Review Article

The potential of desho grass (*Pennisetum pedicellatum*) for animal feed and land management practices in Ethiopia: A review

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Abstract

*Pennisetum pedicellatum* commonly called *desho* grass is found as native plant in many tropical countries including Ethiopia. The grass has multifaceted potential as fodder for livestock, soil conservation, and income generation in the form of small business for smallholder farmers in the country. In highland areas of Ethiopia planting and management of *desho* grass is an example of a locally tested land conservation method recognized by the Ethiopian Ministry of Agriculture and Rural Development. The activity of planting the grass is a response to cropland advance onto communal grazing areas and high pressure of livestock that has led to overgrazing, causing further land degradation and pasture shortages for livestock. Moreover, desho grass characterized by high biomass yield (30 to 110 tons/ha) per unit of land. Physiologically, *desho* grass has a peculiar characteristic of drought tolerance and moisture retention capacity. The grass’ potential for animal fodder for soil and water conservation, ruminant livestock has been documented in many tropical countries. Though available in Ethiopia, *desho* grass is not well known by the concerned bodies and much research and development works are needed to exploit the potential of the grass. In this regards this review paper organized with the objective to produce comprehensive information about the grass for further research and development in Ethiopia.

**Keywords:** Desho grass, Fodder, Grazing, Cut and Carry, Soil bund.

Introduction

The world’s livestock sector is growing at an unprecedented rate and the driving force behind this enormous surge is a combination of population growth, rising incomes and urbanization.
For example, the annual meat production is projected to increase from 218 million tons in 1997-1999 to 376 million tons by 2030 (WHO, 2013). In developing countries, livestock production is increasing rapidly as a result of growth in population and incomes and changes in lifestyles and dietary habits (FAO, 2003). The livestock sector is increasingly organized in long market chains that employ at least 1.3 billion people globally and directly support the livelihoods of 600 million poor smallholder farmers in the developing world (World Bank, 2009).

Most food of animal origin consumed in developing countries is currently supplied by small-scale, often mixed crop-livestock family farms or by pastoral livestock keepers (John and Maria, 2001). The ongoing major expansion of the demand for livestock products for food is expected to have significant technological and structural impacts on the livestock sector. This indicates that the productivity of animal agriculture in developing countries will need to be substantially increased in order to satisfy increasing consumer demand, to more efficiently utilize scarce resources and to generate income for a growing population (John and Maria, 2001). Ethiopia is not different from these countries and known to have large potential in livestock population, being 1st among African countries and 9th in the world (Hunduma, 2012; CSA, 2015). In the country, livestock production plays a significant role for more than 85% of rural smallholders as food, cash income, job opportunity, means of security etc. The unique genetic diversity of the livestock population and the diverse agro-ecologies of the country allow the presence of different production systems such as agro-pastoralism, mixed crop livestock and urban and peri-urban and these systems should take advantage of the current and future opportunities for more market-oriented development (IBC, 2004). According to Shapiro et al. (2015), livestock remains as a pillar for food security, human nutrition and economic growth of the country.

Though Ethiopia is blessed with huge livestock population than any other African countries, the productivity is comparatively low. Feed scarcity is indicated as a factor responsible for the lower reproductive and growth performance of animals especially during the dry season (Legesse, 2008). In Ethiopia, production and productivity of livestock is low due to multidimensional constraints. Among the numerous problems, shortage of feed supply and poor nutritional quality of available feed resources are the major constraints affecting livestock productivity as stated by Tolera et al. (2012). Furthermore, the problem of feed is more severe in the highlands of the country where more than 75% of both the human and livestock population are concentrated. The major available feed resources in Ethiopia are natural pasture, crop residues, aftermath grazing, agro-industrial by-products, to a lesser extent improved pasture, and forage crops (Tolera, 2007; Tegegne and Assefa, 2010; Tasfy, 2010). Out of the total supply of livestock feeds in Ethiopia, 56.23% is derived from grazing, 30.06% from crop residues, and 1.21% from agro-industrial by-products (CSA, 2015). Livestock feed shortage in the country is further aggravated by the continuous changing of grazing land to crop land. In addition, the remaining grazing lands are also vulnerable to degradation and consequently become barren and gullies. The contribution of the natural pasture, on the other hand, is retreating from time to time due to poor management and continued expansion of crop farming (Melaku et al., 2003). This is resulting in the increasing role of crop residues which are generally of poor quality (Wondatir and Mekasha, 2014), which in turn is explanatory for exploring alternative feed resources.

