34 (range: 23–49) days postpartum, respectively. Incidence of silent heat in the respective groups was 11 percent and 75 percent. The days taken to first ovulatory heat (34 vs 48 days) and the proportion of silent heat (11 vs 75 percent) was noticeably lower in the supplemented than in the control buffaloes. Further, the conception rate during the first 70 days postpartum was noticeably higher in supplemented than in controls (30 percent vs 0 percent). Wider observations involving more buffaloes under field conditions showed that 70 percent of the pre-partum UMMB supplemented buffaloes exhibited fertile oestrus within 60 days postpartum, compared with only 14 percent in control animals.

Effect of postpartum UMMB supplementation on reproduction in buffaloes

Good quality nutrition is a necessity for proper puerperal and postpartum production and reproductive events, which, however, remain constrained by limitations in concentrates and green fodder availability, especially among poor farmers. UMMB supplementation to 14 freshly calved buffaloes belonging to small-scale rural farmers proved beneficial. The average percent body weight loss was greater (0.53 to 3.9 percent) in unsupplemented than in supplemented (0.02 to 3.0 percent) buffaloes. Further, the supplemented buffaloes started gaining body weight earlier (5th week postpartum) than did the unsupplemented controls (7th week postpartum). A higher proportion (71 percent) of the supplemented buffaloes displayed oestrus within 50 days postpartum, compared with only 14 percent in the controls (Randhawa, 2002). Similar benefits, however, could not be seen from UMMB supplementation of buffaloes on larger-scale organized urban dairy farms (Kumar, 2001), probably due to the already better nutritional status of buffaloes (Makkar and Saijpaul, 1996).

Effects of UMMB supplementation in true anoestrus buffaloes

Fifty-four rural buffaloes suffering from true deep anoestrus, as confirmed from history, per-rectal examination of genitalia and circulatory progesterone concentrations, were supplemented with UMMB during September–October. Of these, 90 percent came into heat and conceived within one month of supplementary feeding, compared with only 28 percent in the control group (Brar and Nanda, 2002). In another, similar, trial during May–June – a period with minimal breeding activity in buffaloes (Nanda, Brar and Prabhakar, 2003) – UMMB supplementation for 30 days induced behavioural oestrus in 40 percent of the buffaloes, compared with only 10 percent in the control group. Extended UMMB supplementation for another 30 days (total 60 days) induced behavioural oestrus in 85 percent of buffaloes, with a 100 percent first-service conception rate (Kang *et al.*, 2002). These studies suggested that malnutrition is a major cause of anoestrus, and that it could be ameliorated through UMMB supplementation, although the response was poorer during the hot, dry summer than in spring.

Potentiation of reproductive hormonal therapy through UMMB supplementation

Certain hormones are employed to induce fertility in anoestrus animals. Variable responses, however, have been reported in buffaloes, probably due to the variable nutritional status of treated animals. Therapeutic efficacy of certain hormonal interventions was evaluated following UMMB supplementary feeding in buffaloes. Groups of progesterone-primed anoestrus buffaloes were treated with equine chorionic gonadotrophin (eCG), with or without concomitant UMMB supplementation. Behavioural oestrus was induced in 80 percent of the supplemented and 67 percent of the unsupplemented buffaloes, of which 75 percent and 50 percent ovulated. It is thus evident that UMMB supplementation affected behavioural as well as ovulatory responses of the hormone-treated buffaloes (Kang *et al*., 2003; Randhawa *et al*., 2003a).

From the foregoing, it appears that prevention and treatment of anoestrus through UMMB supplementation strategy is better than eCG treatment, taking into account the total time taken to conceive, requirement for veterinary intervention, costs involved and loss of milk yield.

Effect of UMMB supplementation on milk production in buffaloes

UMMB-supplemented buffaloes showed increased milk yield and higher milk fat values at almost all stages of reproduction. Pre-partum UMMB supplemented buffaloes on average yielded 88 kg more milk per head during the first 60 days of subsequent lactation than did their unsupplemented counterparts. Similarly, an average increase of 8 percent milk yield and 0.5 percentage unit milk fat was recorded following UMMB supplementation postpartum (Brar and Nanda, 2002). Supplemented buffaloes sustained peak milk yield for longer (4 vs 2 weeks) than their unsupplemented counterparts (Randhawa, 2002). UMMB feeding during late lactation led to a 4 percent increase in milk yield and 0.7 percent unit increase in milk fat, whereas the unsupplemented controls experienced a decline in milk yield (Kang, 2002).

Buffaloes treated with eCG for induction of oestrus experienced a drop in milk yield, which persisted for about 5 to 7 days. This drop, however, was reduced by 40 percent in buffaloes supplemented with UMMB before and during hormonal treatment.

Earlier studies by other workers in India (Makkar and Saijpaul, 1996) also reported 6–8 percent increase in milk production in cows consuming 400–500 g UMMB daily. This could replace up to 20 percent of the concentrate in the diet without affecting the quality and quantity of milk produced and body weight in buffaloes fed with 30–35 kg green fodder (Chauhan *et al*., 1997).

Biochemical changes after UMMB supplementation

High circulatory urea concentration, which may occur after consuming protein-rich diet, has been linked to an altered uterine environment and reduced fertility in dairy cattle (Beam and Butler, 1998). UMMB is a urea-based nutritional supplement and apprehensions about its possible ill effects on animal health are not totally unfounded. Laboratory studies were undertaken to assess biochemical changes, if any, following long-term UMMB consumption in buffaloes. The blood urea-nitrogen in all the studies cited above remained within physiological limits (<20 mg/dl). Blood glucose did not differ between the groups of buffaloes studied under field conditions. Total plasma proteins, insulin and creatinine, estimated at weekly intervals in various studies, remained within normal physiological limits. Blood concentration of free fatty acids, an indicator of fat mobilization in lactating animals, was relatively lower in UMMB supplemented than in unsupplemented buffaloes (42 vs 49 mg/dl). This suggested a superior nutritional status in the supplemented animals (Kang, 2002; Randhawa *et al.*, 2003b).

Cost–benefit analysis of UMMB supplementation in buffaloes

Use of UMMB supplementation proved economically beneficial. Taking into account milk production alone, the average cost–benefit ratio of feeding UMMB prepared by the cold process was 1:3. It was 1:2.3 during the summer months (Kang, 2002) and 1:2.9 during spring (Randhawa, 2002). The Highest economic gain (1:4; Brar, 2001) was recorded following UMMB supplementation during the last trimester pre-partum. Overall financial gains were better for relatively underfed animals on small, rural farms, compared with well fed animals in urban dairy units (Kumar, 2001; Randhawa, 2002).

Obviously, the economic returns are more appreciable after feeding UMMB prepared by the cold process than by the hot process because of the lower costs of the former (Malik *et al.*, 1997; Brar, 2001). The actual economic returns from UMMB supplementation are much more than reported in the preceding paragraphs because of the general improved reproductive performance in the supplemented buffaloes. Increased milk fat yield would also add to the benefits.

Extension of UMMB technology to the field

Extensive efforts have been made to transfer the technology to the end-user, the farmer. The process of extension adopted by the authors' team included:

(i) training trainers, namely Field Veterinary Officers, veterinary students, research scientists from various national veterinary and animal husbandry teaching and research institutes and state agricultural universities from 17 of the 27 states in India, and international visiting fellows from Indonesia and Bangladesh;

(ii) training farmers, through more than 50 field demonstrations given to rural dairy farmers at village-level centres and at animal welfare camps organized in collaboration with Punjab State Animal Husbandry Department. A UMMB Farmers' Club has been established, which at the time of writing had over 200 members;

(iii) implementing pilot projects in more than 20 villages to study and to demonstrate the benefits of UMMB supplementation. At first, the blocks were prepared and distributed free-of-cost to the enrolled farmers, while later on they were encouraged to produce blocks for themselves on a routine basis;

(iv) training private entrepreneurs in preparation of and supplementation with UMMB on a commercial scale. Several private UMMB production centres, organized mainly by the farmers, are now producing and selling UMMB in Punjab. Mass UMMB production has been initiated at some places after introducing minor changes in the procedures. Production of 1 200 blocks by one entrepreneur in about four hours has been recorded; and

(v) establishing 17 pilot farms in villages in the vicinity of Milk Collection Centres, which are frequently visited by the local dairy farmers. This proved highly effective in transfer of UMMB technology from farmer to farmer.

The UMMB extension procedures used by the team vary somewhat from the approach used by many earlier workers. The current emphasis has been more on improvement of animal reproductive performance, for which veterinary intervention is often needed. Training of field veterinarians has thus been of immense help in extension of UMMB technology to the end user. In addition, the UMMB club has worked well through farmer-to-farmer contacts.

Experiences with medicated blocks

Limited work on this aspect of UMMB use has been done in India. Incorporation of fenbendazole in blocks led to 13 percent increase in milk production in buffaloes (Knox, 1995; Sanyal and Singh, 1995). In the authors' laboratory, preliminary trials on medicated blocks carrying Replanta, a herbal drug, hastened uterine involution and postpartum ovarian activity. Further work is in progress.

Limitations of UMMB Production in India

India is a vast country, with varied agroclimatic conditions and agro-industrial by-product availability. Further, the climate changes a lot over the year. This variability implies that no single block formulation, or even process, may be valid at all times and in all places.

India has extreme fluctuations in green fodder availability over the year. While blocks would be in high demand during the two fodder lean periods (April–June and November–December), use of UMMB might not be beneficial during gluts of lush fodder. This may affect the interests of commercial UMMB firms, making it an unsustainable preposition. Nevertheless, this could be effectively handled through providing information on when and when not to use the feed supplementation blocks.

Blocks prepared by addition of tree leaves (Gupta and Malik, 1991) or other unconventional ingredients (Saijpaul and Makkar 1996) could not be popularized due to the limited area of their potential application.

Future Of UMMB technology in India

The fast increasing human population pressure is reducing the land available for fodder production. However, the increased cereal production leaves abundant agro-industrial by-products, and UMMB has a great role to play in the profitable utilization of these by-products, simultaneously reducing potential environmental pollution. Apart from the importance of UMMB in reproduction, as discussed earlier, there is a great potential role to play in meeting the nutritional needs of animals in drought-prone western states and in flood-affected eastern states of India. The use of medicated blocks for control of endoparasites should be exploited in small ruminants. The authors' have already started exploring the use of UMMB in solving the major problem of "delayed puberty" in buffaloes. The use of UMMB as carrier to deliver many herbal digestive stimulants, herbal galactagouges, herbal ecbolics, ionophores and anthelmintics is under consideration.

