Strategies for improved soil and water conservation practices in hillside production systems in the Andean valleys of Bolivia

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Summary

Soil erosion and declining soil fertility are recognised as problems in the semi-arid valleys of the inter-Andean zone of South America. These have a particularly strong impact on areas of subsistence agriculture and contribute to poverty inducing processes. The mid-Andes area in particular, which includes Cochabamba and parts of Santa Cruz, is recognised as having extreme poverty in rural areas, made worse by land degradation and low productivity. The areas between 1 500 to 4 000 m above sea level are characterised by a multitude of microclimates and low productivity associated with soil erosion and declining soil fertility. The time that land is left in natural fallow has steadily declined as more land for crop production is required. Therefore, there is an opportunity for using live barriers and leguminous cover crops to control erosion and improve soil fertility, increasing productivity and thereby reducing poverty.

Description

1. Soil and water conservation

Soil and water conservation (SWC) technologies are inherently different from other crop improvement technologies such as fertilisers, pesticides and improved seeds. Farmers would expect to see benefits from these within a cropping season. However, conservation measures usually involve significant initial and ongoing investment in cash and labour, with benefits only being realised in the longer term. Since the circumstances of poor farmers are often characterised by critical scarcity of assets, the highest priority is usually placed on short-term benefits. Planning horizons are from one harvest to the next, or even from one operation to the next. This strongly contrasts with the time horizon required for most conservation practices, where considerable investment of capital or labour is required before benefits accrue. A choice often has to be made between maximising present income and investing for future income.

The attraction of receiving benefits within the first year of adoption is of major importance. Traditional SWC practices in the Andes, including larkas (contour cut-off ditches), pircas (stone walls as livestock barriers), linderos (vegetative barriers used as field boundaries), jallmada (ridges), chaupirrayas (intraplot drainage canals), aynoq'as (fallows) and

atajados (small dams for rain water harvesting and water storage) are used by some farmers and have quick pay-back periods (within the first year). They also provide additional benefits, such as acting as field boundaries, keeping livestock out, contributing to soil fertility or soil moisture improvements. Introduced measures such as fanya juu contour stonewalls and bench terraces have not been widely adopted despite promotion by NGOs, unless subsidies are provided for their construction. This has implications for the adoption of improved soil and water conservation technologies, in that low costs, a need to provide short-term benefits and be multi-functional, are important attributes. Live barriers and cover crops have the potential for this.

Fanya juu originated In Machakos, Kenya, where terraces are made by digging a trench along the contour and throwing the soil uphill to form an embankment. The embankments are stabilized with fodder grasses and the space between the embankments is cultivated. Over time, the fanya juu develop into bench terraces.

2. Live barriers

Work has demonstrated the effectiveness of live barriers for soil protection with a range of plant species and under a range of agro-climatic conditions. Phalaris grass, previously unknown in the area, has proved to be particularly successful in areas of higher rainfall and where irrigation is available. It is effective in controlling soil erosion and provides valuable livestock fodder, which is usually cut and fed to both cattle and sheep. Other species, especially vetiver grass, have been as effective, but do not provide fodder. Bushes and trees alone have so far not proved to be as useful in controlling erosion as Phalaris, although the combination of Phalaris grass and broom, locally known as retama (*Spartium junceum*) has potential.

Key indicators for successful barrier formation include barrier closure. Grasses have the potential to form barriers more quickly than shrub and tree species when these are planted alone and not in combination with a grass. Terrace formation, slope change and riser formation (e.g. changes in micro-topography caused by the barriers) were greatest in those areas with higher rainfall or irrigation. In drier areas, the tendency to form terraces was reduced. The intensity of tillage operations, soil erodibility and slope also affects riser formation. On 15 to 30 percent slopes, terrace formation was promoted and where slopes are in excess of 30 percent, terrace formation was minimal. In terms of sedimentation and erosion, live barriers resulted in the deposition of soil above and erosion below the barrier with most sedimentation found on plots as a result of soil tillage and irrigation.

3. Cover crops and green manures

Tarwi (*Lupinus mutabilis*), garotilla (*Medicago polymorpha*), broad bean (*Vicia faba*) and vetch (*Vicia sativa*) in combination with oats were compared with natural fallow regeneration. Two years of on-farm experimentation in three communities in Cochabamba established that tarwi outperformed other legumes in reducing erosion, adding Nitrogen and producing higher biomass, although a vicia/oats mix gave highest overall biomass. When vegetative cover was assessed at monthly intervals at Tirani, tarwi gave the best cover (40 percent), followed by natural regeneration (26 percent) and the association vetch/oats (21 percent),

followed by broad bean and garrotilla at under 15 percent. Water stress significantly affected the development of all species.

4. Benefits

In the first year no productivity differences were apparent with the live-barriers. In the second year all crops were badly affected by drought and yield differences were minimal but by the third year some differences began to emerge. A measure of intensification of crop rotations was also assumed when live barriers were used. A detailed cost benefit analysis of Phalaris (considered the most attractive species by farmers) was done for each agro-ecological zone with and without irrigation, attributing either zero or high value to fodder. Net present values at a discount rate of 20 percent were used to assess viability. Key factors affecting the economic viability used in a sensitivity analysis were costs of establishment and maintenance, which were affected by the land area taken up by conservation; planting density, the distance between barriers and the width of the barriers affected; the yield and value of fodder from the live-barriers, and; the intensity of crop rotations, crop productivity, and possible increases in productivity as a result of using the barriers.

At either a zero or 3 percent productivity increase (with or without irrigation and low value of fodder), live barriers were not viable and unlikely to be adopted. At a high fodder value they were viable, indicating the great importance of the fodder. At 5 percent productivity increase (without irrigation), live barriers became viable even with a low fodder value, though not in the more extensive farming systems found in the Puna and Transition. With irrigation and high fodder value, Phalaris looked increasingly viable. At a 10 percent and 15 percent productivity increase, viability was achieved in all cases. At a 5 percent discount rate viability was greatly improved, although a low discount rate was not considered to adequately reflect farmers' time preferences.

Based on the assumptions made, live barriers were viable and adoption was most likely where either irrigation was available or climatic conditions allowed fast growth of the species. Farming system intensification as a result of live barriers would greatly enhance viability. The fodder value of the live barriers was particularly important in ensuring viability and encouraging adoption. High initial costs of the technology needed to be reduced before unsubsidised adoption is likely to be considered in the extensive cropping systems of the Puna and Transition. In the more intensive cropping systems in the Valley and Valley Head, especially where irrigation was available, technologies were viable, and conservation was likely to promote further intensification.

5. Health and safety

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6. DFID disclaimer

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8. Further reading

- Simms. 2000. Strategies for improved soil and water conservation practices in hillside production systems in the Andean valleys of Bolivia. Technical report: URL
- Simms and Bentley. 2002. Participatory research: a set of tools but not the key to the universe" URL
- Simms et al. 2000. The development of low-cost soil and water conservation for smallholder farmers in the mid-Andean valleys of Bolivia. URL.

9. Agro-ecological zones

- Tropics, warm

10. Objectives fulfilled by the project

10.1 Resource use efficiency

The use of live barriers and leguminous cover crops helps control erosion and improves soil fertility.

10.2 Pro-poor technology

The technology increase productivity, and in so doing reduces poverty.