THE MANAGEMENT AND USE OF FORAGE BANKS

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APPENDIX: CARDI Publications on Animal Production and Forages
FOREWORD

In recent years, many farmers throughout the Caribbean area have established forage banks, and interest in the technique continues to grow. Forage banks can, and do make a substantial contribution to the feeding of livestock in the region, but it must be remembered that results will be disappointing if the bank is too small for the demands placed upon it, and if the management is inadequate.

Banks should be seen as one part of a complete strategy to ensure that grazing animals are properly fed throughout the year. If this is done, the levels of productivity and profitability of livestock farming will both increase and the regional dependence on imported animal products will be reduced.

In the preparation of this bulletin, the authors have drawn freely upon results generated by a programme of pasture research and development initiated by Dr. John Keoghan in 1974 under the auspices of the University of the West Indies. In 1979, the programme and its staff passed to CARDI, but the work continued without a halt. Significant contributions were made in Barbados by Mr. Robert Quintyne, Ministry of Agriculture, Food and Fisheries, whose pasture research work complemented that of Dr. Keoghan and who actively supported CARDI’s pasture development. This work has formed the basis for all of the present pasture recommendations for the drier areas of the Eastern Caribbean.

Thanks are due to a series of aid donors. IDRC, CIDA and CUSO provided financial and technical support for much of the early work, while the European Development Fund (EDF) has, in recent years, funded a large part of the CARDI pasture work in the region, an initiative which includes the publication of this bulletin.

The Authors
1. INTRODUCTION

A Forage Bank is an area of pasture of forage which is not utilized during the wet season when there is plenty of animal feed available, but is saved for use during times of scarcity. It is a reserve of forage which is left in the field until it is required by the animals. It therefore represents a form of deferred grazing, since the animals are not allowed access to it until they actually need it, usually during the dry season. If the bank is large enough, the whole herd or flock can take advantage of it during the worst part of the year. If it is too small to benefit all the animals it should be given only to the most valuable, or most productive ones. In any case, it must be protected from grazing for a large part of the year, while not in use, so that it can accumulate material which will be utilized later. To be effective, a fodder bank must be securely fenced to keep out all grazing animals during the growth phase.

Banks can be classified as either protein, energy or a combination of the two, protein-energy, depending upon the pasture species used, and their purpose on the farm. These three types of reserves, and their management, are described below.

2. PROTEIN BANKS

Although the productivity of high-yielding dairy cows can be limited by a lack of energy in the diet, growing animals are more frequently affected by a shortage of protein. During the dry season, when the pastures stop growing and become coarse and lignified, the crude protein (CP) content of almost all pasture grasses will fall to about 5 percent or less. A mature, dry, non-pregnant cow requires about 7 percent CP in her diet, just to maintain her body weight. If she only has access to grass at this time of the year, she will lose weight, and it is most unlikely that she will conceive again until the pastures improve at the start of the wet season. Cows in production, (in milk, or with calf) and growing animals require even higher levels of protein in their diets. Fortunately, forage legumes are able to provide these higher levels, since even at the worst times of the year and under the poorest management, the leaf material of the recommended legume species contains at least 14 percent CP, and in the case of Leucaena (Leucaena leucocephala), it is usually above 20 percent. With such high levels of CP, legumes can be used to complement poorer quality grasses, the mixture of grass plus legume providing a diet which is adequate for growth and production of all classes of grazing livestock.

Any recommended, perennial legume is suitable for use as a protein bank, provided that it is productive and does not shed its leaves during the dry season. Obviously, a stand with a long useful life will be cheaper to maintain than one which dies out after a few years. Tree or shrub legumes, such as Leucaena or Quickstick (Gliricidia sepium) are often used for this purpose, since they are less susceptible to weed invasion than the herbaceous scrambling species. Provided that good establishment is achieved however, there is no reason why
normal pasture legumes such as Glycine (*Neonotonia wightii*), Siratro (*Macropilium atropurpureum*) or Kudzu (*Pueraria phaseoloides*) should not be used. Rabbit Vine (*Teranmus labialis*) is not usually recommended since it is less productive than the other species mentioned, but it could be included in a mixture with Glycine and Siratro because of its tolerance of heavy grazing pressure.

