Feed supplementation of dairy cattle with UMMB in the northeastern region of Thailand

Narong Wongnen[13]

Introduction

Dairy production in Thailand has developed rapidly in the last decade. The number of dairy farmers has increased from around 6 600 in 1987 to over 24 000 in 2002, and in the same period the number of dairy cattle increased from around 75 000 to about 370 000 and milk production increased from 90 000 to 660 000 tonne/year (Table 8.1).

Table 8.1
Dairy farmers, dairy cattle and milk production, 1987–2002.

Year	Dairy farms (No.)	Dairy cattle (No.)	Raw milk production (tonne)	Milk demand (tonne)	Milk imports (Baht millions)
1987	6 617	75 791	89 713	126 250	2 812
1990	11 539	116 457	129 248	199 593	4 180
1994	17 190	181 026	205 407	417 986	6 200
1998	24 485	287 732	387 918	796 161	11 604
2002*	24 687	374 648	660 297	1 500 000*	12 872

NOTE: * = estimate.
SOURCE: Office of Agricultural Economics, Department of Livestock Development, 1999.

Progress was mainly due to the concerted efforts of four organizations:
- the Dairy Farming Promotion Organization (DPO) (see Table 8.2);
- the Cooperative Promotion Department;
- the Department of Livestock Development; and
- the Bank of Agriculture and Cooperatives.

13 Dairy Extension Division, Dairy Farming Promotion Organization (DPO), Khon Kaen, Thailand. E-mail: <thaidm@kknet.co.th>

Government policy towards dairy development has also played an important role in this development, as demonstrated through Dairy Extension Projects, the Milk Consumption Campaign, the School Milk Programme and others.

However, despite the sharp increase in milk production during the last decade, the availability of milk been insufficient to meet national demand, and hence Thailand has been importing milk powder and other milk products for a value of about US$ 300 million annually (see Table8.1).

Dairy farming in Thailand is mainly a smallholder activity. An average farm will have 10 cattle, with a range of 5–40. Only around 75 percent of such farmers have a land holding of less than 3 ha.

Table 8.2
Dairy Farming Promotion Organization of Thailand – status as of September 1999.

Site **(date of establishment)**	Plant capacity **(tonne/ day)**	Collection centres **(No.)**	Farmers **(No.)**	Total cows **(No.)**	Cows in milk **(No.)**	Production **(tonne/ day)**
Muaglek (1971)	200	13	2 520	29 321	15 636	110.51
Chieng Mai (1984)	15	5	621	7 661	4 139	28.14
Pranburi (1985)	60	10	1 151	16 864	8 680	74.75
Khon Kaen (1997)	60	6	773	8 128	2 748	25.38
Sukothai (1998)	60	5	319	3 262	1 812	10.13
TOTAL	395	39	5 384	65 236	33 051	248.91

Table 8.3
Availability of feeds and fodder in the northeastern region of Thailand in different seasons of the year.

Feeds and fodder	**Rainy season (May–October)**	**Dry season (November–April)**
Concentrate	Limited availability	Limited availability
Green grass	Plenty	Scarce
Green fodder (Congo grass, para grass, lucerne, guinea grass)	Plenty	Scarce (only some lucerne and Congo grass is available where irrigation is available)
Paddy straw	Not used	Used as main roughage source
Sugar cane top	–	Fed especially during November–February
Cassava hay	Limited availability	Some farmers use it as protein supplement
Cassava chips	Mixed with concentrate (not widely used)	Mixed with concentrate (used widely)
Soybean stems and hull	–	Used only in dry season

The basal diet of dairy cattle in the northeast of Thailand consists of unimproved pasture and crop residues. These forages are generally of low quality because of low digestibility and lack of protein. The quality and quantity of rations fed to dairy cattle vary according to the season: there is an abundance of forage during the rainy season, but there is widespread scarcity during the dry season. Usually concentrates are offered during both rainy and dry seasons, the amounts varying depending on availability and price. Thus, there is a marked fluctuation in nutrient supply to the dairy cattle, and this is a major cause of poor production and reproductive performance, characterized by low milk yields and long calving intervals.

Urea-molasses mineral block (UMMB) licks can improve the utilization of low quality roughages by satisfying the requirement of the rumen microorganisms, creating a better environment for the fermentation of fibrous material and increasing production of microbial protein and volatile fatty acids. Urea, after hydrolyzing into ammonia in the rumen, provides a nitrogen source for the rumen microflora. Molasses is a source of readily fermentable energy. Feeding molasses and urea in the form of a block is convenient and economically feasible for small-scale farmers. To ensure a high rate of milk production, particularly during the dry season, farmers feed large quantities of high-priced concentrates to their cattle, which often constrains profit margins. The promotion of use of UMMB at smallholder level and evaluation of its cost effectiveness as a supplementary source of nutrients have been undertaken since 1995 under an IAEA TC Project, RAS/5/035, *Development of supplementation for milk producing animals in tropical and subtropical environments in the northeast region of Thailand*.

Promotion of UMMB and on-farm experiments.

There were several activities promoting UMMB in 1995–1996 under project RAS/5/035, reported by Pimpaporrn Pholsen and co-workers (1996):

- A training course on UMMB promotion and use was held for extension workers in July 1995, and two production units were established by farmer groups at Koksee village, Muang district and at Khon Kaen Animal Nutrition Research Centre, using a concrete mixer and a 10 kg iron mould. UMMB production at Koksee village was about 8 tonne, and Khon Kaen Animal Nutrition Research Centre produced about 10 tonne. Blocks were prepared using two formulas: high urea content (urea, 10%; molasses, 40%; salt, 2%; triple super phosphate, 2%; sulphur, 1%; cement, 14%; and rice bran, 31%) for the dry season, and low urea content (urea, 5–6%; molasses, 40%; salt, 2%; triple super phosphate, 2%; sulphur, 1%; cement, 11–12%; and rice bran, 37%) for the rainy season. The chemical composition with 10% urea was DM, 87.9%; CP, 34.1%; Ca, 6.5%; P, 0.7%; Mn, 0.4%; K, 1.7%; and Na, 0.8%.
- Fifteen dairy farms were studied for production (milk yield, body weight and condition) and reproduction performance.

Activities in 1997–2000

- Block promotion activities started in 1997 at Srithat Milk Collection Centre (MCC) with the cooperation of the Farmer's Cooperative. Blocks were introduced in 1998 to the farmers' groups from Nasee village at Namphong MCC and from Nong Woa Saw district, and to individual farmers of Kudjub MCC. Blocks were distributed to all six DPO MCCs in the northeast in 1999. The amount of UMMB produced by cooperatives, farmers' groups and MCCs increased from 19.1 tonne in 1997 to 82.2 tonne in 1999 (these figures exclude blocks produced by farmers themselves). Blocks were sold to farmers, establishing a revolving fund system. Blocks were made by farmers at the Farmer's Cooperatives or MCCs using concrete mixers and 10 kg iron moulds, 20–30 kg plastic moulds, and 50 kg rubber moulds made from old car tyres. The percentage composition of blocks was molasses, 40%; urea, 5–10%; rice bran, 36–40%; cement, 10–14%; triple phosphate, 0–1%; sulphur, 0–1%; and mineral mixture, 2%.
- Extension activities involved training programmes for block production and use; setting up of demonstration farms; farm and field visits; and the production of a newsletter, posters and reports on block production and use for publication in the DPO bulletins. A dairy journal was also prepared to encourage the dairy farmers in the area to utilize UMMB as an essential supplement in the daily diet. Four revolving funds (US$ 400–800 each) were established for production units for Nasee group, Kranuan Cooperative, Jareonsin MCC and Srithat MCC. Payments for blocks sold were recovered from milk payments every 15 days.

Effect of UMMB on milk production

Experiment 1

Twenty-three crossbred dairy cows belonging to four farmers of the Sithat MCC were used. The cows selected were already at the declining stage of lactation, around 127 ±10.2 days after calving. They were being given a diet of roughage and concentrate, considered adequate by their respective owners. Daily milk production was recorded for each cow for a period of 15 days. Thereafter the cows were offered a supplement of UMMB. Daily milk production was then recorded for a further 15 days. The average block consumption was 0.68 ±0.07 kg/day.

Table 8.4
UMMB-related activities in 1997–2002.

	1997–1999	2000–2002
Training and demonstration		
Courses for farmers	29 (806 participant days)	19 (680 participant days)
Courses for extension workers	20 (296 participant days)	13 (66 participant days)
Study tours		
For farmers	6 (162 participant days)	6 (130 participant days)
For extension workers	8 (11 participant days)	
Farm demonstrations	9	24
On-farm trials	14	9
Exhibitions	11	5
UMMB posters	1 campaign (1 000 posters)	3 campaigns (1 500 posters)
Revolving funds	4 set up (Baht 125 200)	1 set up (Baht 25 000)
UMMB production (kg.)	144 770	91 900

Experiment 2

Thirty-one dairy cows around 60 days after calving and belonging to ten farmers of Kudjub MCC were used. Five farmers with a total of 16 cows formed the control group with no UMMB supplement, while five farmers with a total of 15 cows received UMMB ad lib. All animals received a basal roughage diet plus concentrate, considered adequate by the respective owners. Daily milk yield per cow was recorded for 30 days. The average block consumption was 0.52 ±0.32 kg/day.

Supplementation with UMMB did not increase milk production significantly, but the persistency of lactation became better and also it reduced to 65 days the mean calving to conception interval.

UMMB altered the rate of decline in milk production observed in late lactation. Before supplementation, daily milk yield declined at -0.0126 kg/day, but supplementation after this changed to +0.0142 kg/day (Experiment 1, Table 8.4 and Figure 8.1). In Experiment 2, however, in both treatments there was a decline, but the UMMB group showed a reduced rate of decline in milk production (Table 8.4) compared with the unsupplemented control.

Table 8.4
The effect of UMMB supplementation on milk production – Experiment 1.

	Experiment 1		Experiment 2	
	without UMMB	with UMMB	without UMMB	with UMMB
Duration of experiment (days)	15	15	30	30
Number of farmers	4	4	5	5
Number of cows	23	23	15	16
Average milk production* (kg per cow per day)				
At the beginning of experimental period	9.9	9.7	10.6	10.6
At the end of experimental period	9.7	9.9	10.4	10.6
Mean rate of change (slope) in milk production (kg/day)	-0.0126	+0.0142	- 0.0077	- 0.0011

Note: * Estimated by regression analysis

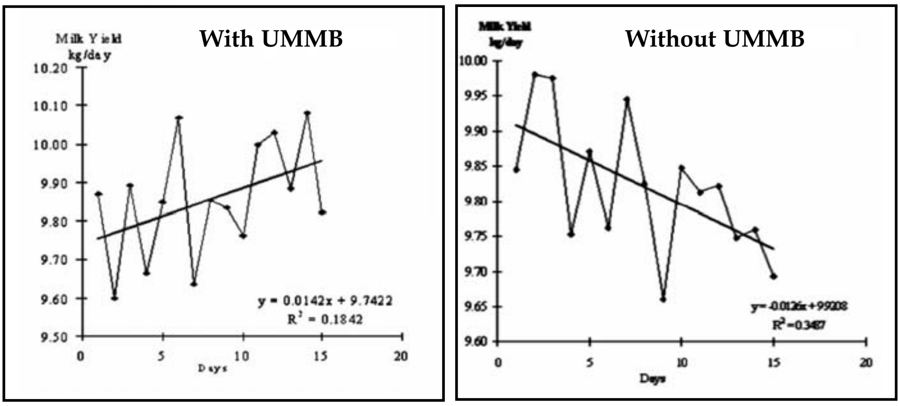
UMMB promotion activities in 2001–2002

In 2001–2002, a revolving fund system was established at Kudjub MCC and five molasses storage tanks (8–12 tonne capacity) were provided to farmers groups, MCCs and cooperatives. Three UMMB production units (Srithat MCC; Namphong MCC; and Tung fon MCC) stopped producing UMMBs, but they continued to supply molasses for farmers to produce their own blocks on-farm.

Twenty-four pilot farms were established. Coral tree (*Erythrina subumbrans*) and leucaena (*Leucaena leucocephala*) were introduced as tree fodder and to provided shade. UMMBs have a wide dissemination as proven technology, and have been demonstrated on the pilot farms. The extension activities conducted involved training programmes for block utilization, visits to pilot farms and the production of a newsletter and posters.

In 2002, UMMBs were promoted to Sukhothai Project, with the cooperation of Narasuan University and the North DPO Division. Farmers have been trained and some have started to produce UMMBs. The Sawankhaloke Cooperative also produces and sells blocks to farmers. A production unit plans to establish a revolving fund to promote UMMB use in Sukhlothai Project, north Thailand.

Experiment 1



Experiment 2

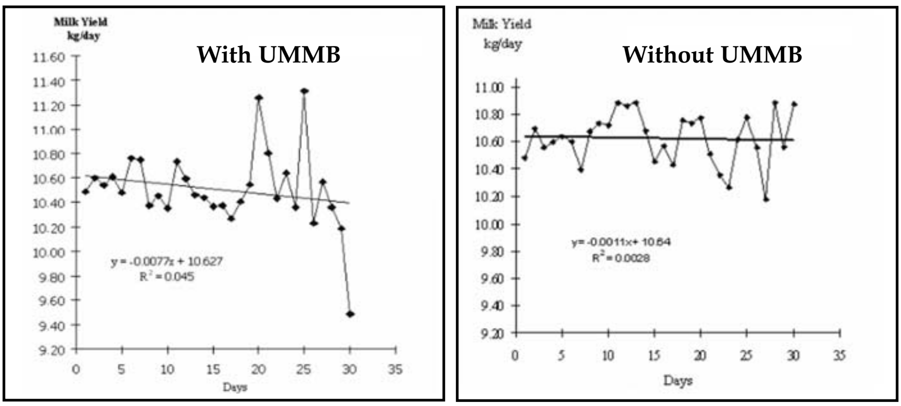


Figure 8.1

Regression lines of milk yield before and after UMMB supplementation

Medicated block on-farm trial

A study was carried out in Kranuan during the dry season, from December 2001 to April 2002, for 120 days. Forty-six dairy-cross heifers, aged between 6 and 18 months, from nine farms were divided into three treatment groups: T1, T2 and T3. Medicated urea molasses block (MUMMB) containing fenbendazole @ 0.5 gram/kg were given to 14 heifers (9 had zero egg counts) in T1; normal UMMBs were given to 17 heifers (11 of which were egg free) in T2; and 15 heifers (11 with zero egg counts) received no supplement (T3). In T1, MUMMB were given for 15 days, followed by UMMB for 45 days, and the cycle was then repeated. In T2, UMMBs were continuously offered during the 120 days. The UMMBs had molasses, 40%;

rice bran, 40%; urea, 5%; cement, 12%; and mineral mixture, 3%. Faecal egg count per gram, packed cell volume and body condition score were determined before the trial and then every 30 days. The average daily gain was also estimated 60 days before and after supplementation. MUMMB and UMMB were given ad lib, and daily consumptions were 1.11 ±0.15 kg and 1.18 ±0.27 kg, respectively.

Reproductive performance of cows supplemented with UMMB

Seventy cows from nine demonstration farms in the Nasee Village of Namphong MCC were used to monitor reproductive performance from September 1995 to September 1997 (without supplementation). From October 1997 to September 1999 these cows received UMMB as a supplement to their regular diet. Records were kept of all reproductive parameters, such as first oestrus after calving, calving to first service, calving to conception, number of artificial insemination services until confirmation of pregnancy by rectal palpation, and calving interval. The results are summarized in Tables 8.6 and 8.7.

