Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia

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Project Achievements in Pakistan

The *"Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia"* project was implemented from 1 June 2006 to 31 December 2009 starting the field activities in the winter cropping season 2006-07 and ending them in the summer season 2009. The project was implemented using a community based participatory approach to meet the needs of resource-poor farmers in Punjab Province[1] (see an. It used an integrated approach testing crop and livestock interventions. The emphasis of the project was on improving the feed resource base through dissemination of improved packages to increase fodder production and conservation; improving the quality and efficient use of crop and agro-industrial by-products for meat and milk production; and value addition to target market niches.

This report summarizes the achievements in Themes 1 to 3 at the rainfed site in Gujar Khan and the irrigated site in Sargodha over the full project duration. It is to be used as an annex to the final Project Report.

1 Theme 1: Socioeconomic Assessments

1.1 Baseline study of smallholder feed-livestock production systems at rainfed and irrigated sites

1.1.1 Introduction

Livestock sector plays an important role in the economy of the Pakistan with a share in national and agricultural GDP estimated to be 11.3 and 51.8 percent respectively. The value of livestock is 6.1 percent more than the combined value of major and minor crops (GOP, 2009). The role of livestock in rural economy may be assessed by the fact that 30 to 35 million rural people are engaged in livestock farming, deriving 30 to 40 per cent of their income from it. Pakistan accounts for 143 million animal heads in 2006 (GOP, 2006). However livestock population and fodder production are inversely related. The fodder area per adult animal unit has significantly declined from 0.067 ha to 0.035 ha and production declined from 1.31 ton to 0.80 ton from 1986 to 2006. Inadequate nutrition is one of the major constraints limiting livestock productivity in the country. Feed accounts for almost 70% of total cost of production of milk or meat. Keeping in view the importance of livestock in the livelihood of the people, scarcity of green fodder and feed different interventions were done at the project sites under Community Action for Livestock Development Project in Pakistan. The objectives of the interventions were to promote the adoption and fulfill the requirement of fodder and feed at local level and to get the maximum potential in terms of milk and meat.

Livestock is an integral component of the rainfed and irrigated farming system. Livestock rearing is considered as a substitute for crop farming and provides security against crop failure due to uncertain weather conditions. Livestock production has tremendous potential for development. The sector confronts host of constraints which if circumvented can double the output of livestock products. The present project was initiated to develop the productive and sustainable livestock based system in the rainfed and irrigated areas through the integration of range, livestock and crop production, with a view to improve the income and

[1] See Annex 1 that gives an introduction to agriculture in Pakistan.

welfare of the small holders. This project was initiated with active participation of the farmers and the direct involvement of the national and provincial agricultural research systems. The applied research approach linked farmers to research in developing market driven technological packages for feed and livestock production.

Feed resources development now understood as the underpinning factor for achieving required growth in livestock productivity. Spread of improved Feed-Livestock Management (FLM) projects' impact assessment has become more demanding and complex. The community based feed-livestock development approach aims at generating suitable technology packages with the particular emphasis on increase in feed as well as livestock productivity and market oriented products development. The ultimate purpose of participatory applied research is to achieve a significant improvement in the feed resources availabilities and promote improved livestock management for sustainable and profitable feed-livestock production.

Policy-makers, donors and their partners, development workers and researchers increasingly demand evidence of the impact of interventions and investments for research, development and implementation in agriculture in developing countries like Pakistan. Impact assessment has been defined as an activity "intended to determine more broadly whether the program had the desired effects on individuals, households, and institutions and whether those effects are attributable to the program intervention." Attribution in the context of impact assessment relies upon the identification of one or more "counterfactual" scenarios, which attempt to project the evolution of metrics of interest in the absence of the assessed activity. In order to appraise whether net benefits are sufficient, it is generally necessary to quantify their magnitude and distribution. Such analysis may be historical (ex post) or prospective (ex ante). We will use ex post analysis technique to assess the impact of this project by collecting data on pre-identified and verifiable indicators and to develop an empirical basis for recommending policy interventions and up-scaling of validated feed-livestock development packages.

1.1.2 Methodology

1.1.2.1 Site Selection

Selection of the sites for the project was made based on the enterprising nature and market access. One control village was selected at both rainfed and irrigated sites. At the rainfed site, Lodhay village of Gujar Khan Tehsil of Rawalpindi district was selected as project site due to the enterprising nature of the community. Nata Mora village which was 8 km away from project site was selected as control village for impact evaluation. At the irrigated site, two villages (Chak No. 74/SB and 105/SB) were selected considering enterprising and market access. Two control villages (Chak No. 72/SB and 100/SB at Sargodha) were selected for impact evaluation. Baseline studies at the rainfed and irrigated sites of the project were conducted in 2007 and impact assessment surveys were conducted in October-November, 2009.

1.1.2.2 Sample Size

Baseline study sample at the rainfed site was comprised of 58 livestock farmers. Number of project participating, non-participating and control group farmers was 23, 18 and 17 respectively. For the baseline study at the irrigated site 110 livestock farmers were

interviewed. Number of project participating farmers was 30 and that of non-participating and control group farmers was 40 each.

1.1.2.3 Animal Specific Costs of Production

Fodder and forage feeding cost, concentrate feeding cost, labour cost, capital input cost (depreciation on present animal value, deprecation on shed and electricity cost of shed) were calculated and added up to get per lactation animal specific costs of production.

Labour Cost

Man hours spent in all livestock management operations by family or hired labour were added up keeping in view labour conversion factors (Table 1) to get total man hours of labour required to perform daily dairy animal management activities. Then, to get per animal unit labour hours, total labour hours were divided by the total animal units. Labour hours per animal unit were then multiplied by adult units of different animal classes (Table 2) to obtain labour hours for the management of dairy animal activities both for buffaloes and cows. Then to get total labour days per lactation length, labour hours of that class were multiplied by the lactation length and then divided by 8, considering eight hours in a labour day. Then averages of labour wages were taken into account to calculate labour costs.

Table 1. Labour Conversion Factor

Labour Type	Units
One adult male	1.00
One adult female	0.75
One young male (10-15 years)	0.50
One young female (10-15 years)	0.37

Table 2. Conversion of Different Animal classes into adult units

Animal Classes	Adult Units
Buffalo milk	1.50
Buffalo dry	1.20
Buffalo breeding bull	1.20
Buffalo heifer	0.60
Buffalo young stock	0.30
Cow milk	1.00
Cow dry	0.80
Cow breeding bull	1.00
Cow young heifer	0.40
Cow young stock	0.20
Bullocks	1.10
Donkey	0.50
Goat	0.25
Goat young stock	0.20

Capital Input Cost

Interest and depreciation on the value of dairy animal: Depreciation charges were taken at the rate of 5.5 percent on the average value of dairy animal during the milking period. Interest charges on the value of dairy animals were taken at 12.5 percent.

Interest and depreciation on the value of shed: Dairy animals are usually kept both in cemented and mud sheds. The present cost of construction of similar shed was used for calculation of interest and depreciation on the value of sheds. For the purpose of cost estimation depreciation at the rate of 2.5 percent on the cemented and 5 percent on the mud sheds were taken into account. Animal shed cost of dairy animal was estimated by the following formula.

$$SCM = SC * MA / TA$$

Where, SCM= Total shed cost of specific dairy animal in rupees
SC= Total Shed cost in rupees
MA = Adult units of specific dairy animal class
TA = Total animal units

Fodder Cost

Average daily weight of green and dry fodder in kilograms, fed to different classes of dairy animals were inquired from the farmers for the abundant, scarcity and dry periods and then multiplied by the price of the fodder. Then these were multiplied by 120 to get total fodder cost of abundant, scarcity and dry periods, as duration of each period was about 4 months. The cost so calculated was divided by 360 to get per day cost, which was multiplied by lactation length of different classes of dairy animals to get total fodder cost per lactation of each class.

Concentrate Feeding Cost

Oil seed cake, choker, *vanda*, wheat and maize grains, molasses (*gur*), spices and salt are concentrates fed to dairy animals. Information about quantity of oil seed cake, choker and *vanda* fed to the different dairy animal classes per day with feeding duration in months per lactation was inquired from the farmers. Then quantity fed per day was multiplied by number of days to get total quantity fed during whole lactation. In case of other concentrates information about total quantity fed per lactation was inquired. Then total quantity was multiplied by prices of concentrates to get the total concentrate feeding cost for whole lactation length.

1.1.3 Baseline Results at rainfed site

1.1.3.1 General Attributes of the Respondents

The information regarding the general attributes of the respondents (participating, non-participating and control group farmers) was collected to compare their socioeconomic status. Main attributes selected for this purpose were farm manager age, experience, education, family size, operational holding and number of male & female family members working on farm. There were significant differences in experience & education of the farm managers and number of male working on farm across respondent categories. Project participating farmers were comparatively younger; less experienced but more educated than non-participating and control group farmers. They had small family size but large operational holding as compared to farmers of other groups. Average area allocation to Rabi and Kharif fodders was almost same across different respondent categories. Fodder area per animal unit in Rabi and Kharif seasons was 0.08 and 0.13 hectare respectively (Table 3).

Table 3. Attributes of the Livestock Farmers and Area Allocation to Fodder

Farmer Attributes	Participating	Non-Partici-pating	Control	All	Sig.*
Age of the Farm Manager (yrs.)	36	51	40	42	0.531
Experience of the Farm Manager (yrs.)	7	17	19	21	0.043
Education (yrs.)	9	7	7	8	0.030
Family Size (no.)	7	9	8	7	0.200
Males Working on Farm (no.)	1.7 (1.1)	1.8 (0.5)	1.3 (0.5)	1.6 (0.8)	0.058
Females Working on Farm (no.)	0.8 (1.0)	0.5 (0.7)	0.6 (1.0)	0.6 (0.9)	0.600
Operational Holding (ha)	5.01 (4.15)	3.48 (2.28)	1.48 (0.94)	3.58 (3.26)	0.465
Rabi Fodder Area/ a. u. (ha)	0.08 (0.06)	0.08 (0.0)	0.06 (0.06)	0.08 (0.06)	0.506
Kharif Fodder Area/ a. u. (ha)	0.13 (0.09)	0.12 (0.10)	0.10 (0.09)	0.13 (0.09)	0.633

Note: Figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.2 Operational Farm Size Categories, Milk Processing and Sale

Project participating and non-participating farmers had almost similar distribution across different farm size categories but it was quite different from the control group farmers. Majority of the project participating (83%) and non-participating (72%) farmers had operation holdings of 2 or more hectare. However, majority of control group farmers (71%) had operational farm size of less than 2 hectare. On the whole, majority of the farmers had small operational holdings and were heavily relying on livestock sector for their living. The data regarding sale of milk verify their dependency on livestock, as majority of them (74%) reported milk sale. Most of them were selling milk to milkmen. Farmers were processing milk for yogurt, butter, butter milk, and ghee preparation. However, there was a possibility for quality enhancement of milk products, as they reported that texture of yogurt prepared domestically was not good. This indicates potential for training of farmers in animal hygiene and women folk in milk processing (Table 4).

