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Fodder bank establishment and management for dry season maintenance of small scale livestock industry: A review

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Abstract

The objective of this study therefore, was to review fodder bank establishment and management for dry season supplementary feeding of livestock. Fodder banking involves fencing, planting, concentrating, storing and reserving of forage legumes in hays and silos to which concentrates, mineral and vitamin premixes are added. In addition, legume trees and shrubs such as Acacia spp, Leucaena leucocephala, Mangifera indica, Musa spp, Cajanus cajan, Tamarindus indica, Stylosanthes guianensis, Centrosema pubescens, Desmodium spp etc. are also good fodder crops which are commonly used. Fodder bank converts the above mentioned crops into supplementary or fall back forage kept in small to large plots for dry season use by aging, ailing, nursing, and lactating and high producing animals. The relatively deep roots of these woody perennials allow them to reach soil nutrients and moisture not available to grasses and herbaceous plants. This characteristic enables these plants to retain fresh foliage into the dry season. The ability of some legumes to fix atmospheric nitrogen makes them protein rich feeds. As with all tree planting activities, fodder bank establishment must be planned to coincide with the rainy season. This ensures high seed emergence, plant survival and establishment. Good site selection is paramount, accompanied with thorough land preparation for excellent establishment of fodder banks. These processes are accomplished by mechanical or chemical means. Methods practiced locally for other high value crops are also often used. The goal is a wider seed-bed, in which plant growth and survival will be maximized.

Keywords: Fodder bank, Management, Dry Season Feed, Livestock, Nigeria

Introduction

Livestock play an important role in most small scale farming systems throughout the world. They provide traction to plough fields, manure which maintains crop productivity, and nutritious food products for human consumption (Kubkomawa *et al*., 2007; Kubkomawa *et al*., 2011). In most small scale farming systems, livestock graze in pastures or wood-lands feeding on grass and other herbaceous plants. During the wet season these lands provide adequate forage to maintain productive animal herds. In the dry season, however, the quantity and quality of forage greatly decreases and is generally low in nutritional value. Livestock sustained on such diets often lose weight and productivity (Akinlade *et al*., 2002; Adjolohoun *et al*., 2008). To avoid this problem, farmers provide their animals with quality feeds to augment dry season forages. One option is to supply expensive concentrates or supplemental feeding. For most small scale farmers, this is not sustainable due to high costs and limited availability of supplements. A more practical alternative is for farmers to establish fodder banks. Fodder banks are plantings of high-quality fodder species. Their goal is to maintain healthy productive animal herds. They can be utilized all year, but are designed to bridge the forage scarcity of annual dry seasons. Fodder banks do not provide 100% of feed requirements, but supplement the available dry season forage. The objective of this study therefore, was to review fodder bank establishment and management for dry season supplementary feeding of livestock.

Factors involved in fodder bank production in the Sub-Humid Zone (SHZ) of Nigeria

The factors involved in fodder bank production in the sub-humid zone of Nigeria include land, labour, capital, soil, climate, seed, fire and ants. Understanding how these factors operate under the varying conditions of different parts of the sub-humid zone helps to identify the problems and prospects of fodder bank development. For example, the availability of land for fodder banks depends on where a small scale livestock producer chooses to settle, since the most common choice is in the vicinity of crop farmers. Fallow land is specifically more attractive because it has less tree and shrub cover and requires less clearing, but there may be difficulties in obtaining it because of rising demand for crop-land. Crop farming communities will, therefore, play significant roles in providing land for fodder banks to those livestock producers settled in their neighbourhood and must eventually benefit from fodder banks or else the intervention will have limited applicability.

Small scale livestock producers settled on grazing reserves or in less heavily populated areas may have easier access to land, but the generally poorer soil and higher ligneous cover of these sites may require a different approach to fodder bank establishment and management. Producers′ decisions on how much labour and capital to allocate to fodder banks will determine the area of land that can be used, the method of land preparation and other inputs affecting the productivity and continued existence of the banks.

Transhumant cattle move across large areas of tropical West Africa in search of better-quality forage, while cattle owned by settled pastoralists are restricted to forage available within herding distance of the home base. The natural herbage is mainly grasses, which are nutritionally adequate for only 3 - 4months in a year (Akinlade *et al*., 2002; Adjolohoun *et al*., 2008). Crop residues contribute significantly to the dry-season diet of cattle of both nomads and settled pastoralists. About 20% of the Nigerian sub-humid zone (SHZ) is cultivated at present, and this proportion is likely to increase rapidly with the growing population.