### 2.1 Establishment

A protein bank should be as close as possible to a pure legume stand, without either grass or broad-leaf weeds, so it is important that a good, weed-free seed-bed should be prepared in the establishment phase. Depending upon the previous use of the area, this can be achieved by either mechanical, chemical, or a combination of these methods. Most pre-emergence herbicides are unsuitable for use with legumes, but paraquat (*Gramoxone*) will kill most annual weeds while glyphosate (*Round-up*) will eliminate many troublesome perennial grasses that are difficult to kill by conventional land preparation. Fluazifop-butyl (*Fusilade*) has been used with success in Antigua to control emerging grasses once the legumes seedlings are growing strongly.

Herbaceous legumes (Glycine, Siratro etc) must be sown from seed. In order to get rapid ground cover to help to combat weeds, they should be shallowly sown at rates of about 6–8 kg per ha (5–7 lb per ac) in rows 50–60 cm (20–24 in) apart. On poorer soils, application of phosphorus and potassium, or farm-yard manure will increase legume growth rates. If broad-leaved weeds become a problem, slashing, either with a brush-cutter or with a cutlass, to top the weeds without cutting the legume, will usually be sufficient to allow the legumes to smother the weeds. In the first few weeks, most legumes are slow growing compared with grasses and weeds. During this period, while they are putting all of their forces into building strong root systems, they need some protection from competition. The growth rate of the above-ground parts increases some 4 to 6 weeks after emergence and the legumes are then able to compete with the weeds.

Leucaena can be sown either as seed or as seedlings, while Quickstick is usually planted as stakes. Unless it is very fresh, the Leucaena seed should be scarified before sowing, by placing it in water at 80°C, (the temperature of a cup of coffee) for 3 minutes. After drying the seed in the shade, sowing can take place immediately. Dense sowing will help to prevent the trees from forming heavy woody trunks, but if it is intended to graze the area, it may be hard for the animals to force their way between close-set trees. A compromise is to sow the seed in continuous double rows about 50 cm (20 in) apart, leaving at least 1.2 m (4 ft) between each pair of rows. This will require about 8 kg per ha (7 lb per ac) of seed.

Leucaena seedlings or Quickstick stakes should be planted on a grid pattern at about 90 cm (3 ft) spacing for cutting, or at spacings of 50 cm (20 in) within rows and 1.2 m (4 ft) between rows if it is intended to graze the area.
2.2 General Management

The protein bank is intended to reduce or replace the use of expensive concentrate or supplementary feeding, and from that point of view, it should be treated as a high value crop. While a Leucaena bank in the drier countries of the region can potentially produce annual yields of up to about 18 t per ha of dry matter, occasional insect attacks can reduce the harvested yield to about half this figure. Where necessary, insect attacks should be controlled. Biological control methods are preferred because of their lower costs, but insecticides should be used where biological methods are unavailable.

Similarly, particularly where the forage is cut and removed, rather than being directly grazed, it will be necessary to pay attention to the nutritive needs of the plant, by giving occasional dressings of fertilizer or farm-yard manure. In general, phosphorus and potassium are the most important nutrients for legumes.

If the bank is carefully managed, weeds should not be a major problem, because the legume cover, present for most of the year, will tend to prevent the development of troublesome species. Occasional cutting of bushes with a cutlass should be the only routine weed control in this situation. If the bank is overutilized, weeds may break through at the start of the wet season. Grasses can be controlled with herbicides, while a slashing will top broad-leaf weeds.

Individual plants of tree species will live for many years if well managed, and it is not necessary to think about allowing the plants to set seed. The trailing species do not live so long and it is advisable to allow a part of the area to set seed each year. Flowering of many species takes place in March or April in the Caribbean region. If the bank is divided into four for general management purposes, one quarter should be allowed to set some seed each year, in order to guarantee a supply of seed in the soil. This will allow the bank to maintain itself for many years without reseeding.

2.3 Cutting

The cutting management will depend on the species which are sown. Herbaceous species should not be cut too low, since this will slow the recovery after cutting and may open the stand to weed invasion. A height of about 20 cm (8 in) above the ground is suitable for most species. Whether the area is cut with a forage harvester to feed large numbers of animals, or with a cutlass to feed a few, cutting too close to the ground will remove the new buds and kill the plants. Leucaena is an exception to this rule, since it will regrow from buds situated below ground level, even when cut very close to the soil surface. With this species, the animals will eat not only the leaves, but also the flexible stems, up to about the thickness of a pencil.

Usually the cut material from a protein bank is fed fresh to animals on a
daily basis, to make up about a quarter of their daily intake. This needs continuous labour. An alternative is to harvest the legumes about 4 times per year and to dry the material in the sun. When dry it can be bagged for storage and then fed, at a later date. The leaves will fall from the stems and the woody material can be discarded. The dry leaf will contain at least 20 percent CP. About 3 kg of this material would provide all of the daily protein requirement for a typical cow, weighing 450kg (1000 lb), even if she obtained none at all from other sources. In this way, the labour requirement is concentrated into a few short periods of the year and the job can be done when other work on the farm is not pressing.

