New Approaches for Rehabilitating and Developing Fodder Production from Acid Mountain Soils in Nepal to Alleviate Poverty and Restore the Environment

D. Pariyar[1] and P. van der Grinten[2]

[1] Nepal Agricultural Research Council, P.o.Box 11660, Kathmandu, Nepal

[2] Hills Leasehold Forestry and Forage Development Project, c/o FAO/UNDP, P.o.Box 107, Kathmandu, Nepal

ABSTRACT

The approach for the re-integration of degraded areas in the farming system demands methods that are simple, affordable and sustainable. Under the Hills Leasehold Forestry and Forage Development Project (HLFFDP) technologies were trialed for the establishment of pasture legume and nitrogen fixing trees on degraded leased sites. Agrisilvipastoralism (ASP) applied using minimum or zero tillage has considerable untapped potential for simultaneously alleviating poverty and restoring the environment in Nepal. Preliminary results presented here indicate that with the introduction of suitable improved forage species under the application of simple establishment techniques, degraded lands have the potential to produce considerable amounts of fodder in a sustainable way.

KEYWORDS

Degraded land, rehabilitation, soil fertility, forage, leasehold forestry

INTRODUCTION

Nepal's hill farming systems are based on strategies to manage forest, pasture and arable lands in an integrated fashion to provide essential items. Resource-poor farming families facing food deficits try to extract their sustenance from support land resources (forests, pasture and other community lands). This is mainly accomplished through an increasing dependence on livestock, or through products and services offered directly by support land resources (HLFFDP, 1996).

In Nepal, at present, forest covers some 5.5 million ha and out of its total area 1.4 million ha (26%) is considered degraded, having less than 40% crown cover, while 0.6 million ha (11%) of the forest land is degraded shrubland (LMP, 1993).

Within the context of the Hills Leasehold Forestry and Forage Development Project (HLFFDP), it is targeted to improve and re-integrate in the farming system, a total area of 13,513 ha using a participatory approach with 14,224 families during the eight-year period of its execution.

The purpose of this study is to develop and demonstrate technologies for the establishment of suitable pasture legume and nitrogen fixing tree species on acid soils of degraded forest land. These technologies should be simple, affordable and sustainable from a farmers' perspective.

MATERIAL AND METHODS

Research sites. Soils on the majority of the leasehold sites are acidic, low in organic matter, available phosphate and possibly sulphur, boron and molybdenum. Grasslands in general, consists of poor sites with exposed rocks, stony at places, dry with severely eroded top soil. In most instances, the area has little plant cover and is of low productivity. Shrublands on the other hand consist of relatively better sites, with moderate soil fertility, thicker top soil layer and better moisture retention capacity.

In 1995, leasehold sites across four districts under grassland and shrubland in low (400-1200 masl) and transitional altitude (1200-1800 masl) were identified and trials established. In accordance with the project strategy, leased sites were protected against free grazing animals.

Soil samples and predominant edible plant species were collected from each site for their laboratory analysis and identification, respectively.

A. Pasture Legume Establishment. At four sites in low and one site in transitional altitude, *Stylosanthes guianensis* (cv. Cook) was established with (T1) and without (T2) fertilizer. A total area of 2000 m2 was covered using simple technologies, including minimum tillage (along the contour), line sowing (5 kg/ha), inoculation and lime pelleting of the seed (10 kg/ha). For T1, a basal dose of (starter-) fertilizer was applied; N, P_2O_5 and S @ 45, 115 and 30 kg per ha. Local grasses and weeds, on both sides of the lines, were occasionally harvested in order to reduce competition. Parameters collected included sward height, plant tillering and green matter (GM) yield.

B. Nitrogen Fixing Tree/Shrub Establishment. At four sites in both altitudes, seedlings (6" to 9") of *Bauhinia purpurea*, *Leucaena diversifolia* and *L. pallida* were planted, along the contour at approximately five meter distance (plant to plant and row to row). Planting technology included three treatments: T1, the recommended method (50x50x50 cm pit size + top soil + DAP 250 g and sulphur 150 g), T2, the improved current practice (30x30x30 cm pit size + top soil) and T3, the indigenous method (20x20x20 cm pit size + top soil). Parameters collected included plant height, number of branches per plant and survival rate.

Both trials had no replication at the sites, but were repeated on grassland and shrubland sites within each district. Data collection was carried out post-monsoon (September) in 1995 and 1996.

RESULTS AND DISCUSSION

Soil analysis confirmed the varied and in general poor soil fertility status of the sites. In addition to the physical conditions, the sites represent the typical characteristics of over-utilized land. In both low and transitional altitude of the mid hills of Nepal, this type of land is found all over as a product of a high population pressure and the prevailing (free) grazing system.

A total of 125 different species of graminea and shrubs were identified. The predominant native forage species encountered included *Heteropogon contortus*, *Imperata cylindrica* and *Pogonatherum sp.*. Although their importance as fodder is clearly recognized and valued by the farmer, their fodder potential, both in quantity and quality is limited.