Pastoralists recognise the need for better pasture as a long-term solution to nutritional shortfalls, especially after the recent sharp price increases and difficulties in obtaining agro-industrial by-products. But settled pastoralists face so many constraints to forage development. These include shortage of labour (all extra labour is required for subsistence cropping), lack of mechanical expertise (not even animal power implements), little security of tenure on land (hence no long-term commitment to land development), use of land is controlled by arable farmers who generally have no direct interest in cattle production, communal grazing by pastoralists and indiscriminate annual bush burning (Olawoye and Kubkomawa, 2018).

The guidelines for the establishment and management of fodder banks

The guidelines for the establishment and management of fodder banks are fencing of a land of about 4 hectares, preparing the seed-bed by confining the herd overnight in the area, prior to the onset of the rains, to fertilize the soil with their droppings, broadcasting scarified seeds, controlling fast-growing grasses by early grazing, defer grazing until the dry season to allow the forage to grow, selected animals are to graze the fodder bank 2½ hours per day during the dry season, ensuring sufficient seed drop and stubble for regeneration in the following season (Olawoye and Kubkomawa, 2018).

The factors that are important for long-term persistence fodder bank

The factors that are important for long-term persistence fodder bank are demographic characteristics in terms of germination, establishment, seedling survival and plant longevity and seed input, dormancy and dispersal; grazing pressure; soil fertility and fertilizer application; nitrogen output to the soil/plant system; other species in the pasture; time of first rains.

Other cultural practices

Planting materials

Direct seeding is normally recommended for fodder bank establishment. Seeds of many fodder bank species are soaked in water or scarified to assure good germination. Sowing depth depends on seed and site characteristics. Most seeds are sown at a depth equal to 1-2 times their width. In heavy soils, or when seed is small, sowing depth is shallow. In arid and semi-arid environments sowing depth is deep. For most seed types, successful sowing methods vary from place to place. Fodder bank establishment is also possible with seedlings or cuttings. However, because of the large number of plants needed, this is often impractical. When seedlings or cuttings are used, wide plant spacing of 50x50cm or 1x1m is usually recommended. Species that are usually established by cuttings include *Gliricidia sepium* and *Erythrina spp* (Obua *et al*., 2012).

Post-establishment care

Although most fodder bank species are considered fast-growing, their initial growth is often slow. During this period, seedlings are susceptible to weed competition for light, moisture and soil nutrients. Depending on weed growth, the fodder banks are thoroughly weeded every 2-4weeks. This level of weed control is maintained until the fodder bank species achieve a dominant canopy position and begin to suppress weed growth. This usually occurs six months after establishment.

The use of fertilizers to improve fodder bank establishment is not generally recommended. Fertilizers are expensive, and if available may be better utilized for food crop production. Fertilizer requirements of many fodder bank species are not well documented. When fertilizers are used, they are accompanied with thorough weed control. Fertilization without adequate weed control results in decreased survival and growth of fodder bank species (Obua *et al*., 2012).

Spacing and design

To maximize dry season production, fodder banks are usually dense, nearly pure stands. Recommended spacing varies from 5x5cm to 1x1m. Choice of spacing depends on management objectives. Total biomass yields per area increase at higher densities. Wider spacing is generally used when both fodder and small diameter wood, for fuel or poles, are desired. Closer spacing maximizes fodder production, but may make access for harvest or grazing difficult. Spacing of 1x1m is common for many species. Closer spacing encourages maximum fodder production. Wider spacing encourages fodder bank and small diameter wood production (Obua *et al*., 2012).

Fodder production and accessibility are improved by using double rows of fodder trees at wider spacing. Rows are established about 50cm apart with 1-1.5m between double rows. In-row spacing of trees varies from 5-50cm. Ideally, rows are oriented along the contours in an east-west direction. This orientation provides optimum fodder bank sun exposure and erosion control. Of course this is not always possible. Row establishment is conformed to site topography. When the slope is steep, it is best to establish rows along the contours. Control of soil erosion improves with closer in-rows spacing as shown in Figure 1 (Obua *et al*., 2012).

Figure 1: Fodder bank

Once the fodder bank is well established, grasses are allowed to grow in the area between double rows. Competition between bank trees and grasses will not be as severe as during the establishment period. Tree roots will feed from deep in the soil, grasses from near the surface. Their difference in height will also decrease competition for sunlight. This two-tiered system produces more fodder per area than either plant type alone. The grasses grown in the inter-row area is an excellent fodder species. Competition between trees and grasses is monitored constantly so that fodder bank productivity does not decrease. The natural establishment of poor quality fodder grasses is also closely controlled as can be seen in Figure 1 (Obua *et al*., 2012).

