Left: Legumes (here peas) used as a relay crop. (Juerg Merz)
Right: Legumes (here pigeon pea) on terrace risers. (Juerg Merz)

Legume integration

Nepal: बाली प्रणालीमा कोसेवाली समावेश

Integration of leguminous crops as intercrops on terrace risers or as relay crops

Legumes are widely grown across the hills of Nepal, with the most common being soybean, lentils, black gram, cow pea, beans, horse gram, field peas, and rice bean. They are mostly intercropped or relay cropped with cereals such as maize, millet, and rice. They are also planted on the edges of terraces and rice paddy bunds. Depending on the species, they may be grown in rain-fed or irrigated fields during the winter or summer seasons.

The majority of the legumes grown by farmers are used for food or as a cash crop. The planting of fodder legumes has become more popular with the expansion of stall-feeding and the development of a dairy industry. The planting of legumes, with the main objective of improving soil fertility is a more recent development in Nepal's hills.

Nitrogen is the main plant nutrient element and is usually applied through commercial fertiliser where available. Legumes fix atmospheric nitrogen through bacterial nodules on their roots, then nitrogen subsequently becomes available to the following crops. It is important, therefore, not to uproot the legume crop during harvesting - it should be harvested by cutting the above ground parts leaving the roots (and the nodules) in the soil. The crop residues can be fed to livestock, used as animal bedding, applied as green manure directly to fields, or incorporated in compost. In this way most of the nitrogen that was fixed by the legume crop is returned to the soil.

Details about the different legume species and their different characteristics and uses are described in detail in SSMP, PARDYP and SSD-NARC (2000).

The Sustainable Soil Management Programme (SSMP) implements its projects in several midhills districts of Nepal
(dark green: previous working districts;
light green: districts in 2007)

WOCAT database reference: QT NEP3
Location: Nepal midhills
SWC measure: Agronomic
Land use: Annual cropping on rainfed agricultural land
Climate: Humid subtropical
Related approach: Farmer-to-farmer diffusion (QA NEP1), Farmer-led experimentation (QA NEP3), Farmer field school on integrated plant nutrient systems (QA NEP4)
Compiled by: SSMP
Date: January 2007

The Sustainable Soil Management Programme is implemented by Helvetas Nepal and Intercooperation in collaboration with the Government of Nepal and civil society actors. It is financed by the Swiss Agency for Development and Cooperation. The technology was documented using the WOCAT (www.wocat.org) tool.

Classification

Land use problems

Intensifying cultivation practices with either 1) inadequate application of fertilisers leading to a decline in soil fertility and the mining of soil nutrients or 2) the application of too much fertiliser causing environmental problems through excessive leaching, losses of fertiliser in surface runoff, and consequent eutrophication or nitrification of streams, ponds, or groundwater.

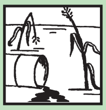
Land use

Annual crops; maize-wheat, potato, mustard, different types of vegetables

Climate

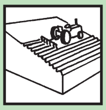
Humid subtropical

Degradation



Chemical degradation; soil fertility decline, soil nutrient mining

SWC measures



Agronomic; introduction of a new crop

Technical function/impact

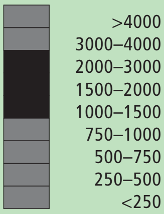
Main:
- increase in soil fertility (nitrogen in particular)
- increase in soil productivity
- nutritious and high value crop
- decrease in soil erosion on terrace bunds

Secondary:
- fodder or green manure
- income

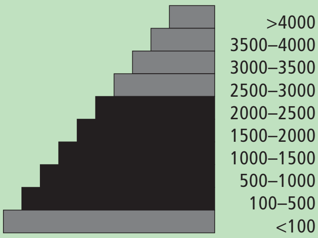
Environment

Natural environment

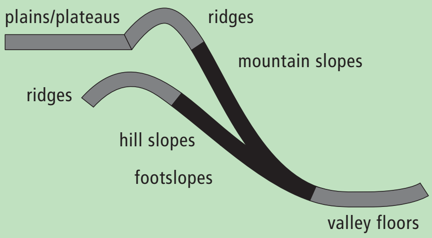
Average annual rainfall (mm)



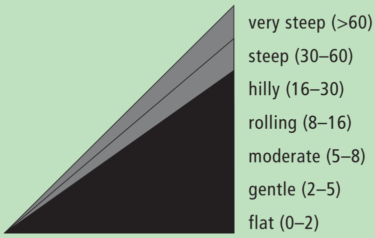
Altitude (masl)



Landform



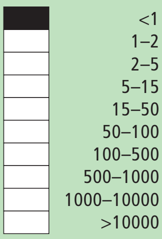
Slope (%)



Applied   Potential

Human environment

Cultivated land per household (ha)



Land use rights: individual, leased (sharecropping between owner and tenant)
Land ownership: individually owned, titled, and not titled
Market orientation: subsistence, commercial, and mixed (subsistence/commercial)
Level of technical knowledge required: low
Number of livestock: Poor households usually have some goats and one cow or buffalo. Rich households often own several cattle, buffaloes, and a pair of oxen for ploughing.
Importance of off-farm income: In most farm households, off-farm income plays at least a minor and increasingly a major role. Occasional opportunities for off-farm income present themselves in the form of daily labour wages. Some households' members receive regular salaries whilst an increasing number of Nepalis are working in India, the Middle East, Malaysia and elsewhere and sending remittance incomes home.

