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Options available for improved forage production under highland conditions. The Pakistan experience

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Abstract. The forage production and availability were affected by single cut *vs*. multi-cut, hybrid *vs*. varieties, legumes *vs*. cereal crops, sole cropping *vs*. intercropping, altering planting dates, different types and doses of chemical fertilizer. Non winter dormant/ improved alfalfa and Egyptian clover varieties were 2-3 times more productive than the local landraces commonly cultivated in the region. The improved forage production techniques also provided forage during the deficit periods. Improving the performance of the high-altitude summer pastures being difficult and time-consuming task and would not alleviate the winter forage scarcity problem. Main emphasis should therefore, be put on improving fodder production and conservation on the agricultural holdings. Since holding size is minute, the aim must be to maximize production per unit of area. Fodder production in these isolated, high areas had been little studied. The population has had no easy access to the technology and seed supplies available in the plains and, for the higher areas, technology from lower down is not appropriate.

Keywords. Forage production – Sole cropping – Inter-cropping – Multi-cut – Single cut – Legumes – Cereal crops.

Les options disponibles pour l' amélioration des productions fourragères dans les Hautes Terres : Cas du Pakistan

Résumé. *La production et la disponibilité de fourrage ont été affectés par la coupe simple* vs *multi-coupe, hybride* vs *variétés, les légumineuses* vs *cultures céréalières, la monoculture* vs *cultures intercalaires, les dates de plantation, les différents types et les doses d'engrais chimiques. Les variétés améliorées de luzerne et de trèfle d'Alexandrie étaient 2-3 fois plus productives que les variétés locales couramment cultivées dans la région. Les techniques améliorées de production de fourrage ont également fourni du fourrage pendant les périodes de déficit. Améliorer la performance des alpages est une tâche difficile et de longue haleine et ne résout pas le problème de la rareté du fourrage d'hiver. L'accent doit donc être mis sur l'amélioration de la production fourragère et de conservation sur les exploitations agricoles. Puisque la taille des exploitations est infime, l'objectif doit être de maximiser la production par unité de surface. La production fourragère dans ces régions isolées et élevés a été très peu étudiée. La population n'a pas eu un accès facile aux technologies et semences disponibles dans les plaines et, pour les zones les plus élevées, la technologie de zones plus bas n'est pas approprié.*

Mots-clés. *Production fourragère – Monoculture – Cultures intercalaires – Multi-coupe – Coupe simple – Légumineuses – Cultures céréalières.*

I – Introduction

Lack of quality fodder throughout the year and especially during winter is the major limiting factor for livestock production in the mountain areas of Pakistan. Most of the rangelands are overgrazed and poorly managed. Most of the irrigated area is planted with cash crops such as orchards, vegetables, staple food crops, etc. Therefore, intensification of improved fodder produc-

tion near villages as a sole crop as well as intercropped in the orchards would be of great economic benefit in order to produce more feed of better quality, for maintaining animals over winter and for weight gains in spring. Under the present situation insufficient fodder with poor quality is available in the area and hence the animals are underfed, lean, and less productive. Traditional systems of farming will not be adequate for a changing human population.

These paper reports results of on-farm evaluations conducted in higher-altitude maize-wheat based farming systems in the Northern areas of Pakistan and options available to enhance forage production.

1. Enhance fodder yields, quality and soil fertility per unit area per season

In order to obtain early and good yields on small holdings in winter, compatible fodder crops may be sown in mixture to produce higher fodder yields and quality per unit area per season. Low growing leguminous fodders such as lucerne, berseem, and vetch can be mixed with oats, barley, ryegrass, brassica etc. Lucerne + oats, berseem + oats and shaftal +oats combinations produced 190, 130 and 80 t/ha of green material compared with 120, 89, 45, and 90 t/ha Lucerne, berseem, shaftal, and oats pure stands respectively (Table 1).

Table 1. Yields (tonnes/ha) of some leguminous forage crops

Variety	Green forage	Air dry matter
Local lucerne	55	19
Sunder lucerne	120	45
Sunder + oats	190	58
Shaftal	45	14
Shaftal + oats	80	25
Berseem	89	28
Berseem + oats	130	47
Oats	90	38

Source: Dost, 1997.

Jefferson and Zentner (1994) reported that lucerne sown alone produced much less than oat sown with Lucerne or oat sown alone in the establishment year. In contrast, Brink and Marten (1986) showed that oat as a companion crop to Lucerne had inferior forage quality compared with barley when the mixture was harvested in the sowing year.

2. Non winter dormant *vs*. winter dormant lucerne varieties

Several non winter dormant and winter dormant varieties of lucerne were evaluated at three sites during 1993-95. The details are presented in Table 2. Non winter dormant lucerne variety Sundar has been extremely successful at all three sites. They may suffer some frost damage at high altitudes but grow throughout the year and yield more than twice as much as the winter dormant landrace in double crop areas below 2,000 m. They also provided maximum green feed in the critical December-January forage deficient period.