Fodder bank management

For effective management and utilization of fodder crops especially in the tropics the following factors are considered:

Age at first harvest

In most circumstances, the first harvest is delayed until the bank is 9-21months old. Actual age at first harvest depends on environmental conditions and bank growth. Under arid or poor soil conditions, growth is usually slow and the first harvest is delayed. When growth is fast, the first harvest may be sooner. The goal is to allow fodder bank species to establish deep roots and thick trunk diameters. The resultant healthy plants have ample carbohydrate reserves and respond well to harvesting. Biomass production/harvest and long-term production both increase when the first harvest is delayed. It is believed that, the first harvest, whether from cutting or grazing, terminates the downward growth of taproots. This is an important consideration in arid and semi-arid environments. To promote establishment of a healthy root system the first harvest is delayed until trees are 9-21months old.

Grazing

Fodder banks can be directly grazed by livestock. This system saves labour and effort but can cause plant damage and fodder waste from trampling. The key to direct grazing is sub-division of the fodder bank into paddocks. Livestock are restricted to one paddock until the available fodder resource is fully utilized. Animals are then moved to the next paddock. If environmental and plant growth conditions are favourable, fodder banks may be grazed year-round. Grazing periods are generally 1-2weeks, followed by recuperation periods of 3-6weeks (or three times the grazing period). Under arid conditions, the recuperation period may need to be longer. To stimulate tree growth fodder banks are cut to a uniform height after the grazing period. With most species, complete defoliation during the grazing period is permissible, as long as cutting and grazing are excluded during recuperation. To assure adequate recuperation, paddocks are fenced or protected in a similar manner. After long recuperation periods, tree height may make fodder inaccessible to animals. This is often a problem when fodder banks are not grazed all year round. Periodic cutting of sections of each paddock may be necessary to improve animal access. The cut fodder is left on the ground where livestock can access it. The area cut should correspond to what will be eaten before the next cutting as shown in Figure 2. Goats and sheep often eat the bark as well as leaves of fodder trees. This can lead to tree mortality and decreased long-term fodder bank productivity. Unless closely monitored, goats and sheep should not be allowed to graze fodder banks. Cattle, generally, do not cause this problem (Olawoye and Kubkomawa, 2018).

Figure 2: Harvesting of fodder trees

Cut-and-carry

Most fodder banks are managed through a cut-and-carry system in which the fodder is harvested and carried to the livestock as shown in Figure 2. The animals may be a great distance from the fodder bank or just across a protective fence. Special harvesting equipment is used for fodder banks but all that is necessary is a sharp machete. A cut-and-carry system decreases fodder waste from animal damage and the necessity to monitor animals. However, labour inputs may be greater than with direct grazing systems. Important management factors to consider for a cut-and-carry system are cutting height, cutting frequency, and dry season management. These factors are all influenced by precipitation, temperature, soils, species, plant spacing, as well as by each other. Interactions are unique for each situation, resulting in effective management prescriptions that differ at each site. However, general recommendations are possible for each management factor. Farmers and managers should refine these recommendations to determine the best management prescription for their specific situation.

Cutting height

To obtain maximum fodder production, research has recommended a great variety of cutting heights. For example, a standard cutting height of 50-150cm is essential. Besides fodder production, this height provides other advantages. Trees retain adequate foliage to ensure rapid re-growth and plant longevity. Fodder is harvested with a minimum of bending or reaching, allowing for efficient movement by the harvester. Cutting heights of 50-150cm often maximize fodder production (Heuzé *et al.*, 2017).

A notable exception to the standard recommendation is the management of *Sesbania grandiflora*. This species experiences a high degree of mortality when its main stem is cut. Side branches can be harvested, but it should not be completely defoliated or have its main stem pruned below 150cm. After 2-3years of production, it is recommended to cut Leucaena back to 25cm. This lower height removes much of the dead wood and rejuvenates foliage production. This may be true for other species also. However, regular cutting below 50cm may cause increased mortality and decreased long-term productivity.

Cutting frequency

As with cutting height, research has recommended a great variety of cutting frequencies. The most common cutting frequencies are 6-18weeks. Generally, longer cutting frequencies of 12-18weeks generates more total biomass but as well increases the proportion of small wood production. Shorter cutting frequencies of 6-12weeks favours fodder yields and fodder quality. Younger foliage tends to have a higher nutritive value and palatability. However, repeated cutting after short frequencies decrease longevity. Standard cutting frequencies were developed for tropical conditions and tend to correlate with re-growth heights of 1-2.5m. Under arid, sub-humid or temperate conditions, re-growth may take longer to reach this height and cutting frequencies may need to be extended (Heuzé *et al.*, 2017).

