Frequently asked questions on Urea-Molasses-Multinutrient Block Technology (UMMB)

What are Urea-molasses multinutrient (UMMB) blocks?

As the name suggests, these are lick blocks containing urea, molasses, vitamins, minerals and other multinutrients. The feeding of the blocks is a convenient and inexpensive method of providing a range of nutrients required by both the rumen microbes and the animal, which may be deficient in the diet. The main justification for using the blocks depends on their convenience for packaging, storage, transport and ease of feeding.

The ingredients are designed to provide a wide rage of nutrients to cover all potential deficiencies. In the wet tropical regions minerals are often deficient in cut and carry grass or crop residue feeding systems. Grasses from road sides or wastelands are particularly low in minerals as generally, no fertilizer is used and the grasses have often been cut for decades for ruminant production, thus depleting the reserves of both soils and plants.

What is the composition of UMMB?

A standard UMMB consists of molasses (30-50 %), urea (5-10 %), a cereal bran such as rice, wheat or maize bran (15-25 %), an oil seed meal such as soybean meal, coconut meal or groundnut meal (10-20), salt (5-7 %), lime or cement (5-10 %), bone meal (5-7 %) and minerals (1-2 %). The molasses being a concentrated plant juice, will provide a range of trace minerals and a complete mixture of vitamins. Cereal brans are high in phosphorus, trace minerals and also a range of vitamins. In addition they provide a slow-release amino acid source from the relatively insoluble proteins to the microbes. Oilseed meals are a good source of phosphorus and soluble and insoluble proteins. Bone meal, salt and lime or cement will provide much of the macro mineral requirements. Urea provides the small amount of extra nitrogen required, for utilization of the dry matter, in addition to that present in the forage. The multinutrient block, therefore, provides the nutrient requirements of both the microbes and the host animal.

Why molasses - urea mixtures?

Molasses is a major by-product of the sugarcane industry. It is a well known source of energy and a widely available concentrated form of `fermentable carbohydrate' that has no role in human nutrition. Urea is a product, which after hydrolysis into ammonia in the rumen can be used as a nitrogen source by the microbes. Therefore, a supplement containing these two can stimulate the development of microbes in the rumen, permitting a better digestion of the forages and a greater production of microbial protein, which could provide essential nutrients in the intestine. For these reasons, liquid supplements containing molasses and urea have been used in many countries such as Australia, India and those of Southern Africa, for drought feeding and for intensive cattle fattening.

Why Blocks?

Supplementation systems based on liquid molasses have been used on ranches, but they are difficult to use under extensive nomadic livestock systems or by smallholder farmers. The main reasons are the necessity to have a minimum of infrastructure to transport and distribute the liquid mixture (tanks for transport and storage, feed troughs etc.) and the difficulty to manipulate this by-product, which is a very viscous and sticky liquid. Therefore, in many countries where there is a surplus of molasses it is either under utilised and, or, exported even when there are problems in animal feeding during the dry season.

The main justification for using blocks, to provide deficient nutrients is, therefore, their convenience for packaging, storage, transport and ease of feeding.

What are the basic feed ingredients of the blocks and what nutrients do they provide?

Many ingredients can be used for making urea-molasses blocks. The choice will depend on their availability, nutritive value, price, easy of handling and the effect on quality of block. Some of the ingredients that may be used are: molasses, urea, bran (rice, wheat or maize), oilseed meals and cakes (soybean, coconut, groundnut, cottonseed, olive), agro-industrial by-products and miscellaneous non-conventional feeds (sugar beet pulp, citrus pulp, tomato pulp, cassava waste, milled groundnut shells, brewers grain, bagasse, poultry manure and waste, slaughter house offals), cement or lime, salt and, or, minerals.

The molasses, being a concentrated plant juice, will provide a range of minerals (except phosphorus) and a complete mixture of vitamins. Because of both it's taste and smell molasses makes blocks appetising for animals.

Urea provides the small amount of extra nitrogen required for utilization of the dry matter in addition to that present in normal dry season forage. It must be sufficient to maintain the ammonia level in the rumen, at a constant and sufficient amount for better development of the micro-organisms, leading to better degradation of the cellulosic components.

Cereal brans (rice, maize or wheat bran) are high in phosphorus, trace minerals and also a range of vitamins. They absorb moisture from the molasses and gives structure to the block. Bran can be replaced by other sources of fibre such as bagasse or finely milled groundnut hulls.

Oilseed meals provide both soluble and insoluble proteins and are a good source of phosphorous. It is appropriate to add such ingredients when blocks are given to animals in production.

Cement or quicklime is used as a binding agent. Although the use of cement has raised questions about possible harmful effects, studies in USA, USSR and Canada have shown no negative effects, over long periods of time, when it constitutes up to 1 % of the total daily intake of dry matter.