Among the options that help in combating the existing nutritional constraints for livestock production, use of indigenous multipurpose forages as a feed source (Mekoya et al., 2008; Anele et al., 2009). The use of indigenous forages as a feed source is appealing under the present Ethiopian conditions (Shapiro et al., 2015) to increase production and productivity of livestock. These plants are familiar with the smallholder farmers, grow with low inputs, and
are adaptable to a wide range of agro-ecological conditions (Anele et al., 2009). But there should be systematic intervention in the livestock subsector so as to balance the demand for livestock output and the growing human population in Ethiopia. One of the intervention areas to boost livestock production in the country is feed and feeds component which includes the use of indigenous forages as major source of feed (Shapiro et al., 2015). 

Ethiopia's soil and water conservationists know that land degradation is a major cause of declining agricultural productivity, persistent food insecurity and rural poverty in the country. Undulating terrain and highly erosive rainfall make Ethiopia's soils fragile, and detrimental farming practices compound the problem. In the densely populated, humid highland regions of Ethiopia, the green canopy of desho grass, local varieties of Pennisetum sp., spread across the escarpment, is one such example of a local tried and tested land management technique. The government of Ethiopia has developed Livestock Master Plan for the next five years, which aims at boosting livestock production via better feed development strategy (Shapiro et al., 2015). One of the options which is incorporated in the plan is to increase forage development based approach based on land resources, farmers preference and production objective of the livestock system. These call researchers and development actors to find solution for animal feed and environmental protection. Desho grass being multipurpose fodder and environment friendly plant shall be one of the candidates to be scaled up in both research and development of the Ethiopia. However, the information available on the plant is scanty and not well documented. This review paper was prepared to highlight the characteristic, economic, environmental and social benefits of the grass in Ethiopia.

Characteristics and Distribution of *Pennisetum pedicellatum*

*Pennisetum pedicellatum* belongs to the Poaceae family and tribe Paniceae. The grass thrives and performs well on a wide range of soils (including degraded sandy or ferruginous soils) provided they are well drained (FAO, 2010). The genus *Pennisetum* contains the most productive tropical grasses even with frequent cutting, this genus out yielded other tropical grasses such as para grass, guinea grass and ruzi grass (Tudsri et al., 2002; Tekletsadis et al., 2004). There are around 10,000 species of grasses worldwide, growing in a range of habitats on all continents (Booth et al., 2009). The works of Techio et al. (2002) indicated that *Pennisetum pedicellatum* has 54 chromosome numbers.

The species belonging to this genus constitute a heterogeneous assemblage with different basic chromosome numbers ($x = 5, 7, 8$ and 9), ploidy levels varying from diploid to octoploid, sexual or apomictic reproductive behavior and annual, biennial or perennial life cycle (Martel et al., 1997).

*Pennisetum pedicellatum* native to northern tropical Africa and India (FAO, 2010). The grass is believed to be native to tropical and sub-tropical Africa (Ethiopia, west tropical Africa and south to Mozambique) and tropical Asia (India, Malay Peninsula, Indo-China, Indonesia and the Philippines) (Parsons and Cuthbertson, 2001; Miller, 2006). Once established, it has a competitive advantage over shorter-lived grasses and replaces native species (Miller, 2006). The grass is a tufted, drought tolerant introduced grass that grows to 1.5 m. It is found in dry savannah regions in sandy and fertile loamy soils and dominates on disturbed land including road reserves. It is very palatable to sheep and cattle and predominantly used for grazing in times of scarcity. It produces a high seed output and occurs in high densities (Setterfield et al., 2005).

*Pennisetum pedicellatum* in Ethiopia

In Ethiopia, *Pennisetum pedicellatum* commonly called desho grass is currently utilized as means of soil conservation and animal feed resource (Leta et al., 2013; Yakob et al., 2015).
The grass has the ability to recover after water stress even under severe drought conditions (Noitsakis et al., 1994). Moreover, desho grass serves as natural resource conservation practice and business opportunity for farmers in the country (Welle et al., 2006; Danano, 2007; Smith, 2010; Shiferaw et al., 2011). Implementing desho with silvo-pasture methods, such as cut-and-carry and biodiversity systems, (Danano, 2007), protects grazing land from further degradation while increasing its productivity, and consequently improving livestock production.

