Food and Agriculture Organization of the United Nations

Introduction of silvo-pastoral systems for cattle raising to sustainably provide fodder to animals in drought periods in Bolivia

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Summary

This technology describes the introduction of silvo-pastoral systems in the dry flats of the Chaco eco-region of Bolivia as a good practice to increase the resilience of cattle raisers to recurrent drought.

Silvo-pastoral systems are a combination of trees, pastures, and livestock. Trees contribute to increased pasture productivity, at the same time providing a natural shelter to animals. Livestock benefits from this good practice, especially during the prolonged drought periods when pasture is otherwise generally scarce and mortality rates increase significantly.

This technology briefly introduces the concept of silvo-pastoral systems and presents a cost-benefit analysis of the practice compared to normal practices for raising cattle.

Description

1. Silvo-pastoral Systems

Silvo-pastoral systems are a combination of trees, pastures, and livestock. Trees contribute to increased pasture productivity, at the same time providing a natural shelter to animals. In order to implement silvo-pastoral systems, farmers have to identify a plot of more than 10 hectares with medium-crowned trees where fast-growing grass forage could grow and this plot has to be fenced with electric wire. In these plots the leaves that fall on the ground add organic matter to the soil, contributing to the improvement of soil quality for the growth of forage grass during summer season. Access of cattle to the plot for grazing purposes is managed, allowing also to harvest and store grass to be used during dry season.

Figure 1. Silvo-pastoral system

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1.1 Forage

During the dry season the refuge mounds are used for the production of forage to feed the cattle. The forage species are Tangola (*Brachiaria* sp, B. *mutica* x B. *tanner*) and Camerún Panameño or liso (*Pennisetum purpureum*).

1.1.1 Tangola

The Tangola (*Brachiaria* sp, B. *mutica* x B. *tanner*) and Camerún Panameño or liso (*Pennisetum purpureum*) are the two species that best adapt to the conditions of droughts and floods in Bolivia. Tangola is a perennial grass, with hollow and creeping stems. It reaches 2 m long and 1.2 m high, with nodes every 7 cm, where new sprouts grow. It is adapted to tropical, humid climates and waterlogged soils. Being not demanding in soils, it supports overgrazing, is tolerant to burning, and grows very well in semi-heights and shallows.

The sowing of tangola allows to ensure the availability of fodder to feed livestock in conditions not suitable for many other forage species. The propagation is carried out by vegetative route since its seed is not viable, using about 3 000 to 3 500 kg of mature vegetative seed/plant parts for the planting of one hectare. Yields depend on climatic conditions, ranging from 9 to 11 t dry matter (DM) per ha yearly.

Among its nutritional characteristics, it has between 7 to 9 percent of protein, depending on the fertility of the soil and the physiological state of the plant. Tangola is used in direct grazing and if the terrain conditions are uniform, it is used for hay or silage.

The harvest of the vegetative seed is realized with machete or brush cutters when the grass is ripen and has a height of between 40 and 50 cm. The cut should be made 10 or 15 cm from the ground, to ensure regrowth after 45 to 50 days.

1.1.2 Camerún panameño

Grasses of the Pennisetum purpureum type are known as Elephant grass, and represent a high yield of fodder, since they adapt to a great variety of soils and tolerate drought. It is a perennial, tall, erect species that forms tillers, with sturdy stems that reach up to about 4.5 m in height, is tolerant to droughts, but not floods, so it must be planted on high ground with good drainage. It has high yield of forage, but its nutritive value begins to descend as the grass is maturing.

The cutting should be done at about 10 cm from the soil, and to be fertilized with at least twice a year, preferably after any cut during the dry season. The reproduction of the Camerún Panameño grass is carried out by the vegetative route; by cuttings or bearings of stem, which must be matured to guarantee a good germination. For the planting of one hectare, 3 tonnes of seed are necessary.

The best sowing time is during the rainy season. Sowing can be done in different ways; V-shaped or with a distance between furrows of 1 m and 0.5 m between plant and plant. It can also be planted in furrows with a distance of 1 m between furrows to a depth of 5 cm. When the vegetative material cannot be planted immediately it can be conserved for some days as long as it is kept under shade and with adequate humidity

Camerún Panameño grass presents an annual production of 14.68 tonnes of green matter per hectare annually and 21.80 tonnes of dry matter per hectare annually, in 4 or 5 cuts. Camerún Panameño grass has an average content of 18.55 percent dry matter, with a protein content of 11.42 per, being this grass the most productive with respect to the Camerún Verde, Camerún morado and Moralfalfo varieties. In addition to the

acceptable nutritional content, it presents good palatability for livestock and has the advantage of having no hair on the stems and leaves thus facilitating its manual handling.

1.2 Socio economic benefits of silvo-pastoral systems

With silvo-pastoral systems more animals can be fed than under open forest grazing systems Livestock weights much more in drought periods, since it has access to more forage, thus the farmers' incomes increase.

1.2.1 Cost

Please see Table 1 for a detailed cost description.

1.2.2 Side effects

No side effects were identified.

1.2.3 Major Barriers

- Land allocation for the implementation of the silvo-pastoral system.
- Agreement at community level for the management of the silvo-pastoral system.