Mineral requirements for animals in maintenance or survival conditions are low. Generally speaking, mineral deficiencies appear only when production is high. Bone meal and salt will provide much of the macro mineral requirements (sodium, potassium, calcium and phosphorus) of the microbes as well as those of the host animal. Minerals are often expensive on the local market and their quality is generally not controlled. Therefore, it may not be appropriate to add minerals unless they are absolutely necessary. Molasses is rich in most minerals but unfortunately not in phosphorous.

The multinutrient block, therefore, provides the nutrient requirements of both the microbes and the host animal.

Many other chemical agents (e.g. veterinary drugs for treatment of parasites or chemical agents for modifying the rumen ecosystem), can be added in the block, which is an excellent carrier for such products. However, their long-term effects have not yet been evaluated.

What should be the characteristics of the block components?

Molasses

The consistency of the molasses appears to play a major role in the successful manufacture of urea-molasses blocks. This depends on the quantity of sugar in the molasses. This sugar quantity, expressed as a percentage of the total weight in the molasses is called the **BRIX** value. To ensure a good hardening of the mixture the molasses should have a BRIX value of 80 or more. The molasses coming from a sugar factory normally attains this degree of BRIX and can even reach 90. It should NOT be diluted with water in order to make it easier to handle as this leads to difficulties during the process of solidifying blocks. The BRIX value can be easily checked with a small pocket refractometer.

Urea

The urea used in this formula is fertiliser grade, normally used as a nitrogen fertiliser in sugarcane plantations and rice fields. Since the urea is hygroscopic it is possible that during storage lumps may form in the sacks. In order to prevent excessive consumption of urea in too short a period, which may cause intoxication of the animals, it is necessary that all the lumps are crushed before introducing the urea into the mixture. This will guarantee a homogenous mixture of urea in the mass.

Salt

The salt in the mixture is ordinary salt (NaCl) or mineral salts, depending on their availability and price. Even though the salt is not toxic it is better to prevent lumps in the mixture.

Cement or quicklime

Cement or quicklime serve as binding or gelling agents. Cement for this mixture is ordinary cement, used in normal construction activities and available on the local market. To obtain a good setting, cement needs a minimum quantity of water. The water present in the molasses does not blend satisfactorily with the cement. Therefore, prior to the introduction of the mixture, in order to improve the setting of the blocks, the cement should be mixed with water at the rate of 3-4 litres of water for each 10 kg of cement (30 to 40 % water on a weight for weight basis). Furthermore it has become evident that salt is an agent which can improve the setting of the cement and thus it can be mixed with the water and cement. The quality of cement is very important. One should never use cement which has hardened while in stock.

Quicklime gives better results, in relation to setting time (hardens quicker) and hardness of the blocks, but it's price and availability may restrict its use in certain countries. Before using it in the mixture it should be finely ground. In order to be sure that the quicklime is still in it's active form, place some lime in a tin (just enough to cover the bottom) and pour the same quantity of water on to it. If the lime is still active heat will be generated (in regions where atmospheric humidity is high, it may be difficult to preserve quicklime).

Bran

In this formula the bran serves, apart from it's nutritive value, as an absorbent and to give structure to the blocks. All kinds of bran can be used. If there is no bran available, or if it can be used more economically elsewhere, it can be replaced by other fibre sources such as ground straw, bagasse or peanut hulls.

Other components

The basic formula contains only components which are essential for the objective of the blocks: improvement of the utilisation of roughages. If a nutritive deficiency is proven, which leads to economic loss, it is possible to include elements in the mixture to cure this deficiency (for instance minerals). Furthermore it is possible to incorporate in the blocks different products such as anthelmintics and other agents that enhance the rumen microbial ecosystem.

The formulae can be changed according to results and specific needs in a given situation. If, for example, the blocks are too hard a reduction in the amount of gelling agent and an appropriate increase of molasses can change the consistency of the block. The opposite is done if the blocks are not hard enough. The percentage of the absorbent (e.g. wheat, rice bran or bagasse) can also be changed.

It is essential to bear in mind that any changes in the formula can lead to modifications in the solidification process and the hardness of the blocks.

How to manufacture the blocks?

The manufacture of blocks must commence well in advance of their proposed use. If they are to be used as a supplement during the dry season, when the quality of forage is very low, their production should start before this period in order to have sufficient numbers of blocks available when required. But in view of the hygroscopic nature of the components, as well as of the blocks, it is better not to start production before the onset of the dry season.

Manufacturing can be divided into five stages:

1. Preparation of feed ingredients
2. Mixing
3. Moulding
4. Turning or cutting out (optional, based on the method adopted)
5. Drying

Urea-molasses blocks may be manufactured either on a small or on a larger scale depending on the number of uses and the expected length of the feeding period. Whatever scale of production is applicable the method of manufacture will be the same; the difference being the quantities of feed ingredients and the implements used in the manufacturing process.

Our experience shows that blocks weighing 5 kg are most appropriate for feeding dairy cattle under smallholder situations. Assuming a daily intake of around 700 g/cow, each block will last for 7 days. Therefore, blocks can be replaced once a week on a specific day, making it a regular activity for the farmer.