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Urea molasses multinutrient blocks technology – Bangladesh experiences

M. A. S. Khan[7], M. A. R. Chowdhury[1], M. A. Akbar[8] and M. Shamsuddin[9]

Introduction

Bangladesh is an agricultural country, and livestock play an important role in the rural economy. There are about 24 million cattle, with an average milk production of 1.0 kg/day in local cow and about 3.0 kg/day in crossbred cow. About 1.62 million tonne of milk is produced for 140 million people, and per capita availability of milk was 30 ml in 1999-2000 (DLS, 2001). The average milk production of small-scale market-oriented dairy cows is 5 kg/day. Practically no grazing land is available for animals due to high pressure on land for cereal grain production for human consumption. Low productivity and poor reproductive performance in local and crossbred cows due to feeding with poor quality straw-based diets and improper management are common features of livestock husbandry in Bangladesh. There is a serious scarcity of green grass, and consequently agricultural crop residues or by-products are fed to the animals, together with only a limited amount of high-cost concentrate. As a result, smallholder farms face serious problems in feeding dairy animals for optimum production. For several years, attempts have been made to help the smallholder farmers make the best possible use of locally available feed resources so that crops and livestock can be produced more efficiently and profitably. Feed supplementation strategies have been developed to correct the nutrient

7 Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. E-mail: <s-khan@royalten.net

8 Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

9 Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh E-mail: <m-shams@royalten.net>

deficiency of poor quality roughages. Urea-molasses multinutrient blocks (UMMBs) have been introduced at village level and on mini-dairy farms in some urban and peri-urban areas in Bangladesh.

Initially, the focus was on increasing straw utilization by ruminants, because straw is the major source of feed available. Although straw is available in large quantities, it is low in nutritive value due to its high lignocellulose content, with only small amounts of crude protein and essential minerals. It was possible to improve the feeding value of rice straw using chemical treatments (Saadullah, 1991), but this approach did not become popular among farmers because of the extra cost and extra work involved (Akbar, 1992). In order to find suitable supplements to optimize rumen fermentation to enhance production and improve reproductive performance, one approach used was to supplement the rice straw with more readily available materials to provide the energy and protein that were lacking in the basal diet.

After studies on the nutritional status of the animals, the selected supplement was made into a UMMB that could be licked by the animal. UMMB was prepared with locally available feed ingredients that are cheap, and with some ingredients produced on-farm as agricultural by-products. Considering the nutritive value and cost of block constituents, the composition of a typical block was 39 percent sugar-cane molasses, 20 percent wheat bran, 20 percent rice polish, 10 percent urea, 6 percent lime powder and 5 percent common salt. Molasses from the sugar cane industry is available at low cost, although it is now also being used for various purposes in the food and pharmaceutical industries. Rice polish and other ingredients are also available at a reasonable low cost. The cold process was used for manufacturing block on a small scale (Sansoucy, 1995). This method is simple and does not require expensive equipment to make the blocks. Urea and salt are mixed in a bowl with the required amount of molasses, and kept overnight. Then lime powder, rice polish and wheat bran are mixed thoroughly (Figure 6.1). The previously mixed molasses, urea and salt is then poured onto the mixture of wheat bran, rice polish and lime powder. The mixture is then mixed thoroughly by hand or with a concrete mixer (for medium-scale production) and poured into a wooden or steel mould, typically about 9″ × 5″ × 6″ (≈23×13×15 cm) in size (Figure 6.2). The material is pressed into the mould using foot pressure or a simple press (Figure 6.3), and then released from the mould and set aside to harden on the floor (Figure 6.4). Pressure on the block in a mould can also be created with a ball press machine for easier operation and small-scale production. Hardening requires at least 15 hours at room temperature. The block is then ready for presentation to the animal (Figure 6.5).

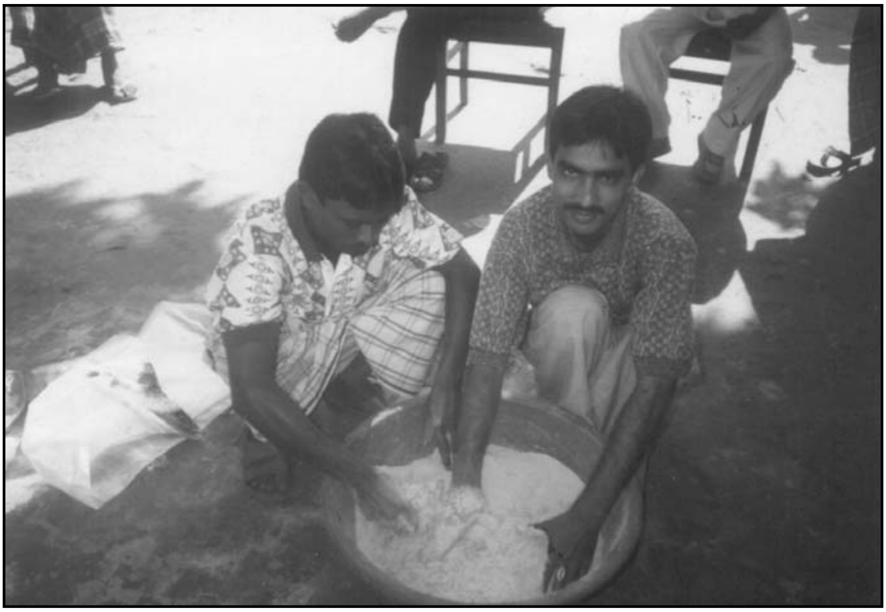

Figure 6.1 Mixing of wheat bran, rice polish and lime powder.

Figure 6.2 Placing the mixture into a mould.

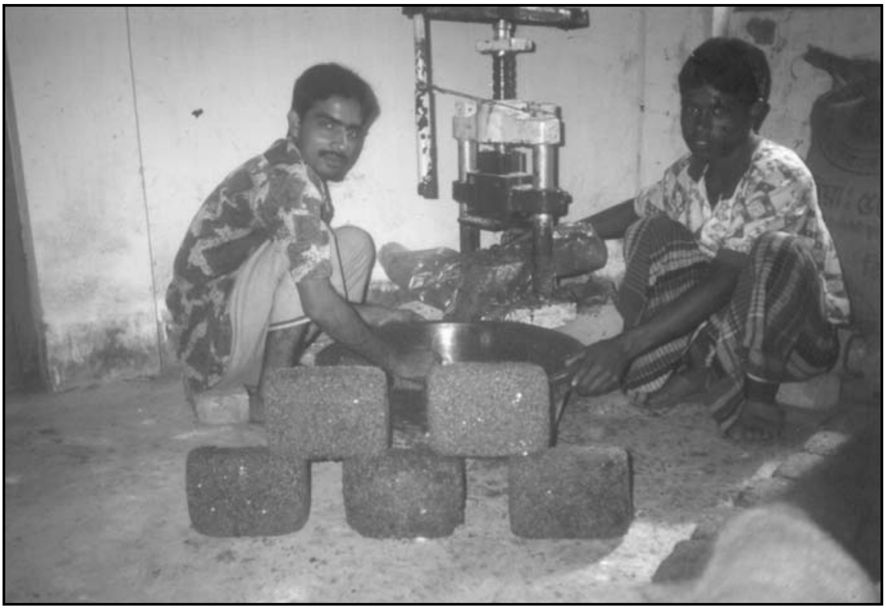

Figure 6.3 A mechanical device being used for making UMMB licks.

Figure 6.4 Removing a block from the mould.

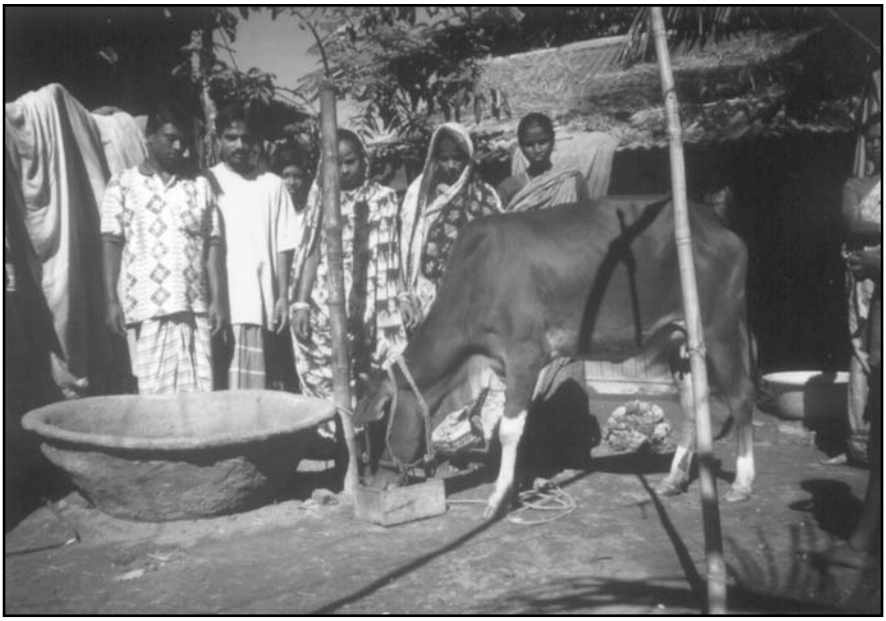

Figure 6.5 Block being licked by a cow.

UMMB licks for improvement of milk yield and reproductive performance of indigenous cows

To test the effects on intake and productivity of cattle, as well to assess acceptance by farmers, UMMBs were distributed to farmers in selected villages in Mymensingh district who were rearing indigenous cows on straw-based diets. Milk yield, body weight gain, calf weight gain and body condition score increased on providing UMMB licks for cows (Table 6.1)

With UMMB supplementation, cows came into heat earlier after calving (Table 6.2). The first progesterone (P4) rise of a cow after calving, first detectable heat, calving-to-conception interval and calving interval were shorter in UMMB-supplemented cows compared with unsupplemented indigenous cows (Mazed, 1997). Positive effects on milk production and reproductive performance of indigenous cows were also reported by others workers (Maih *et al.*, 1999, 2000). They found that milk yield and body weight gain of cows and of suckling calves improved upon providing UMMB licks.

Table 6.1
Effect of feeding UMMB on productive performance of indigenous cows and calves.