1.2.4 General Recommendations

- The preparation of the land for planting the forage must be carried out at the beginning of the rainy season.
- For planting or transplanting cuttings, the ground must be flooded with water.
- Sowing is done at the beginning of the rain season by hand, spreading the cuttings on the ground in the most uniform way possible. Then, the animals are taken to the planted area so that they trample the soil without letting them eat the cuttings, in order bury the cuttings and to favour their multiplication from each knot. The number of cuttings used is approximately 0.8 ton per ha.
- Approximately three months after sowing the grass it multiplies and covers more than 90 percent of the soil surface. It is recommended to carry out direct grazing when the grass is well established, as of the sixth month from the moment of sowing.
- To obtain new cuttings suitable for re-planting in other grazing pastures, it is recommended to let the cuttings to mature for at least one year after being sown.
- Develop a management plan for the silvo-pastoral system at community level.

1.2.5 Synergies with other good practices include:

- refuge mounds;
- deworming and preventive vitaminization and mineralization; and
- pasture production.

2. Benefits

- Availability of pasture for cattle feeding during dry season.
- Conservation of plots' soil quality.
- Silvo-pastoral systems are capable of fixing significant amounts of carbon in the soil under the improved pastures and in the standing tree biomass.

Table 1: Example Table for costs invovled in installing a electric wire fence

Activity	Unit	Price per unit (Bs)	Number of units	Total cost in 2015
Electric wire fence for a 10 ha plot	Equipment	1 000	1	1 000

Source: FAO 2017

2.1 Cost-Benefit Analysis

Cost-Benefit Analyses were conducted based on quantitative data collected during the monitoring period in 2016. Data collected from plots where the silvo-pastoral system is applied were compared with data collected from control plots within the same farms, or from neighbouring farms where the good practice had not been implemented yet.

The costs and benefits were calculated based on the average number of cattle in the monitored farms (i.e. 56 cows). Results show that, when prolonged drought occurs, cumulative net benefits from the good practice (i.e. the implementation of silvo-pastoral system) are about 109 percent higher than the benefits of the traditional practice (appraisal period: 11 years).

The benefit cost ratio of the good practice is 3.78, as compared to 1.74 for the existing local practice. The higher performance of the good practice is mainly attributable to a significant reduction of mortality rates, combined with an increase in average animal weight.

Table 2. Cumulative Net Benefits and Benefit Cost Ratio of DRR Good Practice and Existing Local Practice (USD per average herd size)

Source: FAO 2017

2.2 Added benefits

The non-hazard scenario could not be analysed yet, as all farms were affected by frost and snow during the monitored period.

2.3 Avoided losses

In farms affected by drought, the good practice contributed to reduce livestock mortality and increased animal weight, more than doubling the net benefits obtained by non-adopters.

2.4 Co-benefits

Silvo/pastoral systems are capable of fixing significant amounts of carbon in the soil under the improved pastures and in the standing tree biomass.

3. Validation of the practice

3.1 Geographical area of practice validation

In 2016, the performance of this disaster risk reduction (DRR) good practice was monitored in 7 farms of the community of Curuyuqui in the municipality of Cuevo, and 3 farms of the community of Pueblo Nuevo in the municipality of Boyuibe.

3.2 Context of implementation

3.2.1 Environmental and climatic (period/ season) context

Located in the south-eastern part of Bolivia, the Chaco eco-region consists of a large extension of arid flat land. This eco-region is characterized by an irregular climatology, marked by high thermal and rainfall variations.

Average annual rainfall varies between 450 mm and 700 mm, and it is concentrated (about 85 percent) between December and March. The area faces a period of severe drought between May and October. Given these specific climatic conditions, the availability of pastoral

resources is generally scarce, especially during the dry season. Since all farms were affected by drought in 2016, the performance of the good practice was assessed only under hazard conditions.

3.2.2 Economic (livelihood strategy) and Social (target group) context

Livestock farmers (cattle), affected by drought spells and floods in the Bolivian department of Beni.

4. Minimum requirements for the successful implementation of the practice

- A plot of more than 10 hectares with medium-crowned trees and fast-growing grass forage has to be available.
- The preparation of the land for planting the forage must be carried out at the beginning of the rainy season.
- Sowing is done at the beginning of the rain season. Animals are used to bury the cuttings and to favour their multiplication.
- For planting or transplanting cuttings, the ground must be flooded with water.
- Develop a management plan for the silvo-pastoral system at community level, for which involvement of the community is crucial.

4.1 Constrains (limiting factors) for the implementation of the technology:

- Land allocation for the implementation of the silvo-pastoral system.
- Agreement at community level for the management of the silvo-pastoral system.

5. Agro-ecological zones

- Tropics, warm

6. Related/Associated Technologies

- Introduction of livestock refuge mounds, in combination with deworming and preventive vitaminization and mineralization for cattle raising in the Bolivian Amazonia

7. Objectives fulfiiled by the project

7.1 Resource use efficiency

Using trees, pastures and livestock, silvo-pastoral systems in dry flat regions improved pasture productivity and provided natural protection for livestock against adverse climates.