Biomass production and market value of two types of grasses grown on anti-erosive structures

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Introduction

An effective and profitable way to address the issue of erosion in the mountainous areas of Wolayta, Kembatta and Hadiya Zones (located in the southern region of Ethiopia (SNNPR)), is to combine soil and water conservation structures with the production of fodder grass.

The farming families living in those mountainous and highly densely populated areas (with on average more than 300 inhabitants/km²) are highly exposed to erosion. Anti-erosive structures, acting as cross-slope barriers, are well able to physically support the soil and maintain its moisture[1]. But building these structures requires a significant investment from the farmers in terms of time, labour and energy, and the structures also occupy a significant amount of space on their farms which are already quite small (0,5 hectares on average).

Integrating productive and perennial fodder grasses on these structures is particularly interesting in these mixed cattle-cropping systems as it can compensate the loss of space which is now occupied by the anti-erosive structures (assessed as amounting to 6 to 8% of the total cultivated lands surfaces[2]). The fodder grass production can be rapidly upcycled either to feed the animals of the farm, or to be sold at the local market. The deep rooting system of these grasses also helps maintain the soil and allows the water to infiltrate, while the vegetative part helps reduce the speed of the runoff water. It also helps consolidate the physical structures of the land while ensuring their durability. Perennial grasses, like *Pennisetum purpureum* (also called "Elephant grass" or "Napier grass") or *Pennisetum riparium,* are well resistant to long periods of droughts and are therefore suitable to be planted on the sloping fields of those tropical and mountainous areas. However, it should be noted that while there is almost no competition between *P. riparium* and the field crops, *P. purpureum* can have a negative impact on the development of directly adjacent crops. Usually, *P. riparium* is better suited for higher altitude (highlands and upper midlands) whereas P. purpureum is giving more production during the dry season in the mid-level altitude, when the needs are acute.

Production of Pennisetum purpureum (left) and P riparium (right) on anti-erosive structures.

[1] Cross-slope barriers are techniques used on sloping lands. They are a mixture of earth or soil bunds, stone lines, and / or vegetative strips used to reduce runoff velocity and soil loss, thereby contributing to soil, water and nutrient conservation - http://www.fao.org/3/i1861e/i1861e07.pdf.

[2] See also http://interaide.org/pratiques/content/combining-soil-conservation-and-fodder-production-adaptation-climate-change-southern-regionb

Moreover, these fodder grass productions have a good financial value on the local market, at any given time of the year. Their maintenance requires relatively limited amounts of work, and they also have the advantage of being harvestable in batches rather than all in one go, depending on the needs and availability of the farmer. Cropping fodder grasses is therefore compatible with traditional farming activities. Another important advantage of these fodder grasses is that farmers can sell them either directly in the fields or at the local market, which is particularly interesting for more vulnerable families who have no animals and have only limited workforce.

Left: landscape of Kacha Bira Woreda (Kembata-Tembaro Zone) // Right: anti-erosive structure planted with Pennisetum riparium in Boloso Sore Woreda (Wolayta)

Objective of the study

On-farm measurements have been taken continuously over 15 months (from July 2018 to October 2019) in 57 farms located in 3 districts (Woreda), in order to quantify the fresh biomass of the grass produced on the soil & water conservation structures throughout the year (for young and older plants) and its economic value. Measurements of *Pennisetum purpureum* were carried out in 22 farms and in 35 farms for *Pennisetum riparium*.

To perform these measurements, areas of 10 metres long were marked out inside the farms. The production was systematically weighted in situ directly after harvesting the grass. Plots of grasses of 1 year, 3 years and 6 years of age were included in the measurements in order to assess how the age of the plants impact the production. In certain cases, measurements were carried out on plants of different ages within the same farm. In total, 64 plots were measured in 57 farms (24 plots with *P. purpureum* and 40 plots with *P. riparium*). For *P. purpureum,* the assessment was only carried out in mid-level land *(in Hadero and Tembaro Woreda)* as *P. purpureum* is not well adapted to the high-level land. However, for *P. riparium,* the assessment was carried out in both mid-level land and high-level altitudes (in Hadero and Doyo Gena Woreda).