Parameter	Treatment		Level of significance(1)
	-UMMB	+UMMB	
Milk yield (kg/day)	1.47	1.84	*
Body weight change of cow (g/day)	-33	-4	NS
Calf's weight gain (g/day)	66	110	**
Body condition score of cow on 1-5 scale	2.31	2.51	**

NOTE: (1) * P <0.05; ** P <0.01. SOURCE: Mazed, 1997.

Table 6.2
Effects of feeding UMMB on postpartum reproductive performance of indigenous cows (Mazed, 1997)

Indicators	Treatments		Level of significance
	-UMMB	+UMMB	
Interval from calving to:			
1st progesterone rise (days)	104	103	NS
1st oestrus (days)	194	130	**
Conception (days)	199	162	NS
Calving interval (days)	480	443	NS

NOTE: ** P <0.01

Optimum level of UMMB for crossbred cows

Further attempts were made to assess the effect of feeding UMMB on milk yield and reproductive performance of crossbred cows reared in commercially oriented small-scale dairy farms in peri-urban areas and villages, fed a rice-straw-based diet. UMMB was made using locally available feed ingredients: molasses (39 percent), wheat bran (20 percent), rice polish (20 percent), lime powder (CaO) (6 percent) and common salt (5 percent). The blocks were prepared using the cold process. Four levels of UMMB were fed to the cows (0; 350; 500; and 650 g/head/day of block (treatment groups T_0, T_1, T_2 and T_3, respectively) to establish the optimum amount of UMMB required for maximum production response in crossbred cows with an average of 300 kg body weight and fed 2.75 kg/head/day of homemade concentrate mixture, with an initial milk production of about 6 kg/day. In this context, it should be noted that long anoestrus periods and infertility are serious problems in rearing crossbred cows in Bangladesh. Results were encouraging. On feeding UMMB, milk yields of dairy cattle increased by 1 to 1.5 kg/day (Table 6.3). The optimum level of UMMB for crossbred cows to achieve higher milk production and better reproductive performance was 500 g/head/day.

Cows and calves with access to UMMB licks gained more body weight than their counterparts without access to UMMB. The intervals from calving to initiation of luteal activity, oestrus and conception were shorter in UMMB-fed lactating cows (Table 6.4).

The postpartum reproductive intervals of cow can be reduced by feeding UMMB (Hendratno, 1999), which is of economic significance. It was interesting that the difference between first progesterone rise and first detectable oestrus were 66 to 80 days in groups T_0 and T_3 (Table 6.4), which indicated that the farmers were unable to detect heat at its first occurrence, resulting in 3 to 4 heats lost without insemination. The calving interval of cows was reduced by 64 days in group T_2, which has an economic value as more calves are produced over the total reproductive life of a cow. Taking 10 years as a typical reproductive life of a cow, it is expected that a cow in the T_0 group will produce 7 calves in her total reproductive life, while cows in group T_2 group will produce 8 calves each. The additional calf and lactation from each cow earns more profit in the T_2 group of animals.

Table 6.3

Mean values for milk yield, body weight change in cows and calf weight gain.

Parameter	Diet(1)				SEM	Level of significance
	T_0	T_1	T_2	T_3		
Milk yield (kg/day)						
180 days average	5.42	5.49	6.81	6.83	0.009	*
Lactation average	3.33	3.38	4.19	4.20	0.055	*
3.5 percent FCM(2)	5.95	6.38	8.16	8.16	0.106	* *
Lactation yield (kg)	1115	1196	1527	1531	19.85	* *
Body weight change of cow (g/day)	9.4b	65.9ab	88.1a	88.4a	4.302	*
Calf weight gain (g/day)	159b	167b	215a	228a	2.717	* * *

NOTES: (1) The diets were: T_0 = Control (no UMMB); T_1= 350 g/head/day UMMB; T_2 = 500 g/head/day UMMB; T_3 = 650 g/head/day UMMB. (2) FCM = fat-corrected milk. a,b = means with different superscripts differ significantly (P <0.05).

Table 6.4
Effect of UMMB on postpartum reproductive intervals of cows

Indices	Diets(1)				SEM	Level of significance
	T_0	T_1	T_2	T_3		
Interval from calving to- (d)						
1st progesterone rise (days)	96	87	82	62	3.486	NS
1st oestrus (days)	162	132	123	142	4.555	NS
Conception (days)	234	187	170	170	5.702	NS
Next calving (days)	517	470	453	460	5.670	NS
Calving interval reduced (days)	–	47	64	57		* * *
Service per conception(2) (No.)	2.67^a	2.0^b	1.8^b	1.73^b	0.044	NS

Notes: (1) Diets were: T_0 = Control (no UMMB); T_1 = 350 g/head/day UMMB; T_2 = 500 g/head/day UMMB; T_3 = 650 g/head/day UMMB. (2) Means with different superscripts differ significantly (P <0.05). NS = not significant.

Economic returns were calculated for the different groups of animals. The highest profit was earned from the T_2 group (US$ 2.11), fed 500 g of UMMB/head/day (Table 6.5).

Table 6.5
Economic benefit from UMMB supplementation in cows

Item	Diet(2)			
	T_0	T_1	T_2	T_3
Cost (Tk/day)(1)				
Cost of supplement [1]	0	2.52	3.60	4.68
Cost of basal diet [2]	29.71	32.94	34.13	34.16
Total feed cost [A = 1 + 2]	29.71	35.46	37.74	38.84
Income (Tk/cow/day)				
from milk sale [a]	119.00	127.60	136.20	136.60
from cow weight gain [b]	0.75	5.27	7.04	7.08
from calf weight gain [c]	12.72	13.28	17.20	18.56
Total income [B= a + b + c]	121.80	128.33	160.44	162.24
Profit [B –A] (Tk/cow/day)	92.09	92.87	122.70	123.40
Profit (US$/cow/day)	1.58	1.60	2.11	2.12
Cost:benefit ratio	1:3	1:2.7	1:3.3	1:3.2

Notes: (1) Calculated in taka (Tk). Exchange rate at the time of reporting: Tk 58 = US$ 1. (2) Diets were: T_0 = Control (no UMMB); T_1 = 350 g/head/day UMMB; T_2 = 500 g/head/day UMMB; T_3 = 650 g/head/day UMMB.

A number of studies in villages and peri-urban areas of Bangladesh have demonstrated the benefits of using UMMB as a supplement with cut-and-carry forages offered to dairy cattle on smallholder farms.

Replacement of concentrate by UMMB

Efforts have been made to replace concentrate by UMMB and to study performance under village farming condition. Concentrate feeds are costly and not available throughout the year. Moreover, smallholder farmers are reluctant to purchase concentrate ingredients when milk production goes down at the end of the lactation. Many farmers rear cows on very small amount of concentrate to minimize feed cost. To study the effect of replacing concentrate by UMMB, 60 multiparous crossbred dairy cows reared on straw-based diets were selected. Three diets, comprising a daily ration per head of 2.75 kg concentrate (T_0), 2.45 kg concentrate + 0.30 kg UMMB (T_1) or 2.25 kg concentrate + 0.50 kg UMMB (T_2), were fed to three groups of 20 lactating cows each. Rice straw was fed as roughage, with a very small amount of cut-and-carry grass (1.4 kg/head/day) under zero grazing conditions for 180 days. The results are presented in Table 6.6. Animals in group T_2 had significantly ($P <0.001$) higher roughage intake, and milk yield was also improved significantly ($P <0.05$) (6.94 kg/head/day). The fat content of milk increased in T_1 (45.8 g/kg) and T_2 (48.4 g/kg) groups compared with the control, T_0 (40.4 g/kg). The highest content of fat was in the T_2 group, which resulted in higher economic return. Body weight gain of calves was improved significantly ($P <0.05$). Calving interval was also reduced by 60 days. The highest profit was in the T_2 group (US$ 2.70/head/day), and derived mostly from replacing concentrate by 500 g UMMB/head/day.

Protein content of milk increased with increasing amounts of UMMB, and non-fat milk solids (SNF) and total solids (TS) also increased when concentrate was replaced with 300 g and 500 g UMMB in groups T_1 and T_2, respectively (Table 6.7). Supplementation with UMMB resulted in improved milk quality.

Table 6.6

Effect of UMMB supplementation on intake, milk yield and body weight change of cows and calves.

Parameters	Diet$^{(2)}$ T_0	T_1	T_2	SEM	Level of significance$^{(1)}$
Roughage intake (kg DM/day)	6.9	8.0	9.2	0.177	* *
Total DM intake (kg/day)	9.4	10.5	11.3	0.29	NS
Milk yield (kg/day)	5.6^b	5.8^b	6.9^a	0.07	* * *
3.5% FCM (kg/day)	6.1^b	6.9^b	8.5^a	0.09	* * *
Body weight change of cow (g/day)	6.1	13.7	42.9	5.46	NS
Calf weight gain (g/day)	160^b	181^b	248^a	4.74	*
Calving interval (days)	485	483	425	10.48	NS

Notes: (1) * * * = P<0.001; NS = not significant (P >0.05). (2) T_0 =2.75 kg concentrate per day, no UMMB; T_1 = 2.45 kg/day concentrate + 0.30 kg/day UMMB; T_2 = 2.25 kg/day concentrate + 0.50 kg/day UMMB. Means with different superscripts differ significantly (P <0.05). DM = dry matter

Table 6.7
Effect of UMMB supplementation on milk composition of crossbred cows

Components		Diet(1)			SEM	Level of significance
		T_0	T_1	T_2		
Milk fat	(g /100 g)	4.04	4.58	4.84	0.15	NS
Milk protein	(g /100 g)	3.5	3.56	3.62	0.05	NS
Lactose	(g /100 g)	3.95	3.93	4.10	0.04	NS
SNF	(g /100 g)	8.12	8.17	8.42	0.08	NS
TS	(g /100 g)	12.16	12.77	13.26	0.19	NS

KEY: SNF = non-fat milk solids. TS = total [milk] solids.

NOTES: (1) T_0 = 2.75 kg/day concentrate, no UMMB; T_1 = 2.45 kg/day concentrate + 0.30 kg/day UMMB; T_2 = 2.25 kg/day concentrate + 0.50 kg/day UMMB.

Table 6.8
Economic benefit from UMMB supplementation with different amount of concentrate in crossbred cows.