Cows grazing a Leucaena protein bank.

2.4 Grazing

While cutting makes better use of the available material, preventing trampling and wastage, direct grazing of the protein bank is cheaper, since it requires little labour or machinery. Cattle do not need to be driven into and out of the bank every day, because, if permitted a choice, they tend to limit their intake of legume forage to the amount that they can efficiently utilize. If the gate is left open, they will graze or browse in the bank for an hour or two each day, returning to the lower-quality grass pasture for the rest of the day. Small livestock (sheep and goats) are not so accommodating and will probably need to be removed from the bank by the farmer.

It is usually best to subdivide the bank into sections, to prevent it from all being grazed at the same time. If the length of the normal dry season is 4
months, it is usually enough to divide the bank into 3, one for each of the first 3 months of the dry season, the final month being covered by the regrowth which takes place after grazing. Temporary electric fencing can be used for the internal divisions if animals are trained to respect it.

Leucaena needs to be cut back, close to ground level at the start of the rains each year, to keep it within the reach of the animals. Even if the growth is 3m (10 ft) high at the start of the grazing period, cattle will walk over the plant, bending the stem with their chests, in order to reach the leaves. Goats tend to ring-bark the trees by chewing the bark if they are not able to reach the foliage, so it is probably best to feed them by cut-and-carry methods.

2.5 The Size of the Bank

It is not easy to give general guidelines on the size of a protein bank, because there are many variables to be considered. It should be remembered, however, that the idea of a protein bank is not to provide all of the feed required by an animal, but rather, to provide the protein fraction that is lacking from grass pastures during the worst part of the dry season. It should, therefore, only be used in conjunction with other, poorer quality pastures.

If the grass is a selected, improved species such as Pangola \((Digitaria decumbens)\) or Bermuda \((Cynodon dactylon)\) which is unlikely to fall below a CP content of about 5 percent, then an adequate diet for most ruminants would consist of three-quarters grass plus one quarter legume (as measured on a dry basis). On the other hand, Antigua Hay Grass \((Dichanthium aristatum)\) or Seymour (also known as Barbados Sour) grass \((Bothriochloa pertusa)\) can fall to CP contents as low as 3 percent, and in this state, should not make up more than two-thirds of the animals’ diet if they are expected to grow or to produce milk. Over a dry season of 120 days, a typical, 450 kg adult cow should consume a total of about 1400 kg (3100 lb) of dry matter, the legume component of which should be between 340 and 450 kg \((750 - 1000 \text{ lb})\). In the drier countries such as Antigua, where a pure legume stand can produce 6-10 t per ha \((2.5-4 \text{ t per ac})\) of dry matter, cutting of a protein bank would supplement from 13 to 28 cows per ha \((5 \text{ to } 11 \text{ cows per ac})\) for the whole of a 4 month dry season. Grazing would result in a loss of at least 20 percent of the forage, and so corresponding figures would be 10 to 22 cows per ha \((4 \text{ to } 9 \text{ cows per ac})\) of protein bank, or their equivalent in smaller stock. Clearly, these figures would have to be reduced for heavier animals.

In the wetter areas of the Caribbean, with a shorter dry season and higher legume yields, cutting would supplement 22 to 44 cows per ha \((9 \text{ to } 18 \text{ cows per ac})\) while grazing would reduce these figures to about 17 to 35 cows per ha \((7 \text{ to } 14 \text{ cows per ac})\) of bank.

If used in the recommended way, in conjunction with adequate areas of well managed grass pastures, about 10 percent of the property should be sown
to protein banks. This would provide sufficient high quality grazing to allow the whole herd to benefit. If less than this area were to be established, it could not supplement the whole herd without suffering from the effects of over-utilization. In this case, it should be reserved for the most productive animals on the farm — the milking cows on a dairy farm, or the young growing or fattening animals on a beef farm. If the bank is used in an attempt to supplement too many animals, each one will receive an adequate amount of protein and the bank will have little effect on farm profitability. Better overall results will be obtained by feeding the protein reserve to the most productive animals.

In general terms, it is best to feed legumes to livestock every day during the worst months of the dry season, but if this is impossible, even access to the better feed three times per week during this period results in noticeably higher levels of animal productivity.