Preparation of feed ingredients

All components should be weighed out before mixing. A standard volume or weight can be adopted for each component which would correspond with the weight of the block desired. For example, if each block is to weigh 5 kg and at each mixing 50 blocks are to be produced (a total of 250 kg), then assuming that the feed ingredients available are molasses, urea, maize bran, soybean meal, salt, cement and mineral mixture, then the following formula can be used to prepare the components for mixing. Double the quantity if each ingredient will be required for 100 blocks.

Ingredient	Molasses	Urea	Bran	Soybean meal	Cement	Salt
Proportion (kg)	39	10	25	13	10	3
Requirement for 50 blocks (kg)	97.5	25	62.5	32.5	25	7.5
Requirement for 100 blocks (kg)	195	50	125	65	50	15

<u>Molasses</u>

For the molasses no preparation is necessary apart from measuring the quantity. Even if handling the molasses is a little difficult it should not be diluted with water. When ordering molasses from the sugar factory specify 'undiluted' molasses and check the BRIX value when the molasses is received. Molasses can be stored in the same tank as that used for transporting it. If the quantity of blocks manufactured is large enough, it might be preferable to have two tanks in order to avoid running out of stock.

<u>Urea</u>

As already mentioned, the introduction of lumps in the mixture must be avoided in order to eliminate intoxication. It may be necessary to crush the lumps, either by hand or by passing the urea through a hand mill and sieve.

Salt

As with the urea it is better to avoid lumps. The salt could be mixed with cement and then water added to improve the setting of the blocks.

Cement or quicklime

Cement should be mixed with water and salt. The quantities are: 3-4 litres of water and 2.5 kg of salt per 10 kg of cement. If quicklime is used it should be finely ground and it's reaction to the addition of water tested.

Bran

Bran does not need any preparation. However, if the bran is replaced by another fibre source such as peanut hulls or straw, these materials should be ground before mixing. Experience show that sometimes course grinding of fibrous material gives a better consistency to the block than fine grinding, especially if polishings are being included.

Equipment for mixing

According to the rate of production foreseen and the level of investment different types of mixers can be used. If adequate labour is available and only few blocks (say 50-150) are needed then manual mixing is possible. With 3 labourers and one supervisor, approximately 150 blocks of 5 kg each could be made over a period of 8 hours (a working day).

However, for producing larger numbers of blocks (over 150 blocks/day) a concrete mixer is recommended. The cylinder of this concrete mixer should turn horizontally and as slowly as possible, to avoid the molasses, which is highly viscous, sticking to the side of the mixer. Spillage of the mixture should also be avoided.

For bigger units it is recommended that a horizontal paddle mixer is installed (the ribbon mixer used in feed manufacture is not suitable) with one or two axles and a discharge valve.

Introduction of the components

It has been found that the order of introduction of the components plays an important role in the mixing process. The recommended order is as follows:

- Molasses
- Urea
- Salt, minerals etc.
- Cement or quicklime
- Bran

Following this order a homogenous mixture of the urea, salt and gelling agent in the molasses is assured. Any other components (e.g., minerals, drugs) to be included are introduced together with the salt.

When using a concrete mixer the bran must be introduced in small quantities at a time, in order to ensure an homogenous mix.

After a few minutes, when the mixture appears homogenous, rather like peanut butter, the mixer is emptied (e.g. into wheelbarrows if large scale production is being undertaken) and the mixture transported to the moulding area. With both concrete and horizontal mixers it is not necessary to stop them during emptying. Continuous work is possible.

Moulding

Moulds are necessary to set the blocks in an acceptable shape. Once set the frame can be removed for re-use and to allow the drying process to continue. Moulds can be of different types. The size of the mould(s) will depend on the preferred size of the block(s). The one recommended by the FAO is made out of 4 wooden planks with slots sawn in order to be able to assemble the frame easily. The dimensions of the frame can vary depending on the expected rate of production and size of blocks. A frame of 200 x 250 x 20 cm can contain 1000 litres of the mix (1200 kg). If using this type of frame, after setting-in, the mixture has to be cut into manageable blocks.

The most appropriate for small scale manufacture of blocks are frames made out of a number of wooden planks with slots cut out to enable easy assembly and removal. Each compartment measures 25 x 15 x 10 cm and can hold a urea-molasses block weighing 4.5-5.0 kg. This type of mould is most suitable when drying and storage area is limited. Since the frames are removable they can be re-used as soon as the urea-molasses mixture has started setting-in.

Small plastic containers have been used successfully in Indonesia for preparing urea-molasses blocks. They produce blocks with acceptable solidity and are suitable for use in small units. An advantage of this type of mould is that the block can be offered to the animal while it is in the plastic container and once the block has been consumed the container can be re-used.

Turning out and cutting the blocks

Turning out and cutting is necessary when using large. The board can be taken away the day after moulding in order to facilitate drying. The cutting will take place later with a flat spade. The spade should be wetted in a bucket between each cut to avoid the mixture from sticking to it.