Item		Diet(2)		
		T_0	T_1	T_2
Cost (1)	(Tk/day)			
Cost of supplement [1]		0	2.16	3.60
Cost of basal diet [2]		29.70	29.48	29.75
Total feed cost [A= 1 + 2]		29.70	31.64	33.35
Income (1)	(Tk/day)			
Income from milk sales [a]		122.0	138.2	169.0
income from cow weight gain [b]		0.48	1.09	3.43
Income from calf weight gain [c]		12.80	14.48	14.72
Total income [B= a + b + c]		135.28	153.77	187.15
Profit [B -A]	(Tk/day)	105.58	122.13	153.80
Profit from UMMB supplement	(US$/day)*	1.85	2.14	2.70
Cost:benefit ratio		1:3.5	1:4	1:5

NOTES: (1) Calculated in taka (Tk). Exchange rate at the time of reporting: Tk 58 = US$ 1. Milk price = Tk. 20.00/kg, Concentrate = Tk 7.40/kg; UMMB = Tk 7.20/kg. (2) Diets: T_0 = 2.75 kg concentrate, no UMMB; T_1 = 2.45 kg concentrate + 0.30 kg UMMB/day; T_2 = 2.25 kg concentrate + 0.50 kg UMMB/day.

Economic benefits of partial replacement of concentrate with equal amount of UMMB were assessed. Replacing concentrate by 300 g or 500 g UMMB per day resulted in more earnings than feeding concentrate alone (Table 6.8). The benefits of replacement of concentrate were due to the lower cost of UMMB compared with concentrate mixture, and improved milk yield and quality, especially higher fat content. It was observed that the body weight gain of suckling calves was higher in groups T_1 and T_2 (181 g/day and 248 g/day, respectively) than in the non-replacement group (160 g/day), which also has an economic value. Similarly, early postpartum weight gain of a cow has a positive effect on the next pregnancy and calving. It was observed that the cost-benefit ratio was highest in group T_2 group (1:5), with a total profit of US$ 2.70/day (Table 6.8).

Feeding UMMB to animals for growth

In Bangladesh, animals frequently suffer from stunted growth because of poor nutrition. The only feeds are rice straw and small quantities of cut and carried forage, which is seasonally available., Attempts were therefore made to supplement their diets using UMMB licks. The results were encouraging. Use of UMMB increased liveweight gain of buffalo heifers (Akbar, Islam and Moldak, 1991). UMMB supplementation with straw-based diets for indigenous cows resulted in 4.8 percent increased liveweight gain after calving, and it also stimulated initiation of ovarian cyclicity earlier than in counterpart unsupplemented animals (Ghosh, Alam and Akbar, 1993).

UMMB supplementation in dry season

The principal animal feed resource in Bangladesh is rice straw (90 percent of roughages), and rice by-products, such as rice polish. Farmers also feed their cattle with mixed green fodder (grass and forbs) cut from roadsides, but during the dry season – November to April – such mixed green fodder is not available and the animals are completely dependent on rice straw as the sole feed. To sustain the level of milk production, supplementary feeding is essential for dairy cattle. In addition, many of the cattle in Bangladesh calve during the dry season.

Supplementation with UMMB has been proved to be an effective strategy to compensate for the nutrients deficit in the conventional base diet.

A limited area of fallow land, roadsides and other areas has been used as open grazing land (locally called *Bhathan*) in Sirajgonj district in the dry season (November–April). A limited effort has been made to manage this rough pasture land and mixed grasses are grown naturally. Animals are kept temporarily in this area for the dry period (7 months), with a small amount of concentrate (1 or 2 kg/day). Dairy cows are underfed, and poor milk production and body weight loss are common features of this type of cattle rearing. During the rainy season (June–October) these animals are kept in stalls in the farmer's homestead and stall feeding is practised. In this season, land is inundated and no green grass is available in this area for animals. Consequently, rice straw is the only roughage for maintaining body weight and milk production. UMMB supplementation may play an important role in this situation as well. According to farmer's observation and experience, feeding 500 g UMMB/day to a lactating cow can sustain milk production without any concentrate. Many farmers have been making UMMB on their farms and feeding to lactating cows for more milk and to bring their cows into heat early. Some farmers have been using UMMB as a substitute for concentrate. A considerable number of farmers have accepted this technology on their own initiative.

UMMB supplementation in working animals

In Bangladesh, Saadullah (1991) observed that supplementation of UMMB to draught cows fed a basal diet of urea-treated rice straw or untreated rice straw increased feed intake, daily milk yield, lactation period and daily liveweight gain from calving to pregnancy detection. The supplementation also increased the draught output (Table 6.9).

Table 6.9
Performance of draught cows with or without UMMB supplementation on rice-straw-based diets in Bangladesh.

Parameters	Untreated straw		Treated straw	
	-UMMB	+UMMB	-UMMB	+UMMB
Milk yield (g/day)	452	460	515	570
Lactation period (days)	220	235	246	255
Liveweight gain from calving to pregnancy detection (days)	20	40	87	150
First heat after calving (days)	210	210	205	195

Farmers' observations and experiences with UMMB feeding in Bangladesh

- Farmers reported that their animals looked healthier, their skin appeared shiny, and they had good body condition.
- Their animals consumed more feed, especially roughages, with increased straw intake.
- Their animals came into heat earlier after calving.
- Concentrate provision could be reduced by UMMB use to sustain milk production.
- Cows with access to UMMB continued giving milk for a longer period.
- Milk production could be sustained by providing UMMB to low yielding (2–6 kg/day) cows, without feeding any concentrate.

Factors influencing the adoption of UMMB technology in Bangladesh

- The price of ingredients used in UMMB making fluctuate according to the season. For example, the price of molasses in the local market is unstable, reflecting its seasonal availability. Its availability is higher and price lower in the sugar cane crushing season.
- Farmers are interested in getting the blocks in a readymade form in the local market, but there is no large-scale manufacturer in the market.
- Level of education of the farmers is an important factor. The technology was adopted more rapidly in those places having a higher proportion of literate people.
- The economic condition of farmers affects technology adoption. Poor

farmers are unable to purchase UMMBs due to lack of money, as they purchase their food daily and often meet requirements by selling milk on a daily basis.

- Large-scale production of UMMB, which could increase availability, is probably not possible without financial support from the Government, due to lack of capital investment.
- Usually, medium-scale milk producers (5–15 kg milk/day) at village level are more concerned about increasing milk production and are ready to invest in the technology. Farmers having only one or two cows with low production levels are less interested in additional investment.

Factors for successful development and use of UMMB technology in Bangladesh

The use of UMMB has become popular in Bangladesh. Several factors have influenced this development.

- A severe scarcity of feeds and fodder for ruminants, and feeding low quality rice straw results in lower milk yield and poor reproductive performance. Increased milk production and reproductive efficiency can be easily achieved using an N-containing supplement.
- Good demand for milk. This encourages farmers to use a supplement, such as UMMB, that can be produced at home using cheap, locally available, feed resources.

Conclusion

UMMB supplementation is an effective means of correcting nutrient deficits in poor quality roughages. It use as a supplement improved productivity of local and crossbred cows reared on straw-based diets. High-cost concentrates can be replaced by UMMB licks. The studies showed that milk production could be sustained by providing UMMB without any concentrate up to outputs levels of 5 kg of milk per day. UMMB supplementation can be recommended to improve the nutritional status of cattle fed straw-based diets in Bangladesh. There is a need to extend this technology to a greater number of farmers through intensive extension efforts.

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Feed supplementation blocks – experiences in China

Jian-Xin Liu[10], **Ruijun Long**[11] and **Degang Zhang**[12]

Introduction

With the development of animal production and adjustment in the structure of livestock husbandry, the numbers of herbivores in the People's Republic of China increased rapidly in the last decade. This development has been based on both increased utilization of crop residues and increased cultivation of grass and forage. Since 1992, when livestock production based on crop residues was included in the State Agriculture Comprehensive Development Project, significant progress has been made (Guo and Yang, 1997). There has been a large increase in beef and mutton production, with large-scale extension campaigns for utilization of crop residues. However, efficiency of livestock production is not satisfactory because digestibility of straw is low and lacks protein. Many farmers in rural and peri-urban areas usually offer their cattle and sheep only limited concentrate supplementation. The animals suffer from malnutrition due to insufficient supply of minerals, of nitrogen in particular.

As an important and effective supplementary feed, multinutrient blocks were introduced into China in the early 1990s (Guo and Zhang, 1991). Since then, extensive research work has been conducted in China on the preparation and use of multinutrient blocks for ruminant animals, including beef cattle (Lai *et al*., 1997; Liu *et al*., 1995; Ma *et al*., 1995; Zou *et al*., 1998), goat and sheep (Jia *et al*., 1995; Xu, Tian and Wang, 1994; Yang, Jiang and Wen, 1996; Chen *et al*., 2001b; Zhang *et al*, 1998b), buffalo (Guan *et al*., 2001a; Zou *et al*., 1996; Lu *et al*., 1995), dairy cattle (Chen *et al*, 1993a, 1993b; Wang *et al*, 1995; Tang *et al*., 1998), and yaks (Zhang, 1998; Dong *et al*., 2002; Long *et al*., 1998; 2002). Much progress has been made and new techniques have been developed for manufacturing multinutrient blocks in China.

10 College of Animal Sciences, Zhejiang University, 310029 Hangzhou, People's Republic of China. E-mail: <jxliu@dial.xju.edu.cn>

11 Northwest Plateau Institute of Biology, Chinese Academy of Sciences, 810008 Xining, People's Republic of China.

12 College of Grassland Science, Gansu Agricultural University, 730070 Lanzhou, People's Republic of China. E-mail: <lrj@public.lz.gs.cn> or <longruijun@sina.com>

Formulas and composition of the blocks

Ingredients of the blocks

The multinutrient lick blocks developed in China contain molasses, urea, common salt and minerals, with aim of supplying roughage-based diets with fermentable N, soluble carbohydrates and minerals. In addition to ground maize, rice bran and wheat bran, oilseed meals, grass meal, bone meal and vitamin premix have been included in the blocks (Chen *et al.*, 1993a; Li *et al.* 1995; Zou *et al.*, 1996; Gao and Meng, 2002). Table 7.1 gives some sample formulas of multinutrient lick blocks from China.

