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THE IMPORTANCE OF OATS IN RESOURCE-POOR ENVIRONMENTS

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ABSTRACT

The impact of introduced western oat cultivars, used as livestock fodder, on people living in resource-poor areas of Asia over the past two decades has been remarkable. In Nepal and other areas along the Himalayas, greenfeed oats have helped significantly to alleviate starvation and improve nutrition. This success of this has stimulated the belief that even more can and should be done to help up-date these cultivars and bring new adapted oats and other improved greenfeeds to resource-poor regions throughout the world.

Key words: Oats, Asia, China, Nepal, Pakistan, Himalayas, greenfeed, impoverished regions, resource-poor environments, fodder oat network, forage crops in undeveloped, difficult and cool climatic regions.

INTRODUCTION

Resource-poor areas where oats have potential for poverty alleviation include lowland as well as highland areas stretching all the way from latitude 48^{o} South (Chile and Argentina) to more than 60^{o} North (the former Soviet Union). This includes many areas inhabited by poor minority groups living within larger ethnic majorities in Central and South America, the Horn of Africa, Nepal, Bhutan, Myanmar, Thailand, Indonesia, Cambodia, Laos, Vietnam, the Balkans, Central Asian Republics, South and North Korea for example.

Oats are or have the potential to become an important crop for improving the well being of millions of impoverished people dependent on livestock, who have either been passed by, or fall outside the main stream of international humanitarian aid or other development support. Oats have been shown to have great importance in countries that have been at war for many years, such as Afghanistan, and also in Bosnia and other trouble spots around the world, as well as emerging market economies including China and large areas of the former Soviet Union where they are used directly and/or crossed with local materials including local landraces (still in need of collection, documentation and preservation). More can and should be done to help up-date these cultivars and bring adapted oats and other improved greenfeeds to impoverished regions throughout the world.

Oats originating from New Zealand, Canada and Europe and introduced into Asia over the past 20 years continue to play a highly significant and strategically important role in feeding livestock across a wide range of ecologies, especially within the poorer regions of countries bordering the Himalayas, where they are used either as greenfeed or oaten hay. Considerable genotype by environment interaction has been noted across latitude / altitude / seasonal sequences, with some cultivars producing significantly better than others in certain areas / management regimes. So far, this is poorly documented and has only been modestly exploited due to limited local resources and lack of a regionally co-ordinated approach. Besides historic materials, more recently bred oat cultivars and previously discarded crosses never tested in these areas may have an important role to play in humanitarian relief, poverty alleviation and development throughout the developing world. This is, provided, they can be properly introduced and systematically evaluated, tested, multiplied, maintained, and disseminated / sold / traded. The same applies to legume companion crops such as vetches, peas and clovers.

This paper presents a case study from Nepal covering such materials, dating back to the 1950s, re-enforced with examples from Pakistan, Afghanistan and China, highlighting the need for and advantages of developing a co-ordinated international fodder oat network targeting resource-poor environments.

NEPAL

The increasing population in Nepal (presently more than 20 million inhabitants) has put severe pressure on domestic food production, arable land, forest resources and the environment in general. There has been and still is an on-going massive human migration from the hills to lowland areas, and from rural villages to the cities which has been precipitated by a combination of factors including long-term global climate changes, accelerated population growth, fragmentation of individual family land holdings and accelerated deforestation and degradation of arable and grazing land resources (Table 1).

There has been widespread drying up of natural streams, springs and seepage areas at all altitudes combined with increased flooding, erosion and local climatic changes causing substantial areas of formerly cultivated land to be abandoned. This has been accentuated by the closure of borders with Tibet during the mid 1980s, which broke traditional co-habitation and summer migratory trading and grazing patterns, putting extreme year-round-pressure on already fragile high altitude grazing lands and catchment areas feeding some of the largest and most densely populated river systems in the world. Increased tourism as an alternative income source to traditional farming / livestock management has also put additional pressure on fuel wood supplies in these areas (Rajbhandari and Shah, 1981; DFAMS, 1986; MPFS, 1988 LMP, 1990).

Table 1. Thirty-year trends in human and animal population, and forest coverage in Nepal[1].

Decade	Human Population ('000)	Animal Population ('000 head)	Forest Area ('000 ha)
1960s[2]	9413	-	6500
1980s	15023	8226	6000
1990s	18600	8783	5500

[1]Archives, His Majesty's Government of Nepal.
[2]Feudal system, pre land reform.