Dry-season management

Dry-season fodder production is the main objective of fodder bank management. In areas with severe dry seasons, special management practices are followed. Six to eight weeks before the beginning of the dry season, trees are cut to the recommended height. The new foliage produced over the next few weeks will be retained well into the dry season when it is most needed. Left uncut for 4-6months, *Gliricidia sepium* does not retain its leaves into the dry season. This may be true for other species as well.

When the dry-season is very long or the area of fodder bank very large, the pre-dry season harvest should occur in phases. This will assure that fodder is available throughout the dry-season. During these pre-dry-season harvests the amount of fodder available may exceed normal needs. The excess may be used to increase animal rations, make silage for dry-season use, or mulch crops. Dry season re-growth will be slow, and cutting frequencies may need to be extended (Heuzé *et al.*, 2017).

Fertilization

Fodder banks are long-term crops that are properly maintained to continue high productivity. Even under direct grazing, fodder banks remove large amounts of soil nutrients from the site. These nutrients are replenished by application of manures or chemical fertilizers. As previously mentioned, little is known of the nutrient requirements of most fodder bank species. However, as with most crops, nitrogen, phosphorus and potassium are important nutrients. Application for these and other nutrients are determined locally. Availability and costs of fertilizers may restrict their use. The nitrogen requirement may be self-provided if the species used are nitrogen-fixing (Heuzé *et al*., 2017).

Common fodder bank species found in Nigeria

Many species make excellent fodder bank components. In general, these species establish readily, grow fast, out-compete weeds, produce high quality fodder, remain productive under repeated harvest, remain productive during dry seasons and survive on poor sites (Heuzé *et al*., 2017). Some of these fodder bank species include:

Lead tree (*Leucaena leucocephala*)

This is a fast growing, nitrogen-fixing tree/shrub from the family of Fabaceae and cultivated as a fodder plant, for green manure, as a wind-break, for reforestation and as a biofuel crop as shown in Figure 3 (Goldfarb and Casco, 1995; Maundu and Tegnas, 2005). The tree is, generally, short-lived (20-40years). The hard seed coat means that, germination occurs over a prolonged period after seed dispersal and that seed can remain viable for long periods (at least 20years) in the soil.

Leucaena leucocephala is a tree of open (often coastal or riverine) habitats, semi-natural, disturbed, degraded habitats and other ruderal sites. It tolerates a wide range of rainfall from 500 - 3500mm and withstands strongly seasonal (6-8month dry season) climates (Goldfarb and Casco, 1995). The species also grows poorly on acid soils with high Aluminium saturation which prevail in many humid tropical areas. In broad terms, it thus adapts well to a wide range of tropical and sub-tropical environments, especially seasonally dry tropical areas. *Leucaena leucocephala* is self-fertilized (promoting seed production even on isolated individuals), some out-crossing, pollinated by a wide range of generalist insects including large and small bees. It has the ability to re-sprout after cutting. Flowering and seeding continually throughout the year, as long as moisture permits, combined with self-fertility promotes abundant pod and seed set.

Figure 3: Lead Tree (*Leucaena leucocephala*)

Acacia species

Acacias are native to tropical and sub-tropical regions of the world, particularly Australia (where they are called wattles) and Africa, where they are well-known landmarks on the veld and the savannah as shown in Figure 4.

Acacias′ distinctive leaves take the form of small finely divided leaflets that give the leafstalk a feathery or fern-like (i.e., pinnate) appearance. The leafstalks may be vertically arranged and bear thorns or sharp curved prickles at their base. Acacias are also distinguished by their small, often fragrant flowers, which are arranged in compact globular or cylindrical clusters. The flowers are usually yellow but occasionally white and have many stamens apiece, giving each one a fuzzy appearance. The fruits are legumes and are highly variable in appearance, depending on the species (Maundu and Tegnas, 2005).