Molasses is a source of easily fermentable carbohydrates and is a binder. Blocks are highly palatable when they contain molasses. It has been demonstrated that mixing molasses and urea can greatly slow the release of NH_3-N in the rumen. Mineral premix usually contains calcium, phosphorus and sodium as well as micro-elements such as Fe, Cu, Mn, Zn, I, Se and Co (Liu *et al.*, 1995; Zhang *et al.* 1999). Lime or cement has been used commonly as a solidifer and binder. Ordinary clay or bentonite has also proved efficient for block making (Chen *et al.*, 1993b; Guan *et al.*, 1998). Farmers in some regions used loess as a binder (H.W. Ye, *pers. comm.*).

In a series of demonstration trials in Gansu province, where the basic animal diet comprised wheat straw and other stubble, Chen *et al.* (1993a) chose three formulas to satisfy the needs of cows, heifers and calves (Table 7.1). Many workers have used molasses as one ingredient for blocks (Li *et al.*, 1995; Yang, Jiang and Wen, 1996; Guan *et al.*, 1998), but Liu *et al.* (1995) chose a formula of lick block without molasses, as it is expensive and in short supply in some regions.

Table 7.1
Some formulas of multinutrient lick blocks used in China.

Animal	Urea	Molasses	Salt	Cement	Lime	Clay	Mineral mix	Wheat bran	Maize meal	Oilseed meal	Bone meal	Grass meal	Ref.
Dairy cattle													
Cow	16	8	26	–	10	11.5	23.8	–	5	–	–	–	[1]
Heifer	12	10	26	–	10	15	22	–	5	–	–	–	[1]
Calf	0	15	22.8	–	10	15	22.2	–	10	–	5	–	[1]
Beef cattle	10	38	1	10	–	–	1	40	–	–	–	–	[2]
Sheep	13	26	10	–	–	5	16	30	–	–	–	–	[3]
Sheep	13	26	10	4	–	0	17	30	–	–	–	–	[3]
Sheep	13	26	10	8	–	0	13	30	–	–	–	–	[3]
Sheep	11.8	19.5		13.6	–	–	13.6	20.9	14.6	6	–	–	[4]
Goats	10	35	5	5	10	5	2	25	–	–	–	–	[5]
Goats	10	35	5	–	10	5	2	33	–	–	–	–	[5]
Goats	10	38	5	10	–	5	2	30	–	–	–	–	[5]
Goats	10	35	5	–	–	10	2	36	–	–	–	–	[5]
Yak	10	10	9	–	–	30	–	4	10	20	5	2	[6]
Yak	20	10	10	–	–	30	–	4	3	20	3	–	[7]

SOURCES: [1] Chen *et al.*, 1993a; [2] Liu *et al.*, 1995 [3] Zhang *et al.*, 2000; [4] Zhang *et al.*, 1998b; [5] Guan *et al.*, 1998; [6] Zhang, 1998a; [7] Long *et al.*, 1998.

Nutritional composition of blocks

The nutritional characteristics of multinutrient lick blocks are indicated in Tables 7.2 and 7.3. Most of the multinutrient lick blocks have a high crude protein (CP) value due to the effect of the inclusion of urea. Some workers (Zou *et al.*, 1996; Dong *et al.*, 2002) included oilseed meals in the blocks. Most of the lick blocks contain Ca, P and Mg, and micro-minerals such as Fe, Cu, Mn, Zn, Co, I and Se, but the mineral contents differ greatly between the blocks manufactured by different workers (Table 7.3), depending mainly on the target animals.

Table 7.2
Nutritional characteristics of multinutrient lick blocks.

Animals	DM **(%)**	CP **(%DM)**	Lysine **(%DM)**	Methionine **(%DM)**	ME **(MJ/ kg DM)**	NE **(MJ/ kg DM)**	Reference
Dairy cattle							
Cows	95.8	40.0	–	–	–	3.51	[1]
Heifers	95.1	31.1	–	–	–	–	[1]
Calf	96.1	20.0	–	–	–	–	[1]
Dairy cattle	–	43.0	–	–	–	–	[1]
Beef cattle	–	35.6	–	–	–	2.09	[2]
Yellow cattle	–	40.1	–	–	–	–	[3]
Yellow cattle	–	40.6	–	–	–	–	[3]
Buffalo	87.0	34.2	–	–	–	–	[4]
Buffalo		38.7	0.23	0.15	–	–	[5]
Buffalo	87.0	33.4	–	–	8.2	–	[6]
Sheep	–	29.9	–	–	6.22	–	[7]
Sheep	–	41.54	–	–	1.47	–	[8]
Sheep	93.0	18.75	–	–	–	–	[9]
Goat	87.0	33.4	–	–	–	–	[10]
Yak	–	43.0	–	–	–	–	[11]

NOTES: DM = dry matter; CP = crude protein; ME = metabolizable energy; NE = net energy.
SOURCES: [1] Chen *et al*., 1993a; [2] Xu, Zhao and Liu, 1993; [3] Zou *et al*., 1998; [4] Guan *et al*., 2001a; [5] Zou *et al*., 1996; [6] Yu *et al*., 1998; [7] Zhang *et al*., 1998b; [8] Guan *et al*., 2001b; [9] Xue *et al*., 1995; [10] Guan *et al*., 2001c; [11] Dong *et al*., 2002.

Table 7.3
Mineral contents of multinutrient lick blocks.

Animal	Ca (%)	P (%)	mg (%)	Fe (mg / kg)	Cu (mg / kg)	Mn (mg / kg)	Zn (mg / kg)	I (mg / kg)	Co (mg / kg)	Se (mg / kg)	Ref.
Dairy cattle											
Cows	2.3	5.0	–	1 193	933	3 140	5 412	113	17	57	[1]
Heifers	1.1	3.3	–	1 198	651	2 825	1 814	–	5	26	[1]
Calf	4.3	0.4	–	1 124	140	804	1 002	–	5	42	[1]
Dairy cattle	5	2	0.2	–	–	–	–	–	–	–	[2]
Beef cattle	4.22	0.54	2	160	110	150	110	60	12	1	[3]
Yellow cattle	–	–	–	5 200	44	235	106	0.8	8.8	0.31	[4]
Yellow cattle	–	–	–	5 200	49.7	218	120	0.5	8.9	0.48	[4]
Cattle and goat	>0.9	>0.5	–	1 300	140	450	520	10	5	3	[5]
Buffalo and goat	9.54	0.17	0.55	5 500	170	450	300	0.22	0.53	0.46	[6]
Goat	6.8	3.0	4.2	2 400	–	1 400	1 500	20	14	6	[7]

SOURCES: [1] Chen *et al*., 1993a; [2] Chen et al., 2001a; [3] Xu, Zhao and Liu, 1993; [4] Zou *et al*., 1998; [5] Liu *et al*., 1995; [6] Guan *et al*., 2001b; [7] Zhang *et al*., 1998a.

Manufacture of blocks

Depending on the technical process, preparation of multinutrient blocks developed in China can be classified into two categories: a pressure process, using special equipment (hot process), or a moulding process (cold process), in which the ingredients are automatically bound with each other in mould.

Pressure process

Several specialized equipment sets have been developed to process blocks under pressure (Chang, 1997; Xia *et al*., 1994a, 1994b; Li and Li, 1997; Zhang *et al*., 2000). Xia *et al*. (1994a) designed a novel and simple type of molasses block press system. Zhang *et al*. (2000) developed appropriate equipment for manual processing of lick blocks for cattle and sheep, and observed that there was little influence of pressure intensity (9.7–24.1 kg/cm^2) on density and intake of the blocks by sheep. Liu *et al*. (1995) utilized machinery designed for producing ceramic tiles to manufacture urea-mineral lick blocks with a breaking strength of 40 kg/cm^2. They were easily transported and offered to the animals. Even when they were offered to the animals in situations of high humidity over a long period of time, there were no losses from mould growth or from hydration of the blocks.

Table 7.4 shows the characteristics of two presses used for the formation of blocks, designed by Chen *et al*. (1993a). The blocks were based on a molasses and urea mix. This mixture was heated and the salt added, followed by the addition of the rest of the ingredients, previously mixed together. The complete mixture was then pressed and the resulting blocks were wrapped immediately. Blocks made using both presses had good hardness, the breaking strength being 44 kg/cm^2. The block was oblate (diameter 25.6 cm and thickness 8 cm) and weighed about 7.5 kg.

With these equipment sets, shaped multinutrient lick blocks can be easily produced, while the process does not need much space or labour. The blocks could be rectangular, oblate or cylindroid in shape, and production capacity ranged from 50 to 200 kg/h (Chen *et al*., 1993a; Zhang *et al*., 2000, Xia *et al*., 1994a). The blocks produced were compact, not deliquescent, and hard enough to control their intake. They did not become mouldy nor did they lose shape when exposed to rain or sunshine.

Table 7.4
Characteristics of presses used for making blocks.

Press type	Power source	Dimensions (cm)	Weight (kg)	Working pressure (kg/cm2)	Production capacity (kg/h)
9YK-50 Manual	Hydraulic jack (50 tonne)	60 x 70 x 100	240	52	50
9YK-150 Electrical	Hydraulic pump (0.75Kw)	75 x 40 x 200	640	176	150

SOURCE: Chen *et al*., 1993a.

The moulding process

Many workers have used a simple moulding process to manufacture lick blocks (Ma *et al.*, 1992; Yang, Jiang and Wen, 1996; Chen *et al.*, 2001b). In this process, ingredients are mixed in a manner similar to the hot (pressure) process and then transferred to moulds, using moulds with a wood or metal frame. The blocks produced with this process have advantages compared with hot process blocks, and the cold process is usually fairly simply and requires neither sophisticated equipment nor much energy.

The blocks made by Chen *et al.* (2001b) were rectangular, 15 cm × 5 cm, and weighed about 1 kg each. The blocks produced with a pour process by Ma *et al.* (1992) had the following physical characteristics:

- When water was poured onto the surface of the blocks, blocks would keep their shapes after sun-drying.
- Blocks would hold their shape in water for 1–2 hours, but completely disintegrate after 4–5 hours.
- The shape of the blocks did not change with finger or foot pressure.

The blocks produced by Yang, Jiang and Wen (1996) were square or a compressed cylindroid, with a round hole in the centre (1.5 cm in diameter) to allow the blocks to be hung on a fence. The breaking strength was 56.9 kg/cm^2. The hardness was increased when formaldehyde-treated urea was used in the block instead of urea.