The average area of arable land farmed by a family has dropped from more than one hectare during the 1960s to less than 0.25 ha per family today. Many rural households (almost half) now have less than 0.18 ha, from which they can barely meet half of their staple food requirements. This is forcing impoverished families to become increasingly dependent on the government as well as communal forests and rangeland (FAO, 1992; Pariyar, 1992; HLFFDP, 1996). Other mountainland countries in the region are suffering the same pressures.

Role of Fodder Oats in Nepal's Development Strategy

Resolving livestock forage and fodder constraints have dominated Nepal's development strategies for almost fifty years. During the pioneering 1950 - 60s era, rangelands were targeted for producing more milk and cheese from yaks and yak hybrids. With increasing environmental pressure, this changed to focus more on zero grazing / cut and carry systems targeting environmental conservation and sustainable land management covering a wider range of livestock classes and types, many and varied ecologies, and an increasingly diverse selection of fodder crops (including fodder legumes, oats and trees). Increased importance was given to this during the 1990s, as the widespread extent and seriousness of Nepal's ecological crisis began to emerge, particularly in the medium elevation (700 to 2,500m) and the high hill areas (above 2,500m).

Photo 1. Greenfeed oats quickly developed as a major source of winter and spring fodder for dairy animals.

Malaria control, plus forest clearing in lowland plain (Terrai) areas of Nepal (below 500m) bordering India during the 1970s and 80s opened up new arable land for families from the adjacent middle regions, and the high hill areas (bordering Tibet). Dairying became popular in these lowland Terrai areas where greenfeed oats quickly developed as a major source of winter and spring fodder (Photo 1). Building on this, fodder oat technology was then very successfully re-introduced into mid (400 to 2,500m) and high hills(above 2,500m) during the 1990s (Photos 2 and 3). Degraded forest and other government lands were leased to local families (1 ha / family, for 40 years, renewable) for re-development in conjunction with their traditional holdings, using legume-based rotations incorporating compulsory zero grazing / stall feeding and improved milk

animals, especially buffalo (IFAD, 1990; Pariyar, 1996; Pariyar, Munakarmi, Shrestha and Mishra, 1999).


Photos 2 and 3. Greenfeed oats were successfully re-introduced into the mid and high hills during the1990s using cut and carry systems for stall-fed and tethered animals, to spell degraded land and allow it to regenerate.

Protecting mid- and high altitude degraded land (400 to 2,500 and above 2,500m, respectively) from grazing animals by using stall feeding and tethering[1] as part of traditional rotations, allowed rapid regeneration of the indigenous vegetation and naturalised exotic species in economically viable ways under leasehold forestry. Within a three to five years, depending on altitude, degraded lands could again be producing more than 1 t/ha of dry hay (Paudel and Tiwari, 1992; HLFFDP progress reports 1998/99).

New Zealand Background

Forage crop varieties sent from New Zealand to Nepal have played a significant role over the past 40 years for improving livestock nutrition and alleviating poverty. Fodder oats have been especially successful for zero grazing / stall-feeding which is environmentally friendly and normally practiced across a wide range of altitudes and ecologies from 400 to higher than 2,500m covering tropical / sub-tropical, temperate and continental climates. Very often, farmers have travelled for up to five days each way on foot to procure seed (Photo 4) to begin their own village multiplication and production programmes (Photo 5).


Photos 4 and 5. Farmers from remote areas often travel ten days on foot to collect and carry back fresh oat seed needed to establish and maintain their village seed multiplication programmes.

New Zealand's involvement with fodder improvement in Nepal started during the 1950s with the successful introduction and dissemination of Grasslands Huia white clover (Trifolium repens) in temperate zones 1,200 m and above, followed with Grasslands Maku lotus (Lotus pedunculatus in warm temperate and temperate transition zones 1,200 to 1,800m). Whero field pea (Pisum sativum) at all altitudes and various NZ ryegrass, clover and fescue cultivars (1,200m and above). Plus a range of fodder oat cultivars able to be grown successfully at all altitudes ranging from tropical / sub-tropical winters in lowland areas through to high alpine summers above 2,500m, usually mixed cropped with one of several vetches (Viciasativa, or Vicia faba), field pea (Pisum sativum) or grass pea (Pisum lethyrus) depending on altitude. NZ DSIR (now NZ CFRI) has been the major supplier of research samples / quantities of these seeds (donated), combined with commercial importations made by the Food and Agricultural Organisation of the United Nations, Asian Development Bank and various other projects. Supporting research and extension has been provided by the Nepal Agricultural Research Centre and HMG Ministry of Agriculture as implementing partners.