In addition, at each harvest, information on the financial value of the production was systematically recorded. Three possibilities were considered:

i. the price of the grass when sold directly at farm level (agreements with neighbouring farmers who buy it as “standing crop” have become common);
ii. the price of the grass when sold at the closest marketplace; and
iii. the price of the grass when sold at the main town market.

The following table sets out the number of farmers participating in those measurements for the 2 types of grass and how old their grass is.

Type of grass	Number of farmers	Number of plots and age of the grass planted			
		1 year old	3 years old	6 year old	Total
P. purpureum	22	10	9	5	24
P. riparium	35	14	11	15	40
Total	**57**	**24**	**20**	**20**	**64**

Table 1: number farmers participating in the assessment and number of measurements, by type of grass and by age of the grass

Results

1. Number of cuts per year, for each type of grass

At the start of the study, the first cut of the biomass was harvested but not measured. Only the date was recorded as starting point. The criteria to determine whether the grass is mature and ready to be harvested are as follows:

1. Whether the grass has reached a satisfactory level of production and whether it is palatable to feed animals.
2. Whether the grass has reached the stage that directly precedes the blooming phase, especially in the case of *P. purpureum.*
3. Whether the grass has reached a height close to 1 metre for *P. purpureum* and 0.75 metres for *P. riparium*.
4. Whether part of the plant's colour has changed from a deep green to a lighter green (though this depends on the fertility status of the soil).
5. Whether the growth is homogenous.

The results showed that on average *P. purpureum* is cut 5 times a year and *P. riparium* is cut 4 times a year.

2. Fresh biomass production

An important difference was observed between the biomass produced in mid-level land areas and in high-level land areas. The following table shows the average number of kg of biomass produced over a year for 10 metres of grass. The calculations are based on the total number of days between the initial blank cut and the last cut, and have been brought back to a total of 365 days, in order to determine the yearly equivalent

Type of grass and land altitude	Age of the grass planted		
	1 year old (kg)	3 years old (kg)	6 years old (kg)
P. purpureum (mid land 1600 to 1800m.a.s.l)	159	176	185
P. riparium - Hadero (mid land1600 to 1800m.a.s.l)	158	162	161
P. riparium - Doyo Gena (high-land 2000 to 2300 m.a.s.l)	264	421	169

Table 2: average production in kg per year for 10m of grass

Even if the *P. riparium* is cut less frequently than the *P. purpureum*, its yearly production is higher. It should be noted that the overall results are heavily influenced by the results collected in the Doyo Gena area, where production is much higher given the land is at a high-level. This mainly related to the agroecology and the soil fertility status of the area.

3. Economic value of the fodder production

Depending on the strategy of the farmer, the fodder production is either used to feed the cattle or sold as a source of income. The more well-off farmers usually only sell their surplus production, whereas for more vulnerable families who have fewer animals, the sale of fodder can be an important source of income. When selling the grass, there are usually 3 options available to the families:

1. Selling the grass directly at field level to a neighbouring farmer (described as "Farm" in the table below);
2. Selling the grass at the local market (described as "Market" in the table below); or
3. Transporting the grass to the main town, where the market price is higher (described as "Town" in the table below).

The harvests were weighed after each cut and their prices for each of these 3 options were recorded. This allowed us to assess the economic value of the production. The following table indicates the average value in ETB (Ethiopian Birr) for 10 metres of grass production per year.

	1 year old			3 years old			6 years old		
Type of grass	Farm	Market	Town	Farm	Market	Town	Farm	Market	Town
P. Purpureum (mid land)	145	189	235	156	195	249	175	217	271
P. Riparium - Hadero (mid land)	157	192	253	156	192	255	160	201	255
P. Riparium - Doyo Gena (high land)	287	351	405	468	558	621	202	261	306

Table 3: average production in kg per year for 10 metres of grass 1 USD = 31 ETB in December 2019

Protecting 0.25 hectares of land (a traditional unit of land called a "timad") from erosion requires setting up 200 metres of anti-erosive structures, on average, which is therefore 200 metres' worth of fodder grasses.
The table below shows the different yearly incomes generated from the sale of 200 metres of grass production at farm level, in the local market, and when transported and sold in the main town.