Several acacia species are important economically. Gum acacia (*Acacia senegal*), native to the Sudan region in Africa, yields true gum arabic, a substance used in adhesives, pharmaceuticals, inks, confections, and other products. The bark of most acacias is rich in tannin, which is used in tanning and in dyes, inks, pharmaceuticals, and other products. Several Australian acacias are valuable sources of tannin, among them the golden wattle (*A. pycnantha*), the green wattle (*A. decurrens*), and the silver wattle (*A. dealbata*). A few species produce valuable timber, among them the Australian blackwood (*A. melanoxylon*); the yarran (*A. omalophylla*), also of Australia; and *A. koa* of Hawaii. Many of the Australian acacia species have been widely introduced elsewhere as cultivated small trees valued for their spectacular floral displays.

Figure 4: ***Acacia Specie***

Lebbek (*Albizia lebbeck*)

The plant is a deciduous, perennial, medium-sized legume tree as shown in Figure 5. Lebbek is native to tropical Africa, Asia and Northern Australia. It is widely naturalized within sub-humid, semi-arid tropics and sub-tropical areas where there is a marked dry season and a reliable rainy season (Maundu and Tegnas, 2005). Lebbek is a multi-purpose tree. As a fodder tree, its foliage, twigs, flowers and immature pods are relished by different classes of livestock (camels, cattle, small ruminants and rabbits). It is also a source of firewood and timber. Lebbek is suitable for agro-forestry regimes in which the benefits of animal production are combined with wood production and it is used for shelter belts and as shading tree in coffee and tea plantations. It is found from sea level up to an altitude of 1800m. Optimal growth conditions are average day temperatures ranging from 19°C to 35°C, annual rainfall between 500 and 2500mm and fertile, well-drained loamy soils. It can, however, withstand lower and more irregular rainfall conditions. It can also grow on a wide diversity of soils such as acid, alkaline or saline soils, eroded soils and laterites except heavy clays. It is tolerant of heavy grazing and fire.

Lebbek should not be browsed regularly since it does not readily re-grow. It should instead be lopped or browsed by cattle twice a year as lopping enhances coppicing and yields about 2500kg/ha/year edible material in low rainfall areas where leucaena yields only 1500kg/ha/year. Lebbek is a very efficient Nitrogen-fixing legume that nodulates abundantly without requiring seed inoculation. Its shade-providing with dense canopy, soil moisture remains high under lebbek. Fallen leaves provide a lot of litter rich in organic matter during the dry season. The soil moisture increases litter breakdown and mineralisation of organic matter. Grasses growing under that canopy during the dry season are thus greener, have higher yields (1710kg/ha under lebbek vs. 753kg between lebbek rows) and maintain their nutritive value longer. Moreover, lebbek has an extensive shallow root system that quickly binds soil in eroded lands and river banks. It is used to provide shade in tea, coffee or cardamom plantations. It can withstand saline sprays and is thus valuable in exposed coastal situations where it can be used to form shelter belts for less hardy plants. While leaves and flowers contain no adverse constituents, pods contain saponins that may limit intake but appear to have no other adverse effect.

Figure 5: Lebbek (*Albizia lebbeck*)

Agati (*Sesbania grandiflora*)

The plant is a fast growing perennial, deciduous or evergreen legume tree, up to 10-15m high as shown in Figure 6. Its life-span is about 20years. The plant is a valued fodder for ruminants. It is used in grazed paddocks as mature trees are out of browse height, or as cut-and-carry forage integrated into cropping systems. Its low tolerance to defoliation makes it badly suited to direct grazing (Maundu and Tegnas, 2005). *Sesbania grandiflora* is native to Asia and is now widespread in most humid tropical regions of the world. It is often cultivated on the low dikes between rice fields or in association with Guinea grass. Optimal growth conditions are 22-30°C mean annual temperatures, 2000-4000mm annual rainfall, at an altitude from sea level up to 800-1000m. Agati is adapted to a wide range of rainfall zones and soil types. It can be grown on heavy clay, alkaline and saline soils, as well as poorly drained soils and poorly fertilized soils. During water-logging and floods, it develops floating adventitious roots and protective spongy tissue. Agati withstands acidic soils, 6- to 7-month drought periods and can survive with 800mm annual rainfall. It is intolerant of high winds that can break stems and branches. It does not thrive in temperatures below 10°C.

Figure 6: Agati (*Sesbania grandiflora*)

Conclusion and recommendations

Fodder banks are valuable crops which support productive farming systems. They are managed intensively. Legume fodder banks provide high-quality feed during the dry season, and are gaining acceptance among settled pastoralists in the sub-humid zone. A well-managed fodder bank of Stylosanthes spp. of about 4 hectares provides protein supplements for 15 to 20 cattle during the dry season. For year round and continual use of fodder bank as supplementary feed, proper cutting age, height, frequency and other management practices must be strictly adhered to.

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