The greenfeed oat types sent (Table 2) focused on rapid early growth and a good yield of herbage under the cool, low fertility conditions comparable to those often experienced during the Canterbury, New Zealand winters. G.M. Wright, at Lincoln, bred most of the NZ cultivars sent. The lines designated Can/NZ were derived from crosses made in Canada but selected for New Zealand conditions by M. McEwan at Palmerston North, as part of a collaborative agreement.

Cultivar / Line	Origin	Maturity	Breeding History	Characteristics in New Zealand
32302	NZ	Med	Ohau/Lyon	Med-tall, broad leaved,cold tolerant
346/2	NZ	Med	Goodland/Omihi//293	Med-tall, broad leaved, Good DM yield.
83 Inc 19G3	Can/NZ	Med	Unknown	Good biomass Broad leaves.
Amuri	NZ	Med	3mf/VR Algerian	Good winter greenfeed cultivar. Short straw. Tolerant to BYDV
Awapuni	Can/NZ	Med	Unknown	Good crown rust & BYDV res. Not cold tolerant. Good grain yield.
Canadian	Can/NZ	Med/Late	Unknown	Broad leaved. Very high DM yield. Good grain yield.
Caravelle	France	Med	Unknown	Black hulled. Not cold tolerant. Used for greenfeed in NZ.
Charisma	NZ	Med	Firecracker/Oreti	Good utility oat. Cold tolerant.
Kent	UK	Med	Unknown	----
Swan	Aust	Early / Med	Unknown	Narrow leaves. Not cold tolerant.
Makuru	N.Z.	Med	Forward/Milford	Main NZ milling/utility oat from its release as Mapua in 1953 until 1990's.
Taiko	NZ	Med	Complex cross Based on Onward	Main NZ black oat used for chaffing. Broad leaves. Med-short straw.

Table 2. Origin of Oat Cultivars sent to Nepal from New Zealand in the mid-1980s.

Achievements

Donated and purchased oat materials from New Zealand were first multiplied and then tested and evaluated across a range of altitudes / ecologies during the 1980s and 90s, from 400 to above 2,500m under a series of on-farm, farmer managed, and research station trials, plots and socio-economic surveys. These were variously supervised by technicians from the Nepal Agricultural Research Centre, HMG Ministry of Agriculture, and FAO and Asian Development Bank Projects. Representative examples of data generated from mid altitude zones (400 to 2,500m) / dairy pockets are given below (including Table 3; Pariyar et.al., 1999) and discussed. Green fodder and/or oaten hay produced from these cultivars were usually chopped by hand and fed mixed with other crop residues such as dried grass, wheat and maize

straw. Resulting animal wastes mixed with livestock bedding materials were returned to the land as farmyard manure according to established farmer practices / customs. The basal fertilizer application was 5t/ha of farmyard manure. Fertiliser treatment was either 15:50:0 kg/ha of NPK or zero. There were significant differences between the overall performance of cultivars at two of the three sites, and at all three sites for fertilizer treatments (Table 3), suggesting significant differences in agro-ecological adaptation. Across-site comparisons were not made. These data could not be properly compared with other data on record, due to limited computer and other resources for detailed field research and data analysis. International assistance is needed urgently.

Concurrently (1996-98), a series of on-farm crop-cut surveys was made of farmer-planted and -managed crops involving more than 1000 families farming between 400 and 2,500m above sea level in four districts of central Nepal (Makawanpur, Kavre, Sindhupalchowk and Ramechhap), using one or more of these cultivars of fodder oats grown as a single crop and/or mixed cropped with vetch, grass pea or fodder pea. Trials were replicated across farmers within and across altitude sequences, with and without fertilizer chemical fertiliser (40:60:0 kg/ha NPK) using a split plot design applied over normal farmer basal application rates of farm-yard manure / forest litter (10 t/ha). Activities were organised and implemented jointly by Nepal Agricultural Research Council (Pasture and Fodder Research Division) and the Hill Leasehold Forestry and Forage Development Project (HLFFDP Progress Reports, 1998/99).