The first-service conception rate was low (41.4 percent) and services per conception were high (2.54) on cows without UMMB. Following UMMB supplementation, the first service conception rate improved by 15.3 percentage units (to 56.7 percent). Interestingly, there was a significant decline ($P < 0.01$) in services per conception (1.88). UMMB supplementation also reduced the culling rate due to infertility (8.6 vs 3.2 percent). The significant decline in services per conception reduced ($P < 0.01$) the mean calving to conception interval (days open) from 127.2 to 92.4 days (Table 8.7). Use of UMMB also reduced the calving to first service interval and the calving interval from 77.5 and 405.4 days to 65.9 and 365.1 days, respectively (Table 8.7).

The distribution of calving to conception interval illustrated in Table 8.8 further reveals the beneficial effect of UMMB supplementation. Before UMMB use, among the cows that conceived, 62.6 percent became pregnant by 120 days post partum compared with 76.7 percent with UMMB use.

An improvement in the reproductive efficiency of cows following UMMB supplementation is further evident on perusal of mean values for calving interval, which also was reduced significantly ($P < 0.01$, Table 8.7). This is further illustrated in Table 8.8, which shows that before UMMB, out of 64 calving intervals, 42.2 percent were below 360 days, compared with 50.0 percent after UMMB use.

Table 8.6
Effect of UMMB on reproductive performance of crossbred dairy cattle in northeastern Thailand (DPO Programme).

Parameter	Without UMMB	With UMMB
Number of animals in trial	70	62
Number in oestrus (%)	70 (100.0)	60 (96.8)
Number inseminated	70	60
Number conceived to 1st AI (%)	29 (41.4)	34 (56.7)
Overall pregnancy (%)	68 (97.0)	60 (100.0)
Total number of inseminations	173	117
Services per conception	$2.54^a \pm 0.25$	$1.88^b \pm 0.19$
Number of animals culled or aborted (%)	6 (8.6)	2 (3.2)

NOTES: AI = artificial insemination. [a,b] indicate significant differences (P < 0.01) (one sample t-test)

Table 8.7
Effect of UMMB on fertility of crossbred dairy cattle in northeastern Thailand (DPO Programme).

Fertility measurements	Before UMMB		After UMMB	
	n	Mean ± SEM.	n	Mean ± SEM.
Calving to first service interval (days)	64	$77.54^a \pm 5.20$	60	$65.91^b \pm 3.53$
Calving to conception interval (days open)	64	$127.21^c \pm 11.30$	60	$92.35^d \pm 6.65$
Calving interval (days)	64	$405.40^e \pm 11.34$	60	$365.06^f \pm 5.33$

NOTE: SEM = Standard Error of the Mean. Means with different letters within a row differ significantly (P<0.01) (one sample t-test).

Table 8.8
The effect of UMMB supplementation on calving to first artificial insemination (AI) service, calving to conception (open days) and calving interval of cross-bred dairy cows.

	Cows without UMMB (n = 64)		Cows with UMMB (n = 60)	
	Number of cows	percentage	Number of cows	percentage
Calving to first AI service (days)				
<60	27	42.2	33	55.0
60–90	23	35.9	18	30.0
>90	14	21.9	9	15
Calving to conception (days)				
<60	12	18.8	21	35.0
60–120	28	43.8	25	41.7
>120	24	37.4	14	23.3
Calving interval (days)				
<360	27	42.2	30	50.0
360–480	26	40.6	29	48.3
>480	11	17.2	1	1.7

On-farm evaluation of UMMB

Faecal egg counts and packed cell volume.

There was no re-infection by nematodes in the MUMMB supplementation group, with faecal egg counts at zero at all counts (30, 60, 90 and 120 days). Heifers in the UMMB group showed lower egg counts than control heifers. Packed cell volume (PCV) in the MUMMB group increased from 27.4 ±5.4 to 31.5 ±2.9 at 60 days, and it was higher than in the UMMB and control groups ($P < 0.05$), which were similar ($P > 0.05$). PCV was not significantly different at 30, 90 and 120 days ($P > 0.05$).

Daily weight gain and body condition score

The differences in liveweight gain and body condition score (BCS) between the treatment groups T1, T2 and T3 was attributed to the imbalance of eggs per gram (EPG) and PCV between groups. The measurement of daily weight gain for some heifers was made 60 days after supplementation and body score was also determined every 30 days. The daily weight gain of animals in MUMMB groups (0.73 ±0.17 kg/day) was higher than UMMB heifers and heifers without block ($P < 0.05$), with no difference between the last two groups ($P > 0.05$). The body score improved in every group.

Cost effectiveness of UMMB supplementation

Regrettably, data on actual intake of roughage, concentrate and UMMB by cows and the extent to which concentrates have been replaced by UMMB are not available in all cases, and therefore it was not possible to perform an exact cost–benefit analysis for UMMB supplementation. However, there is no doubt that UMMB supplementation reduced the rate of decline in milk production, which could be inferred as an increase in milk production during the declining phase of lactation. This sustaining or extension of the lactation period undoubtedly would have increased the total lactation yield.

Assuming that UMMB could replace about 25 percent of the concentrate supplement, the economic benefit of supplementation with UMMB was calculated to be in the region of Baht 4.5/cow/day. Studies conducted in Sri Lanka have demonstrated that UMMB could replace 40–60 percent of concentrate supplement without affecting milk production, suggesting that the economic benefits could be even higher.

Table 8.9
EPG values in the groups free of nematodes.

Groups	n	Time of evaluation (days) 0	30	60	90	120
MUMMB	9	0	0	0	0	0
UMMB	11	0	9.1 ±30.2	22.7 ±75.4	0	0
Control	11	0	68.2 ±129.0	81.8 ±255.2	0	63.6 ±167.5

Table 8.10
EPG values for dairy heifers during a 120-day period.

Groups	n	Time of evaluation (days) 0	30	60	90	120
MUMMB	14	32.1 ±49.0	0^{a}	0	0	0
UMMB	17	52.9 ±92.2	5.9^{ab} ±24.3	20.6 ±63.9	11.8 ±48.5	0
Control	15	30.0 ±65.9	50.0^{b} ±113.4	60.0 ±218.9	0	46.7 ±144.5

Table 8.11
Packed cell volume (PCV), weight gain and body condition score (BCS) of dairy heifers over 120 days.

	Group	n	Time of evaluation (days) 0	30	60	90	120
PCV	MUMMB	14	27.4 ±5.	29.6±3.91	31.5^{a} ±2.9	28.4±2.8	29.6 ±3.4
	UMMB	17	27.0 ±3.0	28.5±3.4	26.5^{b} ±7.5	26.2±4.2	27.4 ±3.0
	Control	15	28.7 ±3.7	29.3±3.5	27.1^{b} ±2.9	28.2±2.8	28.4 ±2.5
Weight gain (kg)	MUMMB	13			0.7^{a} ± 0.2		
	UMMB	12			0.5^{b} ± 0.2		
	Control	10			0.2^{b} ±0.2		
BSC	MUMMB	14	2.6^{a} ±0.6	2.9^{a} ±0.5	3.0^{a} ±0.5	3.2^{a} ±0.6	3.2^{a} ±0.6
	UMMB	17	2.3^{b} ±0.5	2.5^{b} ±0.4	2.7^{b} ±0.3	2.8^{b} ±0.2	2.8^{b} ±0.2
	Control	15	3.0^{c} ±0.4	3.1^{c} ±0.5	3.2^{c} ±0.5	3.3^{a} ±0.5	3.4^{c} ±0.6

Note: [a,b,c] Values bearing different superscripts within the same column differ significantly at P<0.05.

Table 8.12
Quantities of UMMB and total milk produced in the six MCCs in 1997–2002, and farmer income.

	Milk Collection Centre						Total
	Namphong	Kranaun	Srithat	Kudjub	Jareonsin	Tungfon	
1997							
UMMB production (kg)	–	–	19 110	–	–	–	19 110
No. of cows	551	291	850	271	572	–	2 535
Total milk yield (tonne/year)	1 858	1 375	3 069	946	1 144	–	8 374
Income from milk (Baht)	17 153 022	12 436 648	28 183 707	8 786 829	10 539 681	–	77 099 887
1998							
UMMB production (kg)	13 460	–	18 000	12 000	–	–	43 460
No. of cows	739	311	658	410	323	265	2 706
Total milk yield (tonne/year)	2 135	1 356	2 702	1 160	1 252	712	9 317
Income from milk (Baht)	21 498 261	13 616 890	26 751 295	11 678 808	12 459 463	7 432 944	93 437 661
1999							
UMMB production (kg)	35 000	7 900	20 500	10 840	7 360	600	82 200
No. of cows	777	414	702	453	341	249	2 936
Total milk yield (tonne/year)	2 371	1 657	2 444	1 228	968	997	9 665
Income from milk (Baht)	25 261 164	17 609 567	26 141 845	13 142 398	10 333 992	10 646 635	103 135 601

NOTE: UMMB production is the total from all sources: MCCs, farmer groups and cooperatives.

In six DPO MCCs between 1997 and 1999 (Table 8.12), UMMB production increased from 19 tonne to 82 tonne, and total milk production increased from 8.37 million to 9.66 million litres, an increase of 1.29 million litres. While some of this increase could be attributed to the increased number of cows (up from 2 535 to 2 936), there is no doubt that a substantial part of the increase was due to improved feeding due to UMMB supplementation and the consequent improvement in reproductive performance. Considering the information given in Table 8.13 and assuming that the cost of production of 1 kg of UMMB is Baht 4, the total cost incurred in the production of UMMB during 1999 was Baht 328 000. The value of increased milk production at Baht 12/kg of milk would be Baht 4 172 000. Even if one assumes that only 10 percent of the increase in milk production was due to UMMB supplementation, it appears that UMMB feeding is cost effective (an income of Baht 417 000 as against a cost of Baht 328 000) and beneficial to the dairy industry. Increases in milk production due to UMMB supplementation have brought additional income while improving reproductive performance, leading to more calves. This has undoubtedly improved the social status of the farmers.

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Development, use and impact of feed supplementation blocks: experiences in Sri Lanka

A. Nimal F. Perera[14], **E.R.K. Perera**[1] and **H. Abeygunawardane**[15]

Introduction

The dairy industry in Sri Lanka has declined rapidly during the past two decades due to various causes. One of the major factors in this decline has been nutrition. Traditionally, dairy farmers are smallholders, comprising about 95 percent of the dairy farms in the country. Under smallholder conditions, feeding has become an important and critical factor with tremendous effect on productivity. The feed and feeding practices in Sri Lanka differ significantly from many other tropical developing countries. The dairy animals in Sri Lanka are malnourished, not because of unavailability of feed resources, but due to underutilization.

About 98 percent of the smallholder dairy farmers neither cultivate nor conserve forage, but instead depend entirely on naturally available forage. Natural forage is abundant during the wet season, but the quantity and quality of green biomass declines as the dry season progresses. Under such circumstances, there is no choice other than to utilize agricultural crop residues to keep the animals alive.

Farming systems in Sri Lanka

Since 95 percent of the dairy farmers are smallholders, there is little organized dairy farming in Sri Lanka, although there are some recognizable categories (see Table 9.1).

The type of dairy farming system depends on land availability, allocation to other agricultural crops, environment, and animal productivity.

14 Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka. E-mail: <nperera@vt.edu>

15 Department of Veterinary Clinical Studies, Faculty of Veterinary Medicine, University of Peradeniya, Sri Lanka.

Table 9.1
Dairy farming systems in Sri Lanka.

System	Agro-ecological zone	Type of management
Plantation crops		
Coconut	Wet to intermediate	Semi-intensive
Tea	Wet hill country	Intensive
Rubber	Low country wet to intermediate	Semi-intensive
Rice based	Wet	Semi-intensive
Rice based	Dry	Extensive
Home garden	Wet	Intensive and semi-intensive
Urban and peri-urban	Wet	Intensive

Ruminant feeding systems

Feed for dairy animals is totally from natural forage, and rainfall determines the quantity and quality of such forage. Quality and quantity are therefore highly seasonal. During the dry season, when good quality forage becomes scarce, farmers have to use alternative feeds, such as agricultural crop residues. In this respect, rice straw plays a vital role. The availability of rice straw is also seasonal, since rice is cultivated only during the two monsoon periods, and the straw becomes available during the harvesting period, which falls in the dry season. This is the season during which animals require a supplementary feed source.

Compared with other straws, rice straw is low in nutritional quality, palatability and digestibility, so upgrading of straw prior to feeding becomes necessary. To achieve this, urea-ammonia treatment was introduced to the country under a straw utilization project funded by the Government of the Netherlands in the early 1980s. After many on-station and on-farm studies, 4 percent urea treatment and storing for 7 days was recommended. However, this technique did not become popular among the farmers, for various reasons. Eventually this practice almost disappeared from Sri Lanka. Later, under the same project, use of urea-molasses mineral block (UMMB) was tested under on-farm conditions in the mid-1980s. The readymade blocks ("Mol-u-min") were imported from India. The results of these experiments were not satisfactory. The effect of UMMB supplementation on dry matter digestibility (DMD) and dry matter intake (DMI) was not significant (Schiere *et al.*, 1987). These trials were done primarily for performance testing under controlled on-farm conditions, and were not extended to the field, probably due to unsatisfactory results. Later, in the mid-1990s, with the assistance of the International Atomic Energy Agency (IAEA) and the Swedish Agency for Research and Economic Cooperation (SAREC), the UMMB technology was modified and widespread use in the field was promoted. Today, this technology is accepted and used at all levels by the dairy farming sector.

Due to extensive cultivation, diminishing land availability, seasonality and uncertainty in income from crop cultivation, an intensive buffalo management system called Smallholder Intensively Managed Buffalo Units (SIMBU) was developed in the dry zone of Sri Lanka. The objective of this model unit was to manage dairy animals under stall-fed conditions, based predominantly on rice straw feed and UMMB (Abeygunawardane *et al.*, 1995).

HISTORY OF UMMB PRODUCTION IN SRI LANKA

In the mid-1980s, state farms in Sri Lanka started to feed molasses to dairy cattle as a source of energy and to improve the intake of low quality forages. No urea was used and liquid molasses was sprinkled over the forage before feeding. This led to uncontrolled intake of molasses by the animals and waste of molasses due to spillage.

The Mahaweli Livestock Development Division (MLDD) manufactured an initial stock of UMMB at Girandurukotte farm. A foreign expert arbitrarily recommended a formula, with no consideration of the available feeds and production potentials of the animals. Following project inception, a number of investigations were conducted on-station and on-farm, and four formulas were developed that reflected the locally available feed types, quality and milk production potentials of the animals. UMMBs with these final formulas were initially manufactured at the same location, in parallel with those already being manufactured. Field testing of these blocks was carried out by distributing them to farmers free of charge. After field testing the blocks and training livestock officers and farmers in the different agro-ecological zones, the current formulas (see Table 9.2) were recommended and released to the farmers. At present, this technology has received wide acceptance and is in use on both state farms and smallholdings.

Table 9.2
UMMB formulas recommended for use in the various agro-ecological regions.

Ingredient (g/kg block)	**Agro-ecological Zone** Wet Zone	Intermediate Zone	Hill Country	Dry Zone
Molasses	400	400	400	400
Urea	100	100	100	120
Rice polish	340	320	300	330
Fish meal	10	30	50	–
Common salt	30	30	30	30
Mineral mixture	20	20	30	20
Cement	100	100	100	100
Total	1 000	1 000	1 000	1 000

SOURCE: Perera, 2002.