2.6 The Siting of the Bank

Since a protein bank must be used in conjunction with other pastures, the ideal position on a large farm is in a corner where several paddocks meet, so that access can be provided from all of the adjacent fields. The bank should, of course, be large enough to complement all of these neighbouring areas, being about 10 percent of the total area. Alternatively, a smaller bank could be established in each field, but since it is more expensive to fence several small areas rather than one larger one, this would increase the costs. A bank is intended to be a permanent feature of the farm, and if it is planned to graze it, or to cut it by hand, it can be situated in an area where stones and rock outcrops make it difficult to work the land. This idea has been successfully used in Barbados.
On smaller farms which are subdivided into several small fields, the planting of tree legumes such as Leucaena or Quickstick along all fence lines will provide shade and shelter for the animals and act as wind-breaks. Once the trees are well grown, they can be used as fence posts, and lopping off the branches during the dry season will make the foliage available to the animals. The trees then become a protein bank, as well as fulfilling several other useful purposes. When planted in this way, from 20 to 30 trees will provide sufficient material to adequately supplement one adult cow during a dry season of 4 months duration.

3. ENERGY BANKS

An energy bank is a reserve of standing grass which is intended to provide sufficient nutrients to maintain the herd in times of severe stress. It is not, by itself, a ration which will give high animal productivity, but it can form part of such a diet if used in conjunction with a high-protein component, such as a
protein bank, protein concentrates or urea (a non-protein nitrogen source). Alone, it is intended only to overcome an absolute shortage of feed during the worst part of the year without paying close attention to feeding quality. Although any perennial grass could be considered as an energy bank if given the right management, it is usual to think in terms of very high yields of dry matter, such as can be obtained from sugarcane (*Saccharum officinarum*) or Elephant grass (*Pennisetum purpureum*). These grasses should not only be cut and carried to the animal, they should also be chopped into short lengths (2-3 cm, 1 in) to increase consumption and decrease wastage. They can be fed fresh or ensiled.

Three energy banks. (i) Top left Elephant grass. (ii) Top right Sordan. (iii) Bottom Sugarcane
As well as the common, giant Elephant grass, there is now available a
dwarf variety that grows to a maximum height of about 150cm (5 ft). It yields
the same amount of leaf as the giant types, but with less coarse stem material
and it therefore maintains a higher level of feeding quality. It is showing con-
siderable promise in several Caribbean countries, but appears to be best suited
to areas which receive at least 1400mm (55 in) of annual rainfall.

3.1 Establishment

The aim of all banks should be to maximise the return on capital. Energy
banks will only achieve this if they produce high yields from small areas. They
must therefore be treated as important crops on the farm, and this implies care-
ful attention to establishment, in order to minimise the weed population. Land
preparation should produce a good, weed-free seed-bed. Although pre-
emergent herbicides can be used to combat broad-leaf weeds, grass weeds are
more difficult to control after planting, and so should be controlled before
hand.

Sugarcane is planted from vegetative pieces commonly referred to as cane
plants. The planting material is taken from relatively mature plants and planted
in furrows about 25-30 cm (10-12 in) deep. Plants are spaced 30-45 cm
(12-18 in) within the row and the rows are usually 165 cm (5.5 ft) apart.
Approximately 10,000 plants are planted per ha (4000 per ac).

Cane plants or planting pieces must have at least two nodes (eyes) and be
about 20 cm (8 in) long. The length will vary somewhat depending on the
variety planted. The cane plants are laid flat in the furrow and then covered
with about 10 cm (4 in) of soil.

Sugarcane for an energy bank is best planted in late September. This
allows the plants to grow and established vigorously so that by the start of the
dry season in late January the plants have attained a height of 1 m (40 in). Fertilizer is best applied in late December or early January before the rains stop
falling. Local fertilizer recommendations can be obtained from the Ministry of
Agriculture or CARDI.

There are many herbicides available to control both broad-leaf and grass
weeds before the sugarcane leaf canopy is sufficiently well developed to sup-
press weed growth. Post planting pre-emergent herbicides such as Candex give
good weed control for both grass and broad-leaf weeds. Candex in combination
with Atril DS or 2, 4-D amine will also give good weed control after the suga-
cane has germinated.

The sugarcane energy bank will not grow very much after the start of the
dry season but as a drought tolerant forage there are very few, if any, grasses
than can out-perform this useful plant. The crop should be harvested in the last
third of the dry season when it should be fed as green-chop. The plants will
ratato and grow vigorously with the on-set of the rainy season and can be cut again in late September for silage production. The plants will ratato a second time and should be kept for feeding as an energy feed in the next dry season.