Technical drawing
A number of species are presented in the legume integration decision support guide (SSMP, PARDYP, SSD-NARC 2000). Here only a selection of useful legume species are presented (from top left corner to lower right corner):
- red clover *(Trifolium pratense)*
- hairy vetch *(Vicia villosa Roth)*
- Chinese milk vetch *(Astragalus sinicus)*
- rice bean *(Vigna umbellata)*
- velvet bean *(Mucuna pruriens)*
- tephrosia *(Tephrosia spp.)*

Implementation activities, inputs and costs

Establishment activities

1. Depending on the type of farm niche - broadcast, line sow, or spot plant the appropriate species during the appropriate season (for more information refer to Training Manual and Decision Guide) (SSMP, 2005; SSMP, PARDYP, SSD-NARC, 2000)

Duration of establishment: < 1 day

Establishment inputs and costs per ropani (= 1/20 ha)

Inputs	Cost (US$)[1)]	% met by land user
Seeds (2–3 kg)	1 - 2	100%
Labour (~2-3 days)	4 - 6	100%
TOTAL	**5 - 7**	**100%**

[1)] Exchange rate as per January 2007 US$1 = NRs 67

Maintenance/recurrent activities

1. None required

Maintenance/recurrent inputs and costs per ha per year

Inputs	Cost (US$)	% met by land user
TOTAL		

Assessment

Acceptance/adoption

The value of integrating legumes in cropping cycles is well understood by most farmers and about 80% of participating farmers used/had adopted this simple and inexpensive technology. It has also been adopted by farmers who have not directly participated in SSMP activities, by learning from their neighbours and peers. While this is not a new technology, farmers now consciously plan a legume crop for improved soil fertility.

Drivers for adoption

- Inexpensive technology
- Provides an additional high value or nutritious crop
- Reduces fertiliser requirements

Constraints for adoption

- Seed of some species may not be readily available

Benefits/costs according to land users

On average a benefit of US$ 40 to 50 per ropani can be expected from the production of legume species

Benefits compared with costs	short-term	long-term
establishment	positive	positive
maintenance/recurrent	positive	positive

Impacts of the technology*

Production and socioeconomic benefits

+ + + Reduced expenses for nitrogen fertilisers
+ Additional high value and nutritious crop
+ Nutritious livestock fodder

Production and socioeconomic disadvantages

- - Risky crop in terms of main yield

Socio-cultural benefits

none

Socio-cultural disadvantages

none

Ecological benefits

+ + + Reduced application of nitrogen fertilisers
+ Reduced soil erosion
+ Increase in organic matter

Ecological disadvantages

- - Highly susceptible to diseases and pests

Off-site benefit

+ + Reduced outside dependency
+ + Reduced nutrient influx into water bodies

Off-site disadvantages

none

* All changes in technology may have gender and equity implications and potentially affect the members of disadvantaged groups differently. This has not been assessed here but should be considered when recommending technology use.

Concluding statements

Strengths and ➔how to sustain/improve	**Weaknesses** and ➔how to overcome
Cost effective in terms of inputs and management practices in comparison with other commodities	Highly vulnerable to diseases and pests ➔ skip planting time (i.e. preponing planting of crops to get around life cycle of pests) , use location specific species, resistant varieties
Needs less agronomic practices and care (i.e. can be cultivated in zero or reduced tillage)	Very susceptible to waterlogging ➔only plant in well-drained soils
Has multiple uses: food crop, feed crop, fodder, soil building	In high fertility conditions, nitrogen fixing *rhizobium* does not work leading to less nitrogen fixation ➔ for very specific and new species, the soil needs to be inoculated with the correct strain of bacteria
Can be integrated in varying niches on farms and therefore does not need additional land	Legumes generally do not respond to nitrogen fertiliser ➔Do not apply nitrogen fertiliser to legumes
Rich indigenous knowledge exists	

Key reference(s): SSMP (2005) *Legume Integration Manual* (in Nepali). Kathmandu: Sustainable Soil Management Programme ■ SSMP; PARDYP; SSD-NARC (2000) *Legume Integration into Hill Farming Systems,* Decision Support Guide. Kathmandu: Sustainable Soil Management Programme, People and Resource Dynamics Project and Soil Science Division-Nepal Agricultural Research Council

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