During the development of blocks for field application, many on-station and on-farm trials were conducted. The results of these extensive studies showed that 100 g of urea per kilogram of block is sufficient to maintain an optimum rumen ammonia levels for efficient microbial activity. The level of external urea input depends on the nitrogen content of the diet. For those animals fed on medium quality forages (CP 10–12 percent), the 10% w/w level was found to be satisfactory. However, in the dry zone, where the feed quality was low (CP 8–10 percent), and highly variable (mainly mature grasses and straws), the level of urea in the block had to be slightly higher (120 g/kg) (Perera and Perera, 1996). For moderate (10–12 litre/day) to high (>13 litre/day) milk yield, there is a requirement for some "bypass" protein since the cow's protein requirements cannot be met by rumen microbial protein production alone. The studies conducted using high milk production cows showed improved response to UMMB when bypass protein was included. Therefore, the formulas developed and recommended for the wet, intermediate and hill country zones also included 10, 30 and 50 g/kg of fish meal, respectively. Although addition of flavomycin has elsewhere improved milk yield in dairy cattle, in these trials there was no significant improvement – it merely increased the feed cost (Perera and Perera, 1996). In developing formulas for the blocks, due consideration was given to selecting suitable local ingredients. Even though coconut oil meal was the most common, freely available and widely used crude protein source in ruminant feeds, it was purposely eliminated from all the formulas, because it tends to become rancid rapidly due to its high oil content (8–12 percent), and its extensive use in other commercial feeds, where demand fluctuations lead to significant price fluctuations during the course of the year. With such price fluctuations, if coconut oil meal is used in the block, the price of the block will fluctuate, discouraging farmers from using the block.

Availability of molasses

Molasses is one of the key ingredients in UMMBs. This is a major source of readily fermentable energy and a good carrier for urea. In addition, molasses supplies micro-minerals, thus eliminating the need to add micro-mineral salts. Molasses is produced in three sugar processing plants in the country and is available for use as animal feed. Average annual molasses production in Sri Lanka is about 35 500 tonne, of which a small quantity is used by the distillery industry for alcohol production. The balance is available for animal feed. This quantity is quite sufficient to satisfy the local demand for animal feed. Molasses is also used in the concentrate feed industry for other livestock, but it is not expected that molasses supply could be a limiting factor in the near future when promoting UMMB technology.

Effect of UMMB on animal performance

Animal performance improved tremendously after the introduction of UMMB under field conditions. This improvement was attributed to "supplementary" and "catalytic" effects of UMMB, as UMMB promotes an optimal ammonia level for efficient microbial activity in the rumen, and the inclusion of fish meal helps to satisfy the total protein requirement of high producing animals (Kunju, 1986).

Effect on intake

According to Schiere *et al.* (1989), the effect of UMMB on DMI was not significant. However, when compared with untreated straw, 4 percent urea-treated straw (5.5 vs 3.3 g/kgW$^{0.75}$) increased DMI fourfold. According to Soetanto, Budi and Sulstri (1987), intake and beneficial effects of UMMB depended on the type and the quality of the basal feed and other supplements fed. Kunju (1986), who reported greater intake by cows fed rice straw supplemented with UMMB compared with cows fed rice straw with 1 kg of concentrates, confirmed this. In his experiment, the straw DMI increased by 29.5 percent when concentrate was replaced by 500 g of UMMB. In Sri Lanka, Badurdeen, Ibrahim and Ranawana (1994) reported daily intake of 226 g of UMMB per 100 kg body weight when untreated rice straw was fed to cattle. However, when untreated rice straw was replaced with 4 percent urea-treated rice straw, the daily UMMB intake dropped to 155 g per 100 kg body weight. This is a 31 percent reduction in intake of UMMB, which clearly demonstrates the self-regulation effect of UMMB use, determined by the dietary nitrogen level. In the dry zone, when rice straw was fed as the sole roughage diet for buffaloes, supplementation with UMMB increased the daily rice straw intake from 1.3 ±0.2 to 2.9 ±0.2 as a percentage of body weight. This was a 110 percent increase in total roughage DMI, and was achieved after 11 weeks of supplementation (Abeygunawardane *et al.*, 1996). Considering the nature of the basal diet, this increase was attributed to a catalytic rather than a supplementary effect. According to Preston and Leng (1987), this catalytic effect phenomenon is the result of optimization of rumen ammonia concentration in the rumen by the supplemental nitrogen, resulting in more effective microbial activity.

Another field study revealed that the intake of UMMB by both adults and calves of cattle and buffalo gradually increased with time. Within one month, the intake of UMMB by Nilli-Ravi buffalo cows increased from 0.17 ±0.02 to 0.43 ±0.04 and in Sahiwal cows from 0.22 ±0.02 to 0.50±0.03 kg per head per day. The overall intake of UMMB in Nilli-Ravi buffalo cows was lower than in Sahiwal cows when fed on the same basal diet (medium quality *Panicum maximum,* 12 percent CP). This may be attributed to the ability of buffaloes to utilize urea nitrogen more efficiently than cattle. In the same study, a similar intake response was observed with Nilli-Ravi and Sahiwal calves. Overall, intake of UMMB by buffalo calves (0.096 ±0.01 kg/head/day) was lower than that of Sahiwal calves (0.165 ±0.02 kg/head/

day) (Perera and Perera, 2000). Sivayoganathan *et al.* (2001) reported that, from field data collected from mid-country smallholder dairies, intake of UMMB was higher under extensive systems of management (600–1 000 g/head/day) than under stall-fed conditions (450–800 g/head/day). Roughage DMI increased by 20–30 percent and the animals readily accepted highly fibrous roughage when UMMB was provided, compared with no supplementation. Fishmeal showed beneficial effects only with high yielding (>10 litre/day) dairy cattle. Addition of 30 g/kg of fishmeal to blocks significantly increased DMI and OMI, and gave a high nitrogen balance (Uthayathas, Perera and Perera, 1999). Under the SIMBU system in the dry zone, when cross-bred buffaloes were raised under stall-fed conditions using rice straw as the sole roughage, supplementation with UMMB increased the daily intake of rice straw from 4 to 7 kg/head/day (75 percent increase) within 60 days (Abeygunawardena *et al.*, 1996).

Effect on reproduction

At initialization of the SIMBU model in the field in the dry zone, cross-bred buffalo cows feeding on medium quality grass and 5 kg/day of traditional concentrates were brought from a state farm. During the field observation period the diet was gradually changed to straw and UMMB. When the animals had completely changed diet, the anticipated results were achieved. The reproductive performance was similar to that under their original farm conditions. The annual calving rate was 62 percent and the calving interval was 584 ±80 days. This long calving interval was not related to nutrition but to inefficient detection of oestrus (Abeygunawardane *et al.,* 1996). Sivayoganathan *et al.* (2001) reported that cross-bred cows with exotic blood in the mid-country region of Sri Lanka responded significantly in reproductive performance to feeding of medium quality fresh grass and 500 g/day of UMMB with 3 percent fish meal compared with traditional concentrates (coconut oil meal + rice bran). When supplemented with UMMB, the period from parturition to first oestrus was reduced from 120 ±60 to 90 ±30 days, with a reduced number of inseminations per conception and an improved rate of conception.

The birth weight of buffalo calves born to cows supplemented with UMMB was 27.1 ±4.0 kg, which was 8.4 percent higher than that of calves born to cows on traditional feed plus concentrates. The calves born to UMMB-supplemented cows had a pre-pubertal daily gain of 250 ±30 g/day, similar to gains by calves on state farms under best feeding and management conditions (Abeygunawardane *et al.,* 1996).

Effect on growth and other parameters

Supplementation with UMMB has proven to exert beneficial effects, such as increased DMI, digestibility and optimum rumen environment, all of which contribute to improved body weight gain by the animal. Buffalo cows supplemented with UMMB exhibited a superior daily body weight gain of 380.9 ±25 g) compared with the control group (238 ±21 g).

In the same study, Sahiwal cows showed even better daily body weight gain response: 261 ±2 g with UMMB supplementation compared with 95.2 ±9 g in the control group. This experiment concluded that UMMB supplementation gave greater response in Sahiwal cows than in buffalo cows. A similar trend was observed in buffalo and Sahiwal calves. One contributory factor for this may be the ability of buffaloes to recycle urea into the rumen more effectively than pure cattle (Perera and Perera, 2000). Abeygunawardane, Abeywansa and Perera (1995) reported a daily body weight gain of 256 ±73 g in buffaloes fed untreated rice straw supplemented with 600–800 g/day of UMMB under the SIMBU model system in the dry zone of Sri Lanka. Dairy farmers in many agricultural zones reported satisfactory growth rates for calves and body weight maintenance of cows – both cattle and buffaloes – irrespective of the type of basal feed, when the bulk requirement was satisfactorily met and supplemented with UMMB. BCS is an important criterion in evaluating the nutritional status of cows. According to Perera *et al.* (1997), cross-bred dairy cattle feeding on medium quality natural forage supplemented with 500 g/day UMMB had a higher BCS (2.75) than cows supplemented with 2 kg of commercial concentrate mixture. Similar observations were made by Sivayoganathan *et al.* (2001) from a two-year field observation in the same region. The BCS improvement in response to UMMB was more prominent in buffaloes than cattle, because most of the buffaloes in Sri Lanka are usually fed on poor quality roughages (including crop residues) that are naturally low in nitrogen (Perera and Perera, 2000).

Supplementation with UMMB facilitates maintenance of optimum rumen ammonia levels, especially when feed quality is low. Badurdeen, Ibrahim and Ranawana (1994) reported both a rumen ammonia level of 10.30 ±0.30 mg/100 ml and a higher rumen mineral content with UMMB supplementation.

Effect on lactation

As a result of the effect of facilitated feed nutrient utilization with supplementation with UMMB, lactation length, yield and quality of milk also improved. In the dry zone of Sri Lanka under the SIMBU model, buffalo cows maintained on a straw-based diet supplemented with UMMB gave a similar milk yield with 800 g intake of block to that from 5 kg of traditional concentrate intake. However, the persistency of lactation was greater with UMMB than with concentrate (Abeygunawardane *et al.*, 1996). Perera and Perera (2000) reported that Nilli-Ravi buffaloes under field conditions gave 11 percent more milk daily when supplemented with UMMB compared with commercial concentrates. In addition, this lactation yield was maintained over a longer period compared with cows on traditional concentrates, resulting in an 18 percent improvement in total milk yield. In the same experiment, the response by the Sahiwal cows was not as satisfactory as that of buffaloes. This low response in Sahiwal cows could be due to comparatively lower nutrient demand due to smaller body size and lower milk yield, which may have been satisfied by the basal diet.

Uthayathas, Perera and Perera (1998) reported that Sahiwal cows given UMMB in the intermediate zone, with or without 3 percent fishmeal, produced 475 kg of milk more than cows fed traditional concentrates. In addition, milk quality also improved due to higher butterfat content (4.59 percent). This study also indicated that the addition of fishmeal to UMMBs had no effect when the daily milk yield was less than 8 litre. Similar improvements in butterfat content were observed by Sivayoganathan *et al.*, (2001) in the intermediate zone with cross-bred cattle. The butterfat content of milk from these cows increased by 0.8 ±0.1 percent. This might be attributable to higher celluloytic fibre utilization by the microbes in the presence of the optimum urea ammonia provided by UMMB. Perera *et al.* (1997) reported 12 percent increase in daily milk yield of Sahiwal cross-bred cows with no change in butterfat when UMMB was supplemented as a substitute for traditional concentrates. In addition, Salgado, Perera and Perera (1996) reported an 18 percent improvement in total milk yield in Australian Milking Zebu cows, not from daily milk yield but from improved lactation persistency with UMMB supplementation. In this study, the increase in daily milk yield (1.5 ±0.5 litre) became significant and prominent during the latter part of the lactation. All these findings suggest that the lactation curve was more prolonged with UMMB supplementation compared with traditional concentrates.

Cost–benefit ratio

Many studies have indicated economic gains as a result of supplementation with UMMB, deriving from factors such as reduced cost of supplementary feeding, increased milk yield, prolonged lactation, better milk quality, reduced calving interval, improved conception rate and younger age at puberty. A field study conducted by Uthayathas, Perera and Perera (1998) in Sri Lanka using Sahiwal cows under a free-grazing management system showed that 1 kg of traditional concentrate produced 1.88 kg milk while UMMB gave 3.69 kg of milk, and that the cost of supplementary feeding to produce 1 kg of milk was SL Rs 2.93 with traditional concentrates and SL Rs 1.38 with UMMB. This was a 112 percent reduction in supplementation cost. Overall, the total daily costs of feeding traditional concentrates vs UMMB per cow were SL Rs 14.40 vs SL Rs 8.70, respectively. Under the SIMBU model in the dry zone state farm, daily supplementary feed cost was reduced by 77 percent in buffalo cows following a change of feed from commercial concentrates to UMMB, with no change in milk production or reproduction parameters. In the same study, periodic monitoring of plasma micro-minerals revealed that when UMMB is supplemented, addition of micro-minerals is not necessary. The total micro-mineral requirement was satisfied by the ingredients used, particularly the molasses (Abeygunawardena *et al.*, 1996). As a result, only dicalcium phosphate and common salt were included in the block. Sivayoganathan *et al.* (2001) monitored nearly 250 small-scale dairy farmers in the intermediate zone of Sri Lanka and showed that, due to improved butterfat content in milk, an additional SL Rs 2.00 ±0.75/litre of milk was received. This was in addition to the reduction in supplementary feed cost due to use of UMMB to replace part of the usual concentrates. After UMMB supplementation, the cost of concentrate feed for cows producing up to 5 litre of milk per day was reduced by 100 percent, whereas for cows producing 5–10 litre/day it was reduced by 45–60 percent. The reduced concentrate feed cost, coupled with the improved butterfat content, gave the farmer a net overall daily economic gain of SL Rs 28.50 per cow. This amount, when expressed in terms of milk yield, is equivalent to an additional 2.85 litre per day per cow. Perera *et al*. (1997) reported a net daily economic gain of SL Rs 8.00/cow due to 12 percent increased milk yield in Sahiwal cows. Compared with the average daily milk yield per cow, this can be considered a substantial return under the present management system. In another extensive field survey conducted to compare the economics of UMMB feeding for cows managed under intensive systems with cows on high-concentrate diets (peri-urban conditions) and semi-intensive management conditions, it was concluded that the profit per cow per day under intensive low-roughage condition was SL Rs 13.00, whereas under semi-intensive and high-roughage condition it was SL Rs 39.00, or three times as much (Perera, 2002). These findings indicate financial benefits from UMMB supplementation in extensive systems where the diet is high in poor quality roughage. Therefore, under Sri Lankan conditions, UMMB supplementation has more of a catalytic than a supplementary effect. Generally, under Sri Lankan conditions, the reported cost–benefit ratio of UMMB supplementation ranged between 1 and 3.5.

Limitations

After a decade of effort in promoting UMMB technology in Sri Lanka, it has become a success story, and one of the national feeding strategies to improve the productivity of dairy animals. However, the process of promotion has not been smooth sailing. There are still certain limitations with UMMB supplementation observed in the field and reported by farmers, namely:

- High cost of molasses.
- Irregular and unreliable availability of manufactured blocks.
- Limited availability of manufacturing units.
- Difficulty in obtaining molasses by private farmers.
- Low quality of ingredients used (e.g. rice polish).
- Lack of infrastructure for distribution.
- Lack of preference by some animals.
- Insufficient farmer knowledge of UMMB use due to poor extension and training.
- Insufficient promotion by the state sector.

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Use of urea molasses multinutrient blocks for improving cattle productivity in Viet Nam

Doan Duc Vu[16]

Introduction

Viet Nam is tropical country with a hot and humid climate. The total land area is 332 000 km^2 and it is densely populated, with about 76 million inhabitants. The rural community accounts for around 80 percent of the population, and some 70 percent of the rural population relies almost exclusively on agriculture for their livelihood. Agriculture is based mainly on rice production, supported by other crops such as maize, potato, sweet potato, cassava, groundnut, sugar cane and perennial commercial trees such as coffee, rubber, tea and coconut. Vietnamese agriculture has been classed in seven zones according to ecological and economic conditions.