Elephant grass can be planted either as short or long setts. In both cases, the mother canes should be allowed to grow and mature before cutting. Short setts with three to five nodes (eyes) should be planted, base end down and inclined at an angle with two to three nodes below, and one or two nodes above the surface. Close spacing of 60 cm (2 ft) both within and between rows will reduce weed competition. Long setts (complete canes) should be laid horizontally in furrows and covered with 5-8 cm (2-3 in) of soil. Best establishment is obtained by laying a staggered, double row of canes in the furrow so that the gap between two canes in one row is near the centre of the cane in the adjacent row. The furrows should be 90 cm (3 ft) apart. Once the plants start to grow, fertilizer can be applied close to the setts, or furrows. In most instances, nitrogen is the most important element for application during the establishment phase.

3.2 General Management

Sugarcane should be left to grow until it is needed for feeding the animals, unless it is planned to make silage. Elephant grass can be managed the same way unless quality is of some concern. If a higher protein content is desired from the reserved forage bank then it should be cut back to a height of about 20 cm (8 in) three months before it is planned to use it. This will reduce the amount of feed available during the dry season, but will prevent the protein content from falling to low levels.

With both types of energy bank, the material should be cut and chopped whole, before feeding it to livestock. This should be a daily operation, since the cut material will ferment rapidly under tropical conditions, losing much of its nutritive value and becoming less palatable to livestock.

After cutting, particularly if there is moisture in the soil, some weeds may grow in the energy bank. They are unlikely to be a serious problem, since the bank itself will recover rapidly under these conditions. Potentially troublesome, broad-leaf, climbing or scrambling species can be controlled by an application of a contact herbicide such as paraquat (Gramoxone), or by 2, 4-D. Grass weeds can be controlled by harrowing between the rows, or by the directed application of herbicides such as Gramoxone, Round-up or Fusilade.

Energy banks should not be grazed, but the material should be cut and fed to the animals. Large yields of forage will remove large amounts of plant nutrients from the soil, so it is important to pay particular attention to feeding the grass in the bank to ensure continued productivity. Where possible, manure from the animal houses should be returned to the field on a regular basis. If this cannot be done, inorganic fertilizers must be used. The most important
nutrients are nitrogen, phosphorus and potassium, although requirements will vary depending on the soil type. It is best to seek local advice on a suitable fertilizer programme, either from the Ministry of Agriculture or CARDI.

3.3 Cutting

Sufficient material to feed the animals should be cut every day during the period of utilization of the energy bank. The material can be harvested either mechanically or by hand. If cut close to ground level, recovery, particularly of the Elephant grass, will be slower and this may allow the weeds to come through. If cut too high, it will tend to shoot again from buds on the existing stems, rather than from ground level. A reasonable compromise that will result in high yields and rapid recovery is to cut at 15-20 cm (6-8 in) height. The forage as harvested should be passed through a forage chopper to prevent animal selection and wastage of a high proportion of the available material. If the energy bank is used in conjunction with a protein bank, it is useful to pass both components through the chopper together to ensure good mixing of the complete ration. This will also improve the acceptability and utilization of the less attractive portions of the grass.

A Sorban energy bank being harvested for silage.

After cutting, a sugarcane bank should be left untouched to accumulate material for use in the following year. Any further cutting or grazing will seriously reduce the yield in the next year, and so should be avoided. An Elephant grass bank, on the other hand, can be cut several times a year, if necessary. As noted above, this will reduce the reserve of material available, but will increase the quality of the accumulated forage. The forage from cuts taken during the wet season can be ensiled if it is not required for feeding at the time of the harvest.
3.4 Grazing

It is not recommended to direct graze an energy bank, because much of the bulk of the available material, contained in the mature stems, will not be consumed by the animals unless it is chopped and mixed with the more attractive green leaf material.

3.5 The Size of the Bank

The appropriate size of an energy bank for a particular farm will depend on many factors. If the farm is not heavily stocked, the bank may be intended only to reduce the grazing pressure on the most delicate pastures during a normal dry season, and to act as a survival ration for the animals during a drought year. On a more heavily stocked farm, the bank may be intended to provide a near maintenance diet for the herd during the worst part of a normal dry season. In this case, animals will have to be sold off, or feed bought-in during a drought year. The availability of conserved fodder on the farm will reduce the demands on the energy bank, as will the existence of improved pastures that grow further into the dry season than the normal native species. Soil fertility and moisture (influenced by the fertilizer programme, the annual rainfall and the availability of irrigation facilities) will determine the yields of fodder produced, not only by the bank, but also by the other pastures on the farm.