Table 4. Operational Farm Size Categories and Milk Sale

Farmer Attributes	Participating	Non-Participating	Control	All	Sig.
Farm Size	Percentage				
< than 2 ha	17	28	71	36	0.465
2-4 ha	39	39	23	35	
> 4 ha	44	33	06	06	
Selling Agency	Percentage				
No sales	22	44	12	26	0.185
Milkmen	69	45	64	60	
Others (Shopkeepers/ Village Consumers)	9	11	24	14	

1.1.3.3 Dairy Animal Ownership

Most of the respondents (46%) were small dairy farmers. There was a significant difference in dairy animal ownership across the respondent categories as most of the project participating farmers (40%) had 5 or more animals, while most of the non-participating (66%) and control group farmers (47%) had only one or two dairy animals (Table 5).

Table 5. Dairy Animal Ownership

Farmer Attributes	Participating	Non-Participating	Control	All	Sig.
Small (1-2 animals)	30	66	47	46	0.044
Medium (3-4 animals)	30	28	41	33	
Large (5 or more animals)	40	06	12	21	
Buffalo Adult and (Heifer +Young Stock) Ratio	1.81	1.52	1.41	1.62	0.324
Cattle Adult and (Heifer +Young Stock) Ratio	1.22	1.08	1.35	1.22	0.451

*Sig. = Significance (p-level)

1.1.3.4 Breeds of the Dairy Animals

On the whole local breed of buffalo (47%) and cross breed of cow (34%) were high yielding breeds on most of the farms at this site. High yielding buffaloes at the farms of participating farmers were mostly of local (46%) and Nili Ravi breeds (31%), while at the farms of non-participating farmers were of local (62%) and cross breeds (13) and at the farms of control group farmers of Nili Ravi (44%) and local breeds (33%). At the farms of participating farmers, New Jersey and local breeds (30 % each) were the major breeds of high yielding cows. While at the farms of non-participating farmers, Frisian, Sahiwal and cross breeds (33% each) were high yielding breeds of cow. Cross breed of cow was the high yielding breed at most of the farms (49%) of control group farmers (Table 6).

Table 6. Breeds of the Dairy Animals

Dairy Animals	High Yielding					Average Yielding				
	Participating	Non-Participating	Control	All	Sig.	Participating	Non-Participating	Control	All	Sig.
Buffalo										
Local	46	62	33	47	0.427	56	0	25	38	0.473
Nili Ravi	31	13	44	30		0	0	50	13	
Cross	8	25	22	16		22	33	0	19	
Kundi	15	0	0	7		22	67	25	31	
Cow										
Local	30	0	13	19	0.098	11	50	100	29	0.862
Cross	20	33	49	34		33	25	0	28	
New Jersey	30	0	13	19		11	0	0	7	
Frisian	20	33	0	14		23	25	0	22	
Sahiwal	00	33	25	14		22	0	0	14	

1.1.3.5 Breeding Methods Practiced and Animal Specific Breeding Costs

Breeding is an important aspect of producing good quality dairy animals. At the rainfed site of project natural breeding method was popular for buffaloes as it was practiced for 94 percent high yielding buffaloes and 88 percent of average yielding buffaloes. In case of cows, both natural breeding artificial insemination methods were practiced. However, artificial insemination was more common than natural method, as it was practiced by 52 percent farmers in case of high yielding cows and 55 percent farmers in case of average yielding cows (Table 7a).

Table 7b contains data about animal specific breeding costs for different respondent categories. Average breeding cost was highest for high yielding cows followed by high yielding buffaloes, average yielding buffaloes and average yielding cows.

Table 7. Breeding Methods Practiced (%) and Animal Specific Breeding Costs (Rs)

Dairy Animals	Breeding Method	Partici-pating	Not partici-pating	Control	All	Sig.*
(a) Breeding Methods Practiced						
High Yielding Buffaloes	Natural	100	90	89	94	0.430
	AI	0	10	11	06	
Average Yielding Buffaloes	Natural	100	75	78	88	0.205
	AI	0	25	22	12	
High Yielding Cows	Natural	42	100	25	48	0.018
	AI	58	0	75	52	
Average Yielding Cows	Natural	40	40	60	45	0.739
	AI	60	60	40	55	
(b) Total per Animal Breeding Cost						
Buffalo High Yielding		122 (86.5)	138 (39.5)	144 (39.1)	132 (62.9)	0.328
Buffalo Average Milk Yielding		131 (87.9)	106 (59.1)	123 (56.3)	124 (69.8)	0.391
Cow High Milk Yielding		158 (93.7)	200 (61.2)	80 (52.9)	143 (86.5)	0.543
Cow Average Milk Yielding		136 (127.1)	118 (95.4)	83 (35.0)	117 (98.2)	0.402

Note: Figures in the parenthesis are standard deviations; *Sig.=Significance (p-level)

1.1.3.6 Animal Specific Fodder Cost

Fodder cost per lactation was highest in case of high yielding cows followed by high yielding buffaloes, average yielding cows and average yielding buffaloes. Average fodder costs were Rs.8365 and Rs.6333 in case of high and average yielding buffaloes respectively. In case of high and average yielding cows, fodder costs were Rs.9044 and Rs.6925 respectively (Table 8).

Table 8. Total Fodder Cost per Animal

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
Buffalo High Yielding	7653.1 (1818.1)	8243.3 (2776.2)	9687.0 (3643.4)	8365.0 (2726.5)	0.491
Buffalo Average Yielding	6806.2 (2288.1)	7658.9 (4092.1)	5354.0 (1384.6)	6332.7 (2427.3)	0.353
Cow High Yielding	8139.4 (2475.2)	10426.5 (6150.1)	10323.0 (2685.3)	9043.9 (3629.5)	0.333
Cow Average Yielding	6787.2 (388.0)	7097.2 (148.5)	7002.3 (169.5)	6924.9 (304.1)	0.353

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.7 Animal Specific Concentrate Feeding Cost

Concentrate feeding is very essential for getting high milk productivity in arid areas as fodders are not evenly available throughout the year. Baseline survey results revealed that there was no significant difference in the total per animal concentrate feeding cost for all animal types across different farm size categories. However these were highest for high yielding cows followed by high yielding buffaloes, average yielding buffaloes and average yielding cows (Table 9).

Table 9. Total Concentrate Feeding Cost per Animal

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
Buffalo High Yielding	17605 (10034.8)	18067 (12255.7)	18362 (9481.1)	17941 (10274.7)	0.409
Buffalo Average Yielding	11812 (7111.7)	10644 (6128.1)	24750 (13834.3)	15718 (11069.8)	0.378
Cow High Yielding	23811 (13329.9)	20126 (5827.7)	18385 (10784.7)	21283 (11353.4)	0.462
Cow Average Yielding	15464 (11633.7)	9180 (5254.5)	12047 (7330.9)	12774 (9066.0)	0.375

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.8 Animal Specific Other Costs

Shed cost, labour cost and capital cost were added up as other costs for brevity. Other costs followed the same pattern as of fodder and concentrates costs i.e. these were highest for high yielding cows followed by high yielding buffaloes, average yielding buffaloes and average yielding cows. Table 10 contains detailed data of these costs.

Table 10. Other Costs

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
Buffalo High Yielding	15053.4 (2667.5)	16995.5 (2331.4)	16906.8 (1352.0)	16115.2 (2422.1)	0.528
Buffalo Average Yielding	10756.2 (3096.7)	13201.6 (897.7)	13015.3 (1984.7)	12363.2 (2328.2)	0.353
Cow High Yielding	16340.2 (1526.0)	18059.2 (799.2)	15845.4 (1274.4)	16806.4 (1485.3)	0.333
Cow Average Yielding	8674.8 (900.0)	8507.0 (1322.9)	9292.1 (936.3)	8827.0 (979.0)	0.353

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.9 Animal Specific Total Cost per Lactation

Total cost per lactation for all animal categories are given in Table 11. It appears that animal specific costs per lactation were quite similar across different respondent categories. These costs were highest for high yielding cows, followed by high yielding buffaloes, average yielding buffaloes and average yielding cows.

Table 11. Total Cost per Lactation

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
High Yielding Buffaloes	40425.5 (10145.8)	43443.5 (15061.2)	45100.5 (10461.6)	42550.6 (11667.7)	0.506
Average Yielding Buffaloes	32936.9 (8778.5)	33885.4 (4876.4)	34424.9 (3868.9)	33842.5 (5468.9)	0.387
High Yielding Cows	51817.1 (11659.8)	47342.3 (10807.2)	46751.0 (4739.3)	499681 (10534.2)	0.381
Average Yielding Cows	34155.0 (6736.5)	27087.9 (3926.2)	30087.9 (6376.6)	31273.2 (6375.4)	0.384

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.10 Animal Specific Daily Milk Yield

Average daily milk yield of high yielding buffaloes was 10 liters and of average yielding buffaloes 6.5 liters. Milk yield of buffaloes was quite similar across different respondent categories. However milk yields of both high and average yielding cows were quite different across farmer categories. In case of high yielding cows it was highest at the control group farms, while in case of average yielding cows it was highest at the farms of participating farmers. On the whole, average yield of high yielding cows was 15 liter and that of average yielding cows 6.9 liters per day.

Table 12. Animal Specific Milk Yield

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
High Yielding Buffalo	10.0 (1.2)	9.3 (1.9)	10.6 (2.8)	9.9 (2.0)	0.168
Average Yielding Buffalo	6.6 (0.6)	6.5 (1.0)	6.4 (0.6)	6.5(0.6)	0.213
High Yielding Cows	15.0 (7.7)	14.1 (2.4)	17.3 (6.5)	15.0 (6.0)	0.333
Average Yielding Cows	9.3 (2.5)	6.5 (1.9)	4.1 (2.3)	6.9 (3.9)	0.409

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.11 Milk Prices in the Project Area

Farmers of project area, usually mix milk of both buffaloes and cows for sale. However, if sold separately, buffalo milk prices remain higher than cow milk prices. Average prices for buffaloes and cow milk were Rs.24.7 and Rs.22.9 per liter respectively.