Desho grass has been tested in SNNPRs especially in Chencha district, for its biomass production, palatability and soil erosion control (MERET, 2012). The results indicated that desho grass has been used as grazing land management intervention has significant positive impacts on the natural environment, particularly when biodiversity is improved. And also is used as a rehabilitation method to overcome land degradation caused by overpopulation and unsustainable farming practices (Smith, 2010). Desho greatly improves ground cover, which in turn controls runoff and soil loss (Fig. 1). Moreover its massive root system strengthens the soil structure and improves water conservation capacities while effectively using deeper nutrients for growth (Danano, 2007). Desho grass is currently used as biological soil conservation, animal fodder and income generation in northwestern Ethiopia (CASECAPE, 2014; Asmare et al., 2015).

![Fig. 1 Desho (Pennisetum pedicellatum) grass grown for animal fodder in northwestern Ethiopia.](image)

**Importance of Pennisetum pedicellatum grass**

Many cultivars from this genus are commonly grown for animal feed. *P. pedicellatum* is widely used as green fodder for cattle (Cisse et al., 2002; Holou, 2002; Ecocrop, 2010). The other importance of *P. pedicellatum* is its role as mulch in the rehabilitation of encrusted soil. In Burkinafaso, study by Adama et al. (2012) indicated that the most available of the green fodders on markets of livestock feed which indicates the utilization of the in the tropics. *P. pedicellatum* has also been sown to control soil erosion and to improve the physical and chemical properties of the soil (Kumar and Jena, 1996). Distribution *P. pedicellatum* grass is among locally available, multipurpose and potential feed resource in Ethiopia (Leta et al., 2013; EPPO, 2014). It is a perennial grass which is abundant in Southern Nations Nationalities and Peoples’ Region of the country. The grass is also available in other tropical countries and is palatable to cattle, sheep and other herbivores (FAO, 2010).

**Fodder potential**

*Desho* grass (*Pennisetum pedicellatum*) is one of the potential forages grasses available in Ethiopia which has a potential role in providing a significant amount of quality forage, both
for the smallholder farmer as well as intensive livestock production systems with appropriate management practices (Leta et al., 2013; Asmare et al., 2016). According to current feed resource assessment study by Wondatir (2015) desho grass (Pennisetum pedicellatum) along with other forages is one of the newly emerging source of feed for ruminant livestock in Jeldu district of Western Ethiopia. The same research indicated that the area cover by desho grass is higher than other forage types which imply the grass is being used by farmers as alternative feed sources in the country.

All most all parts of desho grass are consumed as fresh or in the form of hay by cattle, small ruminant and equine in Ethiopia (Asmare et al., 2015). Desho grass planted for fodder in Northwestern Ethiopia for preliminary observation has shown a chemical composition values 92.22, 86.80, 8.07, 73.73, 48.45, 5.96, and 56.92% for dry matter, organic matter, crude protein, neutral detergent fiber, acid detergent fiber, acid detergent lignin and invitro organic matter digestibility (Asmare et al., 2015). Taking the critical nutrient CP as preliminary evaluation of the grass, the values was higher than the reports of the same species in other countries (6.5%) (Waziri et al., 2013; Heuze and Hassoun, 2015). Furthermore, mean CP content of desho grass of this experiment was within the range (5.9-13.8 %) of Pennisetum species (Napier grass) (Kahindi et al., 2007; Kanyama et al., 1995). This implies that the grass must be well supplemented in order to sustain growth and/or milk production. The grass has considerable potential fodder although it results in lower DM intake than sorghum fodder when offered to heifers (Kishore et al., 2000). Although the research results are not yet published about the form of utilization, desho grass is practiced (Fig.2) in different parts of Ethiopia.

The nutritive value of late stage desho grass hay is low and cannot support the maintenance requirements of adult rams of 17-25kg (Nianogo et al., 1997), but supplementation with nitrogen and energy improves performance (Zoundi et al., 2002). In India, Pennisetum pedicellatum is used as a soil stabilizer (Ecocrop, 2010; Yakob et al., 2015). A combination of Stylosanthes humilis and desho grass in a ratio of 1:2 provides a cover crop and promotes soil formation on coal spoil heaps (Maiti, 1997). It was also assessed in strip cropping in the Sahelian zone in Africa but did not prove to be valuable (Roose, 1994).
Table 1. Dry matter intake and digestibility values of *desho* grass

<table>
<thead>
<tr>
<th>Ruminant nutritive values</th>
<th>Unit</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM digestibility, Ruminant</td>
<td>%</td>
<td>48.3</td>
</tr>
<tr>
<td>Energy digestibility, ruminants</td>
<td>%</td>
<td>45.0</td>
</tr>
<tr>
<td>DE ruminants</td>
<td>MJ/kg DM</td>
<td>8.1</td>
</tr>
<tr>
<td>ME ruminants</td>
<td>MJ/kg DM</td>
<td>6.6</td>
</tr>
<tr>
<td>Nitrogen digestibility, ruminants</td>
<td>%</td>
<td>46.0</td>
</tr>
</tbody>
</table>

Source: Heuzé and Hassoun (2015).