Under dry conditions in countries such as Antigua, an Elephant grass bank could be expected to produce dry matter yields of about 20 t per ha (8 t per ac) on good soils. If utilized efficiently, this would fully support 13 typical 450 kg cows per ha (5 cows per ac) during a 120 day dry season, although animal productivity would be low (or they may even lose weight) during this period. Obviously, if the bank were to be used in conjunction with other pastures which could be relied upon to supply, for example, half of the daily requirement of the animals, the number of animals receiving supplementary feed from the bank could be doubled. If fed at very low levels in order to keep animals alive during six month drought, one hectare (2.5 ac) of bank could save the lives of 25 adult cows, or the equivalent in smaller stock (about 125 adult sheep or goats).

In more favoured climates, or where irrigation facilities are available for the energy bank, Elephant grass would produce about 30 t per ha (12 t per ac) of dry matter. With efficient utilization, this would fully support 30 cows per ha (12 cows per ac) during a 90 day dry season. A bank of one hectare could save 40 cows (16 cows per ac) during a drought of 6 months duration.

As with protein banks, the sowing of about 10 percent of the farm to energy banks would provide adequate protection for most conditions in the drier areas of the Caribbean. This proportion could be reduced to about 5 percent in the wetter areas, where the dry season is shorter and the risk of a
prolonged drought is considerably reduced. The potentially greater yield of sugarcane, particularly in the higher rainfall areas, could reduce the proportion still further, if its main purpose is to save animals during a severe drought.

3.6 The Siting of the Bank

Since it is recommended to cut, rather than to graze the energy bank, it would ideally be situated close to where the forage is to be chopped and where the animals are to be fed. Ease of access is of primary importance, whether it is intended to cut and carry by hand or by mechanical means. Since high yields of forage will increase the requirement for machinery or for labour, the soil should be deep, fertile and well drained. Unless it is planned to feed the animals in the paddock, there is no advantage to having several small energy banks rather than one large one, but as with all banks, the area must be securely fenced to prevent unplanned grazing.

An energy bank sited close to the dairy barn.

4. PROTEIN-ENERGY BANKS

A protein-energy bank is designed to produce a reserve of forage that is, by itself, a balanced ration for grazing livestock. It therefore is a mixture of both grass and legumes, with the grass producing the necessary energy and fibre, while the legume provides the protein required for growth and production. It may be intended as a reserve of quality forage for the whole herd or flock, in order to reduce the pressure on other pastures during the worst part of the year. Alternatively, it could be sown for a specific purpose, such as the finishing of groups of animals just prior to sale. It may be a conventional grass-legume pasture which is not grazed during the second part of the wet season, but rather, saved for use later on, or it may be sown specifically as a bank. Whatever the combination of species employed, the management must aim to favour the legume, since the loss of this component would seriously limit the
value of the area for further animal production, converting it into a poorly yielding energy bank, or a pure grass pasture.

A Leucaena/Guinea grass protein-energy bank

4.1 Establishment

The sowing of conventional grass-legume pastures has been described elsewhere and will not be repeated here. To defer the grazing of a normal associated pasture is a management decision which does not influence either the species to be sown or the method of establishment.

In a purpose-sown protein-energy bank, as with the other kinds of banks described above, the extra time and effort spent to ensure a good, weed-free seed-bed will be handsomely repaid by the greater productivity and longer useful life of the bank, both of which result in lower costs and higher profits. This is true whatever forage species are used to make up the bank.

In the interests of obtaining the greatest sustainable annual yields, most protein-energy banks make use of Elephant grass. This is a very aggressive species however, and particularly in drier areas, it will compete very strongly with scrambling legumes. Dwarf Elephant grass may be better than the common types, particularly in the wetter areas of the region. In order to assure a long useful life of the legume component, it is recommended that they be sown in strips. If sowing is to be by mechanical means, each strip could be the width of the seed drill (about 2 m, or 6.5 ft). The strips should be separated by two or three rows of grass, closely spaced at about 50cm (20 in) apart. Such
a sowing pattern will not yield as highly as an adequately fertilized pure Elephant grass energy bank, but the CP content of the forage will be much higher. Any scrambling legume can be used in this way. Recommended species include Siratro, Glycine and Rabbit vine for the drier calcareous soils and Kudzu for more acid conditions.

An alternative that can add flexibility to the farm plan is the use of Guinea grass (*Panicum maximum*) with scrambling legumes. This grass will support grazing better than the Elephant grass, and the association with legumes can either be used as a normal, high quality pasture, or saved as a bank to satisfy a particular purpose.