With small plastic moulds, the blocks can be offered to animals while in the mould or the blocks may be removed simply by turning the containers upside down and tapping on the bottom of the container.

Drying

After removal of the moulds and cutting up, blocks are arranged on a drying area. Blocks must not be exposed to direct sunlight, but placed under a shade with good ventilation. After 24 to 72 hours the blocks are dry enough to be transported.

Note: Different types of mixing and moulding equipment have been developed in different countries, which work equally well. Some of these are shown in the Slide Presentation.

How to utilize urea-molasses blocks?

Some important guidelines towards the optimum utilisation of urea-molasses multinutrient blocks as supplements for forage based diet are described below. Urea molasses blocks should not be fed alone but only as a supplement. They require a minimum amount of roughage to ensure that the animals are not over fed and thereby avoid urea poisoning.

Species of livestock

Because the blocks contain urea they must only be fed to ruminants (buffalo, cattle, goats and sheep) and **never** to monogastric species (chicken, donkeys, horses, pigs, rabbits) or to young, especially pre-ruminant calves, kid goats and lambs.

Feeding period

The aim of the block is to improve the utilisation of low quality roughages, especially during and at the end of the dry season, when livestock are often dependent on crop residues or low quality dry season grazing, which are both low in crude protein and high in fibre. Therefore, the production and distribution of blocks should be limited to these critical periods.

There is no advantage in offering blocks when green forage is available, as during the wet and early dry seasons. To avoid wasting resources they should not be made available at these times.

Minimum roughage requirements

Urea-molasses blocks are only supplements. Therefore, they should not be fed alone. A minimum quantity of roughage is needed to ensure that the animals do not consume too much urea, possibly leading to urea poisoning. One should remember that the purpose of the block is to improve the utilisation of roughage and not to substitute it.

Adaptation of animals

The full daily ration of the block (e.g. ± 700 g/day per adult cow) should not be offered as soon as the feeding period starts but should be built up to over a period of at least 7-10 days. This is particularly important when animals have suffered a degree of underfeeding as intake can be more rapid than usual. Animals not used to urea and also eating rapidly are the most likely to suffer from urea poisoning. After the adaptation period animals will adjust their intakes to around those recommended earlier (cattle, *ca* 700 g/day: small ruminants, *ca* 100 g/day).

An easy way to restrict intake during the adaptation period is to limit the amount of time the blocks are accessible to an animal. A rule of thumb would be to offer them for one hour per day (or about 200 g for cattle and 30 g for small ruminants) during the first 3-4 days, followed by three hours per day (or about 400 g for cattle and 60 g for small ruminants) during the next 4-6 days. Thereafter, blocks can be offered *ad libitum*.

Feeding system

The distribution of the blocks should be done according to the livestock management system. If animals are on pasture or rangeland during the day, blocks can be offered in the evening when they return to the homestead. When they are tethered, and feed brought to them, blocks can be offered continuously.

Establishing priorities

If a farmer has a limited number of blocks available, he must also establish an order of priority for feeding his animals. Priority should be given to gestating or lactating cows and draught animals.

Provision of additional supplements for production

As specified above, blocks are used for improving the digestion of low quality forages and thus fulfil the requirements for maintenance and low levels of production.

For high producing animals, it is necessary to provide other supplements such as:

a) good quality forages (young grass and especially legumes)
b) rumen non-degradable (`by-pass') nutrients (cottonseed cake, groundnut cake, fishmeal)

Providing blocks and supplement together will increase the benefits from each separately.

Some examples of successful supplementation using urea-molasses multinutrient blocks

A major aim of the Animal Production and Health sub-programme of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture has been to help smallholder livestock farmers make the best possible use of locally available feed resources so that they can raise crops and livestock more efficiently and profitably. The general approach has been to use laboratory-based studies involving relatively small numbers of animals to determine the nutritional value of these materials and then to see whether these can be improved by treatment or supplementation. The next step has been to test these diets by introducing them at the village level to determine whether they work and whether the farmers will accept them.

The Indonesian experience

An example of the above approach has been the IAEA project in Indonesia funded by the United Nations Development Programme (UNDP) and carried out by staff of the Centre for Application of Isotopes and Radiation of the National Atomic Energy Agency (BATAN), working together with the Directorate General of Livestock Services (DGLS) of the Ministry of Agriculture. The project grew out of an FAO/IAEA Coordinated Research Programme which commenced in 1978.

