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ON THE NUTRITIONAL QUALITY OF CATTLE FEEDS
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Abstract

The paper assessed cattle fodder bank establishment and management, and its implication on the nutritional quality of cattle feeds. Though, the production of cattle is based on range grazing, the nutritive value of the range is generally low depending on vegetation type and season. Cattle require consistent source of protein, energy, minerals, vitamins and water to maintain productivity and health; thus, fodder trees and shrubs complement the diet of cattle with protein, vitamins and minerals which are largely deficient in bush and cereal straw on which the animals heavily depend during the dry season. In line with this, the objective of this paper was to determine the implication of fodder bank establishment on cattle nutrition. Using discursive method, data from secondary sources were reviewed to ascertain the principles for the establishment and management of fodder banks; the factors necessary for the durability of fodder banks; as well as the post-establishment care of fodder banks. Consequently, the paper concluded that, to a region facing livestock feed deficits, the fodder bank concept offers a self-help option for producing good-quality supplementary feed on a sustainable basis. Nevertheless, despite the considerable amount of research that has been carried out, there has been very little on adoption of fodder crops by farmers. Hence, the paper recommended that, there is need to resolve major issues like land tenure, protection of planted plots or labour, so as to enhance effective management of fodder banks.

Keywords: Fodder bank, Cattle nutrition, Feeds, Livestock, Nutritional quality

Introduction

Cattle are very important in the agricultural economies of the sub-Saharan African countries. Besides contributing milk and meat, they also have important traditional economic and social values. Cattle are natural grazers and possess

great ability to digest plant carbohydrates that are generally indigestible to most other mammals (Babayemi, Abu, & Opakunbi, 2014). Nigeria has a land area of 92.4 million hectares of which about 44% are under permanent pastures, which support its domestic ruminants of over 101 million (Shiawoya and Tsado, 2011). It is estimated that only about 3% of this number of animals are reared on improved pastures; the remaining 97% are raised on low nutrient native pastures and farmlands (Okorie and Sanda, 1992). According to Kallah (2004), grazing lands in Nigeria, including natural wetlands (fadama), grass and woodlands and forest reserves, are estimated to cover about 32.42 million hectares, while cultivated croplands amount to about 39.41 million hectares. These lands provide substantial amount of forage and fodder as a major source of feed, for the country's ruminant livestock, both domestic and wildlife. In Nigeria, forage quality and availability vary greatly from wet season to dry season which however, affect the output of the animals (Ogunbosoye and Babayemi, 2010).

Cattle production is dependent on range grazing as the major feed resource. But due to seasonal fluctuations in feed quality and quantity, cattle are prone to seasonal weight changes with rapid gains in early summer, maintenance of weight in late summer and losses in the dry season which impact on productivity (Otsyina, von Kaufmann, Mohammed-Saleem & Habibu. 2004). Some deaths occur during the severe dry season. Additionally, due to rapid population growth, the availability of land for cattle grazing (Powell & Fussell., 2004) has decreased as cropping extends into areas hitherto used for that purpose. Therefore, grazing cattle require protein supplements, particularly in the dry season. The protein gap is especially acute in the rapidly growing smallholder dairy sector, where farmers can easily increase their cash profits

from milk sales by investing in protein supplements. However, bought-in protein supplements are expensive and smallholder farmers are seeking affordable alternatives.

According to Smith (2015), poor feeding has limited the ability of livestock to reach their genetic potential and hindered the impact of technology interventions, including artificial insemination and oestrus synchronization. Notably, in the dry season, inadequate nutrition usually results in reduced body weight and body condition scores in adult animals, poor milk yields and long calving intervals in nursing cows, retarded growth and increased mortality rates in calves (Simbaya, 2002). In the same report, Simbaya (2002) associated poor nutrition with increased susceptibility of animals to stress and disease challenges, which result in these animals performing below their expected genetic potential (Simbaya, 2002). Others have demonstrated the nutrition-reproduction interactions as good nutrition increases reproductive efficiency in terms of lowering age at first calving and inter-calving interval, higher productive life leading to higher profitability to farmers (FAO/IAEA, 2003). Bell and Paul, (2016) provided evidence showing that in utero nutrition has an impact on productivity and health of offspring later in life in livestock.

According to the FAO (2011), by 2030, urban beef consumption is projected to grow by more than 36% in developing countries, while rural beef consumption will more than double. Such a growth in consumption will largely drive associated growth in demand for feeds. This creates a tremendous opportunity for increasing livestock productivity through feed supply particularly as good quality feed is the most important constraint limiting livestock productivity (Phillip, Nkonya, Pender & Oni, 2009). The World Bank (2012) also predicted that changes in beef demand and supply in West Africa will likely result in increased sourcing of ruminant livestock feed from the market (13% in 2030 as compared to 2.5% in 2010) rather than from grazing. Hence, in order for livestock farmers to be well positioned to respond to the present and future increase in demand for livestock products, its feed resource base must be proportionally aligned with such increasing

demand. Based on this scenery, a better option is for farmers to set up fodder banks. Fodder banks require the planting 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. This paper therefore examined the implication of fodder bank establishment and management on cattle nutrition.