Table 3. Performance (green weight t/ha) of different cultivars of oat, with and without fertilizer applied in farmer's fields within dairying areas of Rupendehi, Kaski and Illam (Nepal) during 1996-98.

District / Altitude Zone	Rupendehi (550-600 masl)						Kaski (800-850 masl)						Illam (1500-1550 masl)					
Year	1996		1997		1998		1996		1997		1998		1996		1997		1998	
Fertilizer/ Cultivar	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF
Caravelle	32.8	22.7	33.5	28.0	22.0	18.3	24.0	15.3	19.5	14.0	29.5	15.0	32.9	23.7	17.7	15.0	26.3	18.0
83INC 19G3	29.3	22.3	31.5	33.0	17.7	18.3	29.3	20.3	15.7	11.0	26.5	15.0	39.3	25.3	14.3	10.0	24.6	17.0
Canadian	36.3	24.7	29.2	27.0	16.8	13.7	30.0	21.3	17.8	14.0	27.5	16.0	35.0	24.0	17.7	14.0	26.0	19.0
Awapuni	40.3	22.7	29.8	26.0	29.0	13.3	25.3	18.3	15.0	10.0	26.5	13.0	29.7	21.0	13.5	8.0	23.3	16.7
Charisma	29.3	24.6	30.5	28.0	28.3	19.3	24.7	16.0	19.6	16.0	24.5	19.0	31.3	21.0	7.8	6.0	18.7	14.0
Taiko	40.3	30.6	29.3	24.0	16.0	15.5	33.9	23.7	17.5	11.0	28.0	16.5	35.3	24.0	15.7	12.5	22.7	17.0
Kent	31.0	29.0	28.8	32.0	27.0	20.0	27.0	20.9	17.0	9.0	28.5	16.0	39.7	26.0	18.8	14.0	21.3	14.7
Swan	36.0	30.4	28.0	26.0	26.0	15.0	25.9	16.9	19.0	13.0	20.5	13.0	33.7	22.7	16.1	10.0	25.0	19.1
F-test																		
Cultivar	**						*						NS					
Fertilizer	***						***						***					
CV%	3.54						4.25						5.58					
Lsd at 0.05	1.15						0.96						1.4					
Note: Fertilizer Treatment - (F) 5 t/ha farm yard manure plus 15:50:0 NPK (NF) Zero																		

Key findings were that:

- In many, but not all instances, more recently bred cultivars out-produced older ones.
- Oat/vetch combinations produced on average 25 t/ha of green material compared with 21 t/ha from oat plus pea mixtures and 20 t/ha from pure oat stands within the 400 to 800 m band.

- Significantly higher yields (up to three times these quantities) were produced within the 900 to 2,500m band compared with lower altitude zones, possibly reflecting better agro-ecological adaptation, but also higher in-coming radiation levels along the margins of the monsoon rain belt, above and/or beyond the foot hill temperature inversion layers typified by many months of low-lying fog bordering the adjacent plains of Nepal (Terrai zone) and India.
- Using oat/vetch mixtures increased milk production by 30 litres per animal per month on average, compared with traditional practices. At the same time, the demand for purchased concentrates was reduced by 30 kg / month and milk production was extended by an extra eight weeks. This translated into an additional net profit of 1,538 Ruphees per month (USD 22) under conditions where on average, the total cash income of families was USD 264.
- Not all milk was sold; additional production increased family dietary quality substantially over traditional practices, especially important for the young and the aged. (Milk and milk products are valued dietary constituents in this culture.) Fodder oat, vetch and pea seed was also produced for family use, bartering and for sale, represented an additional advantage.
- Compared with wheat and barley, the traditional sources of arable green fodder, fodder oats provided multiple cuts, yielded more, and are of higher nutritional value. Furthermore, they proved more flexible for specialised uses in local management systems where time- isolation was needed to produce commercial maize seed, high-value vegetable crops and other seed crops. A major reason for this was that the standing oat crop could be harvested progressively, releasing land earlier than normal for follow-up crops or relay cropping. Late in the season, any remaining standing crop could be cut at the farmer's discretion and dried as oaten hay, just as the monsoon was starting. This coincided with optimum soil moisture for land cultivation and the planting of the next crop. This also allowed small areas or peripheral lines on terraces to be saved for seed for the next season's crop. Managerial flexibility introduced in this way often made the difference between success and failure, good or bad summer crops, especially at the marginal higher altitudes on the fringes of the monsoon belt, where irrigation was not possible, or restricted.
- N and P fertiliser gave substantially higher yields than using FYM alone, especially on seriously depleted soils which had been monocropped for many years with wheat / maize / rice. However, increased usage of chemical fertilizer could not realistically be justified in many instances for economic as well as logistical reasons since most inputs had to be carried on people's backs along narrow foot tracks, often across steep terrain. Nepal has no indigenous commercial sources of artificial nitrogen or other inorganic fertilizers, is seriously short of foreign exchange, and farmers lack seasonal credit. Soils are mostly pre-weathered, heavily leached and seriously deficient in phosphate. Fertilizer usage is often limited to areas within one- to one and a half days walking distance of road heads, where it can be purchased and back loaded with porters carrying out milk / milk products. Beyond this, it was not economic to transport chemical fertilizer for use on fodder oats.
- More detailed analysis although needed, was not possible due to limited computer and other research resources including formal international linkages.