Table 13. Prices of Milk per Liter

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
Buffalo	25.2 (1.9)	24.7(1.5)	24.2 (1.3)	24.7(1.6)	0.416
Cow	23.1 (2.1)	22.6 (1.3)	23.1 (1.2)	22.9 (1.6)	0.762

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.12 Animal Specific Gross Incomes per Lactation

In case of high yielding buffaloes, gross income per lactation was about Rupees 83282 and in case of average yielding buffaloes it was Rupees 48437. Gross income per lactation of cows was high than that of buffaloes. It was Rs.126800 in case of high yielding cows and Rs.58316 in case of average yielding cows.

Table 14. Gross Incomes per Lactation

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
High Yielding Buffalo	81954.5 (27749.2)	77807.7 (28706.8)	91575.8 (43480.0)	83281.7 (32223.8)	0.343
Average Yielding Buffalo	45433.8 (7950.3)	49610.0 (10846.6)	49852.5 (4809.7)	48436.9 (7028.6)	0.252
High Yielding Cows	125075.0 (67539.8)	132840.0 (41653.7)	119025.0 (34525.2)	126799.5 (54227.9)	0.333
Average Yielding Cows	82846.5 (52125.4)	52940.0 (14986.0)	52899.2 (21422.4)	58316.3 (41149.7)	0.347

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.13 Animal Specific Net Income per Lactation

Net income per lactation was highest for high yielding cows followed by high yielding buffaloes, average yielding cows and average yielding buffaloes. It was Rs.40731 in case of high yielding buffaloes and Rs.14594 in case of average yielding buffaloes. In case of high yielding cows, net income per lactation was Rs.76831; while, in case of average yielding cows it was Rs.26943. In case of high yielding buffaloes net income per lactation was highest for control group farmers followed by project participating and non participating farmers. Net income per lactation of high yielding cows was highest for non participating farmers followed by project participating and control group farmers (Table 15). Data on animal specific cost and net income per liter are given in Table 16 and 17.

Table 15. Net Incomes per Lactation

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
High Yielding Buffalo	41529.0 (29930.3)	34364.2 (29558.3)	46475.3 (45149.1)	40731.1 (33675.9)	0.409
Average Yielding Buffalo	12496.9 (11149.8)	15724.6 (13057.7)	14427.7 (8197.1)	14594.4 (9467.2)	0.353
High Yielding Cows	73257.9 (66049.9)	85497.7 (48216.2)	72273.6 (43416.0)	76831.4 (54554.0)	0.333
Average Yielding Cows	47874.7 (55524.1)	25852.1 (14426.0)	22811.3 (16261.2)	26943.4 (40793.3)	0.347

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

Table 16. Cost Per Liter of Milk

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
High Yielding Buffalo	13.8 (7.1)	14.9 (7.7)	13.9 (7.7)	14.1 (7.2)	0.405
Average Yielding Buffalo	18.8 (5.8)	16.4 (4.9)	16.9 (4.0)	17.4 (4.5)	0.353
High Yielding Cows	10.8 (4.5)	8.7 (3.6)	9.0 (4.1)	10.0 (3.9)	0.333
Average Yielding Cows	8.5 (3.6)	12.5 (4.7)	13.3 (3.3)	10.6 (4.2)	0.347

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

Table 17. Net Income per Liter of Milk

Dairy Animals	Participating	Non-Participating	Control	All	Sig.*
High Yielding Buffalo	11.4 (8.3)	9.8 (7.5)	10.3 (9.1)	10.6(8.0)	0.405
Average Yielding Buffalo	6.4 (5.8)	8.3 (4.2)	7.3 (3.4)	7.3 (4.1)	0.353
High Yielding Cows	12.3 (4.7)	13.9 (3.6)	14.1 (3.8)	12.9 (4.1)	0.333
Average Yielding Cows	14.6 (3.8)	10.1 (4.3)	9.8 (0.5)	10.3 (4.3)	0.347

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.3.14 Dairy Production Problems and Farmers' Suggestions

Major problem faced by the livestock farmers of arid areas in Pakistan and elsewhere in the world is shortage of fodder. Therefore, livestock farmers are to depend on dry fodders, concentrates and to pay high price for feed during fodder scarcity periods. Poor farmers lack financial resources, therefore animals suffer from feed/nutritional deficiency and different diseases. Less productive breeds of the dairy animals is also one of the major constraints to livestock development. Moreover, decreasing farm sizes due to law of inheritance is also aggravating the socioeconomic problems of area farmers. Farmers seek improvement in the quality of feed and its availability at low prices, accessibility to veterinary services, installation of dug wells, loaning on easy terms & conditions and establishment of milk collection centers as solutions to their problems.

1.1.4 Baseline Results at irrigated site

1.1.4.1 Attributes of the Livestock Farmers

Average age of the farm managers at the farms of project participating, non-participating and control group were 55, 50 and 51 years respectively. Similarly, there was not much difference in the experience and education of the farm managers across different farm categories. Project participating farmers had large average operational holding and family size as compared to non-participating and control group farmers. On an average, 1 to 2 family members were working on farms on all types of farms. However, at control group farms participation of females in the farming was nil (Table 18).

Table 18. Attributes of the Livestock Farmers

Farmer Attributes	Participating	Non-participating	Control	Sig.*
Farm Manager Age (years)	55	50	51	0.144
Manager Experience (years)	23	21	26	0.109
Education (years)	6	5	5	0.287
Family Size (no)	9	6	6	0.102
Males Working on Farm (no)	1.70	1.50	1.60	0.026
Females Working on Farm (no)	0.65	0.60	0.00	0.000
Operational Holding (ha)	4.5	3.0	2.3	0.083
On Farm Permanent Hired Labor (no)	0.4	0.5	0.3	0.815

*Sig.=Significance (p-level)

1.1.4.2 Operational Farm Size Categories and Milk Sale

There were significant differences in the operational categories and milk selling agencies across farm types. Majority of the non-participating (85%) and control group farmers (92%) had operational holding less than 5 hectare, while most of the project participating farmers had farm sizes of less than five hectare (57%) and five to ten hectares (36%). Most of the project participating farmers (40%) were selling milk to milkmen while most of the non-participating (40%) and control group farmers (42%) to the consumers directly (Table 19).

Table 19. Operational Farm Size Categories and Milk Sale

Farmer Attributes	Participating	Non-participating	Control	All	Sig.
Farm Size	Percentage				
< than 5 ha	57	85	92	80	0.005
5-10 ha	36	12	08	17	
> 4 ha	07	03	00	03	
Selling Agency	Percentage				
No sales	23	45	10	26	0.002
Milkmen	40	08	35	26	
Consumers	37	40	42	40	
Village Shopkeepers	00	00	13	05	
Nestle	00	08	00	03	

*Sig.=Significance (p-level)

1.1.4.3 Dairy Animal Ownership

Majority of the farms (47%) of the participating farmers were medium sized, while majority of the farms (48%) of non-participating farmers were small sized while control group farmers had equal percentages of small and medium sized farms (40%).

Table 20. Dairy Animal Ownership

Farmer Attributes	Partici-pating	Non-partici-pating	Control	All	Sig.*
Small (1-2 dairy animals)	23	48	40	38	0.301
Medium (3-4 dairy animals)	47	37	40	41	
Large (5 or more dairy animals)	30	15	20	21	

*Sig.=Significance (p-level)

1.1.4.4 Breeds of the Dairy Animals

Local breed of was the most common breed of buffaloes. Project participating, non-participating and control group farmers have almost same percentage of local breeds as high yielding buffaloes. Similarly, most of the project participating and majority of the non-participating and control group farmers had local breed as average yielding buffaloes (Table 21).

Table 21. Breeds of the Dairy Animals

Dairy Animals	High Yielding					Average Yielding				
	Partici-pating	Non-Partici-pating	Con-trol	All	Sig.	Partici-pating	Non-Partici-pating	Control	All	Sig.*
Buffalo										
Local	67	61	55	62	n.s.	55	70	88	72	0.057
Cross	19	22	18	20		30	15	4	15	
Nili Ravi	14	13	18	14		15	5	8	9	
Kundi	0	4	9	4		0	10	0	3	
Cow										
Local	45	22	25	46	n.s.	12	50	70	47	0.069
Cross	46	67	75	46		75	33	20	40	
Sahiwal	9	0	0	4		0	17	0	7	
Frisian	0	11	0	4		13	0	10	6	

*Sig.=Significance (p-level)

1.1.4.5 Breeding Method Practiced and Animal Specific Breeding Costs

At the irrigated site of the project, natural breeding method was more commonly practiced in livestock than artificial insemination method. Natural breeding method was practiced in 82 percent of the high yielding buffaloes and 94 percent of the average yielding buffaloes. It was practiced in 69 percent of the high yielding cows and 77 percent of the average yielding cows (Table 22.a). As natural breeding method was commonly used for livestock at irrigated site, for which generally breeding bulls' owners charges no cost thus average breeding costs were very low both in case of buffaloes and cows. Details about animal specific breeding costs are given in Table 22.b.

Table 22. Breeding Methods Practiced and Animal Specific Breeding Costs

(a) Breeding Methods Practiced						
Dairy Animals	Breeding Method	Participating	Non-Participating	Control	All	Sig.
High Yielding Buffaloes	Natural	90	87	58	82	0.045
	AI	10	13	42	18	
Av. Yielding Buffaloes	Natural	90	100	92	94	0.373
	AI	10	00	08	06	
High Yielding Cows	Natural	73	67	67	69	0.943
	AI	27	33	33	31	
Av. Yielding Cows	Natural	75	83	70	77	0.756
	AI	25	17	30	23	
(b) Total per Animal Breeding Cost						
Buffalo High Yielding		14.3 (45.1)	11.8 (39.6)	125.0 (160.3)	36.5 (92.4)	0.020
Buffalo Average Yielding		12.5 (39.3)	0 (0)	20 (70.7)	11.5 (49.0)	0.451
Cow High Yielding		45.0 (76.2)	70. 0 (113.3)	88.9 (136.4)	67.1(107.7)	0.637
Cow Average Yielding		37.5 (69.4)	35.0 (90.3)	80.0 (131.8)	50.7 (100.4)	0.204

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.6 Animal Specific Fodder Cost

Fodder costs per lactation for different animal categories are given in 2.6. These were highest in case of high yielding cows followed by high yielding buffaloes, average yielding cows and average yielding buffaloes. Average fodder cost was Rs.12088 for high yielding buffaloes and Rs.7241 for average yielding buffaloes. These costs were Rs.12777 and Rs.8451in case of high and average yielding cows respectively. It is note able that fodder costs were significantly different across different respondent categories in case of high yielding buffaloes (Table 23).