A. Pasture Legume Establishment. In the stylo establishment trial, non of the parameters showed any difference between grassland and shrubland sites. Between fertilizer and non-fertilizer treatment, however, differences occurred, more so in the second year of observation at low altitude. On these sites, average sward height was 103.2 and 62.8 cm for fertilized and non-fertilized plots, respectively ($p<0.01$). Average GM yield was recorded at 32.2 and 10.9 t GM per ha per cutting, respectively ($p<0.001$) (Table 1).

The extra quantity and better quality forage available will relieve fodder scarcity and increase livestock production. In some cases, forage may be sold on the local market, on which a high demand for good quality fodder exists. The extra 20 t GM per ha was valued at US$ 265, whereas the additional costs for fertilizer application amounted to US$ 90 per ha. Both, utilization and selling, will contribute to income generation for the poor family and thus will help to alleviate poverty, restoring the environment at the same time.

B. Nitrogen Fixing Tree/Shrub Establishment. As in the above trial, for non of the parameters differences occurred between grassland and shrubland sites. Between treatments, differences were detected only for plant height. At transitional altitude in the first year, the recommended method (T1) differed from T2 and T3 ($p<0.05$) with an average plant height of 27.1 cm for T1, whereas T2 and T3 recorded values of 18.5 and 16.5 cm, respectively. At low altitude in the second year only T1 differed significantly from T3 ($p<0.05$) with values of 126.7, 75.4 and 63.3 cm for T1, T2 and T3, respectively (Table 2). No differences in survival rate were observed for the three establishment techniques.

It may be concluded that for the evaluation of establishment techniques of nitrogen fixing tree, more consecutive years of observations will be needed. The extend to which plant height is an indicator for future fodder production potential is unknown and focus will be on the economic feasibility of fertilizer application, which is mainly related to survival of seedlings and fodder production.

Conclusively, albeit preliminary, it is found that degraded lands have the potential to produce considerable amounts of fodder. Although it is recognized that protection against grazing animals by itself would increase fodder production, the introduction of suitable improved species (like *Stylosanthes guianensis*) and the use of simple establishment techniques can enormously boost fodder production, both in an environmental and economically sound way. This applies not only for the concept of leasehold forestry but for re-integration of degraded lands in the farming system in general.

ACKNOWLEDGEMENTS
We are thankful to Mr. A. Sterk, Chief Technical Advisor of HLFFDP-GCP/NEP/049/NET, Mr. J.C. Gautam, Executive Director of NARC and Dr. E.J. Stevens, FAO International Consultant for their support and help to conduct the research. While in the field, support provided by the field staff of NARC and TA and the assistance provided by the project beneficiaries is highly appreciated.

REFERENCES
HLFFDP. 1996. ASP: Agrisilvipastoral Approach to Poverty Alleviation and Rehabilitation of Degraded Lands. Hills Leasehold Forestry and Forage Development Project. Project Working Paper 19. By: E.J. Stevens, D. Pariyar, B.N. Tiwari and P. van der Grinten.

LMP. 1993. Livestock Master Plan for Nepal. The Livestock Sector. His Majesty's Government of Nepal/Asian Development Bank/ ANZDEC.

TABLE 1
Sward height (cm), tillering and green matter (GM) yield (t/ha per cutting) (±standard deviation) of *Stylosanthes guianensis* (cv. Cook) established with and without fertilizer on grassland and shrubland at different altitudes in Nepal.

Altitude	Low		Transitional	
	Fertilizer	Non-fertilizer	Fertilizer	Non-fertilizer
Sward Height (cm)				
1995	41 ±16*	26 ±10	28 ±33	3 ± 0
1996	103 ±24**	63 ±28	41 ± 3	43 ± 0
Tillers per Plant				
1995	6 ± 2*	4 ± 2	-	-
1996	20 ±16	10 ± 7	9 ± 2	10 ± 1
GM Yield (t/ha)				
1995	3 ± 2	3 ± 3	-	-
1996	32 ±10***	11 ± 5	-	-

*, ** and *** indicate a significant difference with p<0.05, p<0.01 and p<0.001, respectively, between fertilized and non-fertilized plots within each year of observation and altitude.

Table 2
Plant height (cm), branching from main stem and survival rate(%) (±standard deviation) of *Bauhinia purpurea, Leucaena diversifolia and L. pallida* established using three treatments on grassland and shrubland at different altitudes in Nepal.

Altitude	Low			Transitional		
Treatment	T 1	T 2	T 3	T 1	T 2	T 3
Plant Height						
1995	47 ±28	40 ±20	27 ±15	27 ±10^{A}	19 ± 6^{B}	16 ± 6^{B}
1996	127 ±49^{A}	75 ±43^{AB}	63 ±31^{B}	30 ±22	27 ±15	22 ±14
Branches/Plant	-	-	-	-	-	-
1995						
1996	6 ± 2	4 ± 1	4 ± 1	4 ± 2	3 ± 1	3 ± 1
Survival Rate						
1995	89 ± 9	88 ± 8	87 ± 7	79 ±12	76 ±13	81 ±13
1996	71 ±24	88 ± 8	56 ±33	58 ±31	53 ±34	57 ±26

T 1 = Recommended method (50x50x50 cm + Top soil + DAP 250 g + sulphur 150 g per pit).
T 2 = Current Improved Method (30x30x30 cm + Top soil).
T 3 = Indigenous Method (20x20x20 cm + Top soil).