From the beginning, the work concentrated on native grasses and rice straws because they are by far the major sources of roughages available to the farmers to feed their cattle and buffaloes. Although they are available in large quantities, they are low in nutritive value as they contain large amounts of lignocellulose and small amounts of crude protein and minerals. Although treatment with a chemical was possible to improve the feeding value, this approach was not popular with the farmers because of the cost and extra work involved. Therefore, the approach taken was to supplement the grass and rice straw with other more readily available materials to provide the energy and protein which were lacking in the basal diet. In order to find suitable supplements with characteristics that optimized rumen fermentation and provided rumen non-degradable nutrients, the scientists at BATAN used materials labelled with radioisotopes such as ^{14}C, ^{32}P and ^{15}N, to measure the efficiency of the rumen fermentation process, in animals fed some of the most commonly available by-products in the country, and determine how much of the protein could avoid rumen degradation and reach the intestines. This information in combination with data obtained using non-nuclear methods allowed combinations of supplements to be formulated from materials easily available to the farmers.

After further studies on formulation procedures these supplements were made into a urea-molasses multinutrient block (UMMB) which could be licked by the animal. They were then distributed to selected villages to be tested for their effectiveness on intake and productivity of cattle as well as acceptance by the farmers. Results were extremely encouraging. For example, instead of animals losing or only just maintaining weight, they were able to gain body weight at the rate of 300-500 g per week when given access to a block consisting of molasses, urea and local sources of nutrients (e.g. cassava waste, rice bran, soybean curd waste etc.). The efficiency of feed conversion into meat was increased enormously. Similarly, feeding the multinutrient block increased milk yields of dairy cattle and buffaloes by 2-3 litres per animal per day. The primary responsibility for transferring the block technology was passed on to the Ministry of Agriculture and is now being used in many parts of the country.

The use of UMMB has spread rapidly from the initial demonstration sites and many small village dairy cooperatives now make the UMMB themselves, thereby also providing employment to several members of their communities. This is a clear example where basic research and in-depth studies using nuclear and related techniques in laboratories has led to the development of practical concepts and field level strategies to obtain a significant economic impact. It considered basic research and interpreted the results into possible benefits to the farmers. The technology was demonstrated to farmers under their own conditions.

Results of on-farm studies in Indonesia show that, in general, growth rates in cattle, goats and sheep were increased when blocks were offered as supplements to stall-fed animals. Improvements were also noted in milk yield, milk fat and reproductive performance in cows receiving UMMB, compared to their unsupplemented contemporaries. Breeding ewes and lambs also showed improvements in reproductive performance and growth rate.

Results of some of the studies undertaken in Indonesia are summarized below.

Dairy cattle in West Java (pre vs post supplementation responses to UMMB)

- overall increase of 14 % in milk production per lactation
- increases in fat and SNF in milk by 11 % and 3 % respectively
- reduced age at first oestrous (13 vs 15 months)
- reduced age at first insemination (15 vs 17 months)
- reduced age at first calving (27 vs 29 months)
- reduced services per conception (2 vs 2.48)
- reduced interval from calving to re-establishment of oestrous (108 vs 124 days))
- reduced calving intervals (13.3 vs 15.7 months)
- increased annual conception rate (90.2 vs 76.4 %)

Ettawa goats in Central Java

- enhanced litter size in supplemented goats (1.74 vs 1.28)
- enhanced kid birth weights and survival
- improved survival rate of male offspring (60 vs 47 %)
- increased incomes of farmers due to better benefit:cost ratios

Benefit:cost ratio

- growth in beef cattle - 2:1
- milk production in dairy cattle - 4.3:1
- reproduction and survival of kids in goats - 3.6-7.2:1

The examples quoted above (a small number of the many available) demonstrate that UMMB's are a source of supplementary feed that should be considered with other resources available. Managerial arguments for both feeding and not feeding blocks can be advanced: the resolution of these is for the farmer and his extension worker. Whatever physical form the supplement takes, the concepts based on the two compartment model discussed earlier, on which the overall formulation of the supplement is derived, must be considered and incorporated.

The sequence of developments described above is a model that could be usefully applied elsewhere. It involved initial emphasis on basic nutritional concepts of UMMB technology leading to the development and formulation of a satisfactory block, studies on milk production and growth responses to UMMB, and subsequent studies on the reproductive performance in sheep, goats and cattle. Finally, a successful technology transfer package, in conjunction with extension staff, with good rates of adoption and demonstrations of positive economic benefits has ensured a successful outcome to this research project

Experiences from other Asian countries

A regional Technical Co-operation (TC) project (RAS/5/035) was implemented under the framework of the Regional Co-operative Agreement (RCA) for the Asia/Pacific Region during 1999 and 2000. One of the objectives of this project was strengthening and extending the field applications of feed supplementation strategies (mainly UMMB) for ruminant livestock. The meeting was hosted by the Philippine Nuclear Research Institute (PNRI) and the National Dairy Authority (NDA), and was held from 5 - 9 February 2001 at the PNRI in Quezon City, Metro Manila, the Philippines. It was attended by all 21 nominated PCs from 10 RCA Member States (MSs) (P.R. China, India, Indonesia, Malaysia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam). All participating MSs have developed UMMB based on locally available feed resources, completed on-station and on-farm studies, and demonstrated the cost effectiveness of the blocks. This technology has been found to increase animal performance leading to higher income of farmers. Dissemination of the UMB technology through demonstration, training, open days, farmers days and using mass media has lead to adoption of the technology by a large number of farmers (Table 1). In the Phase II of this project (2001-2002) work on the block technology will be extended to use the blocks as a carrier for anthelmintic agents and feed additives. The emphasis is on the use of herbal medicines and natural plant products.