Land rehabilitation role

Degradation of crop and grazing lands is common problem in Ethiopia which resulted reduction in agricultural productivity; continuing food insecurity and rural poverty. The effect of land degradation may extend on species of flora available, shortage of water, reduces surface water and a general bio system loss (Shono *et al*., 2010; Genene and Wagayehu, 2010; Temesgen *et al*., 2014). The problem of land degradation in Ethiopia is not new and has been going on for centuries (Hurni *et al*., 2010). Decreasing in the productivity of land is an important setback in Ethiopia and that with continued population expansion the problem is likely to be even more important in the future (Berry, 2003). Land degradation caused by the various interacting factors of such as biophysical characteristics and socio-economic aspects of communities (ILRI, 2000). The short term outcome of land degradation includes education in crop yield which, in turn, resulting economic decline and social stress. The impact of erosion is particularly severe in the highland parts of the country where farming is practice for many centuries (Desta *et al*., 2000).

Numerous literatures promoted the use of biological conservation such as are promoting grass strips as soil and water conservation measures because they demand less labor than the mechanical measures, do not bury the fertile topsoil and they can effectively reduce erosion on gentle slopes (Turkelboom *et al*., 1994). An additional feature in favor of the grass strip lies in its maintenance (Grunder, 1988). After establishment and stabilization the grass strip needs relatively less follow-up than mechanical measures need annual maintenance to keep their effectiveness. In this regard, the use of *desho* for land rehabilitation has been documented by some workers in Ethiopia (Welle *et al*., 2006; Smith, 2010). The latter authors indicated that *desho* grass had a good potential to reduce erosion next to vetiver grass followed by setaria grasses.

By using the framework to identify, assess and select a solution in partnership with local communities and district level management, *desho* grass was introduced along with legumes such as alfalfa (*Medicago sativa*), in response to degradation caused by overpopulation. Cropland encroachment onto communal grazing areas and overstocking of dairy cows and oxen has led to overgrazing, causing further land degradation, and also serious pasture shortages. Widely available, *desho* grass is ideal for livestock and can be grown on small home plots, where it improves soil cover and fertility, while increasing soil moisture retention and biodiversity. In line with this, Djikeng *et al*., (2014), the use of climate smart grasses like *desho* could be taken as an alternative to improve livestock production and productivity as well as land management and thereby reduce poverty in tropical countries (Fig. 3).
A Study in Ethiopia (Welle et al., 2006) assessed the effectiveness of another use of desho as grass strips, or hedgerows, to protect against runoff and soil loss on the slopes on the Ethiopian highlands. The results of the study showed that desho grass strips reduce soil loss by approximately 45% in the first few years of establishment compared to areas with no barriers. Then the desho grazing land management intervention has significant positive impacts on the natural environment, particularly when biodiversity is improved. And also is used as a rehabilitation method to overcome land degradation caused by overpopulation and unsustainable farming practices (Smith, 2010). Desho greatly improves ground cover, which in turn controls runoff and soil loss. Moreover its massive root system strengthens the soil structure and improves water conservation capacities while effectively using deeper nutrients for growth (Danano, 2007).