Effects on animal performance

Beef cattle

Some outcomes of multinutrient lick block supplementation on bodyweight change in beef cattle are shown in Table 7.5. Use of the blocks improved the productive performance of beef cattle. Zhang *et al.* (1993) observed that daily weight gain was 15.6 percent higher and consumption of roughage and concentrate per kg of gain were 16.9 and 13.3 percent lower, respectively, when hybrid beef cattle were supplemented with multinutrient lick blocks containing non-protein nitrogenous (NPN) compounds. Supplementation with multinutrient lick blocks, with or without urea and salt, could decrease body weight loss in yellow cattle receiving rice straw ad lib as the sole diet (Yi *et al.*, 2000). In another trial (Ma *et al.*, 1995), beef cattle with access to NPN-containing lick blocks had daily weight gain 0.353 kg higher than those with no blocks (1.478 vs 1.125 kg/day).

In a growth trial with heifers (n = 42), animals having access to lick blocks had a daily gain of 0.835 kg/day, which was 0.112 kg/day ($P < 0.05$) higher than the control group (Chen *et al.*, 1993a). Animals supplemented with lick blocks would reach 380 kg body weight (weight at first service) 65 days earlier, giving an earlier first calving. Other advantages observed during the on-farm animal feeding trials were better skin coat, better body condition and lower mortality. The urea-mineral lick blocks without molasses were also palatable to both cattle and goats (Liu *et al.*, 1995).

Local yellow cattle grazing and with access to the blocks performed better than those on the control diet (370 vs 203 g/day weight gain). The animals offered blocks had better body condition and looked healthier than animals on unsupplemented diets.

Sheep and goats

Xu, Tian and Wang (1994) observed increased feed intake and improved daily gain (23 percent) in sheep having access to lick blocks, compared with controls (Table 7.6). The supplemented sheep produced wool of high quality with higher contents of S, Fe and Zn. Similar results were observed by Jia *et al*. (1995) and Yang, Jiang and Wen (1996). When hybrid goats had access to urea-molasses blocks, average block intake was 80 g/day (Guan *et al*., 2001b). During the last three months of the experiment, daily weight gains were 67 g and 43 g for goats with and without access to the blocks, respectively. Effects of multinutrient lick blocks on performance of growing goats were investigated by Zhang *et al*. (1999), where goats with access to lick blocks had a liveweight gain 38.3 percent higher than those without the blocks.

Table 7.5

Effect of multinutrient block supplementation on performance of beef cattle

	Treatment			
	1	2	3	4
Hybrid yellow cattle (1)				
Intake (kg/day, as fed)				
Concentrate mixture	1.5	1.5		
Brewer's grains	19.7	18.2		
Carrots	1.1	1.1		
Maize silage	3.7	3.6		
Multinutrient block	0	0.19		
Liveweight gain (g/day)	896	1 036		
Huangpo yellow cattle (2)				
Intake (g/day)				
Rice straw	ad lib	ad lib	ad lib	ad lib
Block B	0	120	0	0
Block IB	0	–	46.5	46.5
Urea + salt	0	–	0	suitable
Body weight change (g/day)	-311	-88	-140	-176
Qingchuan bull cattle (3)				
Intake (kg/day, as fed)				
Concentrate mixture (4)	4.5	4.5		
Microbe-treated rice straw	4.0	4.0		
Multinutrient block	0	20		
Liveweight gain (g/day)	930	982		
Angus calves (5)				
Number of calves (head)	10 bulls	10 bulls	10 heifers	10 heifers
Initial weight (average; kg)	111.4	116.1	94.0	105.5
Intake (kg/day, as fed)	2	2	2	2
Liveweight gain (g/day)	542	794	373	591

NOTES: (1) Data from Zhang *et al*., 1993. N = 12 in each group, ca 330 kg body weight. (2) Data from Yi *et al*., 2000. N = 10 in each group, ca 175 kg body weight. Block IB is equivalent to block B but without urea and salt. Animals in treatment group 4 were supplemented with urea and salt to the same level as in group 2. (3) Data from Liu *et al*., 2001. N = 11 in each group, ca 290 kg body weight. (4) Ingredients: maize, 26%; wheat, 30%; millet, 20%; sesame cake, 20%; lime, 2%; and salt, 2%. (5) Data from Zheng *et al*., 2001. All calves suckled for 1 hour in the morning and evening, and each animal was offered 1 kg of hay and 1 kg of concentrate mixture per day.

When the multinutrient lick blocks were provided as a supplement to grazing goats and sheep, the effect on productive performance was significant (Table 7.6), with much higher weight gain in the block-supplemented animals than in the control group without blocks. Liu *et al*. (1995) reported their results with two groups of goats, which grazed together on hill pasture during the day and were offered rice straw ad lib in stalls at night. One group had free access to the urea-mineral lick blocks along with rice straw at night. Goats with access to the blocks performed better than those in the control group. Liveweight gains were significantly higher in animals with blocks compared with those without blocks (95 vs 73 g/day).

Buffaloes

Effects of providing blocks to buffaloes have been observed by some workers (Lu *et al*., 1995; Zou *et al*., 1996, Guan *et al*., 2001a). When buffalo heifers (n = 12) fed on rice straw diets were supplemented with urea-molasses lick blocks, daily weight gain was 650 g, versus 620 g for control animals (Lu *et al*., 1995). Feed cost and concentrate consumption per kg of gain were 9.8 percent and 33.3 percent lower, respectively, for the supplemented buffaloes. Animals were not poisoned, even when block intake exceeded 1 000 g/day, indicating that the blocks were safe for animals. Zou *et al*. (1996) chose a block formula for growing buffaloes with molasses, urea, grain by-products, minerals and vitamin premix. Intake of the blocks increased during the of the experimental period, and was 172.4, 330.2 and 374.1 g/day at 30, 60 and 80 days after start of the experiment, respectively. Compared with control animals with no blocks, the daily weight gain of buffaloes with access to the blocks was 22.6 percent (395.4 vs 484.6 g/day) higher. In animals supplemented with blocks, the feed conversion ratio was 22.5 percent less and concentrate consumption was 22.8 percent less per kg of gain.

Table 7.6
Effect of multinutrient block supplementation on performance of goats and sheep

	Treatment			
	1	2	3	4
Zaanen castrated goats (1)				
Intake (g/day, as fed)				
Concentrate mixture	200	200		
Fresh grass	3300	3400		
Liveweight gain (g/day)	24	34		
Fine wool sheep (2)				
Intake (g/day)				
Dry matter	1200	1200	1200	
Block I (N:S = 6.1:1)(3)	0	23.8	0	
Block II (N:S = 9.2:1)	0	0	27.8	
Liveweight gain (g/day)	71.7	83.3	80.0	
Wool production (g/day)	4.0	4.3	4.4	
Goats (4)				
Intake (g/day)				
Sugar cane tops/elephant grass	*ad lib*	*ad lib*		
Ground maize	50	50		
Block	0	80		
Liveweight gain (g/day)	43	67		
Sheep (5)				
Intake of supplement (g/day)	300	300		
Liveweight gain (g/day)	116	143		
Castrated goats (6)				
Intake of blocks (g/day)	0	20	40	60
Liveweight gain (g/day)	75	110	179	73
Black goats (7)				
Intake (g/day)				
Blocks	ad lib	ad lib	ad lib	
Ground maize	0	0	100	
Liveweight gain (g/day)	58	73	90	
Black goats (8)				
Liveweight gain (g/day)	60	87	83	
Dressing rate (%)	43.4	47.8	47.9	
Lean meat percentage (%)	64.4	72.6	67.7	
Tibetan sheep (9)				
Intake of block (g/day)	0	152		
Liveweight gain (g/day)	111	192		

(1) Data from Xu, Tian and Wang, 1994. n = 10 in each group, ca 13 kg body weight. Concentrate comprised: maize, 53%; wheat bran, 32%; rapeseed meal, 10%; soybean meal, 4%; common salt, 0.5%; and $CaCO_3$, 0.5%. Group 2 received UMMB supplementation.

(2) Data from Jia *et al*., 1995. n = 5 in each group, ca 31–33 kg body weight. The diet consisted of hay, maize silage, ground maize and groundnut cake.

(3) N:S = Nitrogen to Sulphur ratio.

(4) Data from Guan *et al*., 2001b. n = 15 in each group, ca 15 kg body weight. Animals were fed in-house without supplements.

(5) Data from Xu, Tian and Wang, 1994. n = 20 in each group, ca 20 kg body weight. Animals were grazed without supplements.

(6) Data from Lu and Gao, 2001. ca 24–25 kg body weight. Animals were grazed without supplements. Supplement ingredients were: maize, 60.4%; wheat bran, 25.0%; rapeseed meal, 10%; and soybean meal, 4.6%. UMMB was included in treatment 2.

(7) Data from Chen *et al*., 2001b. n = 9 in each group, ca 16 kg body weight. Animals were grazed with supplements.

(8) Data from Zhang *et al*., 1998a. n = 10 in each group, ca 15 kg body weight. Animals were grazed without supplements. The goats in group 1 formed the control; the animals in groups 2 and 3 were supplemented with multinutrient block with Clenbuterol and Monensin, respectively.

(9) Data from Yu, Chen and Feng, 1998. n = 8 in each group, ca 32 kg body weight. Animals were grazed without supplements.

Dairy cows

Among the limited work on multinutrient lick blocks with dairy cattle, Chen *et al*. (1993a) observed that cows (n = 15) having access to blocks had an average milk yield of 20.7 kg/day, which was 1.3 kg (6.7 percent) higher ($P < 0.01$) than the average of the control group (n = 15). Additional advantages from use of the blocks included an increased conception rate (12.2 percent), decreased morbidity (22.5 percent), improved body condition and increased income (Chen *et al*., 1992). In another trial by Wang *et al*. (1995), dairy cows (n = 10) supplemented with multinutrient blocks produced 1.1–1.5 kg (5.3–5.9 percent) more milk than those without blocks (n = 10), and less metabolic disorders were observed in the supplemented animals. Xu, Zhao and Liu (1993) investigated the performance of Holstein dairy cows (n = 22) in the middle stage of lactation, and found that when urea-containing lick blocks were provided, the cows produced 20.5 kg/day of milk, which was 4.1 kg (25 percent) higher than the average of the control group. It was estimated that cows with access to blocks gave an increased income of RMB¥ 736 per head per year.

Several workers offered their dairy cows lumpish concentrate supplements rather than lick blocks, because the intake of the "block" was high, from 580 g/day (Chen *et al*., 2001a) to 2000 g/day (Zhang, Li and Liu, 1996).