Experiences of some African countries

In Sudan, the Animal Production Research Centre of the Ministry of Agriculture, Natural and Animal Resources, has a beef fattening scheme where bull calves are bought from the local market between the ages of 1-4 years. They are then fattened for a period varying from 3 to 12 months on a 80 % concentrate diet made up of molasses, wheat bran, cottonseed cake, urea, salt and other locally available agro-industrial by-products. The remaining 20 % of the diet is composed of crop residues such as sorghum stover, groundnut hulls and native pastures. The fattening scheme has been shown to be a viable and a profitable enterprise and could benefit many smallholder farmers in and around the city of Khartoum.

Other work from Sudan has also demonstrated how the composition of a UMMB can be altered to include components with nutrients which vary widely in their characteristics (e.g. molasses versus sorghum grain; urea versus oilseed cakes). Replacement of part of the urea with oilseed cake increased live-weight gain in lambs, as the total or partial replacement of urea by fishmeal has been found to do. In this trial molasses supported the same level of gain as sorghum.

In another trial, dairy cows were fed either sorghum by-products from the wet milling industry, used as the basis of a block containing 15.9 % crude protein, or a conventional concentrate (13.1 % crude protein). Sorghum or maize fodder offered *ad libitum* completed the diet. Dry matter intake and milk yield were not affected by diet, although milk fat was greater and milk protein less with the blocks. Live-weight gain was lower in cows receiving blocks.

The use of blocks for emergency feeding is a possibility. Depending on the availability of roughage it would probably be prudent to limit access to the blocks. In such cases intakes around, or slightly above maintenance, have been recorded.

A number of preliminary studies, in the peri-urban areas of Morogoro, Tanzania (a city located about 200 km west of Dar-es-Salaam), have clearly demonstrated the benefit of using urea-molasses multinutrient blocks as a supplement to 'cut and carry' forages offered to dairy animals in smallholder farming enterprises. However, the technology has not been well tested on a large scale, although it is reported that many farmers use a locally available UMMB as a feed supplement during periods of fodder shortage. Sugar cane molasses and various crop residues and agro-industrial by-products are easily available for making such multinutrient blocks in Tanzania.

In Morocco, at the Department of Animal Physiology, Institut Agronomique et Vétérinaire Hassan II, Rabat, the silage made out of fish waste, molasses and other locally available feed ingredients, has been found to be an effective supplementary source of energy, protein and minerals to low quality forage based diets offered to cattle, sheep, goats and camels. The strategic supplementation of native pastures and other low quality forages with fish-molasses silage mixture or blocks has enhanced both production and reproductive performance of high yielding breeds of dairy cattle and their crosses, maintained under harsh environmental and nutritional conditions.

The main animal feed base of Mauritius is made up of by-products of the sugar cane industry. Therefore, it is a common practice amongst dairy farmers in Mauritius to feed fresh green sugar cane tops to their cattle during the main cropping season, June to November. During the rest of the year, farmers feed their cattle with mixed grasses from road sides and by-products of the sugar industry such as bagasse and molasses. Therefore, past and present research efforts in the country have centered around maximizing the use of local feed resources, especially of sugar cane by-products, by conservation (sugar cane tops/urea silage) and production of effective supplements (urea-molasses-multinutrient blocks) for dry season feeding.

As in many other tropical environments with marked wet and dry seasons, the primary factor contributing to the generally poor nutritional status of dairy cattle in Zambia is the low nutritive value of mature and senesced pastures and cereal crop residues available as forages. The animal nutrition research group of the Livestock and Pest Research Centre, Chilanga, has been actively involved in the past in the development and field testing of UMMB for smallholder dairy production systems in the peri-urban areas of Lusaka. Given the difficulties of distributing liquid molasses the supply of UMMB appears to be the most promising technology for providing supplementary nutrients to dairy cattle during the dry season. Agro-industrial by-products such as cotton, soybean and sunflower seed meals, maize bran, brewers and distillers grain are readily available during the dry season.

In the Ethiopian highlands, milk production is a vital income generating activity of many smallholder farmers. The available basal diet consists of poor quality native pastures, crop residues and agro-industrial by-products. Since these are highly fibrous in nature and low in nutritive value they have to be supplemented with protein, energy and mineral nutrients, if the crossbred cows kept by the smallholder farmers are to provide a substantial income to the household. The urea-molasses-mineral block developed at the Institute of Agriculture Research in Holetta is a simple and an inexpensive way of supplementing dairy animals fed on poor quality native pastures. Preliminary trials have indicated that supplementation with UMMB can increase milk production by reducing the rate of decline in milk yield in crossbred cows, thereby extending the lactation period to its optimum. The high cost of feeding concentrates to milk producing animals could be offset by using urea-molasses blocks and strategic supplementation using other locally available feed resources.