**Compatibility to tropical environments**

*Pennisetum pedicellatum* is a C4 plant such as maize, sorghum, and sugarcane, approximately have 50% higher photosynthesis efficiency than those of C3 plants such as rice, wheat, and potato (Kajala et al., 2011). C4 plants are often called tropical or warm season plants. C4 plants grow best at 90-95°F. They begin to grow when the soil temperature is 60-65°F. Forage of C4 species is generally lower in protein than C3 plants but the protein is more efficiently used by animals. The density of the large longitudinal leaf veins is similar in C3 and C4 grasses but C4 grasses have denser transverse leaf veins and denser small longitudinal veins than C3 grasses (Ueno et al., 2006). As a result, C4 grasses have a photosynthate translocation and water distribution system which is structurally different from C3 plants, and which is considered (Woerner and Martin, 1999) to contribute to better water use efficiency than C3 species. The C4 photosynthetic pathway requires much less Rubisco, so consequently and importantly, less leaf nitrogen (N) per unit leaf area for rapid photosynthesis (Sage et al., 1987). These adaptations allow C4 grasses to use water and nitrogen efficiently to achieve very high growth rates, provided temperatures are adequate. The same literature described that C4 plants are more efficient at gathering carbon dioxide and utilizing nitrogen from the atmosphere and in the soil. They also use less water to make dry matter. However forage of C4 species is generally lower in protein than C3 plants but the protein is more efficiently used by animals which are the characteristics of desho grass (Asmare et al., 2016).
According to Thornton and Herrero (2010), balanced agricultural development practices have the potential to offset 5-14% (with a maximum of 20%) of the total annual CO\textsubscript{2} emissions. The grass lands of the world, including rangelands, shrub lands, pasture lands, and croplands sown with pastures, trees and fodder crops, represent 70% of the world’s agricultural area. Again, soils under grasslands contain about 20% of the world’s soil carbon stocks (FAO, 2010). On the other hand, these carbon stocks are at risk from land degradation. As a result, one of the means of adaptation and mitigation strategies is arresting further land degradation and restoring the degraded grasslands. This would entail improved grazing management and restoration of the grasslands through the establishment of pasture enclosures, diversification of grass and forage species, postponing grazing to allow pastures to grow to maturity, ensuring even grazing of various species and improving forage productivity and efficient nutrient recycling processes. The so called climate-smart agriculture involves practices such as the cultivation of perennials (like desho grass) increasing tree and shrub cover on smallholder farms (Wambugu et al., 2014). Plantation of desho grass in communal grazing lands and backyard of smallholder farmers as well as roadsides are likely to contribute to increased carbon sequestration, improved land and livestock productivity and increased resilience to climate change.

Desho grass can be combined with other fodder legumes either in mixtures or in rotation (with legumes) cropping (Skermanand Riveros, 1990; Schmelzer, 1996). The grass has the potential to meet the challenges of feed scarcity as it not only provides more forage per unit area, but also ensures regular forage supply due to its multicut nature (Ecocrop, 2010). Means of income Desho grass many function such as animal fodder, soil water conservation strategies, and income source for producers. Desho grass can be planted in small plot of land and produce large amount of DM yield (10 to 30 t/ha), desho grass can be easily consumed by ruminant livestock (Leta et al., 2013). Both workers reported that the consumption of desho grass by livestock increased the animals’ biological performance in terms of body weight change and overall productivity. So, desho grass can help in poverty reduction directly or indirectly. Directly desho grass planting material can be sold from producer to user and by doing so the process increases the income of desho producers (Shiferaw et al, 2011; Asmare et al., 2015). The indirect benefit is that desho grass can be fed to animals and then production and productivity of animals increases which results the increment in the income through the sale of animals themselves or their out puts. Both the direct and indirect process increase the income of desho producers and help to reduce the level of poverty in the areas.

The way forward
Due to the recurrent climate change and result of poor accessibility to feeds in many areas of Ethiopia the utilization of desho grass will be likely to be expanding, however, the main challenge is lack of awareness on the characteristics of the plants and its utilization. Moreover, the vulnerability of soil towards erosion, high density of livestock per household may demands utilization of biological conservation methods like planting desho grass should be used as ruminant livestock feed and for soil conservation in Ethiopia. As desho grass has multipurpose roles, the number of farmers who participate in desho grass production may increase as far as there is training service in wider areas.

Conclusion
Desho grass is a multipurpose fodder used for animal fodder, soil water conservation and means of income for smallholder farmers in Ethiopia. The grass thrives well on different soil types, potential to produce large amount of biomass per unit area, suitable to different forage
production strategies, acceptable to different livestock species and increases productivity of livestock. Moreover, desho grass is drought resistant plant unlike most other forages in the tropical countries. Furthermore, the grass used to adapt the changing climate because of its drought resistant and high temperature tolerance characteristics. By planting desho grass, producers can earn income, improve production and productivity of livestock and can be an employment option for most people in Ethiopia. Hence, desho grass based diets is one of these types of feeds because of this potential the grass can be a candidate for livestock improvement in the country. As a result, it is possible to conclude that benefits of desho grass are in line with the government’s natural resource conservation and increasing agricultural production which are being implemented in different parts of the country. However, for optimum utilization of the grass further research is vital particularly on the grass’s agronomic characteristics, laboratory and animal evaluation under different conditions.

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