Table 23. Total Fodder Cost per Animal

Dairy Animals	Participating	Non-Participating	Control	All	Sig.
High Yielding Buffalo	12451.3 (1170.7)	12825.9 (1181.0)	10144.2 (2253.4)	12088.2 (1777.8)	0.077
Average Yielding Buffalo	7422.1 (3419.9)	6782.3 (2556.0)	7378.3 (1104.3)	7421.0 (2740.1)	0.140
High Yielding Cow	12025.9 (2139.5)	14029.1 (917.7)	12022.4 (1487.3)	12776.6 (1810.6)	0.529
Average Yielding Cow	7672.5 (1582.2)	9687.6 (2593.0)	8671.1 (1752.6)	8450.8 (2158.2)	0.554

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.7 Animal Specific Concentrate Feeding Cost

Concentrate feeding cost was highest in case of high yielding cows, followed by high yielding buffaloes, average yielding buffaloes and average yielding cows. Average concentrate feeding costs were Rs.7885 and Rs.4392 for high and average yielding buffaloes respectively. In case of high yielding and average yielding cow these costs were Rs.8896 and Rs.4234 respectively.

Table 24. Total Concentrate Feeding Cost per Animal

Dairy Animals	Participating	Non-participating	Control	All	Sig.*
High Yielding Buffalo	8485.7 (3341.8)	7405.0 (2337.6)	6282.6 (2456.4)	7884.5 (2765.2)	0.415
Average Yielding Buffalo	6287.8 (6014.1)	3180.5 (3461.6)	3745.4 (3036.2)	4392.3 (4156.8)	0.423
High Yielding Cow	11141.3 (7388.8)	6623.3 (4211.2)	6730.0 (5712.4)	8895.6 (5850.6)	0.313
Average Yielding Cow	7848.8 (3778.8)	4227.5 (2597.8)	2792.2 (3575.5)	4233.5 (3639.7)	0.306

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.8 Animal Specific Other Costs

Shed cost, labour cost and capital cost were added up for brevity and ease of explanation. These were highest in case of high yielding cows, followed by high yielding buffaloes, average yielding cows and average yielding buffaloes.

Table 25. Other Costs

Dairy Animals	Participating	Non-participating	Control	All	Sig.*
High Yielding Buffalo	15182.4 (2704.8)	13954.2 (3672.0)	16241.8 (2552.4)	14215.4 (3105.1)	0.422
Average Yielding Buffalo	7022.3 (3923.3)	11322.4 (6405.5)	8951.1 (9857.9)	8656.1 (7135.0)	0.408
High Yielding Cow	16028.0 (1943.3)	20713.7 (7432.0)	17257.5 (3287.4)	17938.8 (4649.2)	0.313
Average Yielding Cow	13060.4 (1326.1)	8439.5 (12815.7)	11343.5 (5280.2)	11015.4 (10219.7	0.387

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.9 Animal Specific Total Cost per Lactation

Table 26 shows the total cost per lactation for different animal categories across different respondent categories. Total cost per lactation at the irrigated site of the project was highest in case of high yielding cows, followed by high yielding buffaloes, average yielding cows and average yielding buffaloes. Total costs per lactation were Rs.32669 in case of high yielding buffaloes and Rs.20073 for average yielding buffaloes. These were Rs.36009 in case of high yielding cows and Rs.22804 in case of average yielding cows.

Table 26. Total Cost per Lactation

Dairy Animals	Partici-pating	Non-participating	Control	All	Sig.*
High Yielding Buffalo	35009.1 (3402.2)	34154.2 (3177.9)	32668.7 (2523.0)	34201.4 (3212.3)	0.418
Average Yielding Buffalo	20732.4 (4155.9)	21284.7 (2694.1)	20073.1 (2940.0)	20669.3 (3161.2)	0.392
High Yielding Cow	39195.18 (7886.2)	41366.1 (2950.1)	36009.3 (4512.4)	39611.5 (5693.2)	0.313
Average Yielding Cow	28574.0 (8237.2)	22325.8 (6138.9)	22804.3 (4694.1)	23722.9 (5580.1)	0.341

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.10 Animal Specific Dairy Milk Yield

Daily milk was highest in case of high yielding cows, followed by high yielding buffaloes, average yielding cows and average yielding buffaloes. Average daily milk yields of all animal categories were highest at the farms of project participating farms. On the whole at the irrigated site of the project average daily milk yields of high and average yielding buffaloes were 7.9 and 4.8 liter respectively. Average daily milk yields of high and average yielding cows were 9.4 and 5.7 liter respectively.

Table 27. Animal Specific Milk Yield

Dairy Animals	Participating	Non-participating	Control	All	Sig.*
High Yielding Buffalo	8.2 (1.5)	7.6 (1.5)	7.9 (0.7)	7.9 (1.8)	0.495
Average Yielding Buffalo	4.9 (1.2)	4.7 (0.7)	4.8 (0.8)	4.8 (0.9)	0.219
High Yielding Cows	10.4 (1.9)	8.7 (1.3)	8.4 (0.2)	9.4 (1.6)	0.324
Average Yielding Cows	6.1 (1.5)	5.3 (1.3)	6.1 (0.8)	5.7 (1.2)	0.234

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.11 Milk Prices at the irrigated site of the Project

As at the rainfed site, farmers at the irrigated site of project, usually mix milk of both buffaloes and cows for sale. However, prices of buffalo milk were higher than prices of cow milk. Average prices were Rs.20.8 and Rs.18.5 per liter for buffalo and cow milk respectively. So the price of buffalo milk was higher than price of cow milk by Rs.2.3 per liter.

Table 28. Prices of Milk per Liter

Dairy Animals	Participating	Non-participating	Control	All	Sig.
Buffalo	20.9 (2.3)	21.2 (1.9)	20.4 (1.8)	20.8 (2.0)	0.095*
Cow	18.7 (1.0)	18.8 (1.5)	18.1 (1.0)	18.5 (1.2)	0.093*

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.12 Animal Specific Gross Incomes per Lactation

At the irrigated site of the project, gross income per lactation of buffaloes was less than that of cows. In case of high and average yielding buffaloes gross incomes per lactation were Rs.52848 and Rs.29432 respectively. Gross Incomes per lactation of high and average yielding cows at this site were Rs.79900 and Rs.33907 respectively.

Table 29. Gross Incomes per Lactation

Dairy Animals	Participating	Non-participating	Control	All	Sig.*
High Yielding Buffalo	54628.7 (21480.0)	53131.4 (13831.7)	49029.0 (7532.0)	52848.5 (16392.8)	0.408
Average Yielding Buffalo	33350.4 (9854.3)	30373.1 (7110.1)	28455 (4899.9)	29432.1 (7289.4)	0.369
High Yielding Cow	86220.0 (35834.9	73500 (30214)	76864.6 (7636.7)	79900.0 (29070.2)	0.324
Average Yielding Cow	40365.5 (15556.2)	44500.3 (12949.3)	37219.9 (11319.8)	33907.1 (12894)	0.510

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.1.4.13 Animal Specific Net Income per Lactation

Net income per lactation for buffaloes was less than that of cows. In case of high yielding buffaloes net income per lactation was Rs.16360 and in case of average yielding buffaloes it was Rs.3382. Net incomes per lactation in case of high and average yielding cows were Rs.40855 and Rs.14416 respectively. In case of high & average yielding buffaloes and high yielding cows net incomes per lactation were highest at the farms of project-participating farmers. While in case of average yielding cows' net income per lactation was highest at the farms of non-participating farmers and lowest at the farms of project participating farmers.

Table 30. Net Income per Lactation

Dairy Animals	Participating	Non-participating	Control	All	Sig.*
High Yielding Buffalo	20457.2 (21236.4)	18977.2 (15367.1)	16360.3 (18160.4)	19027.0 (16710.4)	0.418
Average Yielding Buffalo	14172.6 (7316.6)	9088.4 (6174.5)	8381.9 (4346.9)	10306.3 (6217.3)	0.392
High Yielding Cow	47024.8 (33402.8)	32133.9 (31341.4)	40855.3 (17825.7)	40690.2 (27408.4)	0.324
Average Yielding Cow	11791.0 (3408.9)	22174.2 (13114.5)	14415.6 (12359.6)	16054.0 (11332.3)	0.341

Note: figures in the parentheses are standard deviations; *Sig.=Significance (p-level)

1.2 Post project impact assessment at the rainfed site

As mentioned in the methodology of section 2.1.1, Lodhay village of Gujar Khan Tehsil of Rawalpindi district was Rainfed project site. Nata Mora village which was 8 kilometer away from project site was selected as control village for impact evaluation.

1.2.1 Fodder Availability

The comparison of the changes in fodder areas per animal unit between 2007 and 2009 revealed that the participating farmers increased the area for rabi fodders from 0.08 to 0.09 hectare per animal unit and for kharif fodder from 0.13 to 0.16 hectare. The reason for this increase is seen in a timely supply of quality seeds through the project well before sowing time. Moreover, the better quality seeds resulted in higher production, which may have increased the interest of framers in producing fodders. The fodder area per animal unit decreased at the farms of non-participating farmers both in rabi and kharif season. In the controlled group the fodder area per animal unit decreased in the rabi season while it increased in kharif season but the increase was smaller than in the participating farms (Table 31).

Table 31. Fodder Area planted per Animal Unit

Fodder area per Animal Unit (ha)	Participating	Non-participating	Control	All
Rabi Fodder Area (Baseline 2007)	0.08 (0.06)	0.08 (0.0)	0.06 (0.06)	0.08 (0.06)
Rabi Fodder Area (Post Project Assessment 2009)	0.09 (0.09)	0.06 (0.05)	0.05 (0.03)	0.07 (0.07)

Kharif Fodder Area (Baseline 2007)	0.13 (0.09)	0.12 (0.10)	0.10 (0.09)	0.13 (0.09)
Kharif Fodder Area (Post Project Assessment 2009)	0.16 (0.13)	0.11 (0.11)	0.11 (0.07)	0.13 (0.10)

1.2.2 Use of Concentrates by Project Participating Farmers

During last couple of years, arid site remained under drought conditions, which resulted into low crop productivity and affected purchasing power of the farmers. A decrease in use of concentrates for all types of animals is an indicative of this fact, as described by the data given in Table 32.