	Farm		Market		Town	
Altitude	ETB	USD	ETB	USD	ETB	USD
Mid land	2900	94	3780	122	4700	152
High land	4040	130	5220	168	6120	197

Table 4: minimum yearly income from the sale of fodder grass planted on 200 meters anti-erosive structures built on 0.25ha from mid land and high-level land areas (with 1 USD = 31 ETB)

We can see that there is a very small price difference between the high land and the mid-level land, with a price slightly higher in the mid-level land (+ 10 to 15%), especially during the dry season. But whatever the land level, fodder grass can clearly be a very good alternative source of income for farmers. Indeed, considering the daily wage for a farm worker is close to 75 ETB in the rural communities (around 2 USD), this yearly income generated from the sale of fodder is equivalent to between 40 and 60 daily wages of a farm worker.
Is it also important note that, among the 57 farmers who took part in the survey, the average length of linear grass production on their anti-erosive structures was 308 linear metres (even though this level does vary depending on the socio-economic situation of the farmers, their land ownership, and the number of anti-erosive structures on their land following the slope of the plot).

4. Time needed to crop and harvest the grass

The time required to crop the fodder, to maintain the structures and harvest the fodder was not measures. However, while building the physical structure is labour-intensive (on average 1 day is necessary to build 8 metres of physical structure) and while producing and transplanting the fodder seedlings correctly also takes time, once they are established, the work required to maintain the structures or to harvest the fodder is relatively low compared to the work needed for any other type of crop. Fodder grasses are perennial and have the main advantages (i) of being able to be harvested at any time, either in one go or in several batches; and (ii) of being easy to sell, as they are in high demand on the local market.

5. Influence of the age of the grass planted

For *P. purpureum*, the production levels tend to increase slightly as the grass gets older. However, for *P. riparium*, there is a clearly perceptible decline in production in high-level land from 4th year after planting, onwards. It explains why farmers tend to replace P. riparium with new seedlings after 5 years, which is commonly observed on the field, as older plants become less productive.

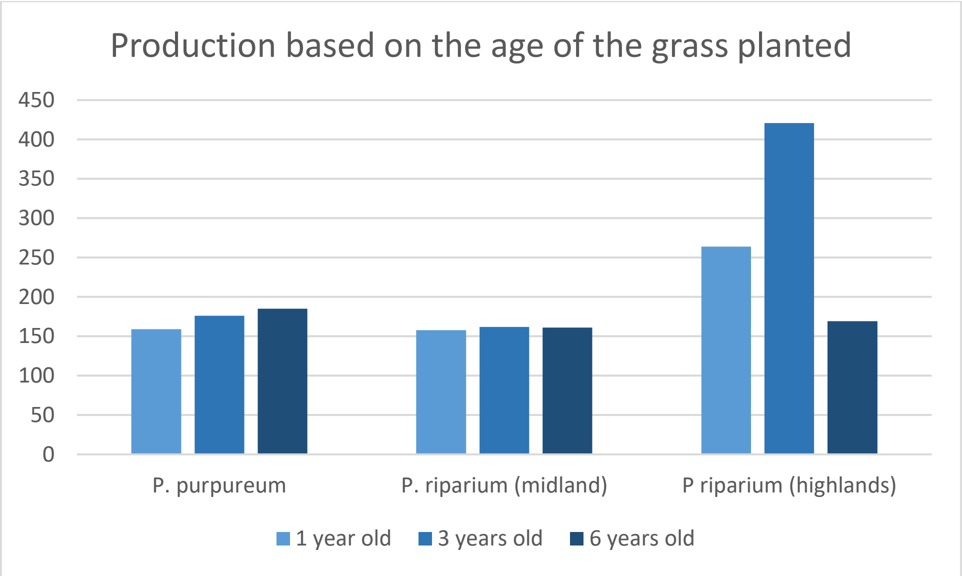

Chart 1: evolution of the production of fodder based on the age of the plants

Conclusion

The space that soil & water conservation structures require is significant, especially given that the average size of a farm in these mountainous areas of south Ethiopia is 0.5 hectares. Usually between 300 to 500m of anti-erosive structures are necessary to protect the soil against erosion. However, planting perennial crops such as fodder grasses on these structures not only physically stabilize the soil and helps maintain its moisture, it also enables farmers to significantly increase the fodder resources of their farm and thereby generates a significant additional source of income for them.

The space "lost" is therefore largely compensated by the high economic value of these grass productions.