Perhaps the highest yielding protein-energy bank for Caribbean conditions is the combination of Elephant grass with a tree legume such as Leucaena in the drier, calcareous areas, or Quickstick in the wetter, more acid soils. Again, the Elephant grass can be sown in double, or triple, closely spaced (50 cm, 20 in) rows, alternating with single or double rows of the legume. Leucaena is relatively slow to establish, so it is sometimes advantageous to plant it first, either as seed or as seedlings. Plant the grass some weeks later, once the legume has begun to grow rapidly and has reached a height of about 1 m (40 in). In this way, it is easier to care for the seedlings in the early stages when they must be protected from weed competition. When the area is to be grazed, Guinea grass should be used instead of Elephant grass.

### 4.2 General Management

If the protein-energy bank contains an adequate amount of legume (at least 25 percent on a dry matter basis), it can be considered as a complete ration for all grazing animals except for cows producing over 9 kg. (20 lb) of milk per day. It is therefore a valuable resource which must be carefully managed. As with other banks, it must be well fenced to prevent any unplanned grazing.

If an insect attack threatens the productivity of the legume component, steps should be taken to control it, preferably by biological means. If all else fails, a small investment in insecticides can yield a large return in terms of feed quality.

Weeds will seldom be a problem unless the area is over-grazed. In this instance, weeds may break through before the legumes recover at the start of the subsequent wet season. Control of broad-leaf weeds can be achieved by topping, either with a cutlass or a brush-cutter, while if necessary, a herbicide such as Fusilade will control the annual grasses within the strips of scrambling legumes.

The legume component can be expected to supply the nitrogen require-
ments of the grass, but occasional applications of phosphorus and potassium will benefit the legumes on most soils, particularly if the forage is removed by cutting.

The most important aspect of the management of a protein-energy bank is to ensure that the utilization of the fodder produced is not severe enough to damage the legume component. Tree legumes are generally quite hardy once they are well established, but the scrambling legumes will be killed if they are cut or grazed too close to the ground. Defoliation should not be permitted to a level of less than about 20 cm (8 in) where herbaceous legumes are used. If the bank is to be grazed by cattle, Leucaena should be cut back close to ground level (less than 30 cm, 12 in) after dry season grazing has been completed (at the start of the rains), in order to keep it within the reach of the animals.

4.3 Cutting

It is preferable to cut and chop the forage produced from a protein-energy bank, since this will result in better utilization of the available material. Both grass and legume components should be handled together, so that they are well mixed before being fed to the animals. In this way, there will be very little wastage.

As noted above when discussing energy banks, the grass component can be cut during the wet season. It is advisable to leave the legume as untouched as possible, to allow it to accumulate material for use later in the year. The grass so removed can be ensiled if it is not immediately needed, and the quality of the bank will be increased by fresh grass growth, even though the final yield will be reduced. With careful planting on a measured strip pattern, the grass could be cut with a mechanical forage harvester.

4.4 Grazing

Although it is recommended that protein-energy banks should be cut and chopped in order to minimise wastage, they can be directly grazed, particularly where scrambling legumes have twined around the stems of the grass. In this situation, the animals will have difficulty in selecting the legume at the expense of the grass, and both will be consumed together, although some heavily lignified Elephant grass stems will still be rejected. The presence of high quantities of nitrogen in the legume will allow animals to digest mature grass stems that would otherwise contribute little to animal nutrition. Tree legumes are not as suitable for this purpose, since they do not mix as closely with the grass component, and are easier for the animals to select.

As with pure protein banks, the area should be subdivided to reduce the opportunity of the animals to select only the most desirable components of the forage. Temporary electric fences can be useful if the animals are trained to respect them, since they can be moved every few days to allow access to a new, fresh area of pasture.
Light grazing can sometimes be used to remove part of the bulk of the grass during the wet season, since at this time some scrambling legumes are less palatable to animals than fresh, green grass. The feasibility of this practice will depend upon the species of animal used, the species of pastures in the bank and the stage of pasture growth. Best results would be obtained with cattle offered relatively unpalatable legumes such as Kudzu, when the Elephant grass component is up to about 120 cm (4 ft) tall and actively growing. If the grazing pressure is too high, the animals will begin to eat the legume once the grass is grazed down below about 60 cm (2 ft). This situation should be avoided, since it will reduce the reserve of legume for later dry season use.