Table 32. Use of Main Concentrates by Project Participating Farmers (kg/lactation)

Animal Category	High Yielding Buffalo		Average Yielding Buffalo		High Yielding Cow		Average Yielding Cow	
Survey	Baseline 2007	PPA 2009	Baseline 2007	PPA 2009	Baseline 2007	PPA 2009	Baseline 2007	PPA 2009
OSC	620.8	488.6	539.9	409.9	1024.7	750.0	540.0	120.0
Choker	359.3	153.9	284.1	0.0	400.5	0.0	6.1	150.0
Vanda	0.0	165.8	0.0	108.2	9.5	150.0	25.7	112.0
Wheat grains	16.0	7.5	0.0	5.3	22.6	0.0	30.0	17.3
Total	996.1	815.8	824.0	523.4	1457.3	900.0	601.8	399.3

1.2.3 Change in Number of Milk Selling Farmers

At the rainfed site, a decrease in number of farmers having milk surplus was observed. Main reason for this decrease was drought that prevailed during last year. However, an increase was occurred in the number of milk selling project participating and control group farmers (Table 33).

Table 33. Milk Selling Farmers (Percent Farmers)

Survey	Participating	Non-participating	Control	All
Base line 2007	78	56	88	74
Post Project Assessment 2009	88	30	100	71

1.2.4 Change in Milk Yield of Buffaloes and Cows

Project intervened through provision of fodder seed to the project participating farmers, by giving them trainings in hay making, clean milking & processing and installing a feed mill at each project site. Moreover, feed supplementation and young stock fattening trails were also conducted. Milk yield of high yielding buffaloes at the farms of project participating farmers increased from 10.0 liter in year 2007 to 11.2 liter per day in year 2009. Thus increase in milk yield was 1.2 liter per day. At farms of control group farmers' increase in milk yield was 0.9 liter. The reason for this is that livestock rearing at control group farms was of commercial nature, as they had small land holdings and mainly depend on livestock

for their living. While at farm of non-participating farmers' there was a decrease in milk yield of 1.8 liter per day. Reason for this was poor feeding by them due to increase in prices of feed and concentrates. An increase of 1.8 liter (from 6.6 to 8.4 liter) in the per day milk yield of average yielding buffaloes was observed at the farms of project participating farmers. At the control group farms increase in milk yield of average yielding buffaloes was 0.7 liter. While, a decrease in milk yield of average yielding buffaloes at farms on non-participating farmer was occurred (Table 34).

Table 34 Animal Specific Milk Yield of Buffaloes

	Participating	Non-Participating	Control	All
High Yielding Buffalo				
Baseline (2007)	10.0 (1.2)	9.3 (1.9)	10.6 (2.8)	9.9 (2.0)
Post Project Assessment (2009)	11.2 (3.0)	7.5 (2.2)	11.5 (2.7)	10.6 (2.7)
Change	1.2	-1.8	0.9	0.7
Average Yielding Buffalo				
Baseline (2007)	6.6 (0.6)	6.5 (1.0)	6.4 (0.6)	6.5(0.6)
Post Project Assessment (2009)	8.4 (1.3)	5.9(2.8)	7.1 (0.3)	6.7 (1.9)
Change	1.8	-0.6	0.7	0.2

Milk yield of high yielding cows increased by 4.3 liters per day at the farms of project participating farms and remained constant at the farms of control group farmers. However impact of project on productivity of average yielding cows was not very encouraging. In case of average yielding cows, a decrease in yield of 2.0 liter per day at the farms of project participating farmers and 1.8 liter per day was observed. However, an increase of 2.8 liter per day at farms of control group farmers was reported (Table 35). Main reason for these mix results was that farmers keep rarely average milking cows. In addition they keep on replacing old dairy animals with the new ones. Moreover, their responses are generally based on memory as they don't keep record of feeding, milk production and lactation length etc.

Table 35. Animal Specific Milk Yield of Cows

	Participating	Non- Participating	Control	All
High Yielding Cows				
Baseline (2007)	15.0 (7.7)	14.1 (2.4)	17.3 (6.5)	15.0 (6.0)
Post Project Assessment (2009)	19.3 (6.0)	-	17.3 (5.4)	18.9 (5.3)
Change	4.3	-	0	3.9
Average Yielding Cows				
Baseline (2007)	9.3 (2.5)	6.5 (1.9)	4.1 (2.3)	6.9 (3.9)
Post Project Assessment (2009)	7.3 (0.0)	4.7 (0.1)	6.9 (1.2)	6.5 (2.1)
Change	-2.0	-1.8	2.8	-0.4

1.2.5 Change in Total Cost per Lactation of Buffaloes and Cows

An increase in total cost per lactation of high yielding buffaloes at the farms of all types of farms was observed. Increase in cost was highest at the farms of project participating farmers, followed by control and non-participating group farmers. Main reason for this was better feeding by project participating farmers than non-participating and control group farmers. In case of average yielding buffaloes, an increase in total costs per lactation at the farms of participating and control group farmers was observed while a marginal decrease at the farms of non-participating farmers was occurred (Table 36).

Table 36. Total Cost per Lactation of Buffaloes

Survey	Participating	Non-Participating	Control	All
High Yielding Buffaloes				
Baseline (2007)	40425.5 (10145.8)	43443.5 (15061.2)	45100.5 (10461.6)	42550.6 (11667.7)
Post Project Assessment (2009)	60874.7 (3491.3)	53058.9 (5030.1)	56927.1 (4739.3)	57654.6 (4701.3)
Change	20449.2	9615.4	11826.6	15104.0
Average Yielding Buffaloes				
Baseline (2007)	32936.9 (8778.5)	36178.6 (4000.7)	34424.8 (3868.9)	34221.2 (5531.3)
Post Project Assessment (2009)	37194.4 (6095.0)	34469.9 (5720.5)	40345.2 (13479.5)	37349.4 (6682.9)
Change	4257.5	-1708.7	5920.4	3128.2

Results of baseline survey indicate that total costs per lactation of cows were higher than buffaloes at all farm types. However, with an increase in prices over time, farmers started to use less quantity of concentrates and as a result total cost per lactation had decreased to some extent at almost all types of farms. However, a marginal increase in total cost per lactation of average yielding cows at the farms of project participating farmers was occurred (Table 37).

Table 37. Total Cost per Lactation of Cows

Survey	Participating	Non-Participating	Control	All
High Yielding Cows				
Baseline (2007)	60874.7 (3491.3)	53058.9 (5030.1)	56927.1 (4739.3)	57654.6 (4701.3)
Post Project Assessment (2009)	58867.3 (8148.1)	-	56213.5 (4367.4)	58336.5 (7155.5)
Change	-2007.4	-	-713.6	681.9
Average Yielding Cows				
Baseline (2007)	37194.4 (6095.0)	34469.9 (5720.5)	40345.2 (13479.5)	37349.4 (6682.9)
Post Project Assessment (2009)	38287.5 (5304.7)	33307.1 (1793.5)	39031.3 (8560.0)	37594.0 (6780.8)
Change	1093.1	-1162.8	-1313.9	244.6

1.2.6 Change in Net Income per Lactation of Buffaloes and Cows

There is always a potential to increase yield of the dairy animals which are yielding below potential. Greater is the gap between potential and actual yield, higher will be the increase in yield due to adoption of better management practices. This was the case for average yielding buffaloes as net income of the project participating farmers increased to the maximum (by Rs.34484). While increase in net income per lactation of average yielding buffaloes at the farms of project non-participating and control group farms was of Rs.10999 and 15652 respectively. An increase of Rs.17348 in net income of the project participating farmers was occurred in case of high yielding buffaloes. However a decrease of about Rs.7000 to Rs.10000 per lactation occurred at the farms of non-participating and control group farmers (Table 38).

Table 38. Net Income per Lactation of Buffaloes

Survey	Participating	Non-Participating	Control	All
High Yielding Buffaloes				
Baseline (2007)	41529.0 (29930.3)	34364.2 (29558.3)	46475.4 (45149.1)	40731.0 (33675.9)
Post Project Assessment (2009)	58876.9 (37969.4)	24630.9 (7005.6)	38772.9 (15648.3)	41058.0 (25142.7)
Change	17347.9	-9733.3	-7702.5	327.0
Average Yielding Buffaloes				
Baseline (2007)	12496.8 (11149.8)	15724.6 (13057.7)	15427.6 (8197.1)	15594.4 (9467.2)
Post Project Assessment (2009)	46980.6 (25560.1)	26724.5 (30710.6)	31079.8 (13479.5)	32362.0 (21326.2)
Change	34483.8	10999.9	15652.2	16767.6

As the cost of production decreased to some extent in case of cows and price of milk goes up over time, net income of project participating farmers increased more than double from 2007 to 2009 in case of high yielding cows. An increase of Rs.11642 in the net income of the farmers at the farms of control group farmers occurred in case of high yielding cows. However, in case of average yielding cows a decrease in net income of the project participating and non participating farmers was occurred due to decrease in milk productivity (Table 35 & Table 39).

Table 39. Net Income per Lactation of Cows

Survey	Participating	Non-Participating	Control	All
High Yielding Cows				
Baseline (2007)	73257.9 (66049.9)	85497.7 (48216.2)	72273.6 (43416.0)	76831.4 (54554.0)
Post Project Assessment (2009)	149370.2 (91293.4)	-	83916.5 (37480.9)	136279.5 (84307.2)
Change	76112.3	-	11642.9	59448.1
Average Yielding Cows				
Baseline (2007)	47874.7 (55524.1)	25852.1 (14426.0)	1597.7 (16261.2)	26943.4 (40793.3)
Post Project Assessment (2009)	45015.0 (23040.7)	20692.9 (12811.8)	10680.7 (9691.7)	20535.5 (16186.0)
Change	-2859.7	-5159.2	9083.0	-6407.9

1.3 Post project assessment at the irrigated site

At the irrigated site, two villages (Chak No. 74/SB and 105/SB) were selected for project interventions. Moreover, two control villages (Chak No. 72/SB and 100/SB at Sargodha) were selected for impact evaluation at irrigated site.

1.3.1 Fodder Area

Better quality seeds of both rabi and kharif fodders were provided to participating farmers which enabled them to get higher fodder yield specially during rabi season; therefore a potential impact could have been a change in the fodder area per animal unit. Only a small decrease in the rabi fodder area per animal unit and no change in the kharif fodder area were observed for the participating farmers. Furthermore, there was no clear difference in the changes between participating, non-participating and control farmers (Table 40).