The zones are:

- Northern Mountainous and Middle Highlands.
- Red River Delta.
- North Central Coast.
- South Central Coast.
- Central Highland.
- North East of Southland.
- Mekong River Delta.

In Viet Nam, dairy production started in the 1970s and developed slowly. In 1980, national milk consumption was barely 0.3 kg per capita. It was still only 0.5 kg by 1990, but it rose to 6 kg per capita in 2000. At present, the fresh milk supply meets only 10 percent of demand (Anon., 2002), and developing domestic milk production is a priority strategy of the National Food Programme in

16 Institute of Agricultural Science of South Viet Nam, Ho Chi Minh City, Viet Nam. E-mail: <doanducvu@yahoo.com>

Viet Nam. Decision No. 167, signed on 26 October 2001 by the Prime Minister, spelled out some specific goals: increasing the dairy population from 35 000 head (in 2000) to 200 000 head by 2010; and increasing milk production from 54 000 tonne (in 2000) to 350 000 tonne by 2010 in order to meet 40 percent of local demand.

Dairy and beef cattle production is almost entirely in the hands of smallholders. Although it is reported that there are 1 million hectares of so-called natural pasture, in fact Viet Nam has very few areas of natural pasture. With the increasing human population and the establishment of new economic zones, natural pasture has been reduced to small areas mixed among crop and built-up areas.

Because of the shortage of grass, farmers use many agro-industrial by-products as feed for cattle, such as rice straw, sugar cane tops and cassava root waste. Nutritionally, these feedstuffs are unbalanced, especially in terms of their mineral and protein contents. Their use results in poor body condition, short lactation periods, low reproductive performances, early culling and ultimately poor economic efficiency.

However, these feedstuffs can be better used if the rumen environment is improved through supplementation with limiting nutrients, such as nitrogen, carbohydrate, minerals and vitamins. One of the most suitable methods under tropical smallholder conditions of supplying the nutrients that are lacking is to give the animals urea and molasses in the form of urea-molasses mineral blocks (UMMBs).

Since 1996, within the framework of IAEA TC Projects RAS/5/030 and RAS/5/035, studies have been carried out to assess the effects of UMMB supplementation on productivity, reproductive performance and economic efficiency of dairy cattle fed rice-straw-based diets. Based on the results of these studies, pilot farms have been established in order to disseminate this technology to more farmers.

Formulation and chemical composition of UMMB

Based on locally available ingredients, two formulas for UMMBs have been developed and introduced to sugar factories and smallholder farms (Table 10.1).

Table 10.1
Ingredients of UMMBs (percentage) used in Viet Nam

Ingredients	Formula 1 (For sugar factories)	Formula 2 (For smallholder farms)
Molasses	40	37
Urea	5	5
Rice bran	25	43
Bagasse	15	–
Lime	7	7
Cement	6	6
Salt	1	1
Pre-mix	1	1

NOTE: The chemical composition of UMMBs was dry matter (DM) = 89.3 percent; crude protein (CP) = 16 percent of DM; and metabolizable energy (ME) = 2 350 Kcal/kg.

Effects of UMMB on milk production and reproductive performance in dairy cows fed diets based on rice straw

Experimental design

A trial was carried out on 11 smallholder farms around Ho Chi Minh City (Southern Viet Nam), where there are two seasons: a rainy season (from June to November) and a dry season (from December to May). Sixty cross-bred Holstein Friesian cows with accurate records from the survey phase were divided randomly into one control group of 20 cows and two trial groups of 20 cows each. Each group included lactating and non-lactating cows. The control group was traditionally fed (without any intervention), and lactating cows were fed 25.2 kg of grass, 4.3 kg of rice straw, 11.6 kg of brewers grains, 2.1 kg of soybean residue and 4.2 kg of concentrate, while non-lactating cows were fed 17.5 kg of grass, 5.6 kg of rice straw, 4.5 kg of brewers grains, 1.2 kg of soybean residue and 1.2 kg of concentrate.

Cows in trial group 1 received a diet based on untreated rice straw plus supplementation with UMMB, and cows in group 2 were on a diet of treated rice straw and were not supplemented with UMMB. The average quantity of UMMB fed was 1.5 kg/cow/day during lactation and 1.0 kg/cow/day during the dry period. Urea-treated rice straw (UTRS) was produced by adding 4 percent urea, and given to the cows *ad lib*. The crude analysis of UTRS was 49.1 percent DM, 8.6 percent CP in DM, and 24.5 percent of CF in DM.

The trial experimental rations were balanced to meet nutrient requirements calculated for F_1 (half Holstein Friesian + half Red Sindhi) and F_2 (three-quarters Holstein Friesian + quarter Red Sindhi) cows (Nguyen Van Thuong, 1992) with a milk production of 12.6 litre/cow/day in the control group, 14.1 litre/cow/day in trial group 1 and 13.9 litre/cow/day in trial group 2. In order to balance the trial rations, the quantity of brewers grains was deceased to 4.3 kg and 3.3 kg in lactating cows in group 1 and 2, respectively, and to 1.9 kg and 1.8 kg in non-lactating cows, respectively. The quantity of concentrate fed to non-lactating cows was decreased from 1.2 kg for the control group to 0.5 kg for group 1 (Table 10.2).

Milk yield was recorded daily and the milk fat content for each cow was determined by the Gerber method at two-week intervals. The profit per cow per day for the whole lactation was calculated by deducting the cost of feeds from income generated from milk sales (exchange rate: US$ 1 = VND 11 000). Every two weeks, the body weight of each cow was estimated with a weight tape and body condition score (BCS) determined by the 5-point system. Milk samples for progesterone analysis were collected once a week from month 1 after parturition and stored at -20°C until analysed (Plaizier, 1993). Data were recorded for date of onset of ovarian activity, oestrus, date of insemination and conception rate, and analysed statistically by T-test and χ^2.

Results of the study

Effects of UMMB on productivity of dairy cows and profit of farmers

Data in Table 10.3 show that the milk yield of cows fed rations containing UMMB or UTRS increased significantly by 1.5 kg (11.9 percent) and 1.3 kg (10.3 percent), respectively, compared with the control group. The milk fat content increased significantly, from 3.21 percent in the control group to 3.32 percent and 3.36 percent in groups 1 and 2, respectively. However, feeding either UMMB or UTRS did not significantly increase body weight or BCS. As a result of the improvement in milk yield and reduction in ration cost, profit increased from VND 20 290/cow/day in the control group to VND 28 700 in trial group 1 and VND 25 850 in trial group 2.

Table 10.2
Details of diets fed to dairy cows

Parameter (unit)		Control		Trial group 1		Trial group 2	
		L	NL	L	NL	L	NL
Daily ration							
Grass	(kg)	25.2	17.5	23.5	16.0	26.3	19.4
Rice straw	(kg)	4.3	5.6	5.9	3.6	-	-
UTRS	(kg)	-	-	-	-	8.8	5.2
Brewers grains	(kg)	11.6	4.5	4.3	1.9	3.3	1.8
Soybean residue	(kg)	2.1	1.2	2.2	1.2	2.1	0.8
UMMB	(kg)	-	-	1.5	1.0	-	-
Concentrate	(kg)	4.2	1.2	2.5	0.5	3.9	1.2
Cost of ration	(VND '000s)	20.03	9.13	16.42	7.39	18.63	8.46
Nutrients supplied							
ME	(Mcal)	32.1	19.5	28.8	15.2	28.7	15.2
CP	(g)	2 125	1 066	1 645	854	1 772	950
Nutrients required							
ME	(Mcal)	27.0	15.2	28.9	15.2	28.7	15.2
CP	(g)	1 496	802	1623	802	1606	802

KEY: L = lactating cows; NL = non-lactating cows; UTRS = urea-treated rice straw; ME = metabolizable energy; CP = crude protein.
NOTE: Exchange rate at the time of reporting was US$ 1 = VND 11 000.

Effects of UMMB on reproductive performances of dairy cows

The effects of UMMB on some reproductive parameters of dairy cows are shown in Table 10.4. The data show that the intervals from calving to onset of ovarian activity, to first oestrus and to conception, and the calving interval, in the trial groups were significantly shorter than in the control group. Conception rate at first artificial insemination was not significantly affected by the different feeding regimes.

The important finding from this study was that supplementation of the diet of dairy cows in Viet Nam with either UMMB or UTRS significantly improved productivity. This improvement was seen not only in comparison with the control group but also with the data obtained from the survey phase of the field studies when UMMBs were introduced.

The improvement in milk yield and milk fat content when the ration was supplemented with UMMB or UTRS may be explained by the fact that the ME/CP ratio was balanced in the rations and the subsequent maintenance of NH_3 content in the rumen led to an improved ruminant environment for micro-organisms, with consequent increased digestibility and dry matter intake of rice straw and other feedstuffs (Wanapat, 1985; Preston and Leng, 1987).

Perdok *et al.*, (1982) carried out experiments on Surti buffaloes and demonstrated an increase in milk yield and milk fat content when the ration was supplied with UTRS. Results from Thu, Dong and Preston (1996) showed that the milk production of the swamp buffalo in the Mekong Delta of Viet Nam increased by 14.1 percent when the ration was supplemented with UMMB and UTRS. Total volatile fatty acid (VFA) content is an important factor for milk quality, and in particular for milk fat content. Chanthai, Wanapat and Wachirapakom (1986) noted that the total VFA with the UTRS ration was higher than that with untreated rice straw rations (87.86 vs 68.86 mol/litre). At the same time, addition of UMMB to a rice straw ration increased straw digestibility, feed intake, total nutrient absorption and protein:energy ratio in the nutrients absorbed (Leng, 1991). This also led to improvement in reproductive performance. Energy from the diet an important factor for dairy cows both before and after calving. The importance of energy after parturition is well known, as well as during the first two to three weeks of lactation. Energy from any source is important for onset of ovarian activity and coming into oestrus (Lotthammer, 1991; Leng, 1991) and, related to this, for uterine involution. Energy deficiency has been reported to lead to acyclicity, silent and delayed ovulation, and follicular cysts (Lotthammer, 1991).

Table 10.3

Effects of UMMB on milk production and body weight of lactating cows (Mean ±Standard Deviation).

Parameter (unit)	**Control**	**Trial group 1**	**Trial group 2**
Number of cows	20	20	20
Milk yield (kg/cow/day)	12.6 ±2.2 [a]	14.1 ±2.5 [b]	13.9 ±2.0 [b]
Milk fat content (%)	3.21 ±0.12 [a]	3.32 ±0.22 [b]	3.36 ±0.25 [b]
Profit (VND ‘000s)	20.3	28.7	25.9
Body weight (kg)	434 ±76 [a]	462 ±85 [a]	451 ±93 [a]
Body condition score (1–5)	3.3 ±0.70 [a]	3.3 ±0.60 [a]	3.5 ±0.75 [a]

NOTE: Within rows, values with different superscripts are significantly different (P <0.05).

Table 10.4
Effects of UMMB on some reproductive parameters in dairy cows.

Parameter (unit)	**Control**	**Trial group 1**	**Trial group 2**
Number of cows	20	20	20
Calving to onset of ovarian activity (days)	112 ±25 [a]	94 ±19 [b]	91 ±36 [b]
Calving to 1st oestrus (days)	135 ±39 [a]	110 ±26 [b]	114 ±28 [b]
Calving to conception (days)	152 ±51 [a]	121 ±49 [b]	122 ±42 [b]
Calving interval (months)	14.4 ±1.7 [a]	13.4 ±1.5 [b]	13.4 ±1.4 [b]
Conception rate at 1st service (%)	60 [a]	70 [a]	65 [a]

NOTE: Within rows, values with different superscripts are significantly different ($P < 0.05$).

Medicated blocks

Gastro-intestinal nematode parasitism of ruminant livestock causes significant losses in production in Viet Nam through mortality and reduced production of meat, milk and work potential. Some researches have been carried out to develop means of controlling nematode parasites through use of UMMB containing anthelmintic in production systems where the regular use of UMMB supplements has proven to be beneficial. Before disseminating this technology to farmers, two experiments were carried out in order to determine the effects of medicated blocks on controlling parasites in cattle.

Experiment 1

Experimental design

Twenty-four dairy heifers on a farm in Long Thanh district, Dong Nai Province, were divided into 3 groups with 8 animals per group. The animals in group 1 were supplied with UMMB containing fenbendazole (FBZ), at a dose of 0.5 g FBZ/kg (FBZ-UMMB); animals in group 2 were fed UMMB without anthelmintic; and animals in group 3 formed a control group (Table 10.5).

The experiment last three months. The animals were kept all day in a cattle shed and each animal received a daily ration of 30 kg of natural grass and 1 kg of concentrate. FBZ-UMMB was provided every tenth day. The daily intake of both UMMB and FBZ-UMMB was 950 ±154 g/head. Faecal samples were collected after 10 days, 1 month and 3 months for analysing gastro-intestinal nematodes, and the body weight of the animals was determined every 15 days by weight tape.

Results

Table 10.6 shows that FBZ-UMMB supplementation progressively decreased parasite infection to 75 percent, 82.8 percent and 87.9 percent of the initial level after 10, 30 and 90 days, respectively. In addition, use of UMMB alone also helped ruminant parasite control, as the egg per gram (EPG) count decreased 37.5 percent, 45.4 percent and 51.7 percent after 10, 30 and 90 days, respectively.

Table 10.7 shows that as a result of the decreasing level of parasite infection, animal weigh gain improved, as, compared with the control group, animals increased about 7 kg/head/month in group 3 (with FBZ-UMMB) and 3 kg/head/month in group 2 (with UMMB alone).

Table 10.5
Experimental design for the trial with FBZ-UMMB.

Treatment Group	Treatment	Number of animals	Body weight (kg/ head)
Group 1	FBZ-UMMB	8	178.9 ±4.8
Group 2	UMMB	8	177.7 ±5.2
Group 3	Control	8	176.9 ±3.7
Total & Average		24	177.8 ±4.4

Table 10.6
Effect of FBZ-UMMB on infection of parasites in dairy heifers

Group	% of animals infected by parasites			
	Before trial	**After 10 days**	**After 1 month**	**After 3 months**
Group 1 – Control	100.0	100.0	91.5	100.0
Group 2 – with UMMB, without anthelmintics	100.0	62.5	54.6	48.3
Group 3 – with FBZ-UMMB	100.0	25.0	17.2	12.1

Table 10.7
Effect of FBZ-UMMB on average weight gain in dairy heifers after 3 months of treatment.

Group	**Weight gain**	
	kg/month	kg/day
Control group	8.5 ±3.08 [a]	0.28 ±0.10 [a]
UMMB group	11.21 ±3.14 [b]	0.37 ±0.10 [b]
FBZ-UMMB group	15.38 ±3.39 [c]	0.51 ±0.11 [c]

NOTE: [a,b] Means with different superscripts within column are significantly different ($P < 0.01$)

Experiment 2

Experimental design

From a population of 220 cattle at the Ruminant Research and Training Centre of the Institute of Agricultural Science, 45 animals were selected that had worm EPG counts of around 380 each. They were divided into three groups of 3×5 animals – i.e. three replicates of five animals each in each of two treatments and a control. Animals in group 1 formed the control set, while group 2 was supplied with 1 kg/head/day of UMMB containing 150 g dried ground pineapple leaves (PL-UMMB)/kg (a single dose, at the beginning of the experiment). Animals in group 3 were given Levamisole at a dose of 1 ml/10 kg body weight. The experimental plan is summarized in Table 10.8.

The faecal samples of the animals were collected on the day before treatment and 3 and 10 days after treatment, and worm EPG counts were assessed.