Yaks

Effects of giving UMMBs on productive performance of yak have been observed by Long and colleagues in Gansu Province (Dong *et al*., 2002; Long *et al*., 1998, 2002; Zhang, 1998). Dong *et al*. (2002) studied the effect of the blocks on liveweight change in yak calves, and productive and reproductive performance of yak cows in the feed-deficient cold season on the Qinghai-Tibet Plateau. Each calf in the supplemented group was offered daily 250 g of block and each cow had a 0.5 kg block daily, together with grazing on natural grassland from January to May 1998. Liveweight losses of 1-year calves, 2-year calves and yak cows were reduced by 1.2, 8.3 and 7.9 kg in the experimental period after block supplementation ($P < 0.01$, Table 7.7). One-year-old calves gained liveweight mostly in the first supplementation month, and two-year-old calves and yak cows gained liveweight in the first and last supplementation months. Long *et al*. (2002) reported similar results, and that there were significant effects of UMMB supplement preventing yaks from losing more body weight in inadequate forage seasons (Figures 7.1 and 7.2). In particular, the effect of UMMB on performance in terms of less body weight loss seemed better in April than in February and March, which was clearly reflected in positive monthly liveweight gains for one-year-old calves in April. Again, UMMB contributed much to minimizing cow body weight losses ($P < 0.01$) from both under-feeding and calves suckling during the hard period (Figure 7.2). Daily milk yield of yak cows increased by 0.21 kg/day when the lactating animals were supplemented with block ($P <0.01$, Table 7.8), although there was no significant effect of block supplementation on hair and downy hair production of yak cows ($P>0.01$). Block supplementation also significantly improved yak cowreproductive performance ($P<0.01$, Table 7.8), with increments of 8.8 and 30.9 percent in pregnancy rate and newborn weight, respectively. Economically, the benefits with two-year calves and yak cows were reasonable – the output:input ratio reached 1.8: 1 and 1.4: 1 respectively – but block supplementation for one-year-old calves was far from economic.

Zhang (1998) conducted trials on cold-season supplementary feeding of urea molasses multinutrient blocks in Gansu province: in Tianzhu county with 90 white yak cows and in Luqu county with 60 black cows. The blocks, which contained 10 percent urea and 10 percent molasses, were offered at a daily intake of 500 g per cow for five months, from December to April. The results were 80.3 and 46.8 percent less liveweight in the white and black yaks, respectively. It also lead to 20 and 13.6 percent more milk yield, 17.4 and 20 percent higher pregnancy rate and output:input ratios of 1.35:1 and 2.11:1, respectively in the two yak groups. These authors concluded that supplementary feeding with the blocks was an effective way to mitigate liveweight loss and to improve the productive performance of yaks during the cold season in the pastoral counties.

Table 7.7
Effect of UMMB on liveweight change of yak calves and cows

		Control (no supplement)	Treatment (with supplement)	Standard error of the mean
One-year-old yak calves		n = 10	n = 20	
Initial weight	(kg)	61.4	61.1	0.2
Final weight	(kg)	60.2	61.6	0.4
Gain	(kg)	-1.2 [a]	-0.03 [b]	0.05
Two-year-old yak calves		n = 10	n = 20	
Initial weight	(kg)	95.4	95.9	1.3
Final weight	(kg)	85.7	94.5	2.1
Gain	(kg)	-9.7 [a]	-1.4 [b]	0.61
Yak cows		n = 20	n = 20	
Initial weight	(kg)	162.9	158.9	2.2
Final weight	(kg)	154.7	158.5	1.4
Gain	(kg)	-8.2 [a]	-0.4 [b]	0.081

NOTES: [a,b] Mean values in the same row with different letters are significantly different (P<0.01).

SOURCE: Dong *et al*., 2002

Table 7.8
Effect of supplementary blocks on performance of yak cows

		Control (without supplement)	**Treatment** (with supplement)	**Standard error of the mean**	**Increment** (%)
Milk yield	(kg/day)	1.3 [a]	1.5 [b]	0.04	16.4
Cheese production	(kg/day)	0.03 [a]	0.04 [b]	0.001	18.8
Butter production	(kg/day)	0.05 [a]	0.06 [b]	0.002	15.4
Hair production	(kg)	0.77	0.81	0.09	7.8
Downy hair production	(kg)	0.41	0.46	0.02	12.2
Pregnancy rate	(%)	63.7 [a]	72.5 [b]	0.014	8.8
Caving rate	(%)	86.3	90.2	0.015	3.9
Survival rate of calves	(%)	90.2	96.4	0.023	6.5
Birth weight of newborn	(kg)	13.6 [a]	17.8 [b]	0.011	30.9

NOTES: [a,b] Mean values in the same row with different letters are significantly different (P <0.01).

SOURCE: Dong *et al*., 2002

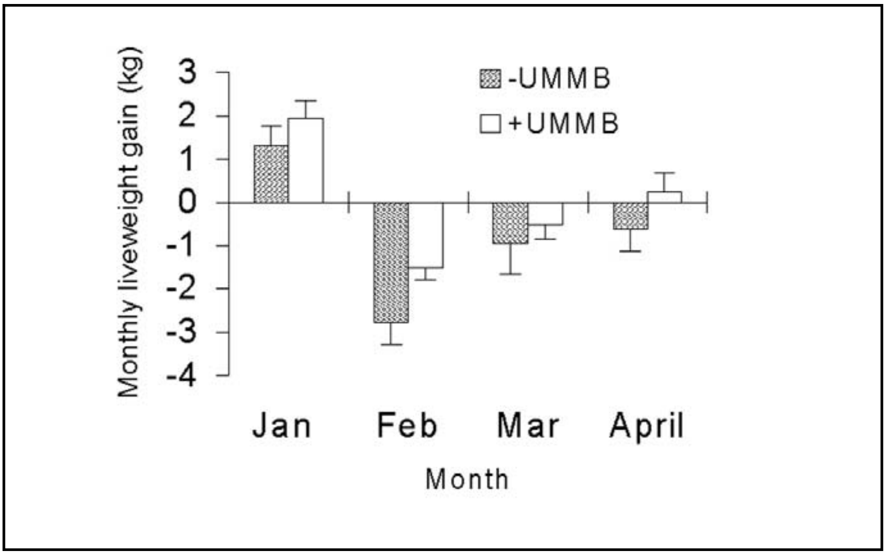

Figure 7.1

Monthly gain in body weight of one-year-old calves with (n = 20) or without (n = 20) UMMB supplementation (from Long, *et al*. 2003)

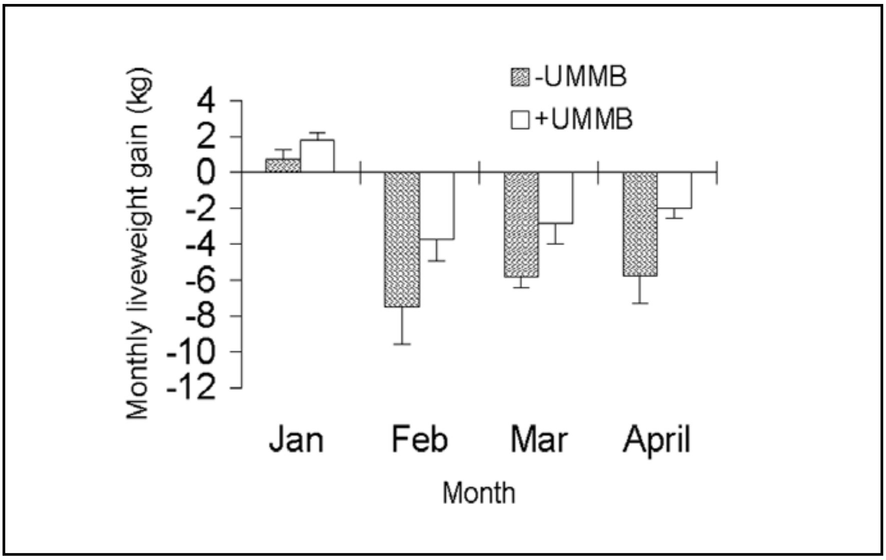

Figure 7.2

Monthly gain in body weight of cows with (n = 20) or without (n = 20) UMMB supplementation (from Long *et al*., 2003.)

Effects on digestion and metabolism

Much of work on blocks in China has been concerned with effects on animal productive performance. In addition, some workers have investigated the effects of block use on rumen fermentation (Zhang *et al*., 1997; Xue *et al*. 1995) and digestion and utilization of nutrients of the diets (Wu and Liu, 1996; Li *et al*., 1999). Blood physiological and biochemical parameters have been compared between animals with and without blocks supplementation (Zhang *et al*., 1998a).

Rumen fermentation

Zhang *et al* (1997) studied the effect of supplementary urea blocks on NH_3-N concentration and pH value in the rumen of wethers. The pH did not alter, while rumen NH_3-N ($P < 0.01$) concentration significantly increased and approached or exceeded 13 mg/100 ml rumen fluid, the optimal level of NH_3-N for rumen microbial activity suggested by Hume, Moir and Somers (1970). Improvement in the rumen ecosystem is beneficial to rumen microbial activity, and hence rumenal digestion. Xue *et al*. (1995) observed that when the animals were supplied with an additional urea block of 50 g per head per day, the microbial protein yield was increased (11.87 vs 10.18 g/day) and synthetic efficiency (26.4 vs 23.0 g/ kg fermentable organic matter) was improved, compared with the control. When rice straw, maize stover and sugar cane bagasse were incubated in the rumen of buffaloes supplemented with urea-molasses block, the 48-hour degradation of feedstuff nutrients was significantly higher than in the rumens of animals without block supplementation (Table 7.9, Guan *et al*., 2001c).

Table 7.9
Degradation (48 hours) of rice straw, maize stover and sugar cane bagasse in the rumen of buffaloes.

	Dry matter		Crude protein		Neutral detergent fibre	
Blocks	without	with	without	with	without	with
Rice straw	68.7 [a]	62.3 [b]	69.7	67.5	62.7 [a]	56.4 [b]
Maize stover	85.8 [a]	78.6 [b]	86.5	85.7	82.1 [a]	75.6 [b]
Sugar cane bagasse	55.3 [a]	50.2 [b]	63.8	61.4	47.9 [a]	43.6 [b]

NOTES: [a,b] Figures for same parameter with different superscripts differ ($P < 0.05$).
SOURCE: Guan *et al*., 2001c.