Table 2. Green and dry matter yields (t/ha) of lucerne varieties at three sites

Varieties	Sites					
	Chilas		Gilgit		Skardu	
	Green fodder	Dry matter	Green fodder	Dry matter	Green fodder	Dry matter
Sundar	165	50	174	52	90	26
Misasirsa	98	32	117	34	74	20
Pioneer	92	29	95	30	86	22
Sanora	90	27	84	24	73	20
Illunico	71	22	68	22	70	19
Type 8/9	100	32	96	30	74	21
Powera	58	19	61	19	68	18
Local	55	16	60	18	57	17
Average	91.13	28.38	94.38	28.62	73.25	20.38

Source: Dost, 1995.

1.3. Forage availability through manipulation of planting seasons

Supply of forage mainly depends on the time of sowing. In developing countries where fodder is very scarce, the time of fodder availability during deficit or lean periods is more important than the total quantity of fodder available. Sowing date trials on high forage yielding oat cv. Scott were conducted at research institutes throughout the country under various agro-ecological environments. The results obtained are presented below.

At Gilgit and Chilas, the 15 October sowing, and the 15 November sowing at Juglot, provided maximum forage in December-January, the fodder deficit period. September sown crops provided acceptable yields in November at all sites, time of fodder availability is directly correlated with sowing time (Table 3).

Table 3. Green yields (t/ha) of oat cv S-81 at various sowing dates at three sites during 1995

Treatments	Gilgit	Chilas	Juglot
September 20	74	55	25
September 27	65	53	27
October 1	62	50	29
October 7	80	60	30
October 15	88	78	30
October 22	70	55	35
November 1	60	52	37
November 8	55	40	39
November 15	51	43	47
November 22	48	35	36
November 29	40	58	31

Source: Dost, 1997.

1.4. Increased forage production through fertilization

Different doses of nitrogenous and phosphatic fertilizer produced substantially higher yields at five locations in Pakistan than using no fertilizer or farmyard manure alone, especially on seri-

ously depleted soils that had been mono-cropped for many years with cereals. Maximum forage yields were obtained through application of 150-75 N-P kg/ha at most sites, followed by 150-25 N-P kg/ha (Table 4). However, increased use of fertilizer could not be justified in many instances for economic and environmental reasons.

Table 4. Green yield (t/ha) of oat cv. Scott under different fertilizer doses and sites in 1999-2000

Fertilizer (N-P kg/ha)	Green fodder yield				
	Islamabad	Tandojam	Tarnab	Sariab	Faisalabad
100-25	74.69	59.56	30.78	46.00	96.29
50-50	61.11	52.16	28.01	42.33	79.32
50-25	56.79	57.40	25.23	40.33	70.37
50-75	61.11	55.24	28.94	47.33	101.23
150-25	80.86	74.99	29.40	45.33	98.45
150-75	87.04	74.09	30.78	56.66	112.04
100-50	74.69	62.34	31.95	50.00	99.38
00-00	37.65	44.13	27.78	32.00	52.16

Source: Annual Report 2000, Fodder Research Programme, NARC, Islamabad.

1.5. Single cut *vs*. multi-cut forage varieties

Compared with wheat and barley in Pakistan, oats provide multiple cuts, tiller profusely, yield more, and are of higher nutritional value (Table 5). Standing oats can be cut progressively, releasing land earlier than normal for follow-on crops or relay cropping. Any remaining oats can be dried as hay. This coincides with optimum soil moisture for land cultivation and sowing of the following crop, and also allows small areas or peripheral lines on terraces to be saved for seed. In many, but not all instances, more recently bred cultivars out-yield older ones (Dost, 1994).

Table 5. Average plant height (PH), tillers per plant (TL), leaves per tiller (LV), green fodder yield (GY), dry matter yield (DY), seed yield (SY), Crude protein content (CP), and crude fibre contents (CF) of oats cv. S-81 in Islamabad, 1991-92

Treatments	PH	TL	LV	GY	DY	SY	CP	CF
CT 1	63.63	6.18	4.89	13.59	2.07	0.85	12.29	22.32
CT 2	83.70	6.80	5.89	16.92	2.57	0.54	12.25	22.94
CT 3	90.06	6.89	6.26	23.46	4.08	0.48	8.68	24.50
CT 4	94.74	7.07	6.59	33.33	6.60	0.46	8.46	25.58
CT 5	134.78	6.46	6.56	54.99	12.99	–	7.94	25.60
CT 6	–	–	–	–	–	1.34	–	–
LSD (P = 0.01)	10.70	0.54	0.63	4.73	1.24	0.24	0.34	0.36

CT 1: Cut for fodder 70 days after sowing and then for seed, CT 2: Cut for fodder 85 days after sowing and then for seed, CT 3: Cut for fodder 100 days after sowing and then for seed, CT 4: Cut for fodder 115 days after sowing and then for seed, CT 5: Cut at 50% flowering for fodder only, CT 6: No fodder cut but left for seed only.
Source: Dost, 1994.