Results

Table 10.7 indicates that use of dried ground pineapple leaves as a herbal medicine incorporated in UMMB can control nematodes in cattle, as the faecal worm EPG count fell from 379 to 53 after 3 days and to 71 after 10 days. Data of the table also showed that two methods of Levamisole injection and PL-UMMB had the same results in controlling parasites.

Establishment of pilot farms for disseminating UMMB technology

Farm selection

Farm selection is an important step when establishing pilot farms in order to ensure that the farms are an effective tool for technology transfer. The criteria include:

- Farm size (number of animals) must be representative of most of the farms in the area.
- The farmers must be willing to participate and have the financial capacity to apply new techniques and invest in them.
- The farmers must have knowledge and skill in livestock production so that they can understand the technology, can implement it themselves; and can demonstrate it to other farmers.
- There is easy access to the farm and good communication infrastructure so that it is easy for extension workers to organize training courses and visits.

Table 10.8
Experimental design for PL-UMMB.

Group	De-wormer	Number of animals			Body weight (kg/head)
		First replicate	Second replicate	Third replicate	
1	Control	5	5	5	214.9 ±8.6
2	PL-UMMB	5	5	5	222.7 ±7.2
3	Levamisole	5	5	5	215.7 ±8.2

Table 10.9
Effects of herbal UMMB on worm egg counts

Group	Worm faecal EPG counts (mean ±Standard Deviation)		
	Before	**After 3 days**	**After 10 days**
Control	371.00 ±40.99 [a]	378.00 ±42.00 [a]	377.93 ±34.55 [a]
Levamisole (injected at 7.5 mg/10 kg body weight)	385.00 ±46.05 [a]	26.60 ±47.93 [b]	22.40 ±44.52 [b]
Herbal UMMB	379.73 ±51.73 [a]	53.2 ±22.26 [b]	71.40 ±27.26 [c]

NOTE: [a,b,c] Means with different superscripts within column are significantly different ($P<0.05$)

Implementation steps

- Conduct a survey in the region to identify potential farmers on the basis of the above-listed criteria.
- Organize a meeting with farmers in order to introduce them to UMMB technology.
- Register the farmers willing to participate in the programme.
- Implement technology transfer, through on-farm demonstrations; assistance in maintaining records; monitoring and evaluation of the response to the intervention; organization of training workshops; bringing other farmers to the pilot farms; and promoting farmer to farmer horizontal learning.

Results from the establishment of pilot farms

Southern Viet Nam

Dairy cattle. Six farms, two in Binh Duong Province producing UMMB for themselves and four in Ho Chi Minh City using blocks from the Dairy Research and Training Centre (DTC). Farms averaged 5 dairy cows and the roughage was mainly natural grass and rice straw.

Beef cattle. Ten farms in Binh Duong and Dong Nai Provinces in two groups making blocks themselves, and two farms in An Giang Province using blocks from the DTC. The average was 3–4 local beef cattle per farm. The feeding system was mainly based on grazing poor natural pasture, with rice straw in the cattle shed in the evening.

Meat goats. Two farms in Ninh Thuan Province, with 80 animals in total. They produced their own blocks but sometimes purchased from the DTC if molasses was not available. Animals grazed all day on very poor natural pasture with no supplementation.

Cooperatives. One dairy cooperative at Lai Thieu, Binh Duong Province producing blocks for 30 members (about 100 milking cows) of the cooperative.

Sugar factories. One sugar factory, at Hiep Hoa, Long An Province, made an industrial line for UMMB production. At the time of writing, the factory was producing 1–2 tonne/day of UMMB, depending on the market, being sold to dairy farmers in Long An Province and in Ho Chi Minh City.

Northern Viet Nam

Dairy cattle. Ten farms with 42 animals in total.

Beef cattle. Eight farms with 52 animals in total.

Dairy goat. Five farms with 96 animals in total.

Analysis of economic efficiency

It is clear from Table 10.10 that the use of UMMB as a supplement for both dairy and beef cattle is beneficial to farmers.

Table 10.10
Economics of block use with an average intake of 1 kg/head/day.

	Blocks produced by farmers	Blocks purchased from DTC
Dairy Cattle		
Production cost (VND/kg)	1 200	1 600
Average milk increase(kg/cow/day)	0.6	0.6
Average income increase(1) (VND/animal/day)	2 100	2 100
Cost–profit ratio	1:1.75	1:1.31
Beef cattle		
Production cost (VND/kg)	1 200	1 600
Average daily gain (kg/day)	0.15	0.15
Average income increase(VND/animal/day)	1 950	1 950
Cost–profit ratio	1:1.63	1:1.22

NOTE: (1) 1 kg of milk was worth VND 3 500 (US$ 1 = VND 15 000 at the time of reporting).

Activities and mechanisms for establishing a stable technology

- Transferral of technology through a revolving fund for cooperatives. In this approach, an initial amount is provided to a cooperative to start UMMB production. The UMMBs are then sold to farmers at a small margin over costs, and that “profit” is used for maintenance and replacement of equipment.
- Transferral of technology to sugar factories with plenty of molasses. This enables use of molasses at source and decreases transport costs. It also provides the factory with a value-added product from a process by-product.

Conclusions

The use of UMMB has increased productivity, improved animal reproductive performances and helped farm economic efficiency. For effective and stable cattle industry development, it is necessary to disseminate this technology widely through appropriate extension. The use of revolving fund approaches and transferring production to sugar factories could help make the technique sustainable.

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Experiences with multinutrient blocks in the Venezuelan tropics

Pablo Herrera[17], **Beatriz Birbe**[1], **Carlos Domínguez**[18] and **Nelson Martínez**[19]

Introduction

The extensive grasslands in the Venezuelan tropics constitute a most valuable feed resource for development of ruminant production systems. However, their use and outputs are constrained by quality, availability and management.

Strategic supplementation considers the limitations of feeding ruminants and develops strategies and resources that contribute to improve the efficiency of use of the abundant low quality fibrous resources, addressing the various animal groups and the local conditions and resources available.

Supplementation with multinutrient blocks (MBs) has had a great impact on Venezuelan livestock husbandry, with beneficial effects on both the biological response of the supplemented animals, and in economic terms. The use of blocks enables the use of non-traditional feed resources, both by-products and residues produced on-farm and others found within local production systems. They can be integrated into and provide a broader basis for agronomy and animal husbandry in the same environment.

With an integrated systems focus and using participatory research approaches, the dual producer-researcher teamwork can extend achievements, yielding innovations that go beyond the traditional use of agro-industrial resources. As well as the traditional whole cotton seed and rice polishings, the resources of the savannah itself, such as *cañafistola*

17 Universidad Nacional Experimental Simón Rodríguez Estación Experimental “La Iguana”. Valle de la Pascua, Estado Guárico, Venezuela. E-mail: Pherrera@mailcity.com; Bbirbe@mailcity.com

18 Universidad Rómulo Gallegos. Decanato de Ingeniería. E-mail: <cdomig@cantv.net>

19 Universidad Central de Venezuela. Facultad de Agronomía.

(*Cassia moschata*), and traditional local minor and subsistence crops, such as the yard-long bean (*Vigna unguiculata*) and cassava (*Manihot esculenta*) can be integrated to expand potential strategic supplementation. Using MBs based on local resources has a significant socio-economic impact for communities, when using otherwise waste materials for an activity that supports two of the most important elements of the plains: man and beast.

Principles of multinutrient blocks in the venezuelan tropics

The most outstanding characteristic of the Venezuelan Central Plains is the dominance of low-quality fibrous resources, which constitute the basal diet of a significant part of the national bovine herd. The vegetation is subject to the vagaries of recurrent rainy and dry periods that, due to their intensity, degrade resource quality and quantity.

The stimulus for strategic supplementation with MBs was precisely the availability of abundant fibrous resources in Venezuelan savannah, but resources that required, initially, a source of fermentable nitrogen (N) capable of promoting better fibre utilization (Combellas, 1994) and increasing degradability by regulating rumen-N levels.

Some fundamental parameters determine the use of MBs under local conditions. Firstly, the availability and quality of forage at the time of supplementation. In relation to the availability of basal diet, even though no specific work seems to have been done on this, it has been observed that limited basal diet availability has limited response to MB supplementation. Regarding quality of basal diet, Mata and Combellas (1992) have indicated that the utilization of medium to high quality grass does not improve with soluble-N supplementation. At the same time, Domínguez (1994), working with on-farm basal diets of different types, with weekly measurements of forage protein content and DM intakes, found a high significant negative correlation ($r = -0.92$) between forage protein content and DM intake, with a high determination coefficient ($Y = 0.36 - 0.023X$; $R^2 = 0.85$).

Another important aspect of MB as a supplementation strategy is the fermentation pattern. Urea ferments rapidly in the rumen. With grazing animals in extensive areas, it has been observed that the frequency of MB intake is only once or twice daily, due to availability and distribution of the MB in the pasture (Birbe *et al.*, 1998c). This prevents rumen ammonia levels from becoming high enough to obtain satisfactory response.

As pointed out by Domínguez *et al.* (1998), a possible means to correct NH_3-N deficiencies in the rumen is either to ensure consumption of the supplement several times a day, or to use protein sources, such as whole cotton seed, with low degradation rates that prolong higher N levels. Other protein sources have been tested with grazing cattle, including *Gliricidia* *sepium* leaves, yard-long bean, cassava and the fruits of native legumes such as *cañafistola* and *saman* (*Albizia saman*). The responses indicated a slower degradation rate, with the consequent positive effects mentioned above.

Evaluation of the physical characteristics, acceptability and intake of multinutrient blocks

An important feature, not well documented in the literature, is namely the physical characteristics of the MB. This is an important aspect to be considered during manufacture, particularly under artisanal conditions. It must be emphasized that the ingredients used in the MB and their proportions determine the physico-chemical characteristics, and hence affect acceptability and intake by ruminants.

An MB is an aggregate of components that each has individual physical characteristics, *inter alia* particle size and shape, density, and moisture content. The manner in which ingredients arrange themselves in the mixture determines its physical characteristics, affecting MB hardness and intake.

Birbe *et al.* (1994) reported that numerous factors affect MB utilization, including environmental, biological, chemical, technical and physical, but highlighted the technical factors. The more important variables have been evaluated and some of their effects are summarized in Table 11.1.

MB moisture content plays a fundamental role in relation to blending, setting and mixture manipulation. As indicated in Table 11.1, variations in the water content modify compaction and hardness. The water is a critical agent in achieving a good mixture between the agglutinant and the fibre, obtaining the chemical reactions needed for block hardening.

Table 11.1
Technical factors in production that affect MB hardness.

Variable		Level	Effect in MB	
			Penetrometer resistance (kg/cm^2)	**Press resistance** (kg/cm^2)
Mb moisture content	(%)	10	3.7	6.86
		15	2.8	4.1
		20	2.1	3.2
Lime content	(%)	5	2.2	4.4
		10	4.1	8.1

Table 11.2
Subjective evaluation of ease of blending, compaction and manipulation for MBs with two ingredients and three moisture levels.

Main ingredients and proportion in the MB	**Moisture content** (%)	**Score** (Scale of 1 to 5)			
		Blending	Compaction	Handling	Total
MB with 27 percent whole cotton seed	10	3	5	3	11
	15	4	3	2	9
	20	4	2	1	7
MB with 27 percent bean leaves	10	1	5	4	10
	15	2	5	5	12
	20	3	3	3	9

In the search for the appropriate moisture content for producing MBs, a simple methodology is often used (Guzmán *et al.*, 2000; Birbe *et al.*, 2000) whereby blending, compaction and handling are evaluated under different moisture percentage regimes, using a subjective scale from one to five, where 1 = very difficult, 2 = difficult, 3 = intermediate, 4 = easy and 5 = very easy. An example of this methodology is shown in Table 11.2.

It should be noted that for the determination of the moisture level for MB production, component particle size plays an important role. As can be seen from Table 11.2, in two MB formulas, as the main ingredient changes, there are related changes as particle size influences the water necessary for production. Whole cotton seed with 98.3 percent of its particles with diameter greater than 4.7 mm required less water than bean leaves with 95.7 percent of the particles less than 4.7 mm in size.

The hardness (penetration resistance) (measured in kg/cm^2) is a factor that markedly defines animal intake (Mwendia and Khasataili, 1990; Hadjipanayiotou *et al.*, 1991; Birbe *et al.*, 1994), and acquires greater importance when MBs are used for drug and minerals delivery, since dosages are based on MB intake. As block hardness increases, animal intake diminishes (Figure 11.1).

Productive and reproductive responses in grazing ruminants with blocks

The poor quality and low feed intake of the forages available, as well as management factors, lead to suboptimal nutritional status in grazing animals, and this directly affects both production and reproduction. With poor forages, there is a limiting effect on consumption, directly affecting herd productive and reproductive performance (Adesipe and Oyedipe, 1985; González *et al.*, 1988; Meirelles, Abdalla and Vitti, 1991; De Moraes *et al.*, 1992; Wetteman, 1993; Vale *et al.*, 1993; Mathis *et al.*, 2000).

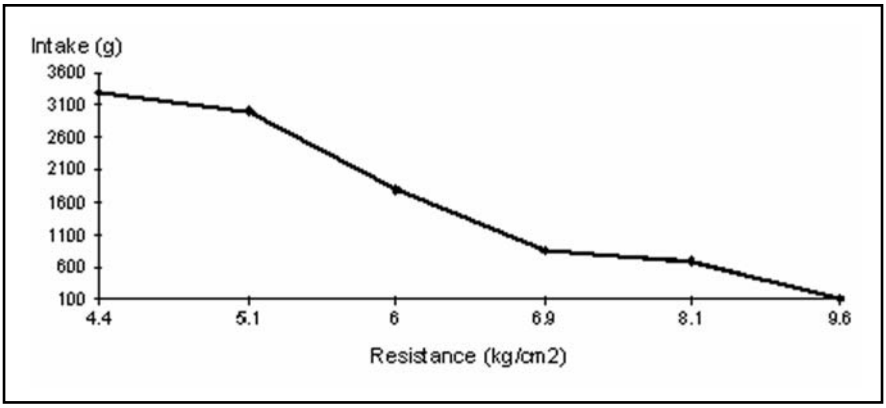

Figure 11.1

Relationship between intake (g) and block hardness (resistance; kg/cm^2) (Birbe *et al.*, 1988b).

In FAO/IAEA trials, MB supplementation has shown variably favourable responses in terms of reproductive performance of cows in the Venezuelan central plains, but MB supplementation produces its best results in reproduction, with positive responses in all the grazing females, both heifers and cows.

Experiences with growing heifers

Grazing heifers deserve special attention, because this group has both reproductive needs and growth requirements. These factors have to be considered when designing strategic supplementation.

Table 11.3 gives some examples of blocks prepared with different local raw materials, reflecting location-specific conditions. In the case of well drained savannahs, where, besides protein, phosphorus is the most limiting element, additional phosphorus was added in addition to the commercial minerals used in the block at a 15 percent level. This ensured adequate phosphorus supply to meet animal requirements. Phosphorus contents in the blocks used in well drained savannahs were 2.51 percent on average, with 37 percent crude protein. Heifer weight gain varied from 121 to 568 g/day with MB intakes of around 300 g/day/animal. These responses imply not only an improvement in weight but also an earlier first mating and first calving 300 days before the unsupplemented group.

In the various studies reported in Table 11.3, it is evident that ovarian activity rises from 17 to 45 percent with the use of MB. A reproductive response of 17 percent in 2-year-old heifers, in the dry season, represents a positive impact for cattle in well drained savannahs, considering that the normal initiation of ovarian activity is more usually at four years of age. These effects could be improved on, when base diet availability is guaranteed and using good quality MB.