PAKISTAN AND AFGHANISTAN

Western fodder oat cultivars from Canada, Australia, New Zealand and Europe form the basis of Pakistan's fodder oat improvement programme which, dates back to the British era and includes materials (comparable to those supplied to Nepal) donated by NZ DSIR

/ NZ CFRI in 1979 then up-dated during the mid1980's both directly with NARC (National Agricultural Research Centre) which has the national mandate in oats, and through the FAO Across Border Agricultural Assistance Programme for Afghanistan. These materials were augmented by commercial importations made under the WB for Azad Kashmir during the late 1970s and the FAO Afghan Programme during the 1980s which, arranged for these materials to be further multiplied in the private sector in Pakistan under Government supervision (Seed Certification).

Fodder oats from these sources have been grown and used routinely by resource-poor farmers, commercial dairy units and the army in Pakistan in lowland as well as hill areas for 20 years, as green fodder (and some oat hay), and in Afghanistan by returning refugees, internally displaced persons and local residents since the mid 1980s. Depending on altitude and where they fitted into the rotation, they have usually been mix cropped with a range of locally adapted clovers, vetches, alfalfas, medics or brassicas, to improve traditional fodder yields in terms of quantity, quality and seasonal availability, grown as an alternative to barley, wheat or one of the forementioned fodder crops grown by itself.

Oats are especially important on the plains during the cooler autumn, winter and spring months and in the mountains during autumn, spring and early summer. Reported yields of green fodder and dry matter are generally higher than in the lowlands and mid hills of Nepal (up to three times using comparable varieties which include locally bred / selected materials of western origin), due mainly to better inherent soil fertility combined with the widespread use of chemical fertilizer and higher in-coming radiation (less fog and cloud cover).

In Afghanistan, oats have proved to be invaluable for feeding animals, especially those in milk, not able to use traditional grazing lands because of landmines. They were also of great importance where traditional cropping routines had been disrupted by war. Often the age-old irrigation systems had either been destroyed or had fallen into disrepair. Families were without their menfolk, impoverished and displaced. Available and safe cropping area had been diminished, the population was at the mercy of unreliable and highly seasonal rainfall and seldom able to harvest their grain crops. Under these circumstances, the people were even more dependent on livestock and fodder for their survival and very vulnerable to the vagaries of war.

CHINA

China has a long history in selecting and using local oat landraces, and in modern times, especially the last twenty years, breeding and testing improved cultivars incorporating materials from the same western sources as those successfully introduced into Nepal and Pakistan. Oats are now the main source of winter and spring forage in the higher and colder regions, especially Xinjiang, Inner Mongolia, Qinghai, Gansu, Heilongjiang, Jilin, Tibet and Shanxi Provinces. They are grown on more than 35% of the available arable land of northern Inner Mongolia and over 15% of the arable area of Gannan, Dixi, and the Linxia prefectures of Gansu. Grain yields vary from 2.4 to3.2 t/ha in the better environments but, less at higher altitudes (3000m). Green weight yields range from 40 to 80t/ha. In Gannan at an altitude of 3500m the highest recorded yield was 12t/ha greenweight.

CONCLUSIONS

Modern oat cultivars are not reaching millions of needy people in resource-poor environments, particularly in populations with minority groups, and in areas of the world where the people survive in difficult environments. Landraces and inferior cultivars bred and released

decades ago continue to be grown. New and improved material, although available internationally, cannot be easily or legally introduced or circulated, because of the absence of proper mechanisms, financing and networks, especially in small nations and/or minority areas which lack resources to develop their own breeding programmes.