The Final Review Meeting on a TC project entitled “Development and Field Evaluation of Animal Feed Supplementation Packages” under IAEA/AFRA Regional Project RAF/5/041 (AFRA II-17) held at Egyptian Atomic Energy Authority (EAEA) and was held in the premises of the EAEA in Cairo from 25-29 November 2000 reviewed the work conducted by MSs on UMMB. All MSs that participated at this Final Review meeting have developed feed supplementation packages based on locally available feed resources and have completed on-station and on-farm studies (Cameroon, Egypt, Madagascar, Mauritius, Nigeria, Sudan, Tanzania, Tunisia, Zambia). Most MS have established cost: benefit ratios for feeding supplementation packages (Table 2).

In addition to above Asian and African countries, a number of countries in Latin America (Venezuela, Chile, Mexico, Cuba) have been actively involved in the development and, or, utilization of the urea-molasses multinutrient block technology, as appropriate for individual country situations.

Supplementation strategies for incorporating urea-molasses multinutrient blocks

Every productive livestock enterprise will have groups or classes of stock that will benefit from dry season supplementation. These include:

- Lactating stock
- Young growing animals
- Pregnant females who have just weaned young or been dried off
- Draught animals towards the onset of the rains

Where there is a defined wet season followed by a long dry season cattle follow a pattern of live-weight gain followed by loss, accelerating as the dry season progresses and then rapid gain (compensatory growth) as the rains recommence. With cattle kept in extensive conditions at low or medium levels of production this is acceptable. However, with the need to intensify, especially with small numbers of animals, the consequences of not supplementing must be reconsidered. Live-weight loss can be avoided by feeding small supplements of a protein mix. The source of nitrogen and the interval between feeds can be varied. However, where non-protein nitrogen is used response is less than with true protein, particularly where the feeding interval is more than 24 hours. But the major response is between no supplement and supplement regardless of the source of nitrogen.

The economic value of a supplement must be considered when supplementary feeding is to be practised. Two dry seasons without a supplement can reduce carcass weight by 10 kg. A breeding heifer has to reach approximately 66 % of mature weight before she will conceive. With a fixed breeding season failure to reach the correct weight can increase the age at first calving by 12-15 months. With a pregnant cow, poor body condition through lactation coupled with inadequate feeding will result in low milk yield and a long anoestrous period after calving.

In the smallholder production system a major constraint to milk production is the seasonality forced on the cow by inadequate feeding during the dry season. Maintaining the production of milk during this time increases family nutritional status and income. Improved nutrition should also reduce calving interval and calf mortality. Over a five-year period, a cow with a 24-month calving interval, where calf mortality is 20 %, will wean two calves. However, if the same cow has a calving interval of 15 months, and calf mortality is reduced to 10 %, she will wean 3.6 calves.

How much supplement should be given and over how long a period is a question that is often asked by farmers. Animals coming up for breeding or slaughter should not be allowed to lose weight. This suggests that supplementation should start at the appropriate time according to production purpose and criteria and should be carried out strategically, especially when economic considerations dictate management strategies. The farmer has to judge the condition of his stock, what his grazing and other feed reserves are and the cost of feed ingredients used for supplementation, before deciding upon how much, and when, to feed a supplement. Economic dry season feeding cannot be done from a blueprint; it is the application of research coupled with the farmer and extension worker's expertise and knowledge of the local environment. Anything else will involve the use of expensive safety margins (especially in good years) or conversely under feeding in bad years.

Table 1
RAS/5/035 – Review of Achievements – Component 1: Nutritional Supplementation