In the work by Santaella (2001) reported in Table 11.3, productive and reproductive traits among heifers groups supplemented with minerals and MB did not differ. The block effect was minimized by factors such as good supply (5 571.7 kg/DM/ha) and reasonably good quality of basal fibrous feed resource (sorghum with 5.35 percent crude protein), a compensatory effect of mineral salts (animals that had never previously been fed minerals), a low stocking rate and an off-season rain during the dry season.

Table 11.3
Productive and reproductive responses of heifers with MB supplementation during the dry season in the Venezuelan central plains.

Ecosystem (base diet)	MB		Variable	Response		Ref.
	Raw material	Intake (g/day)		With mineral	With MB	
Well drained savannah (*Trachypogon*)	Gliricidia (*Gliricidia sepium*) (leaves)	305	No. of heifers(1) DWG (g) % OA % pregnancy	16 -182 31 26	16 302 76 70	[1]
Well drained savannah (*Trachypogon*)	Whole cotton seed	357.5	No. of heifers(1) DWG (g) % OA % pregnancy	27 189 45.6 39.2	27 324 66 61.8	[2]
Well drained savannah (*Trachypogon*)	Cañafístola (*Cassia moschata*; fruit)	328	No. of heifers(4) DWG (g) % OA	21 121 66.7	21 191 90.5	[3]
Well drained savannah (*Trachypogon*)	Cañafístola (*Cassia moschata*; fruit)	328	No. of heifers(5) DWG (g) % OA	23 120 0	23 202 17	[4]
Hills zone (*Hyparrhenia rufa* and rice hay)	Cassava (leaves and root)	291	No. of heifers(1) DWG (g) % OA	25 -353 31	49 568 54	[5]
Hills zone (sorghum stubble)	Yard-long bean (whole plant)	318.3	No. of heifers(1) DWG (g) % OA % Pregnancy	24 555 91 79.1	24 542 83.3 79.1	[6]

NOTES: (1) No age given. (2) DWG = daily weight gain. (3) OA = ovarian activity. (4) 3-year-old heifers. (5) 2-year-old heifers.

SOURCES: [1] Birbe *et al.*, 1998c. [2] Domínguez *et al.*, 1998. [3] Herrera *et al.*, 2001. [4] Jaimes *et al.*, 2000.
[5] Martínez *et al.*, 2000. [6] Santaella, 2001.

Experiences with dual purpose cows

In dual-purpose cows, similarly to heifers, the responses have been mainly on reproductive efficiency. There have been improvements in postpartum body condition (Martínez *et al.*, 1998), but there are few experiences reported of supplementation pre-calving. In relation to milk production, no positive responses have been observed, although significant responses have been reported in weight gain in calves from MB-supplemented mothers (Herrera, Birbe and Martinez, 1995).

As reported in Table 11.4, differences observed in ovarian activity and pregnancy percentages with grazing cows ranged from 18 to 52 percent among those consuming minerals and MB.

In the study reported in Table 11.4, from Domínguez *et al.* (1998), MB supplementation was provided in the morning at milking time and in the evenings at suckling time, for an hour each time. Intakes reached 774 g/animal/day, which resulted in the observed responses, being superior in the supplemented group by 52.9 and 64.7 percent in ovarian activity and pregnancy, respectively, compared with the control group.

Table 11.4
Reproductive response in dual-purpose cows consuming MB in the dry season in the central plains of Venezuela.

Ecosystem (base diet)	MB Raw materials	MB Intake (g/day)	Variable	Response With mineral	Response With MB	Ref.
Well drained savannah (*Trachypogon*)	Whole cotton seed	355	No. of cows	21	21	[1]
			BCS	1.54	1.77	
			% OA	22.2	54.5	
			% Pregnancy	18.3	48.2	
Well drained savannah (*Trachypogon*)	Whole cotton seed	774	No. of cows	15	14	[2]
			BCS	1.48	1.79	
			% OA	40	92.9	
			% Pregnancy	6.7	71.4	
Hills zone (*Hyparrhenia rufa* and maize stubble)	Gliricidia (leaves)	270	No. of cows	80	80	[3]
			BCS	1.55	1.74	
			% OA	32	50	
			% Pregnancy	27.6	47.1	
Hills zone (sorghum stubble and paddocks of *Echinocloa polystachya*)	Whole cotton seed and sorghum grain	256	No. of cows	20	21	[4]
			BCS	1.6	1.9	
			% OA	47	74	
			% Pregnancy	43.2	70.1	

NOTES: BCS = Body Condition Score. OA = ovarian activity.
SOURCES: [1] Herrera, Birbe and Martinez, 1997. [2] Domínguez *et al.*, 1998. [3] Domínguez *et al.*, 1998.
[4] Taylhardat *et al.*, 1998.

Conclusions

In the conditions in the Venezuelan tropics, strategic supplementation with MB, manufactured from local raw materials and with a formulation taking into account local ecosystem deficiencies and animal physiological requirements, resulted in better reproductive performance in cows grazing poor quality fibrous resources.

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Experience with development and feeding of multinutrient feed supplementation blocks in Pakistan

G. Habib[20]

Feed Resources and Requirements

Livestock in Pakistan are predominantly reared in mixed crop-livestock farming systems. Major feed resources are supplied by the agriculture sector in the form of crop residues (44 percent), fodder crops (15 percent) and by-products as concentrate (3 percent). Grazing serves as the second major feed source and contributes the balance of total feed supply. Local feed supply is not adequate to support the requirements of the large livestock population, comprising 20.4 million cattle, 20.3 million buffaloes, 23.5 million sheep and 41.2 million goats. The major reason is that crop residues and grazing, classified as of poor quality, form the bulk (82 percent) of the feed supply, but these feeds are low in fermentable nitrogen, less digestible, low in minerals and are poorly consumed by animals. In the conventional feeding systems, severe feed shortages occur for 2–3 months in summer and 4–6 months during winter. Crop residues serve as the main feed during these periods. In the mountainous region, due to climatic constraints, grazing during winter is almost entirely substituted by stall feeding with crop residues and mature-grass hay. Most of the farmers are subsistence and cannot afford to feed expensive concentrates. Due to high pressure on cultivable land due to the increasing human population (0.13 ha/person), only 2.9 percent of land in arid and 17.5 percent in irrigated areas can be spared for fodder cultivation. Comparing feed supply and livestock requirements indicates deficiencies of 42, 53 and 41 percent in dry matter, crude protein and total digestible nutrients, respectively (Table 12.1).

20 NWFP Agricultural University, Peshawar, Pakistan. E-mail: <fayez@brain.net.pk>

Assuming that livestock numbers continue to increase by 2.5 percent per annum, and with a 3 percent annual increase in crop production, the feed gap would by 2010 further widen to 61 percent, 69 percent and 60 percent in dry matter, crude protein and total digestible nitrogen, respectively. The feed deficit would be aggravated if drought conditions continue. The recent drought decreased enormously the carrying capacity of grazing lands, especially in the arid zone. For three locations in Balochistan province, the average dry matter yield per hectare decreased from 352 kg before the drought in 1996–97 to 69 kg after the drought in 2000. Such feed shortages for grazing animals has seriously threatened their survival.

Table 12.1
Livestock feed shortfalls in Pakistan (‘000 tonne)

	Biomass (DM)	Crude protein	Total digestible nitrogen
Available	87 642	5 736	42 928
Demand	152 373	12 161	72 292
Deficiency	42%	53%	41%

Feed shortage is a major constraint in sustainable livestock production in Pakistan, and dairy animals clearly suffer more seriously from feed inadequacy, as they share more than 63 percent of the overall feed requirement. The current annual milk yield of 23 million tonne is far below the estimated genetic potential of 44 million tonne in the country, with the gap of 21 million tonne/year attributable to suboptimal feeding of dairy animals (Iqbal and Ahmad, 1999).

Conventional feed supplementation practices

Supplementation of poor quality diets with home-made concentrate mixtures is general practice among urban and peri-urban dairy farmers, where input costs are high due to market-oriented farming. However, concentrates are not always fed to animals in the subsistence smallholder system that constitutes 72 percent of the livestock farms in the country, and animals for most of the time subsist on cereal straw, stovers and other dry roughages. In the northern mountainous areas of Pakistan, farmers grow some lucerne and conserve it as hay for supplementary feeding together with crop residues during winter. However, the quantity is insufficient for the long, dry, 6-month winter period.

Previous efforts to promote urea treatment of straw in arid and semi-arid areas of Pakistan did not attract farmers. The labour and input demands associated with the technology probably constrained its on-farm adoptability under local conditions. Instead, the use of multinutrient feed block as a supplementation strategy has become increasing popular in the rural livestock farming community during the last few years. The experience and progress made in implementation of feed block supplement technology in the country is reported below.

Urea-Molasses Block as a supplementation strategy – Research and Development

Formulation of urea-molasses mineral blocks

Work first started on preparation of urea-molasses mineral blocks (UMMB) in March 1983, under UNDP/FAO Project PAK/80/019. Initially, efforts focused on finding a suitable hardening agent. Various chemicals, including MgO, bentonite, NaH_2PO_4, CaO, $Ca(OH)_2$ and cement, were tested in different combinations in laboratory-scale experiments. The first recipe that produced hard blocks contained molasses, 49 percent; urea, 10 percent; magnesium oxide, 1 percent; bentonite, 5 percent; common salt, 5 percent; minerals, 5 percent; and wheat bran, 25 percent, and was adopted. However, the cost of the block was high, mainly due to expensive chemicals like MgO and bentonite, and work on block formulation continued with a view to make a cheaper product. These cheaper formulations are shown in Table 12.2.

There were practical problems with the initial formulations, as some of the ingredients, such as monosodium phosphate, were not available in rural areas, and calcium oxide was difficult to grind. The formulation was therefore further refined in the 1990s to use ingredients that were easily available in rural areas and were less expensive, such as calcium hydroxide, cement and clay. The final recipe selected for farmer demonstration in villages consisted of molasses, 47 percent; urea, 7 percent; calcium hydroxide, 8 percent; clay, 5 percent; common salt, 3 percent; dicalcium phosphate, 7 percent; and wheat bran, 23 percent. This produced hard blocks and the cost was 40 percent less than the previous formulas. The block composition is kept flexible, and alternative ingredients, such as oil-cakes or meals, are being used in various commercially manufactured UMMBs. For example, one manufacturer uses cottonseed meal, 8 percent, and gypsum, 2 percent, with no clay in UMMBs.

Table 12.2
Percentage composition of trial urea-molasses mineral blocks (initial investigation).

Ingredient	Formula						
	1	2	3	4	5	6	7
Molasses	45	45	45	45	45	45	45
Urea	10	10	10	10	10	10	10
CaO	10	8	8	10	6	12	8
NaH_2PO_4	5	5	5	2	3	1	5
Cement	–	2	2	–	2	2	1
NaCl	–	–	–	3	2	2	1
Minerals	5	5	5	5	5	5	5
Rice polishings	–	–	–	–	10	5	25
Maize gluten	–	–	25	–	–	18	–
Wheat bran	25	25	–	25	17	–	–

Methods of UMMB Preparation

Hand mixing

In the beginning, a hot process was used that involved heating molasses for about 30–40 minutes in a container. After cooling the molasses to 60°C, urea and then the other ingredients were added in the order shown in Table 12.2, and mixed manually using a steel scoop or piece of wood. The mixture was then transferred to a rectangular mould or any suitable container. After pressing into the mould, the block was removed and allowed to harden over 48 hours. After that the blocks were hard enough to be offered to animals. A longer hardening period was allowed if the blocks were still soft.

The hot process was replaced by a cold process to reduce the energy cost and reduce labour in order to make the process more convenient for farmers. In the cold method, all the ingredients were mixed with cold molasses without adding any water. The mix was then pressed into home-made mould of timber or metal sheet, using a pressing implement or by simply standing on it. The blocks were then removed from the moulds and allowed to harden off in a shady place for 48–72 hours.

Mechanical mixing

On a commercial scale, ingredients are mixed with molasses in a paddle mixer for about 20 minutes, transferred to moulds and pressed with a power-driven hydraulic press. Since blocks are hygroscopic, they are packed in polythene bags and sealed.

Feeding Trials with UMMB

Studies both on-station and under private farm conditions were conducted by different institutions in the country to investigate intake and the productive and reproductive responses in animals to UMMB supplementation. The main findings are summarized below.

Adaptation pattern and UMMB consumption levels in farm animals

Animal adaptability to block licks varied enormously among different animal species and among individual within the same species. Generally, block intake gradually increased over two weeks, with large diurnal variations, and thereafter intake became more or less constant (Figure 12.1). Some animals did not consume blocks for the first 10 days, and then slowly started licking. Farmers reported that buffaloes adapted to UMMB use less easily than milch cattle, but there was great variability.

Block hardness also affected intake by animals. Very hard blocks did not attract licking, while soft blocks were chewed rather than licked. Blocks that on pressing showed no finger impression were considered to be the desirable texture. Block urea content also affected block consumption, as shown in Table 12.4. The quality of the basal diet was another factor affecting block consumption. Animals receiving dry roughages (cereal straw and stover) consumed more block than those given green fodder.

Some farmers (about 25 percent) induced block licking by spreading small quantity of salt or wheat flour on top of block for the first few days. In cases where animals refused to consume blocks on their own, farmers cut the block into small pieces and fed one piece daily mixed in concentrate or forced into the animal's mouth. Variation in block consumption by different species of farm animals is summarized in Table 12.3.

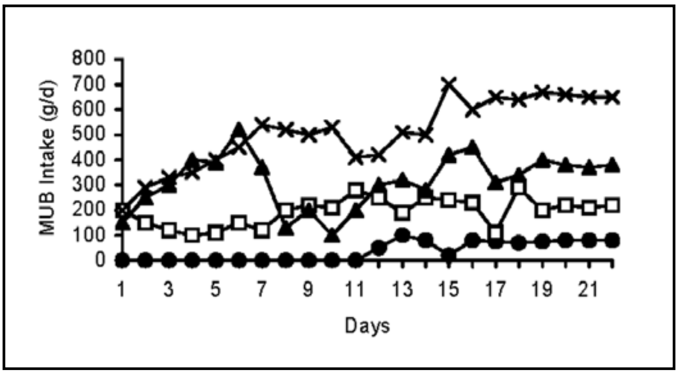

Figure 12.1

Diurnal variation in UMMB consumption by farm animals

Key: –×– Buffaloes; –▲– Cows; –❑– Bull calves; –●– Cow calves.

Table 12.3
Average daily intake of UMMB in different farm animals.

Animal Specie	Daily block consumption (g/day)	
	Average	**Range**
Adult cows	350	100 – 450
Adult buffaloes	500	150 – 714
Cow calves	196	50 – 300
Buffalo calves	292	80 – 496
Sheep	80	30 – 200
Goats	100	63 – 214

SOURCE: Habib *et al.*, 1991; Habib, unpublished.

The large difference in block intake (g/day) between cattle and buffaloes is explained by different body weights, but the calculated block intake per unit of body weight were similar (117 g vs 100 g/100 kg body weight in cows and buffaloes, respectively). Block consumption on a body-weight basis was found to be higher in sheep and goats (276 g/100 kg body weight) than in large ruminants.

Optimum UMMB urea levels

The urea level in feed blocks is important as it influences the rumen ammonia level, affecting fibre digestion. A study evaluated different levels of urea in blocks. UMMB with 2, 10, 15 and 20 percent urea were prepared and fed to rumen-cannulated sheep in a 4×4 Latin square design. The animals were given a basal diet of wheat straw ad lib. As shown in Table 12.4, UMMB consumption decreased linearly with increasing levels of urea. Daily intake of oat chaff showed a curvilinear response to urea levels, and was at a maximum when the UMMB contained 10 percent urea. *In sacco* DM digestibility of wheat straw increased from 31.3 percent with 2 percent urea, to 35.9 percent with 10 percent urea in the blocks. Further increases in urea level in UMMBs did not change the digestibility. However, ammonia concentrations in the rumen progressively increased with increasing levels of urea. The findings suggested that 10 percent urea was an optimum level in the feed blocks. The negative effect of high urea levels on block intake may be related to low palatability or excessive ammonia concentrations in the rumen.