Table 40. Fodder Area planted per Animal Unit

Fodder Area available per Animal Unit (hectare)	Participating	Non-participating	Control	All
Rabi Fodder Area (Baseline 2007)	0.15 (0.11)	0.14 (0.09)	0.16 (0.08)	0.14 (0.09)
Rabi Fodder Area (Post Project Assessment 2009)	0.12 (0.05)	0.15 (0.13)	0.14 (0.05)	0.14 (0.08)
Kharif Fodder Area (Baseline 2007)	0.21 (0.17)	0.15 (0.10)	0.17 (0.13)	0.17 (0.13)
Kharif Fodder Area (Post Project Assessment 2009)	0.21 (0.22)	0.14 (0.11)	0.16 (0.07)	0.16 (0.15)

1.3.2 Use of Concentrates by Project Participating Farmers

An improvement in use of concentrates for all types of dairy animals by project participating farmers was observed at the irrigated site. The main increase was in the use of oil seed cake for high yielding buffaloes and in use of both oil seed cake & vanda in case of high yielding cows (Table 41).

Table 41. Use of Concentrates by Project Participating Farmers (kg/lactation)

Animal Categories	High Yielding Buffalo		Average Yielding Buffalo		High Yielding Cow		Average Yielding Cow	
Survey	Baseline 2007	PPA 2009	Baseline 2007	PPA 2009	Baseline 2007	PPA 2009	Baseline 2007	PPA 2009
OSC	325.7	405.0	265.2	360.0	155.8	215.0	90.0	107.1
Vanda/Choker	86.5	65.0	32.4	0.0	123.3	175.0	67.5	70.3
Wheat Grains	4.2	0.0	3.6	3.5	3.3	0.0	5.7	6.7
Total	415.9	470.0	301.2	363.5	282.4	390.0	163.2	184.1

1.3.3 Change in Number of Milk Selling Farmers

At irrigated site an increase in number of farmers having milk surplus for sale was observed over time at all types of farms. However, this increase was maximum for project participating farmers, followed by non-participating and control group farmers (Table 42).

Table 42. Milk Selling Farmers (Percent)

Survey	Participating	Non-participating	Control	All
Base line 2007	77	55	90	74
Post Project Assessment 2009	100	75	100	93

1.3.4 Change in Milk Yield of Buffaloes and Cows

Average milk yield of high yielding buffaloes at the farms of project participating farmers increased from 8.2 liter in year 2007 to 8.8 liter per day in year 2009. Thus increase in milk yield was 0.6 liter per day. At farms of control group farmers, milk yield remained constant, while there was an increase of 0.5 liter per day at the farms of non-participating farmers. A marginal increase of 0.2 liter in milk yield of average yielding buffaloes was observed at the farms of project participating farmers; while, a decrease of 0.8 liter at the farms control group farmers and an increase of 0.9 liter per day at the farms of non-participating farmers was occurred (Table 43).

Table 43. Animal Specific Milk Yield of Buffaloes

Survey	Participating	Non-Participating	Control	All
High Yielding Buffaloes				
Baseline (2007)	8.2 (1.5)	7.6 (1.5)	7.9 (0.7)	7.9 (1.8)
Post Project Assessment (2009)	8.8 (1.1)	8.1 (0.9)	7.9 (1.8)	8.2 (1.2)
Change	0.6	0.5	0.0	0.3
Average Yielding Buffaloes				
Baseline (2007)	4.9 (1.2)	4.7 (0.7)	4.8 (0.8)	4.8 (0.9)
Post Project Assessment (2009)	5.1 (1.0)	5.6 (0.3)	4.0 (0.4)	5.0 (0.8)
Change	0.2	0.9	-0.8	0.2

Milk yield of high yielding cows increased by 4.4 liters per day at the farms of project participating farms and by 4.1 liter at the farms of control group farmers. Average milk yield of average yielding cows decreased at all farm types. However lowest decrease was observed at the farms of the project participating farmers followed by non-participating and control group farmers (Table 44).

Table 44. Animal Specific Milk Yield of Cows

Survey	Participating	Non-Participating	Control	All
High Yielding Cows				
Baseline (2007)	10.4 (1.9)	8.7 (1.3)	8.4 (0.2)	9.4 (1.6)
Post Project Assessment (2009)	14.0 (3.5)	-	12.5 (0.5)	13.5 (2.6)
Change	4.4	-	4.1	3.1
Average Yielding Cows				
Baseline (2007)	6.1 (1.5)	5.3 (1.3)	6.1 (0.8)	5.7 (1.2)
Post Project Assessment (2009)	5.7 (3.1)	4.5 (0.7)	4.7 (0.4)	5.1 (2.0)
Change	-0.4	-0.8	-1.4	-0.6

1.3.5 Change in Total Cost per Lactation of Buffaloes and Cows

Baseline survey results indicate that in case of high yielding buffaloes and cows, cost of production per lactation was highest at the farms of project participating farmers, followed by non-participating and control group farmers. Similarly, highest increase in cost of production per lactation in case of both high and average yielding buffaloes and high yielding cows was at the farm of project participating farmers followed by non-participating and control group farmers. In case of average yielding cows situation was quite opposite, with maximum increase in total cost per lactation at the farms of control group farmers followed by at the farms of non-participating and participating farmers (Table 45 & 46).

Table 45. Total Cost per Lactation of Buffaloes

Survey	Participating	Non-Participating	Control	All
High Yielding Buffaloes				
Baseline (2007)	35009.1 (3402.2)	34154.2 (3177.9)	32668.7 (2523.0)	34201.4 (3212.3)
Post Project Assessment (2009)	44679.7 (6170.1)	43324.0 (2320.4)	40709.2 (2072.0)	42959.3 (4455.8)
Change	9670.6	9169.8	8040.5	8757.9
Average Yielding Buffaloes				
Baseline (2007)	20732.4 (4155.9)	21284.7 (2694.1)	20073.1 (2940.0)	20669.3 (3161.2)
Post Project Assessment (2009)	30419.7 (2778.4)	29708.6 (9203.5)	21079.9 (5435.8)	28338.4 (7771.2)
Change	9687.3	8423.9	1006.8	7669.1

Table 46. Total Cost per Lactation of Cows

Survey	Participating	Non-Participating	Control	All
High Yielding Cows				
Baseline (2007)	39195.18 (7886.2)	41366.1 (2950.1)	36009.3 (4512.4)	39611.5 (5693.2)
Post Project Assessment (2009)	57907.4 (6766.6)	-	50549.0 (5878.2)	55454.6 (6398.6)
Change	18712.22	-	14539.7	15843.1
Average Yielding Cows				
Baseline (2007)	28574.0 (8237.2)	22325.8 (6138.9)	22804.3 (4694.1)	23722.9 (5580.1)
Post Project Assessment (2009)	30612.5 (3728.9)	25513.6 (2050.0)	32185.4 (2345.5)	28887.5 (3798.1)
Change	2038.5	3187.8	9381.1	5164.6

1.3.6 Change in Net Income per Lactation of Buffaloes and Cows

Average increase in the income per lactation in case of high yielding buffaloes was highest for project participating farmers followed by control and non-participating farmers. In case of average yielding buffaloes, an increase in net income per lactation was occurred at the farms of both project participating and non participating farmers, while a decrease occurred at the farms control group farmers (Table 47).

Table 47. Net Income per Lactation of Buffaloes

Survey	Participating	Non-Participating	Control	All
High Yielding Buffaloes				
Baseline (2007)	20457.2 (21236.4)	18977.2 (15367.1)	16360.3 (18160.4)	19027.0 (16710.4)
Post Project Assessment (2009)	45575.3 (22603.6)	22676.0 (13416.8)	37145.8 (21512.4)	37212.5 (21293.0)
Change	25118.1	3698.8	20785.5	18185.5
Average Yielding Buffaloes				
Baseline (2007)	14172.6 (7316.6)	9088.4 (6174.5)	8381.9 (4346.9)	10306.3 (6217.3)
Post Project Assessment (2009)	22155.3 (12991.5)	23891.4 (27404.2)	1420.1 (3314.5)	18529.1 (18029.4)
Change	7982.7	14803.0	-6961.8	8222.8

Project had a considerable positive impact on the net income of the project participating farmers as an increase in their average net income was observed both in case of high yielding and average yielding cows. Moreover, increase in their net income was highest in case of both high yielding and average yielding cows (Table 48).

Table 48. Net Income per Lactation of Cows

Survey	Participating	Non-Participating	Control	All
High Yielding Cows				
Baseline (2007)	47024.8 (33402.8)	32133.9 (31341.4)	40855.3 (17825.7)	40690.2 (27408.4)
Post Project Assessment (2009)	18177.6 (57827.6)	-	95700.9 (48274.2)	110685.4 (42900.1)
Change	71152.8	-	54845.6	69995.2
Average Yielding Cows				
Baseline (2007)	11791.0 (3408.9)	22174.2 (13114.5)	14415.6 (12359.6)	16054.0 (11332.3)
Post Project Assessment (2009)	23751.2 (23070.1)	1836.8 (2216.4)	-4185.4 (1847.5)	11288.5 (19762.3)
Change	11960.2	-20337.4	-18601.0	-4765.5

1.4 Evaluation of feed-livestock production technologies by the farmers

1.4.1 Introduction

Livestock sector plays an important role in the economy of the Pakistan with a share in national and agricultural GDP estimated to be 11.3 and 51.8 percent respectively. The value of livestock is 6.1 percent more than the combined value of major and minor crops (GOP 2009). The role of livestock in rural economy may be assessed by the fact that 30 to 35 million of the total rural population are engaged in livestock farming, deriving 30 to 40 per cent of income from it. Pakistan accounts for 143 million animal heads in 2006 (GOP 2006). However livestock population and fodder production are inversely related. The fodder area per adult animal unit has significantly declined from 0.067 ha to 0.035 ha and production declined from 1.31 ton to 0.80 ton from 1986 to 2006 (Shah *et al* 2009).

Inadequate nutrition is one of the major constraints limiting livestock production in the country. Feed accounts for almost 70% of total cost of production of milk or meat (Sharif et al 2009). Keeping in view the importance of livestock in the livelihood of the people, scarcity of green fodder and feed different interventions were done at three project sites under Community Action for Livestock Development Project in Pakistan. The objectives of the interventions were to promote the adoption and fulfill the requirement of fodder and feed at local level and to get the maximum potential in terms of milk and meat.

The applied research in project sites was conducted in collaboration with national and international research institutes for the last two years. Scientists from National Agricultural Research Centre, Islamabad, University of Arid Agriculture, Rawalpindi and Fodder Research Institute, Sargodha were collaborating to execute research with technical backstopping from ICARDA. The multidisciplinary programs are working on three target sites, one in rainfed area of Rawalpindi and two in irrigated area of Sargodha district. The field trials managed on participatory principles provide farmers' views, their acceptance of the intervention and information on the compatibility of the intervention within the farming systems and an opportunity to further fine tune (Anderson et al, 1985 and Hildebrand and Poey, 1985).