Overview of Fodder Banking

Fodder banking involves the fencing, planting, concentrating, storing and reserving of forage legumes in hays and silos to which concentrates, mineral and vitamin premixes are added (Mohamed-Saleem and von Kaufmann, 1995). Fodder banks convert plants such as *Stylosanthes guianensis*, *Centrosema pubescens*, and *Desmodium* spp. into supplementary or fall back forage kept in small to large plots for dry-season use by aging, ailing, nursing, and lactating animals (Tarawali and Pamo, 1992). The fodder bank concept started in Nigeria in the late 1970's through the activities of the ILRI Sub-humid Programme, Kaduna and involved establishment and management of concentrated units of forage legumes by pastoralists near their homestead (Saleem and Suleiman, 1986). The legumes are fed to "selected" animals as dry season supplementary feed, with 4-ha fodder banks having a potential dry matter yield of 4 to 5 t/ha which would adequately meet the supplementary needs of eight lactating cows during the dry season (Otsyina et al., 1987).

According to Haydock and Shaw (1975), 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 pastoralist 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 cropland. Crop farming communities will therefore play significant roles in providing land for fodder banks to those pastoralists settled in their neighbourhood and must eventually benefit from fodder banks or else the intervention will have limited applicability. On the other hand, pastoralists 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. Pastoralists' 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. As regards climate, Mohamed-Saleem and von Kaufmann, (1995) reports that forage legumes could help minimize moisture runoff and soil erosion and improve infiltration and water retention.

Although various forage legumes have been tested in Nigeria, Mohamed-Saleem and von Kaufmann, (1995) states that, little or no effort has gone into screening types suitable for the sub-humid zone. The National Animal Production Research Institute (NAPRI) released three stylo cultivars for general adoption: *Stylosanthes guianensis* cv Schofield, *S. guianensis* cv Cook and *S. hamata* cv Verano. Of these, *S. guianensis* cv Schofield is highly susceptible to anthracnose, caused by the fungus *Collectotrichum gleosporoides*. Hence, low seed quality increases the seed requirements, as well as the cost of establishing a unit area of fodder bank. Seed shortages and the absence of more appropriate legume varieties are the two key impediments to fodder bank development. Meanwhile, fodder banks can only be useful for feed supplementation if forage is available throughout the dry season. Their regeneration depends on the amount of stubble and of seeds in the soil. Also, the annual burning of both crop- and rangeland by farmers and pastoralists is a serious problem for fodder bank management, since it not only destroys the herbage but may also affect legume

regeneration. On the other hand, legume establishment in both the first and subsequent years is largely determined by the number of seeds germinating per unit area. Although collection by harvester-ants has been found useful in concentrating good-quality seed so that it can be easily gathered, it can lead to a very serious loss of viable seed needed for establishment and regeneration.

Forage Crop Production

Cultivated fodder species are of two types: grasses and legumes. According to Fall, Rippstein, & Corniaux, (2005), their yields vary based on a range of factors (rainfall for rainfed system or quantity and frequency of applied water for irrigated system, soil preparation, sowing date, density, soil fertilization, harvesting, drying and conservation techniques, etc.). In general, grass seeds are difficult to collect and have low germination rates. The annuals include non-cultivated but also cultivated species (sorghum, millet, peanuts and corn grown for forage). The perennials are easy to multiply vegetatively and are more resistant to trampling, grazing and bush fires. The most common local species is *Andropogon gayanus*. When planted, these grass species require fertilization, and can yield up to 22 t ha⁻¹ of biomass (Fall et al. 2005). Legumes constitute the second group of cultivated fodder species. For this group, many exotic species, mostly Australian herbaceous species and their cultivars (*Stylosanthes hamata*, *Macroptilium atropurpureus*, *Mucuna aterrina*, *M. purpureum*, *S. gracilis*, *Vigna unguiculata*, *Lablab purpureus*, *Dolichos lablab*, etc.), have been introduced and screened based on their bio-chemical and nutritional composition, fertilizer requirements, persistence, management and use as forage legumes (Thomas and Sumberg et al. 1995). In general they are annuals, germinate well but are less resistant to grazing than grasses and need to be planted annually. Being legumes, most are N-fixers and do not require mineral fertilization except for phosphorus at a rate of 50-200 kg ha⁻¹. Literature indicates that *Stylosanthes hamata*, *Digitaria umfolozi*, *Eulesine indica*, *Eleusine coracana*, *Cenchrus ciliaris*, *M. atropurpureus*, *M. aterrina*, *S. gracilis*, *V. unguiculata*, *L. purpureus*, *Brachiaria ruziziensis*, *Panicum maximum*, and *Dolichos lablab* were introduced and evaluated in