Urea levels in UMMB for dairy buffaloes

Nitrogen dynamics in the rumen of buffaloes and cows differ. Buffaloes have more efficient urea recycling in the rumen and that may affect dietary urea requirements. UMMB containing 5, 10 and 15 percent urea were offered to rumen-cannulated buffalo steers fed wheat straw ad lib. Results in Table 12.5 show that intake and *in vivo* and *in sacco* digestibilities of wheat straw increased with UMMB supplementation, but did not show response to varying levels of urea in the blocks. Rumen NH_3-N concentrations improved from a suboptimum level of 21.11 mg/litre in controls to optimum levels varying from 59.19 to 96.11 mg/litre in UMMB-fed steers.

The results shown in Table 12.5 indicate that the urea level in feed blocks should not exceed 5 percent for efficient utilization by dairy buffaloes.

Table 12.4
Changes in feed intake and rumen parameters in sheep fed UMMB with different urea concentrations.

Parameter	Level of urea in UMMB			
	2%	10%	15%	20%
Block intake (g/day)	131	123	224	82
Oat chaff intake (g DM/day)	649	777	725	681
Rumen ammonia concentration (mg N/litre)	53.5	162.5	206.3	226.4
In sacco DM digestibility of wheat straw (% at 24 hours)	31.3	35.9	36.1	34.8

SOURCE: Habib *et al.,* 1991.

Table 12.5
Urea levels in feed blocks for buffaloes.

Observations	Control	Urea level in feed blocks		
		5%	10%	15%
Wheat straw intake (kg DM/day)	6.30[b]	7.04[a]	7.20[a]	7.40[a]
Block intake (g/day)	–	606[a]	714[a]	606[a]
In vivo organic matter digestibility (%)	46.89[b]	55.56[a]	52.31[a]	53.72[a]
In sacco DM digestibility of wheat straw (% per hour)	1.30[a b]	3.80[a]	4.00[a]	3.40[a]
Rumen NH_3-N concentration (mg/litre)	21.11[d]	59.19[c]	96.11[a]	79.38[b]

NOTE: Means with different superscripts in the same row differ significantly (P <0.05).

Comparison of feeding UMMB vs urea supplement

Positive changes in rumen fermentation with UMMB feeding are related to the sustained supply of urea supporting optimum ammonia concentrations for rumen microbes. The same could be achieved through spraying urea solution onto straw before feeding. The two strategies of urea supplementation were compared. Three groups of rumen-cannulated buffalo steers (3 animals per group) were fed a basal diet of wheat straw. One group had free access to UMMB containing 10 percent urea, and the second group was given wheat straw sprayed before feeding with an aqueous solution of 50 g urea in 2 litre. The third group served as control. All animals received 70 g/head/day of mineral mixture. The daily consumption of UMMB averaged 546 g. Daily wheat straw intake per animal increased from 5.33 kg in the control group to 6.93 kg and 7.27 kg in the UMMB- and urea-fed steers, respectively. *In vivo* digestibility of

DM, organic matter and crude fibre did not vary among the three diets, presumably due to high rumen passage rate in animals fed UMMB or urea, as indicated by higher feed consumption. However, in line with increase in rumen ammonia concentrations, *in sacco* DM digestibility at 24 hours increased to the same extent with UMMB and urea feeding compared with the control animals. The results indicated that both methods of urea feeding were equally effective in stimulating straw intake and ruminal digestibility. However, daily spraying of urea solution onto straw was highly labour intensive and would not be practical on a routine basis for farmers. In contrast, UMMB use required no extra management and was highly compatible with existing feeding practices in smallholder systems.

As illustrated in Figure 12.2, maintenance of high ammonia concentrations in the rumen throughout a 24-hour feeding cycle is important in optimizing rumen fermentation. This is obtained by continuous intake of urea from UMMB licks. In contrast, if urea is fed only once a day, rumen ammonia concentration peaks during the first hour and then gradually declines to a pre-feeding level. Thus ammonia concentrations would remain suboptimal for most of the time, limiting microbial activity in the rumen.

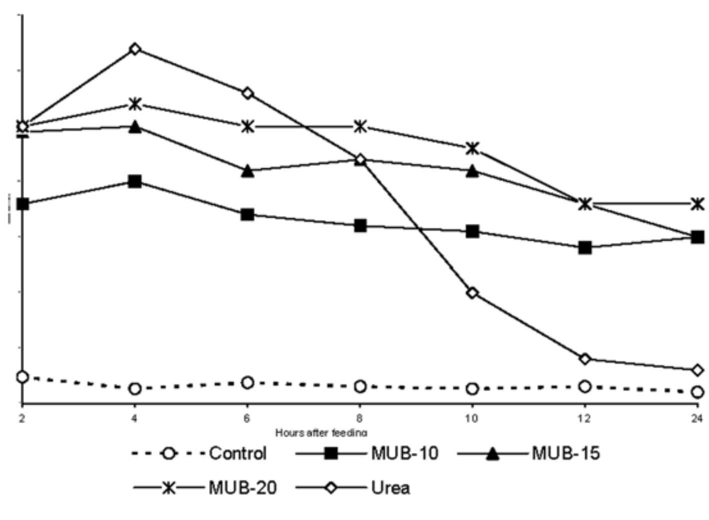

Figure 12.2

Rumen ammonia concentrations in sheep supplemented with UMMB or with urea 14 g once daily on a basal diet of oat chaff.

Associative effect of UMMB and forage quality

Generally, UMMB is considered an appropriate supplement with poor quality roughages that are deficient in nitrogen and with poor digestibility, but it may also be useful when animals are given good quality forage. Two experiments were conducted to determine the associative effect of UMMB feeding and quality of the basal diet in sheep and growing calves.

A nitrogen balance trial in a 4×4 Latin square design with four wethers was reported by Saeed, Siddiqui and Habib (2002). The four diets were maize stover with and without UMMB, and lucerne hay with and without UMMB. Intake of basal diet and *in vivo* DM and organic matter digestibility were not affected by UMMB with both maize stover and lucerne diets. However, UMMB feeding significantly increased nitrogen retention by a factor of 2.5 in wethers given maize stover, but had no effect in wethers fed lucerne hay. Nitrogen retention as a percentage of total N intake was 26.7, 29.4, 38.0 and 39.6 percent on maize stover; maize stover + UMMB; lucerne; and lucerne + UMMB diets, respectively. These findings suggested a positive effect of UMMB on N status in sheep on solely a poor quality diet.

Similarly, when Faizi (2000) fed untreated and urea-treated maize stover to Holstein Friesian calves with or without UMMB, daily consumption of stovers and *in vivo* digestibility of DM and organic matter significantly increased with UMMB on untreated stover, but had little affect with urea-treated stovers (Table 12.6).

Table 12.6
Response in feed intake and nutrient digestibility to urea-molasses block feeding with untreated and urea-treated maize stover

Parameter	Untreated maize stover		Urea-treated maize stover	
	- UMMB	+ UMMB	- UMMB	+ UMMB
Maize stover intake(kg DM/day)	1.72[c]	2.35[b]	2.78[a]	2.85[a]
Block intake (g/day)	-	496[a]	-	180[b]
Water intake (litre/day)	14[b]	16[a]	15[ab]	16[a]
In vivo DM digestibility (%)	43.7[b]	55.8[a]	58.0[a]	58.1[a]
In vivo OM digestibility (%)	55.1[c]	62.6[a]	65.7[a]	65.7[a]

NOTES: OM = organic matter. DM = dry matter. [a,b,c] Means with different superscripts in the same row differ significantly ($P < 0.05$).

SOURCE: Faizi, 2000.

These results suggested that UMMB significantly increased feed intake and digestibility when the basal diet was of poor quality, but had no positive effect with a high quality diet. Secondly, UMMB feeding was as equally effective as urea treatment of straw in improving utilization of poor quality roughages. However, the comparison set out in Table 12.7 logically justifies the use of UMMB as a more appropriate strategy for local smallholder farming.

Productive responses to UMMB

Milk production

Both on-station and on-farm studies demonstrated that daily milk yield consistently increased with UMMB supplementation in all species of lactating farm animals. The response was more pronounced in rural animals receiving no or little concentrate allowance. In urban and peri-urban dairy farms with improved feeding of animals, milk response to UMMB supplementation was relatively low.

Feeding of UMMB to lactating buffaloes and cows on 16 farms in an arid region of NWFP demonstrated a persistent increase in daily milk yield over 90 days in both cows and buffaloes (Figure 12.3). The response was 42 percent greater in cows than in buffaloes (22 percent increase over controls). Average daily milk yield over 90 days in control cows was 3.8 litre, which increased to 5.4 litre with UMMB feeding, and averaged 3.7 and 4.5 litre in control and UMMB buffaloes, respectively. Daily block intake was 320 g per cow and averaged 450 g per buffalo.

An extensive study was recently conducted by Khanum and co-workers (personal communication) in an irrigated area of Punjab Province. It included 350 milking buffaloes from 75 peri-urban and rural smallholder dairy farms. The animals on each farm were divided into control and UMMB groups, and all of them received 3 to 4 kg home-made concentrate mixture, mainly comprising cottonseed cake and wheat bran (Table 12.8). Milk yield response was classified in lactation stages: early (1–60 days), mid (61–120 days) and late (>120 days).

More importantly, the lactation curve remained persistently higher in UMMB-fed buffaloes in all the three groups. Daily milk production increased in 78 percent, did not change in 15 percent and fell slightly in 7 percent of buffaloes in response to UMMB supplementation. Daily UMMB consumption was variable, and averaged 500 g/day/animal.

In another trial with milking buffaloes in 18 peri-urban farms, daily milk yield was higher during most of the lactation period in response to UMMB feeding, despite all the animals receiving 3–4 kg of concentrate mixture (Figure 12.4). The difference in milk yield between the two groups was pronounced after 13 weeks of lactation. Farmers reported that the effect of UMMB on milk yield started showing 3–5 days after the start of UMMB supplementation. Milk production over a 38-week period averaged 8.86 and 10.30 litre/day in control and UMMB buffaloes, respectively.

Table 12.7
Comparison of UMMB and urea-treatment of straw technologies for improving livestock nutrition in smallholder farming systems.

Parameter	UMMB	Urea treatment
Feeding management	Easy.	Labour intensive
Storage	Easy	Difficult
Shelf life	Long	Limited
Transportation	Easy	Difficult (bulky)
Relative cost	Low	High (twice UMMB)
Nutrient supply	Diverse (multinutrient)	Energy and N only
Risk of urea poisoning	Low	High
Scope for income generation activity (mini-enterprise)	High	Nil
Environment pollution	Nil	Yes
On-farm adaptability	High	Low

Reproductive efficiency

A study with 100 lactating buffaloes at three different research institutes in Punjab showed that buffaloes consuming 200 to 600 g of UMMB per day not only had higher milk yield than a control group but their reproductive efficiency was also improved (Hussain *et al.*, 2002). Buffaloes fed UMMB resumed postpartum ovarian cyclicity earlier than the un-supplemented group. Milk progesterone assay in 16 buffaloes revealed that UMMB buffaloes resumed ovarian activity 88–102 days after parturition, indicated by higher milk progesterone levels of 3 to 5 ng/ml, while the control group resumed ovarian cyclicity later (138–172 days) with little fluctuation in milk progesterone levels.

Khanum and co-workers (personnel communication) further confirmed a positive effect of UMMB feeding on reproduction in 85 milking buffaloes from 18 peri-urban dairy farms, using a milk progesterone assay. UMMB-supplemented buffaloes resumed postpartum ovarian activity earlier than the control group. Difference in the distribution of cycling buffaloes in control and UMMB groups over the experimental period of 51 days (Table 12.9) is of great economic importance. The practical implication of these findings is that UMMB-supplemented buffaloes would increase farm income through higher milk yield and a shorter calving interval resulting from early resumption of postpartum oestrus.

Table 12.8
Daily milk yield (litre) in peri-urban and rural dairy buffaloes with or without UMMBs.

Lactation stage	Control buffaloes	UMMB buffaloes
Early lactation (1–60 days)	9.6 –13.4	13.2 – 15.5
Mid-lactation(61–120 days)	7.0 – 10.2	11.0 –12.8
Late lactation (>120 days)	4.5 – 8.5	6.8 – 9.5

SOURCE: Anonymous, 1999.

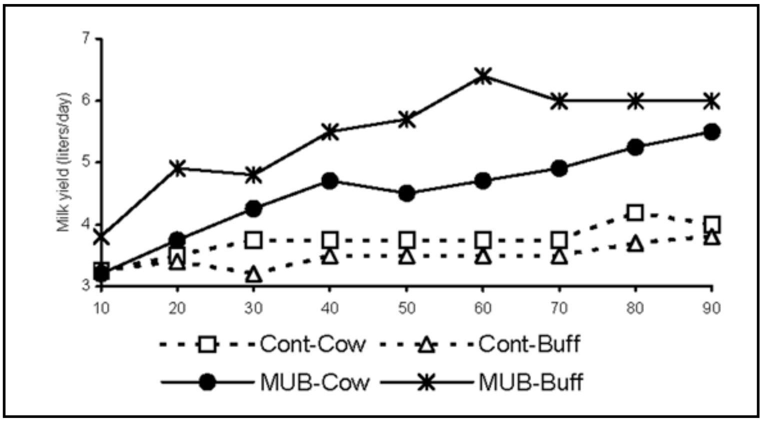

Figure 12.3
Effect of urea-molasses block on milk yield in rural cows and buffaloes
KEY: Cont. = control. Buff. = buffalo. MUB = UMMB supplemented

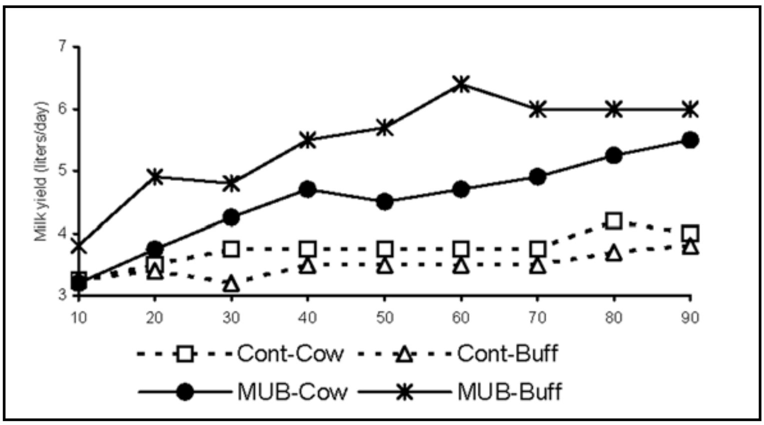

Figure 12.4
Milk yield response to UMMB feeding in dairy buffaloes.
KEY: MUB = UMMB supplemented.

Table 12.9
Reproduction response to UMMB feeding in peri-urban buffaloes.

Postpartum interval	Control		UMMB	
	Oestrus (%)	Conception[(1)] (%)	Oestrus (%)	Conception[(1)] (%)
12 to 18 weeks	4.6	0	12	12
21 to 36 weeks	64	71	72	71
39 to 51 weeks	30	92	16	90

NOTE: (1) Conception expressed as a percentage of those that showed oestrus.

Table 12.10
Effect of UMMB lick on growth performance in different species of animals.