4.5 The Size of the Bank

Since the protein-energy bank is designed to provide a balanced, productive ration, it should be expected to fully support animals without any supplementation. In this respect, it differs considerably from a protein bank, which is only expected to provide the protein requirement. The productivity of the bank is lower than that of an energy bank, since the proportion of the high-yielding grass is reduced to ensure the survival of the legume. In the drier parts of the Caribbean, annual yields of dry matter would not be expected to exceed about 15 t per ha (6 t per ac) of good quality fodder. During a 4 month dry season, this could provide a complete ration for 10 typical, mature, 450 kg cows per ha (4 cows per ac) if cut and chopped, or about 8 cows per ha (3 cows per ac) under direct grazing. In the wetter areas, with yields of about 20 t per ha dry matter, corresponding figures would be 19 cows per ha (7 cows per ac) for a 90 day dry season under cutting, or 15 cows per ha (6 cows per ac) under grazing.

If the bank is expected to keep all of the animals on the property during the dry season it should cover up to 25 percent of the farm in the drier areas, falling to not less than 15 percent in more favoured environments. If it does not reach these dimensions, it cannot be expected to feed the whole herd. In this case, it should be saved for feeding to the most productive animals (milk- ing cows, fattening males and young calves).

4.6 The Siting of the Bank

Since the bank is not intended for use in conjunction with other pastures, it does not have to be sited close to them. As with the energy bank, if the plans are to cut it, it should be placed where good access can be attained and as close to the chopping and feeding areas as possible. Since high yields are necessary to maximise profitability, it should occupy an area of fertile, well-drained soil. It would be advantageous to place it where farm yard manure can be easily returned to the field. Fencing costs and machinery time will be reduced if the whole bank is concentrated in a single area.

If the bank is to be grazed, its location is not so closely restricted by ease
of access and proximity to centralised facilities, although the use of fertile, well-drained soil is still of great importance.

5. BANKS IN THE MANAGEMENT OF THE FARM

In almost all areas of the world where animals are grazed, pasture productivity varies widely during the course of the year, as a result of changes in climatic conditions from one season to the next. It is usually impossible to adjust stock numbers frequently enough on the individual farm to maintain an adequate stocking rate all through the year, so other steps must be taken to ensure that the animals are well-fed at all times.

Some attempt is usually made to reduce the number of animals to be carried through the period of poorest pasture production. Towards this end, it is customary in the tropics to sell at least some finished or cull animals towards the end of the wet season. Where a breeding season is imposed, it is usual to time it so as to wean the young while there is still plenty of fresh, green pasture available. These practices can help, but particularly in a small, restricted market situation, they make only a limited contribution to the feeding of the herd or flock during the dry season.

In some instances, extra feed, either as forage or as concentrates is bought-in to improve livestock nutrition during the the worst time of the year. In general, under tropical conditions, this is only an economically viable alternative for intensive dairy operations.

On intensively managed farms, high use of fertilizers (particularly nitrogen), on selected pure grass pastures during the second half of the wet season, will cause them to produce more feed for use during the first few weeks of the dry season. These areas are then heavily grazed, being used as sacrificial, or buffer pastures to protect the more delicate grass-legume associations from over-grazing. This technique can also help, but its effect is not great in areas which experience a long, hard dry season.

Mixed cropping and livestock enterprises are at an advantage, in that crop residues become available for animal feeding after the harvest of the crop, e.g. sugarcane tops but it is not common to find truly mixed farms in the Caribbean region.

In general terms, the most appropriate and economical techniques to ensure an adequate supply of feed to growing animals in the Caribbean are those which employ either forage conservation or standing reserves of forage (banks). Good quality fodder can be, and is conserved in some Caribbean countries, but it is not a simple matter. For hay to have the protein content necessary for it to be more than just a survival ration, it must be made from fresh, green forage, preferably with a legume component. It must therefore be cut and dried during the latter half of the wet season, at a time when rain can interfere with field activities. Silage is less susceptible to problems of rain, but
requires large amounts of machinery and labour both to fill the silos and to feed the conserved fodder during the dry season. These requirements add considerably to the cost of the feed. For many farmers in the region, and particularly for those with limited access to machinery and labour, forage banks represent the most attractive of the available alternatives. Banks should not be seen as the answer to all the feeding problems on the farm, but if used as part of a rational, dry season feeding strategy, they can make a significant contribution to animal nutrition.
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CARDI TECHNICAL BULLETINS


ACRES BECOME HECTARES

1 ACRE 1 ACRE 1/2 ACRE

1 HECTARE

100 m x 100 m = 10 000 m² = 1 hectare (ha)

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