	CPR	INS	**IND**	**MAL**	**MYA**	**PAK**	**PHI**	**SRL**	**THA**	**VIE**
Type of supplement	UMMB	UMMB	UMMB	UMMB, UMMB powder	UMMB, UMMB powder	UMMB	UMMB	UMMB	UMMB	UMMB
Units of supplements made (kg): 1999 2000	15,000 15,000	33,515 33,520	4,450 19,000	30,000 50,000	43,125 55,274	24,000 2,000	1,500 15,000	20,635 51,915	82,000 80,000	20,000 20,000
No. of farmers currently using supplement(s)	900	637	200 - 300	75	715	400	40	765	300	150
No. of locations in the country	9	13	2	5	7 states 10 locations	2	4 zones 12 locations	4	6	6
No. of animals currently fed the supplement: ➢ Cattle/buffaloes ➢ Goats/sheep ➢ Other	 2,500 120 (Yak)	 1,506 - -	 100/300 - -	 1,200/120 4,500/100 -	 1,507 - -	 500/700 30/50 -	 100/300 - -	 2500 - -	 2,936 - -	 600 - -
No. of training activities conducted: ➢ Farmers ➢ Extension workers	1999/2000 210/135 6/67	1999/2000 166 12	1999/2000 4/41 0/45	1999/2000 5/3 2/2	1999/2000 6/10 5/4	1999/2000 - -	1999/2000 4/41 2/45	1999/2000 15/7 29/10	1999/2000 13/11 10/0	1999/2000 23/20 8/3
No. of man days of training provided: ➢ Farmers ➢ Extension workers	1999/2000 420/135 6/131	1999/2000	1999/2000 40/205 0/77	1999/2000 200/150 35/35	1999/2000 448/600 312/270	1999/2000 806/82 72/33	1999/2000 90/205 90/77	1999/2000 154/38 295/100	1999/2000 325/254 89/0	99/00 250/691 428/92
Cost of supplement fed/day	Yuan 6	Rupiah 2,850	Rupees 2.19-2.80	Renminbi 50	Kyat 17.1	Rupees 13.6	Peso 2.19-2.80	Rupees 7	Bhat 2.5	VN Dong 1,600
Selling price of: ➢ Milk /L ➢ Live Weight /kg ➢ Meat /kg	Y 2.4 6 10	Rp 900-1400 12.50 35,000	Rs 12	Rmb 1.60 4 14-18	Ky 105 220 375	Rs 16	P 2	Rs 10 45 180	B 10.75	VND 3,500
Cost:benefit ratio: ➢ Milk ➢ Meat	 1:4.8 1:4 Cattle; 1:2.9 Yak	 1:4 1:3.7-3.98	 1:1.4 - 4	 1:2 1:1.6	 1:2	 1:4	 1:1.4 - 4	 1:4		 1:2.2

Table 2
AFRA II-17 (RAF/5/041) - Review of Achievements - Development and Testing of Feed Supplementation packages

	CAM	EGY	MAG	MAR	NIR	SUD	TUN	URT	ZAM
Type of supplement	Legume leaves +	Poultry litter	UMMB and other[1]	UMMB	Fodder Legume ++	Poultry manure /molasses mix, Molasses	Mineral block +++	UMMB, FC ++++	UMMB
Units of supplements made	-	8 tons	UMMB 4.5 tons	10000 kg	-	60 tons PM/UMMB/ molasses	5000 kg	5000 kg	2700 kg
No. of farmers currently using supplement(s)	NA	30	270	100	30	75	23	56	7
No. of locations in the country	3	5	2	4	1 zone	2	10	2	2
No. of animals currently fed the supplement ■ Cattle/buffaloes ■ Goats/sheep ■ Other	- 70 -	100 100 -	For cattle 36 (UMMB) 350 (other)	100 100 1000 deer	180 - -	500 - -	190 - -	64 - -	210 - -
No. of training activities conducted ■ Farmers ■ Extension workers	- -	5 2	18 12	6 2	10 -	10 5	5 2	1 1	- 1
No. of man days of training provided									

■ Farmers ■ extension workers	- -	120 20	180 60	180 24	50 -	17 10	150 6	364 12	5 112
Production responses (average increase) ■ milk (L/animal/day) ■ growth (g/animal/day) ■ Other	- 20	Substitute	4 (2-8) 200	1 -	1.4 400	2-3 -	1 milk (20%increaseinfat) - *	1.5 -	1.6 -
Cost of supplement fed/day		?	MGF 600	MRs.2.50	?	LS 150	TD 0.03	TS 182	ZK 570
Selling price of -2 milk (/L) -3 meat (/kg)	CFA 400(US$ 0.527) CFA 1500(US$ 1.977)	LE 1.5(US$0.4) LE 15-20 (US$ 4-5.33)	MGF 3000 (US$ 0.45) MGF 12000 (US$ 1.81)	Rs 9.00 (US$0.32) Rs 80-120 (US$ 2.92-US$4.39)	N 10 (US$ 0.09) N 120 (US$ 1.12)	LS 1000(US$ 3.88) LS 5000 (US$ 19.44)	TD 0.65 (US$ 0.431) TD 8 (US$ 5.57)	TS 275(US$ 0.34) TS 1000 (US$ 1.259)	ZK 800 (US$ 0.22) ZK 2000 (US$ 0.563)
Cost:benefit ratio ■ milk ■ meat ■ reduction in cost of feed	45% increase in income	- - 10%	1:4-5 - -	1:1.5 - -	1:2 - -	1:4 - 50%	10 % increase in income	1:2 - -	NA

[1] fodder radish, concentrate and ground nut cake; * 38 days reduction in calving interval;

\+ leucaena, calliandra, sesbania, cotton seed cake; ++ Lablab; +++ Di calcium phosphate; ++++ Farm made concentrate

<u>Exchange rate for 1 US$ according to the UN exchange rate in different currencies – 1 December 2000</u>

Cameron = CFA 758.352
Egypt = LE 3.75
Madagascar = MGF = 6607.64
Mauritius = MUR 27.318

Nigeria = NGN 106.5
Sudan = SDD 257.2
Tunisia = TND 1.436
United Republic of Tanzania = TZS 794
Zambia = ZMK 3550

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