Animal	Basal diet	Block intake (g/day)	Body weight change (g/day)	
			- UMMB	+ UMMB
Buffalo calves	Wheat straw + wheat bran (300 g/day)	292	+ 32	+ 187
Cattle cow calves	Wheat straw + wheat bran (300 g/day)	196	+ 137	+ 307
Lambs	Grazing	38	- 29	+ 133
Lambs	Grazing	200	- 11	+ 38
Lambs	Grazing + concentrate	75	+ 66	+ 90
Goats	Grazing	138	+ 21.3	+ 32.4

Growth performance

Supplementary feeding of UMMB was found equally effective in stimulating growth rates in all species of ruminant farm animals studied (Habib *et al.*, 1991). Response to UMMB was related to quality of the basal diet and grazing conditions. Findings from various studies conducted by our group under local conventional farming systems are summarized in Table 12.10.

In general, the quality of communal rangelands used for grazing of animals in Pakistan, except possibly the high altitude alpine pastures, is very poor and is constantly declining. Range vegetation is predominantly unpalatable and consists of drought resistant species that have poor feeding value, with low crude protein contents of 3 to 8 percent and *in vitro* DM digestibility varying from 35 to 45 percent (Habib and Bashir, 1982–83). Block supplementation under such conditions was found highly useful. It was not possible to provide block licks on common-property rangelands during free grazing. Blocks are offered to the animals in the evening on their return from grazing. As goats are more selective in grazing and browsing behaviour and select higher protein herbage (fodder trees and shrubs), growth response to block supplementation was not marked and weight gain increased only slightly, from 21.3/day in the controls to 32.6/day in UMMB-supplemented goats. This is similar to our findings reported above that UMMB feeding did not significantly improve digestibility and nitrogen retention in sheep and calves on good quality forages.

Field experience

UMMBs were distributed among farmers of various community organizations in arid and semi-arid regions of NWFP through various non-governmental organizations (NGOs). Farmers' observations were recorded using a structured questionnaire during weekly visits by extension workers. These are summarized below and classified on the basis of comments received from respondents.

UMMB consumption

- Average daily intake of block Cow, 300 g; buffalo, 500 g.
- Licking 65 percent.
- Biting 35 percent.
- Fed in pieces 17 percent.
- Started licking on day 1 60 percent.
- Stated licking after day 7 30 percent.
- Never licked 10 percent.
- Self licking 58 percent.
- Induced licking 25 percent.

Feed consumption

- More feed consumed 100 percent.
- Less selective when fed stover 100 percent.
- Active grazing 100 percent.
- Consumed more water 100 percent.

Milk production

- Daily milk increased 94 percent.
  Milk increased 0.5 litre/day 43 percent.
  Milk increased 0.750 litre/day 31 percent.
  Milk increased 1.0 litre/day 26 percent.
- Daily milk did not change 6 percent.

Depraved appetite

- Stopped eating abnormal things 82 percent.
- Reduced eating abnormal things 12 percent.
- Continued eating abnormal things 6 percent.

Changes in health/body condition

- Improved 100 percent.

Oestrus resumption

- Started showing heat signs 30 percent.
- Did not notice 70 percent.

The above observations by farmers showed that UMMB was successful in increasing milk production and had many positive effects. Variation in milk yield was apparently related to the quantity of block consumed and quality of the basal diet the animals received. Most of the animals had no problem in adapting to the blocks as a new feed supplement. Changes in milk yield were visible on the third day after starting feeding UMMB. Pica is a common problem in almost all the animals of arid regions due to mineral deficiencies, but it was effectively reduced by UMMB supplementation. In some cases, animals suffering from haemoglobinurea due to phosphorus deficiency recovered when UMMB was supplemented. Interestingly, all farmers invariably reported higher feed intake with UMMB supplementation. The majority of animals received wheat straw, sorghum stover or maize stover with little or no green fodder and concentrate. In such situations, UMMB stimulated feed consumption and the animals were less selective in consuming stovers, thus minimizing wastage. Similarly, grazing animals were more active in searching for feed on ranges with sparse vegetation. However, their requirement for drinking water was increased, probably due to high feed consumption and urea intake from the blocks.

The farmers reported better general body condition of the animals, with glossy coats and healthier appearance. Due to prolonged mineral deficiency in the animals, milking and pregnant buffaloes and cows especially suffered from bone disorders, manifested by stiff joints, ataxia and characteristic posture with bulging scapula and stiff neck. Interestingly, when the animals were offered UMMB that contained 5 percent dicalcium phosphate and 5 percent other minerals, the symptoms subsided with a week's intake of the blocks. Cows that had not shown oestrus signs for a long time due to inadequate nutrition were reported to be resuming their oestrus cycle when given mineral-rich blocks.

Farmers in the arid and semi-arid regions very much appreciated the management aspect of UMMB use, because block feeding did not demand extra arrangements. In some cases where animals chewed the blocks, these were then offered in a close fitting wooden box. No case of urea poisoning was reported, except in one instance when a farmer cut the block into small pieces and fed it all at one time to a cow to boost milk production.

During a field investigation in Punjab province, Khanum and co-workers (personal communication) found that UMMB feeding increased feed intake and prolonged the lactation period in dairy buffaloes. The response in daily milk production among 350 buffaloes was that 70 buffaloes (20 percent) increased by 10 percent; 140 (40 percent) increased by 11 to 20 percent; 60 (17 percent) increased by 21 to 30 percent; 17 (5 percent) increased by >30 percent; 49 (14 percent) showed no change; and 14 (4 percent) showed a decrease.

In comparison with the observations from arid and semi arid areas of Pakistan reported earlier, the lower response in milk yield to UMMB in the irrigated area in Punjab Province was attributed to the fact that the feeding regime included green fodder and a concentrate allowance for milking buffaloes. This may also explain the absence of response in 14 percent of the buffaloes. Decreased milk yield in 4 percent of buffaloes with UMMB feeding was associated with the pregnancy status of the animals.

Considerable fieldwork on preparation and feeding of UMMB was been carried out in Balochistan, another drought-prone province of Pakistan, by a UNDP/FAO project during 1995–96 (Soomro *et al.*, 1996). Large-scale production of UMMB was accompanied by feeding to sheep and goats as the major livestock species in five pilot areas, and in some places also to cattle. In all cases, farmer interest in the technology was very high. Farmers generally allowed a limited access period to the blocks, but invariably reported that animals consumed them and their health condition improved. The work showed that UMMB strategy was highly relevant to drought-affected areas and proved to be one system for maintaining live weight in small ruminants when fed cereal straw, with little alternative for cheaper supplements.

Training Of Farmers And Extension Workers

Extension workers of the Livestock Departments in all the four Provinces of Pakistan received training in UMMB technology, including awareness creation and preparation of UMMB by hand. Special matrix lessons were developed on UMMB technology for teaching to livestock extension workers and trainees in various in-service training institutes. Female extension workers of the Livestock Departments and NGOs were also given such training (Figure 12.5) .

Figure 12.5 Small scale preparation of feed block is a relevant activity for women: extension workers are trained on the block technology .

The extension workers first prepared blocks (Figure 12.6) and then distributed these among farmers, and regularly monitored animal performance and farmer response using a structured questionnaire developed in local languages.

Figure 12.6 Extension workers preparing blocks

Under an IAEA project (Feed supplementation and reproductive management of cattle, IAEA/RCA 05/035) at the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, more than 21 000 blocks were distributed among rural farmers to familiarize the technology in the field. Similarly, in Balochistan Province, farmers were helped in making UMMBs (Figure 12.7) and provided with an extension brochure on block technology under a UNDP/FAO project (Livestock Development in Balochistan, PAK/88/050). In NWFP, Livestock Production Officers and extension workers were helped in making blocks. Different village organizations received demonstrations of the on-farm method for making UMMBs. Information leaflets in local languages on preparing and feeding blocks were being produced at the time of writing. In all cases, farmers have shown keen interest in and want to adopt this new technology. However, molasses is not available to a common farmer and, being liquid, it is difficult to transport over long distances. Therefore, due to high demand for UMMB in the field, five commercial UMMB manufacturing plants in the country have become operational during the last five years, with a leading role being taken by the Feed Technology Unit of the National Agricultural Research Centre, Islamabad. These plants have variable production capacity and prepare blocks on demand. At present they have also been meeting the increasing demand for UMMBs from neighbouring Afghanistan.

Figure 12.7 Young farmers preparing on-farm molasses-urea blocks.

New Experience In Making Mulberry Fruit Multinutrient Blocks

The Hindu Kush northern mountainous belt of Pakistan is a semi-arid region where livestock is a major source of livelihood. Due to extremely limited cultivable land and climatic constraints, livestock subsist on grazing and crop residues. During the long 6-month winter dry period, livestock are kept indoors and stall fed with crop residues and forage hay. UMMB feeding is therefore highly relevant to the feed situation in the region. However, molasses is not available locally and transporting molasses or UMMB to such remote areas over poor roads is expensive.

The area is rich in fruit trees, including mulberry, a popular native tree. Drying mulberry fruit for human consumption is a centuries-old practice throughout the region. The harvesting season of mulberry fruit is short and limited to about the two summer months of July and August. During this period, it is not possible to harvest all the mulberry fruit, and more than one-third of the fresh fruit and a similar proportion of the sun drying fruit is wasted. To prevent such wastage, feed blocks were prepared, substituting molasses with mulberry fruit. Small laboratory-scale studies (Habib and Ishrat, 2000) were followed by on-farm preparation of mulberry feed blocks. Block recipes using fresh mulberry fruit with different ingredients are given in Table 12.11.

Table 12.11
Composition (percentage) of trial mulberry-based urea-multinutrient blocks.

Ingredient	Block formula					
	1	2	3	4	5	6
Mulberry fruit (fresh)	48	45	45	45	45	45
Urea	7	7	7	7	7	7
Lime powder	10	10	5	5	5	5
Cement	0	5	5	5	5	0
Clay	0	0	0	0	0	5
Mineral mixture	10	10	10	10	10	10
Common salt	3	3	5	5	5	5
Wheat bran	22	20	23	0	13	23
Lucerne leaves (dried)	0	0	0	23	10	0
Hardness after 24 hours	Soft	++	+	Nil	+	+
Hardness after 48 hours	Soft	+++	+++	Nil	++	+++

Formula 6 was finally selected for on-farm implementation. More than thirty farmers, including females, in two village organizations in Chitral were given training in making the mulberry feed blocks on their farms. Farmers having waste dried mulberry fruits were given a demonstration of making blocks based on the formula given in Table 12.12.

The farmers readily accepted the innovation, and when the blocks were fed to animals they produced highly encouraging results in terms of increased milk production, and improved health and fertility. The animals readily adapted to the block licks and on average consumed 300 g/cow/day or 70 g/goat/day. Increased milk yield was notable after 3 days of feeding the blocks. Local cows in the area are of small frame size (150–200 kg body weight) and maximum milk production varies from 1 to 2 litre/day, primarily due to poor genetic make up and undernutrition. Feeding of mulberry feed block increased milk by 33 to 43 percent (Figure 12.8).

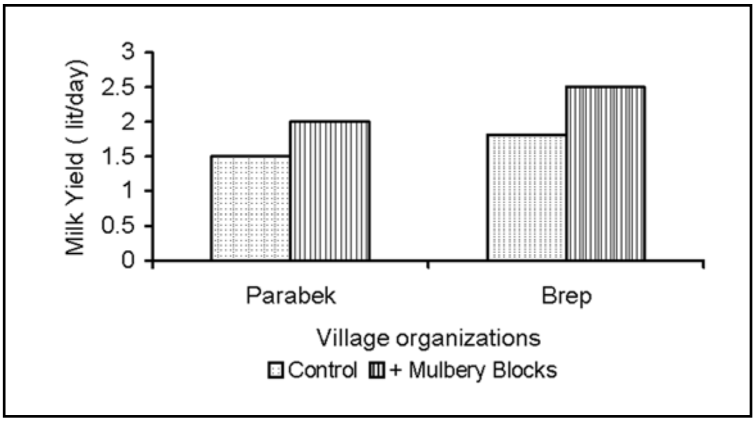

Figure 12.8

Milk yield response to mulberry-based urea-multinutrient block supplement in cows.

Recently, Roomi (2002) investigated the effect of mulberry fruit-based blocks on digestibility parameters in two local cattle breeds. Mulberry feed block licks significantly increased the digestibility of dry matter, organic matter and acid detergent fibre (Table 12.13). The calves on average consumed 416 g/day, or 8.25 g/kg body weight, and readily adapted to the lick, with no lag period.

Table 12.12

Composition of multinutrient block (3 kg weight) produced using dried mulberry fruit.

Ingredient	By percentage	By weight (g)
Dried mulberry fruit	23	690
Water	22	660
Urea	7	210
Lime	5	150
Clay	5	150
Minerals	10	300
Common salt	5	150
Wheat bran	23	690
Total	100	3 000 (3 kg)

Table 12.13
Effect of mulberry-based urea-multinutrient feed block on *in vivo* digestibility in two breeds of calves given a basal diet of maize stover.

Observations	Control diet			+ Mulberry block licks			Significance		
	Sahiwal	Achai	Mean	Sahiwal	Achai	Mean	Diet (D)	Breed (B)	D × B
DM digestibility (%)	47.01	45.69	46.35	55.56	58.42	56.99	P <0.001	NS	NS
OM digestibility (%)	50.74	49.49	50.11	59.16	60.42	59.79	P <0.001	NS	NS
ADF digestibility (%)	42.63	41.36	42.00	48.91	46.64	47.78	P <0.01	NS	NS

Notes: DM = dry matter. OM = organic matter. ADF = acid detergent fibre. NS = not significant.

Convinced by the positive responses in animal performance, farmers after training have started preparing blocks on their own (Figure 12.9 and 12.10). Almost every farmer in the Northern Areas of Pakistan has a few mulberry trees. An average size tree would produce more than 50 kg of mulberry fruit in a season. Thus every farmer can easily make mulberry feed blocks for winter feeding of their animals. Some farmers have already started preparing blocks as an income generation activity, selling to other farmers. The Agha Khan Rural Support Programme (AKRSP) in Chitral has recently commenced an impact study on supplying mulberry feed blocks to milking cows, and have plans for introducing the innovation as a mini-enterprise for income generation in the project area.

Figure 12.9 Fresh mulberry fruit is crushed into a paste and mixed with urea and other ingredients to make mulberry feed blocks.

Figure 12.10 On-farm training of household members to make mulberry feed blocks for winter feeding of their animals.

Future Use Of Feed Blocks

Solidified feed blocks (both UMMB and the mulberry variety) can be used as a carrier for delivering anthelmintics, rumen modifier and specific minerals. Gastro-intestinal parasites are a common problem in almost all farm animals in Pakistan, and their incidence peaks during the humid months of July to September. Repeated oral dosing of animals with anthelmintics is difficult and farmers cannot do it on regular basis. Work on incorporating anthelmintics in blocks and their strategic use for controlling worms in animals is planned for the near future. Locally available herbal anthelmintics that are cheaper than imported drugs will be investigated. In the northern areas of Pakistan, farmers have identified some plants as anthelmintic, and these could potentially be incorporated in mulberry-based blocks for animals.

Feeding feed blocks fortified with minerals can effectively control location-specific mineral deficiencies, such as haemoglobinurea and osteodystrophic disorders associated with phosphorus deficiency. Work on this aspect through farmer field school campaigns should be initiated soon with the help of a community-based rural development organization in NWFP.

Rumen modifiers of herbal origin, such as tree leaves, can be included in blocks as antiprotozoal agents and rumen fermentation enhancers. Similarly, drugs for controlling bloat, a frequent problem with legume feeding, can be controlled through medicated blocks.

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