This study was planned specifically for ongoing assessment of the research activities, which would help to observe the short-term effects and long-term impacts of individual project components. Short-term assessment of any technological development process is indispensable because it provides logical basis for upgrading, enhancing and redesigning the project activities. In this regard, indigenous knowledge and observation of the farmers about the new technologies are vital to be considered at initial stage. The prime intention of the study was to explore the development status of feed livestock production technologies, farmers' adoption behavior and farmer's assessment of these technologies. This would serve as a feed back to the researchers and development agencies involved in this project. The specific objectives of the study are

- Evaluate economic viability of the technological interventions tested by all components of the project.
- Examine the compatibility of project interventions with the farm situations and rural livelihood strategies.
- Understand farmers' perceptions of the adoption of project interventions.

1.4.2 Materials and Methods

A set of different questionnaires along with checklist was developed to collect farmers' response in a systematic way for different technological interventions. For assessment of different interventions information was mainly collected on parameters like environment for the trial, area of the trial, number of varieties, farmers' involvement in the trial, knowledge of inputs, farmer evaluation in terms of different attributes, and future potential. For the present study only farmers' assessment about these interventions was explored.

Twenty eight farmers from rainfed site Lodhay and thirty five farmers from irrigated sites (Chack 105 and Chack 74) who had hosted different interventions/trials during the year 2009 were interviewed. In most of the cases more than one intervention/trail was experimented with each of the host farmer and therefore it was easy to get comparison and farmers' choices for different fodder crops along with the perceptions of the individual crop varieties and their local check, hay making intervention and their views about the balance feed introduced at the sites.

1.4.3 Results at Rainfed Site

1.4.3.1 Fodder & Hay Intervention

Fodder

Winter fodder mix (oat+vetch) was experimented at the rainfed site. All the farmers had knowledge about recommended seed rate, fertilizers types and doses. However none of farmers knew the name of varieties sown by them. Interest of fallow farmers in the trail was high. Improved sowing (oat+vetch) resulted into 35 percent more increase in fodder yield than conventional sole oat sowing. Average area allocation for seed production was 0.15 hectare. However, most of the farmers suggested a change in trail. Type of change suggested by them sole oat sowing. Reason given by them was non availability of vetch seed in the local market. All of the farmers expressed their satisfaction over the trial and majority of them (80%) showed high interest in its continuity.

Hay

Farmers viewed oat plus vetch hay intervention very positively and majority of them (85%) stated that they will adopt it and continue at their own. However, they showed their concern about high labour requirement for hay making. Average green fodder production of oat plus vetch was 1729 monds per hectare with dry matter/ hay production of 570.6 monds per hectare. Farm gate prices of hay were Rs.172 per mond which were less than its close substitute (wheat straw) by Rs28 per mond. Thus financial benefit with hay production was Rs.28 per monds or Rs.15977 per hectare. It is also worth mentioning that oat plus vetch hay have more nutritive value than wheat straw.

1.4.3.2 Fodder Seed Enterprise

At the rainfed site four farmers experimented to initiate oat seed enterprise. Two of them also had some experience of fodder seed production. Average seed production was 59.3 monds per acre with wastage of 6.2 monds per hectare. On an average, farmers stored 5.5 monds for self use and sold the surplus during month of September at average prices of Rs.35 per kg. Fellow farmers in the village and farmers of neighboring villages were the seed buyers. Though they reported no problem in seed marketing but two of them (50%) showed their intention to continue oat seed production activity. Reasons of discontinuation forwarded by them were non existence of any crop security measures against free grazing of livestock, shortage of labour and water shortage. Average cost of oat seed production was Rs.33138 per hectare with a gross income of Rs.74340 per hectare and net income of Rs.41202 per hectare. Cost benefit ration of oat seed production enterprise was 1:2.24.

1.4.3.3 Feeding Lactating Buffalos

Purpose of this trial was to improve the milk productivity of buffaloes. Number of farmers who performed this trial was seven and total duration of the trial was 60 days. Average quantity of ration used per day was 13.8 kg. Fellow farmers view about the trial was positive. Increase in cost with the use of ration was about 11 percent which resulted into an increase in milk yield of 15 percent.

1.4.3.4 Feedlot Fattening Trial

Purpose of the trial was dissemination of improved fattening feed. Feedlot fattening trail was performed by six farmers. Trial duration was 60 days. All the farmers had knowledge about ingredients of the feed. Seventy percent of them replied that equivalent feed was available in the local market. Majority of them (70%) showed their concern about more labour requirement for feedlot fattening activity. Seventy five percent of them reported to mange extra labour by hiring it. Both male and female laborers were engaged in the activity. Average increase in the weight of buffalo calves at the farms of farmers who were involved in the trial was 30.5 kg and at the farms of the control group farmers was 30.8 kg. Thus weight gain was same at the farms of farmers who were involve in the trail and at the farms of control group farmers. Similarly the weight gain in case of cow calves was quite same at both types of farms. It was 31.4 kg and 31.8 kg at the farms of participating and control group farmers respectively. Majority of the farmers (75%) were not satisfied with the performance of the trial and informed that they would not to continue it any more. Reasons for discontinuation of the practice forwarded by the farmers were poor performance of the trail and more labour requirement than conventional calf fattening.

1.4.4 Results at Irrigated Site

1.4.4.1 Farmers' Assessment and Perceptions about Fodder Trials at Irrigated Site

Summer (Kharif) Fodder Crops

At irrigated sites in Sargodha improved varieties of four fodder crops were introduced. Farmers' varietals know how except for sorghum was also poor at irrigated sites while the input knowledge was good. These new varieties in terms of different attributes were considered better than the local varieties. Farmers reported that fodder plants of these varieties had bold stem, log tassels, large leaves, soft and sweet and cow pea mix with sorghum and millet is more palatable and had positive effect on milk yield. These also remain green for longer period than the local one. The yield achieved at farmers' fields was 50-75% higher than the local varieties being grown by the farmers. There was no difference in number of cuttings with the local varieties. Keeping in view the above observations farmers were intended to adopt these varieties. The main problem highlighted by the farmers was that seed of millet and sorghum could not be produced due to bird attack and late maturity. The results of the farmers' perceptions about kharif fodder trails at irrigated sites are summarized in Table 49.

Table 49. Farmers' Perceptions and Assessment of Kharif Fodder Crops

Parameters	**Sorghum**	**Pearl Millet**	**Maize**	**Sorghum, millet, Cow pea mix**
Farmers' knowledge				
Varietal know how	Partial	Poor	Partial	Poor
Input knowledge	Good	Good	Good	Partial
Farmer evaluation in terms of attributes:				
Palatability	Better	Better	Better	Best
Nutrients	More sweet	Better	Better	Better
Green Fodder availability	One month more	15 days more	Same	15-20 Days more
Evaluation in terms of Yield				
Green Fodder Yield difference ↑	50-75%	50-75 %	50%	50-75%
Number of cuttings	Same	Same	Same	Same
Own interest	High	High	High	High
Fellow farmers interest	High	High	High	High
Future intentions	Adopt	Adopt	Adopt	Adopt

Winter (Rabi) Fodder Crops

The results regarding the farmers' knowledge about the name of varieties and input use were almost similar as reported above. The nutrients and palatability attributes as judged by the farmers were better than the local varieties of rabi fodder. Berseem and oat mixture was considered best fodder for rabi at irrigated site. Berseem gave one additional cut and the time period was also 15-20 days more. The yield difference for oat was 50-100% at different farmers' fields and berseem and oat mix provided more than double yield. Farmers were intended to adopt and the interest of fellow farmers was also high. The results are presented in Table 50.

Table 50. Farmers' Perceptions and Assessment of Rabi Fodder Crops

Parameters	Oat	Berseem & Oat Mix
Farmers' knowledge		
Varietal know how	Partial	Poor
Input knowledge	Good	Good
Farmer evaluation in terms of attributes:		
Palatability	Better	Best
Nutrients	Better	Better
Green Fodder availability	Same	15-20 days more
Evaluation in terms of Yield		
Green Fodder Yield difference ↑	50-100%	100-150%
Additional cuttings	Same	1
Own interest	High	High
Fellow farmers interest	High	High
Future intentions	Adopt	Adopt

1.4.4.2 Farmers' Assessment and Perceptions of Hay Production

The intervention of Hay was also very much appreciated by the farmers. According farmers' point of view it's a new activity for them and it would help to manage fodder for lean period. Oat was considered best for hay making that could be used in the fodder lean periods of May-June after the harvest of wheat. According to farmers it was better than wheat straw and it had more nutrients almost equal to the green fodder.

Although most of the farmers were interested and appreciated this activity yet farmers would not be able to make hay due to the small land holdings and small area allocated to fodder crops. Only the farmers with excess fodder availability would be able to make hay.

1.5 Investment appraisal and evaluation of community based production of balanced feed

1.5.1 Introduction

Pakistan's livestock activities accounted for about 36 percent of the total value of agricultural output and about 9.0 percent of the GDP in the country during the year 1999 - 2000 (GOP 2001). In the year 2005-06 (GOP 2006) livestock sector contributed almost 50 percent to the value addition in the agriculture sector and almost 11 percent to Pakistan's GDP, which is higher than the contribution made by the crop sector (47.4%) in agriculture and (10.3%) in GDP. The role of livestock sector in the rural economy of Pakistan is very critical as 30-35 million rural population of the country are engaged for their livelihood. Within the livestock sector, milk is the largest and the single most important commodity. Despite decades of neglect, Pakistan is the fifth largest milk producer in the world. The total value of milk produced is higher than the value of two major crops, that is, wheat and cotton. The contribution of livestock to the national economy takes different forms such as, yielding milk, providing meat and by-products like leather, hide and manure. Its products constitute an important source of foreign exchange earnings (Herani et al 2008).

Natural fodders along with crop residues are important forage feeds of livestock both in rainfed and irrigated areas of Pakistan. The severity of fodder shortages in rainfed areas is high as compared to irrigated areas. Commonly the forage feed are often of poor quality, usually deficient in protein and minerals. To improve production, the farmer should optimize the efficiency of utilization of the available feed resources. This is done by the use of supplements that provide the deficient nutrients, especially protein. Some of these supplements can sometimes be produced using locally available ingredients and agro-industrial by-products. At present a number of supplemental feeds as commercially available in the market. The farmers use these feeds for milking animals as well as for fattening animals but the quality is often questionable.