Mali. Feeding calves with green *S. hamata* fodder led to a daily body weight gain of 178 g (Kouriba and Nantoumé 2008). In Burkina Faso, research on cultivated forages started in 1961 involving various institutions (IRAT, CERCI, IEMVT and INERA) and consisted of introducing exotic plant species which were then compared to local fodders species. A total of 42 species, including annual and perennial grasses, annual and perennial legumes, were tested for their adaptation to drought and productivity as well as their management. They produced about 1.5-20 t ha⁻¹ depending on the management practices and the ecological zone (Sanon and Kanwé 2002).

Principles for the Establishment and Management of Fodder Banks

The rules for the establishment and management of fodder banks are:

- Σ fencing of a land of about 4 hectares
- Σ 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,
- Σ broadcasting scarified seeds,
- Σ controlling fast-growing grasses by early grazing,
- Σ deferring grazing until the dry season to allow the forage to grow,
- Σ 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).

Factors necessary for the Durability of Fodder Banks

The factors that are important for the long perseverance of fodder bank are demographic characteristics which constitutes 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; as well as time of first rains. Other cultural practices that are necessary include:

Planting Materials

Direct seeding is normally recommended for

fodder bank establishment. Seeds of many fodder bank species are soaked in water or scarified to ensure 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, McAlbert, Okoro & Efenie, 2012).

Post-Establishment Care of Fodder Banks

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 2-4 weeks. 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. Ordinarily, rows are oriented along the contours in an east-west direction. 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 (Obua et al., 2012). Once the fodder bank is well established, grasses are allowed to grow in the area between double rows.

Effective Management of Fodder Bank

For effective management and utilization of fodder crops, the following factors are considered

Age at First Harvest

In nearly all situations, the first harvest is delayed until the bank is 9-21 months 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.

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 1-2 weeks, followed by recuperation periods of 3-6 weeks (or three times the grazing period).

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. 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. The advantage of 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.

Cutting Height

It has been recommended that a standard cutting height of 50-150cm is essential in order to obtain maximum fodder production. Apart from 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, Tran, Boudon, Labussière, Bastianelli, & Lebas, 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 2-3 years 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

There are varieties of recommended cutting frequencies; however, the most common cutting frequencies are 6-18 weeks. Generally, longer cutting frequencies of 12-18 weeks generates more total biomass but as well increases the proportion of small wood production. Shorter cutting frequencies of 6-12 weeks 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 4-6 months, *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 ensure 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).

Implication of Fodder Banks Establishment for Cattle Nutrition

According to Kubkomawa, Kenneth–Chukwu, Krumah, Yerima, Audu & Nafarnda,, (2015),

cattle require consistent source of protein, energy, minerals, vitamins and water to maintain productivity and health. The nutrient requirements of cattle can be classified as follows: maintenance, lactation, growth, and reproduction requirements. Thus, fodder trees and shrubs complement the diet of cattle with protein, vitamins and minerals which are largely deficient in bush and cereal straw on which the animals heavily depend during the dry season in arid and semi-arid West Africa (Bayala, et al, 2014). Fodder trees are also often used as a buffer to overcome feed gaps that arise from seasonal fluctuations in the productivity of other feed sources. During the period of drought, trees and shrubs are the major source of fodder for livestock. Fodder banks are valuable crops which support productive farming systems. Legume fodder banks provide high-quality feed during the dry season, and are gaining acceptance among settled pastoralists. A well-managed fodder bank provides protein supplements for cattle during the dry season (Kubkomawa, et al., (2015). Thus, to a region facing livestock feed deficits, the fodder bank concept offers a self-help option for producing good-quality supplementary feed on a sustainable basis (Mohamed-Saleem and von Kaufmann, 1995). Because previous feed improvement strategies were ineffective, great care has been taken through research to tailor fodder banks appropriately to producer circumstances. Inputs and management requirements for fodder banks are simple and within the reach of the targeted beneficiaries; hence, the potential benefits to cattle, and to household income, can be substantial.

Conclusion

Although a fodder bank requires considerable capital investment, the saving in recurrent costs, as compared to purchasing feed, more than compensates. Nevertheless, despite the considerable amount of research that has been carried out, there has been very little on adoption of fodder crops by farmers. Moreover, the main constraints faced by farmers are poorly understood.

Recommendations

As a way to resolve the major issues affecting fodder bank establishment such as land tenure,

protection of planted plots or labour, there is need for support biophysical research. On the biological side, trees and shrubs recognized as fodder species vary depending on the ecological zones, animal type, as well as the associated knowledge about their uses and values. Hence, this local knowledge if associated with laboratory data on feed quality can help speed up the identification of good quality species, to further enhance cattle nutrition.

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