There is an urgent need to launch and develop a globally co-ordinated forage and fodder oat programme for resource-poor regions of the world, to up-date and dispense suitable, modern oat cultivars through the CGIAR and other networks, along comparable lines to those which have been in place and operating globally since the late 1970s, for wheat, barley, maize, pulses, selected vegetables and other cash crops. Serious consideration should be given to bulking up and systematically evaluating past fodder oat crosses derived in New Zealand, Canada and Europe with good re-growth potential, never advanced due to poor seed yield characteristics, because some of them will undoubtedly have substantial application in developing countries / ecologies where seed yield is secondary to green fodder production for resource-poor farmers. Care should be taken while doing this to replicate tests / evaluations properly across altitude / latitude / planting date / management sequences at national, regional and international levels using well known, internationally recognised and established cultivars as standards, besides locally recommended cultivars and farmer choices.

Plant breeding alone will not be enough. A hands-on, multi-disciplinary, integrated approach is needed including, livestock improvement, small-scale direct seeding equipment and other appropriate mechanisation and seed supply systems. The organisation should involve representatives of the countries in need, plus the international community working with oats and other greenfeed crops. ILRI (International Livestock Research Institute), we feel would be an ideal international focal point for the proposed initiative (network), to be established and managed in co-operation with other international and national agencies, etc. throughout the world with the combined objectives of:

- Attracting donor funding (in cash and/or kind).
- Successfully linking the network with recognised United Nations and other educational and technical organisations, agencies and institutions mandated to work within targeted areas for humanitarian relief, rehabilitation and development.
- Suitably endowing the network with a portfolio of oat breeding materials, guidelines and finished cultivars keeping in mind that plant variety rights would probably have to be negotiated by the network as an integral part of releasing them to needy countries, through the network.

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REFERENCES

FAO. 1992. Government Co-operative Programme. Plan of Operation. Hills Leasehold Forestry and Forage Development Project (GCP/NEP/049/NET), Kathmandu, Nepal.

HLFFDP. 1996. Agrisilvipastoral approach to poverty alleviation and rehabilitation of degraded lands, strategies, policies and procedures. Hill Leasehold Forestry and Forage Development Project Working Paper 19, Kathmandu, Nepal.

HLFFDP. 1998/99. Hill Leasehold Forestry and Forage Development Project Progress Reports. Unpublished Reports. Hill Leasehold Forestry and Forage Development Project, Kathmandu, Nepal.

IFAD. 1990. International Fund for Agricultural Development, Appraisal Report. Hill Leasehold Forestry and Forage Development Project Working Paper, Kathmandu, Nepal.

Pariyar, D. 1992. Existing feed situation in different regions of Nepal and strategies developed to increase fodder production. Proceedings, ISGR Workshop, Huhahot, China.

Pariyar, D. 1996. A new approach for technology generation for forage resource development from degraded land. Unpublished paper presented at regional expert meeting on rangeland and pasture development in the Hindu Kush Himalaya, ICIMOD, November 5-7, 1996.

Pariyar, D., P.B. Munakarmi, K.K. Shrestha and C.K. Mishra, 1999. Performance of fodder species and their mixtures in dairy pocket areas (DPA) of Illam, Kaski and Rupendehi Districts. In proceeding of Third national workshop on livestock and fisheries research in Nepal, June 26-28, 1999, ARS, Lumle, Pokhara, Nepal.

Paudel, K.C. and B.N. Tiwari. 1992. Fodder and forage production in sustainable livestock production in the mountain agro-ecosystems of Nepal. FAO Animal Production and Health Publications. No. 105.

DFAMS. 1986. Main report of national farm management study , Nepal, 1983-85. Department of Food and Agricultural Marketing Service, Kathmandu, Nepal.

MPFS. 1988. Master Plan for the Forestry Sector, Nepal , His Majesty's Government of Nepal/ Agricultural Development Bank / FINIDDA.

LMP. 1990. Livestock Master Plan , Volume II. HMG/ADB/ANZDEC LTD.

Rajbhandari , H. B. and Shah , S. G . 1981. Trends and Projection of Livestock production in the hills of Nepal, Seminar on Nepal's experience in hill agricultural development , March 30-3 April,1981, Kathmandu , Nepal.

[1] Made possible by introducing fodder oats on to adjacent arable land, mixed cropped with legumes.