Although the use of oats as a multi-cut crop is common in Pakistan, relatively limited research data are available in Pakistan on forage quantity in crops harvested at various stages of maturity, so studies were carried out to determine the ideal stage to obtain a compromise between maximum

forage yield and reasonably good forage quality. Hussain *et al*., (1998) evaluated oats, barley, and wheat for forage yield and quality at nine growth stages at Islamabad during 1990-1992. Oats harvested at head emergence stage and barley and wheat at full flowering produced maximum green yields. In all three crops, the highest dry matter yield was recorded at early dough stage. The maximum crude protein content was recorded at four leaf stage repeatedly, whereas minimum protein content was recorded in the early dough stage. Oats, barley, and wheat harvested at boot stage provided a good compromise among green fodder yield, dry matter yield, and forage quality. At this stage, a sufficient quantity of fodder with moderate forage quality was obtained (Table 6).

Table 6. Green and dry matter yield and crude protein content of oats, barley, and wheat under various cutting regimes

Cutting stage	Green fodder yield (t/ha)				Dry matter yield (t/ha)				Crude protein (%)			
	Oats	Barley	Wheat	Mean	Oats	Barley	Wheat	Mean	Oats	Barley	Wheat	Mean
CS 1	37.66	33.15	21.73	30.84	5.81	4.80	3.93	4.85	14.93	13.47	12.56	13.65
CS 2	40.43	35.74	26.26	24.15	7.13	5.75	4.78	5.89	14.07	12.78	11.97	12.34
CS 3	56.45	44.77	24.49	41.90	10.68	7.49	4.67	7.61	12.65	11.70	11.53	11.36
CS 4	67.16	51.30	28.80	49.09	12.41	9.21	6.52	9.39	10.80	9.85	10.21	10.28
CS 5	69.44	48.45	31.78	49.89	12.15	8.05	7.41	9.21	8.75	8.42	8.15	8.44
CS 6	64.60	56.39	30.66	50.55	11.43	10.26	7.08	9.59	8.10	7.72	7.50	7.77
CS 7	68.21	58.42	40.51	55.71	13.35	11.17	9.83	11.44	7.63	7.54	7.32	7.50
CS 8	64.27	53.93	33.95	50.72	13.99	13.40	10.83	12.74	7.50	7.02	6.96	7.16
CS 9	51.21	42.52	33.72	42.52	17.17	14.67	12.23	14.69	7.15	6.85	6.75	6.92
Mean									10.17	9.22	9.48	

CS 1: Repeated cutting at 4 leaf stage, CS2: Repeated cutting at tillering, CS 3: Repeated cutting at jointing, CS 4: Repeated cutting at boot stage, CS 5: Harvesting once at head emergence, CS 6: Harvesting once at 50% flowering, CS 7: Harvesting once at 100% flowering, CS 8: Harvesting once at early milk stage, CS 9: Harvesting once at early dough stage.

Source: Hussain et al., *1998.*

1.6. Hybrid *vs*. varieties

Local maize and millet are dual purpose crops extensively grown in North Pakistan. Multi-cut hybrid sorghum could ensure maximum tonnage of green as well as dry matter well distributed throughout the summer growing period.

Overall hybrid sorghums provided four cuttings in Gilgit and Chilas and two in Skardu and Khaiber. At all the locations, all the hybrids produced 2-3 times more green fodder and dry matter yields well distributed over the entire growing period as compared to the traditional local maize and millet cultivars. Due to higher temperatures in Gilgit and Chilas, maximum forage yields were recorded as compared to Skardu and Khaiber (Table 7).

Table 7. Green and dry matter yields (t/ha) of different sorghum hybrids and local maize and millet cultivars

Varieties	Sites							
	Gilgit		Chilas		Skardu		Khaiber	
	Green fodder	Dry matter	Green fodder	Dry matter	Green fodder	Dry matter	Green fodder	Dry matter
LS-4000	117	34	109	32	68	26	62	22
S.S.G.988	141	42	92	30	60	20	53	18
Forage sorghum	125	37	75	28	66	24	58	20
Sordan-91	138	45	102	30	75	29	66	23
S.S.G-1	110	33	95	26	64	23	56	19
Average	126.20	38.20	94.60	29.20	66.60			
Local Maize	38	13.23	41	15	33	12.49	30	9
Local Millet	35	12	33	11	30	9	28	8

Source: Dost, 1998.

II – Conclusions

It was observed that the hybrid multi-cut hybrid sorghums which were scarcely known in the area have produced 100-125 tones/ha green fodder yields as compared to 25-30 tones/ha fodder yields by local maize. The improved varieties of maize were superior in grain yields, stover yields, and green fodder yields as compared to local landraces. However, improved varieties were 20-30 days late in grain maturity. Also the improved oats and lucerne varieties produced 2-3 times more yields as compared to local varieties.

The improved berseem clover varieties produced 132-140 tones green fodder yields in six cuts as compared to 80-85 tones by shaftal clover in three cuts. Although there is no tradition of applying chemical fertilizers to the forage crops, maximum forage yields were obtained through application of 150-75 N-P kg/ha at most sites. However, increased use of fertilizer could not be justified in many instances for economic and environmental reasons.

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