Digestion and utilization of the diets

Many investigators have observed that supplementation with blocks can improve digestion and utilization of nutrients from diets. Wu and Liu (1996) studied the effects of giving a urea mineral lick block on the kinetics of ruminal fibre digestion, nutrient digestibility and nitrogen utilization of rice straw, ammonium bicarbonate (AB)-treated straw and hay prepared from wild forage. The results are summarized in Table 7.10. With block supplementation, the digestibility of dry matter and organic matter of rice straw were increased by 13.1 and 12.7 percent ($P < 0.05$) and approached that of the AB-treated straw, indicating that the effect of the blocks on digestibility of rice straw may be similar to that of AB treatment. The digestibility of the treated straw was improved slightly when animals had access to blocks. Nitrogen retention was highest in lambs on AB-treated straw alone, followed by hay with blocks, and was lowest in animals on rice straw with blocks. However, both the amount of nitrogen retention and proportion relative to intake were increased by block supplementation in lambs fed on hay. The proportion of nitrogen retained to that digested decreased with block supplementation in lambs on both untreated and treated straw. Access to blocks did not significantly influence the rumen degradation of either dry matter or crude protein in any of the three diets. From the results, it is inferred that while the block is effective in increasing nutrient digestibility of low quality roughages through improved ruminal fibre digestion, a simultaneous supply of nitrogen and energy to rumen microbes should be considered to improve the utilization efficiency of nitrogen when the basal diet is ammoniated straw.

In experiments with goats, Li *et al* (1999) observed similar results. The effect of the blocks on digestibility of rice straw was similar to that of treatment with ammonia, and further improvement in digestibility of ammoniated straw was obtained by supplementation with the blocks. Retention and net utilization efficiency of nitrogen were improved more in the animals fed untreated rice straw than in those fed ammoniated straw. It might be due to the oversupply of nitrogen when ammoniated straw diets are supplemented with urea blocks.

Blood parameters

Numbers of red and white blood cells, concentrations of alkaline phosphatase, lactate dehydrogenase and serum levels of total protein, albumin, globulin and haemoglobin were significantly higher in goats supplemented with multinutrient blocks than in goats without blocks (Table 7.11, Zhang *et al*., 1998b). Compared with the controls, contents of all minerals except copper were higher in serum of goats supplemented with multinutrient blocks.

Table 7.10
Effects of use of a urea-mineral block on the intake and digestibility of diets offered to lambs

	Rice straw				Hay		Significance		
	Not treated		AB treated						
Blocks (without/ with)	**without**	**with**	**without**	**with**	**without**	**with**	**R**	**B**	**R × B**
Intake (g DM/day)	576	534	683	591	735	705	*	NS	NS
Apparent digestibility (%)									
Dry matter	48.9	55.3	54.4	57.1	49.1	55.0	*	**	NS
N × 6.25	39.5	45.7	60.1	61.0	35.2	48.8	**	*	NS
NDF	62.6	66.8	65.6	68.5	66.2	69.4	*	*	NS
Nitrogen intake (g)	8.1	8.1	13.2	12.3	12.5	12.5	**	NS	NS
N in faeces (% of intake)	60.5	54.3	40.9	39.0	64.8	51.2	**	*	NS
N in urine (% of intake)	19.8	27.2	17.4	25.2	9.6	12.8	*	*	NS
N retention (% of intake)	19.7	18.5	41.7	35.8	25.6	36.0	*	*	NS
N retained / N digested	50.0	40.5	70.5	58.7	72.7	73.8	**	*	NS
DM degradability (%)	42.9	44.0	52.0	52.2	43.7	46.3	*	NS	NS
EED (%)	26.6	28.2	33.6	36.1	23.1	28.9	**	*	NS

NOTES: R = roughage effect; B = block effect; R × B = interaction effect between roughage and block; * = significant at P<0.05; ** = significant at P<0.01; NS = not significant; AB = treated with ammonium bicarbonate; EED = effective extent of ruminal fibre digestion.

SOURCE: Wu and Liu, 1996.

Table 7.11
Blood cell counts, enzyme activity, protein and mineral contents in serum of goats with or without multinutrient block supplementation for 30 and 60 days (Zhang *et al.*, 1998a)

	30 days			60 days		
	Control	Block 1	Block 2	Control	Block 1	Block 2
Red blood cells ($\times 10^4$/mm^3)	15.9 ^{b}	18.5 ^{a}	18.3 ^{a}	15.6 ^{b}	18.4 ^{a}	18.2 ^{a}
White blood cells ($\times 10^4$/mm^3)	6.9 ^{b}	7.4 ^{a}	7.6 ^{a}	6.9 ^{b}	7.5 ^{a}	7.7 ^{a}
Haemoglobin (g/litre)	72.4 ^{b}	97.3 ^{a}	94.6 ^{a}	72.6 ^{b}	96.8 ^{a}	95.1 ^{a}
Alkaline phosphatase (Units/litre)	16.6	17.1	16.7	16.6 ^{b}	17.8 ^{a}	17.5 ^{ab}
Glutamate dehydrogenase (Units/litre)	15.7	48.2	45.6	48.8	51.4	49.3
Lactate dehydrogenase (Units/litre)	5.1	5.4	5.2	5.2 ^{b}	5.8 ^{a}	5.7 ^{a}
Serum protein level						
Total protein (g/l)	72.0 ^{b}	87.2 ^{a}	85.8 ^{a}	73.6 ^{b}	88.8 ^{a}	85.7 ^{a}
Albumin (g/l)	48.7 ^{b}	57.1 ^{a}	56.8 ^{a}	48.8 ^{b}	59.0 ^{a}	57.1 ^{ab}
Globin (g/l)	23.3 ^{b}	30.1 ^{a}	29.0 ^{a}	24.8 ^{b}	29.8 ^{a}	28.6 ^{a}
Non-protein nitrogen (mg/ml)	0.28 ^{b}	0.41 ^{a}	0.42 ^{a}	0.29 ^{b}	0.37 ^{a}	0.37 ^{a}
Serum mineral content						
Ca (μg/ml)	94.8 ^{b}	113.6 ^{a}	114.5 ^{a}	93.6 ^{b}	114.2 ^{a}	114.7 ^{a}
P (μg/ml)	75.4 ^{b}	91.7 ^{a}	93.6 ^{a}	75.0 ^{b}	93.2 ^{ab}	95.3 ^{a}
Mg (μg/ml)	23.3 ^{b}	34.7 ^{a}	35.5 ^{a}	23.1 ^{b}	34.0 ^{a}	34.3 ^{a}
Na (mg/ml)	2.6 ^{b}	3.0 ^{a}	3.0 ^{a}	2.7 ^{b}	3.0 ^{a}	3.0 ^{a}
Cl (mg/ml)	4.5 ^{b}	5.1 ^{a}	5.1 ^{a}	4.5 ^{b}	5.0 ^{a}	5.0 ^{a}
Fe (μg/l)	28.4 ^{b}	34.9 ^{a}	36.1 ^{a}	29.1 ^{b}	36.1 ^{a}	37.4 ^{a}
Cu (μg/l)	7.0	8.3	8.7	7.2	8.1	8.4
Zn (μg/l)	6.2 ^{b}	8.7 ^{a}	9.2 ^{a}	6.6 ^{b}	9.0 ^{a}	9.7 ^{a}

NOTES: ^{a,b} values within same period with different superscripts differ significantly ($P < 0.05$). The composition of the blocks were the same (see Zhang *et al.*, 1988a; Table 7.1) except that the Block 1 formula contained clenbuterol and Block 2 contained monensin.

Conclusion

Since the introduction of multinutrient blocks into China in the early 1990s, much research work has been carried out nationwide. New techniques have been developed to manufacture the multinutrient blocks in China, and the blocks have been demonstrated to be an efficient way to improve performance of beef cattle, goats and sheep, dairy cows and yaks, no matter whether the animals were indoor fed or grazing. The beneficial effects on performance of animals are attributed to improved rumen fermentation, digestion and utilization of diets. However, much effort is still needed to extend the multinutrient block concept and product more widely in China.

Addendum

Note added by one of the Editors (HPSM) after his visit to the sites of IAEA TC Project CPR/5/014 in the People's Republic of China in August 2003. The principal investigator of this project is one of the authors (ZD) of this chapter and the chapter covers in part the activities of this Technical Cooperation Project.

The objective of the project is to enhance livestock production in northwest China, using appropriate feed supplementation strategies, particularly the use of UMMBs. This project became operational in mid-2000 with the setting up of UMMB production facilities at 10 sites in Gansu province. At the time of reporting, approximately 2 000 farmers were feeding the blocks to over 17 000 animals at these sites, and farmers earned an additional income of RMB¥ 3 million in 2002 as a result of this technology, with a rate of return (ROR) of 160 percent on the investment made by IAEA and counterpart institutions (for every dollar invested by IAEA and the national government in extending the technology, the investment generated an additional US$ 1.60 for each US$ 1 invested, after paying the investment). The cost–benefit ratio varied from 1:1.5 to 1:2.9 for beef cattle; 1:5.4 to 1:6.5 for dairy cattle; 1:3.5 for yak cows; 1:4 for sheep for meat; and 1:3 for sheep for wool. Increased income of RMB¥ 1.2 to 3.5 per animal per day for dairy and beef cattle, 44 percent increased reproductive efficiency in yak, and a 40 percentage unit increase in twinning rate (from 20 to 60 percent) in Alpine short-tail sheep have also been recorded. Income of farmers using the blocks has increased by approximately 10 percent. The ROR of 160 percent in the second year of the project clearly shows that the project has had a very good impact. The rate and density of adoption of the technology was higher in those areas where the extension workers could easily contact farmers and where education levels of farmers were higher.

Methodology for preparation of blocks using wheat flour in place of molasses has been standardized. The basic formula (dry ingredients; weight basis) of the wheat-flour-based blocks is: wheat flour, 5%; urea, 10%; sesame cake, 12.5%; rape seed cake, 12.5%; wheat bran, 10%; maize flour, 10%; bone meal, 3%; common salt, 7%; and bentonite, 30%. It is similar to the molasses-based blocks, except that 1 kg of molasses is replaced with 0.5 kg of wheat flour. These blocks are being used by farmers, with considerable beneficial effects. This technology for wheat-flour-based blocks will have spillover effects for other countries short of molasses or where molasses is not produced.

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