Keeping in view the importance of livestock in the livelihood of the people, scarcity of green fodder two feed producing units were provided under Community Action for Livestock Development project. One unit was installed at rainfed site in village Lodhay (Gujar Khan) and other at irrigated site in Ckack No 105 SB, Sargodha. Technical support and formulation of the balance feed of balance feed for milking and meat animals were also provided by the experts to the entrepreneur at community level. The main objective of feed production micro enterprise development at community level was to provide quality feed at cheaper prices and doorstep availability.

As the investment appraisal is a tool that helps individuals and companies to plan for the acquisition of long-term investments in capital assets, such as new machinery for use in a business or the replacement of existing machinery with upgraded equipment. Therefore the present study for investment appraisal of micro feed enterprise would enable the entrepreneurs and the planners with the cost and revenue implications of their venture decisions through real time break even analysis, and investment dashboard indicating the danger zones in investments during accelerated growth.

The financial viability and sustainability issues for the development of feed enterprise are focused with the following objectives:

- To analyze the financial viability of the small enterprise.
- To estimate the economic production levels.
- To suggest policy recommendations for sustainability of the enterprise.

1.5.2 Methodology

Investment appraisal analysis was carried out to determine the extent of incentives for future investment in Balance Feed enterprise. The entire subsidy and the expenditures of the farmers in the establishment of the enterprise including the construction/rental charges of the buildings and family labour were included. The present market cost of the inputs was used. To calculate the fixed cost depreciation @5% on initial investment and 12% interest rate was used.

If the feasibility study or business plan shows that project will bring direct tangible benefits, the classical methods of project evaluation can be applied (Brzozowska 2007). Having data of projected capital expenditures, projections of turnover, income and cost statement projections and in effect on expected cash flows the further evaluation can be lead through different stages. The one is the calculating of the payback period ratio, accounting rate of return and break-even-point (Mishan, 1982). The second one, the most popular, is the assessment based on changes of value in time that is calculating of

discounting ratios, like as NPV or IRR and others like sensitivity analysis, different scenarios or simulation game (Myers, 1984).

Break even out refers to the level of output where TR = TC. This is the minimum out put the firm need to produce its costs. Any output thereafter will grant profit to the firm. Usage of breakeven point for corporate decision making is called Break even analysis. At breakeven point total cost is equal to total revenue. After breakeven point the profitability begins. The output less than break even output shows losses. Every firm aims at breakeven level of output in the beginning. The breakeven level is a no profit no loss condition. In other words it is case of normal profits. The costs cover only the fixed cost and there is no surplus over that. It is similar to the condition AR = AC.

$$\mathbf{TR = TC}$$

$$\mathbf{P \times Q - TFC + AVC \times Q}$$

And breakeven quantity is

$$\mathbf{Q=TFC/(P-AVC)}$$

Where,
TR is total revenue
TC is total cost
P is price
AVC is average variable cost
TFC is total fixed cost
Q is output
Two simple methods are commonly used to appraise investment decisions: (i) "Pay Back method" and (ii) "Return on Capital". Pay back methods is simply based on the time taken to repay the capital invested, a guide for decision-making. In other words, if a project has the ability to pay back the investment within a predetermined period, it is worth investing, otherwise no need to invest. This method can also be used for comparing the project in hand with other projects, i.e. the projects can be ranked based on speed of "pay-back". The earliest paying-back projects are naturally most favored over the slow ones (Lumby, 1991).

"Return on Capital" is used for investment decision-making. In this method profit from an investment is estimated after deducting depreciation cost and before incorporating taxation allowance (Lumby, 1991). Both methods have pros and cons. In addition, there are two more advanced techniques based on analysis of discounted cash flows (DFC) that are "Net Present value" (NPV) and "Internal Rate of Return" (IRR).
Lumby, S. 1991, “Investment Appraisal and Financing Decisions”, Fourth Edition, London: Chapman and Hall.

1.5.2.1 Net Present Value (NPV)

The basic criterion of this assessment is that an investment is said to be worthwhile, when the money received from an investment is at least equal to the money invested. The decision rule of this technique is to accept those projects which have a positive or zero net present value and reject those investment which have a negative net present value (Lumby: 1991). The present value of an investment is the sum of its net discounted future cash flows:

$$NPV = \sum_{t=0}^{n} \frac{A_t}{(1+r)^t}$$

Where, "A_t" is the project's cash flow (either positive or negative) in time (takes on value from year 0 to n. where n represents the point in time when the project comes to the end of its life) "r" is the annual rate of discount or the time value of money (which is here assumed to remain a constant over the life of the project).

1.5.2.2 Internal Rate of Return (IRR)

The internal rate of return (IRR) is known as the rate of discount, which applied to an investment's cash flow, produces zero net present value (NPV). Simply IRR is the value of 'r' which satisfies the following expression:

$$\sum_{t=0}^{n} \frac{A_t}{(1+r)^t} = 0$$

The decision rule in this approach is to accept that investment having an IRR greater than or equal to the market rate of interest.

These two methods were used to assess the financial viability of the enterprise. In addition to it the per unit production cost was calculated with different levels of the production to identify the breakeven point.

1.5.3 Results

1.5.3.1 Ownership and investment

The community member selected the entrepreneurs for the running of the feed units through the communities. Both the persons are very well linked socially with the farming community and also have some entrepreneurship skills and business orientation. Both the units are funded through the project with machinery cost of around Rs. 80,000/- each. The installation cost, building along with the provision of electricity and inputs were provided by the entrepreneurs at both the sites. However technical guidance along with feed formulation was provided time to time by the concerned experts from NARS involved in the project.

1.5.3.2 Ingredients of the Balanced Feed

The main ingredients of the feed along with the current market prices are listed in Tables 51 and 52 at both rainfed and irrigated sites respectively. The prices of inputs may vary from season to season. The prices of inputs purchased during January 2009 at irrigated site and during March 2009 at Rainfed site are reported. The formulation was done according to the availability and prices of different potential ingredients keeping in view the quality aspect in terms of percent protein and energy in the feed.

At rainfed unit the maize gluten followed by maize cake, wheat bran and cotton seed cake are the main ingredients both in terms of input and cost except for CSK with is ranked third in terms of cost and fourth in terms of weight.

Table 51. Formulation and Input Prices of Balance Feed at Rainfed Site

Inputs	Prices	Percent Share	
	Rs/kg	Inputs	Cost
Maize Gluten 30% protein	19.8	40.5	30.45
Rap Seed Cake	21.0	5.0	6.21
Cotton Seed Cake	21.0	14.0	16.82
Wheat Brain	14.8	19.0	16.16
Maize Cake	14.0	20.0	25.06
DCP	2.0	1.0	1.80
Rap seed Oil	140.0	0.5	3.51

At irrigated site the formulation was little different with cotton seed cake making the major share both in terms of weight (47.5%) and in terms of cost (53.4%) followed by wheat bran, maize gluten and maize cake.

Table 52. Formulation and Input Prices of Balance Feed at Irrigated Site

Inputs	Prices	Percent Share	
	Rs/kg	Inputs	Cost
Maize Gluten	13.0	15.0	10.97
Rap Seed Cake	21.5	5.0	6.05
Cotton Seed Cake	20.0	47.5	53.44
Wheat Bran	17.4	15.0	14.64
Maize Cake	21.3	10.0	11.95
Salt	2.0	1.3	0.14
Molasses	8.0	6.3	2.81

1.5.3.3 Breakeven Analysis

The Breakeven Analysis is an important management tool and control device. The analysis shows the point at which a business has covered its expenses and begins to post a profit. It is based on breaking down costs into 'variable costs' (costs that are directly related to the manufacture or production of a product or those necessary in providing a service) and 'fixed costs' (costs that remain fairly constant and are not affected by a change in output) and comparing those costs to certain levels of sales.

Break-even point is the point at which the product stops costing money, and starts to generate a profit for the venture. The principle behind this is to plot a graph of the total cost and total revenue against the volume of production. The intersection of the lines is the breakeven point and it indicates the minimum units to be produced to come out of loss situation. The given Volume of production, the break even can also be found out in terms of time.

The results of the breakeven analysis are depicted in Figures 1 and 2 for units at the rainfed and irrigated sites. Daily units breakeven are 60 kg at rainfed site and 67.7 kg at irrigated site with daily revenue breakeven of Rs. 1283 and Rs. 1313 respectively. Based on the results of breakeven analysis you have to sell about 1.8 tons of feed in a given month in order to breakeven and have at least sales of Rs. 38436 per month at rainfed unit. Similarly unit at irrigated site have to keep sales of at least Rs. 39375 per month by sale of about 2.04 tons of feed.

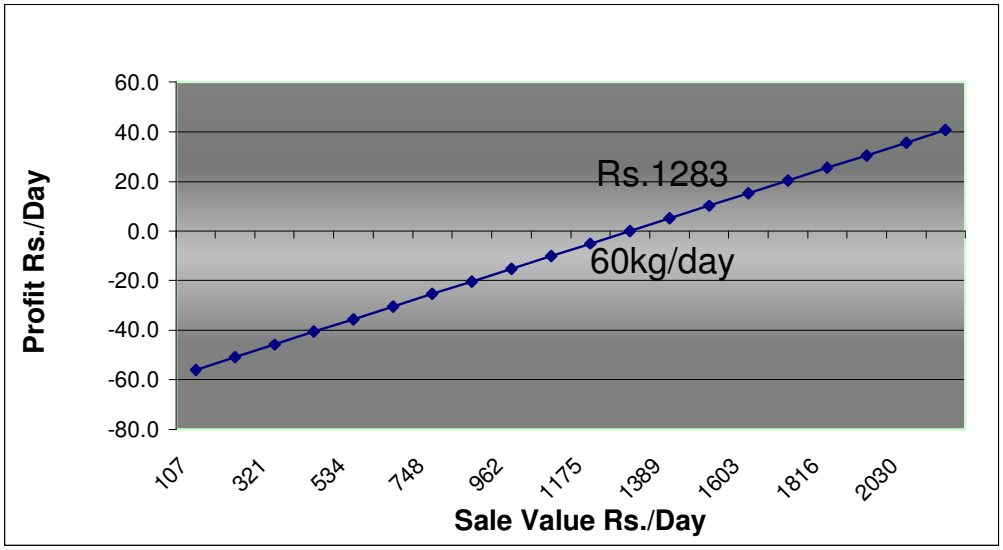

Figure 1. Breakeven point for Feed Unit at rainfed site

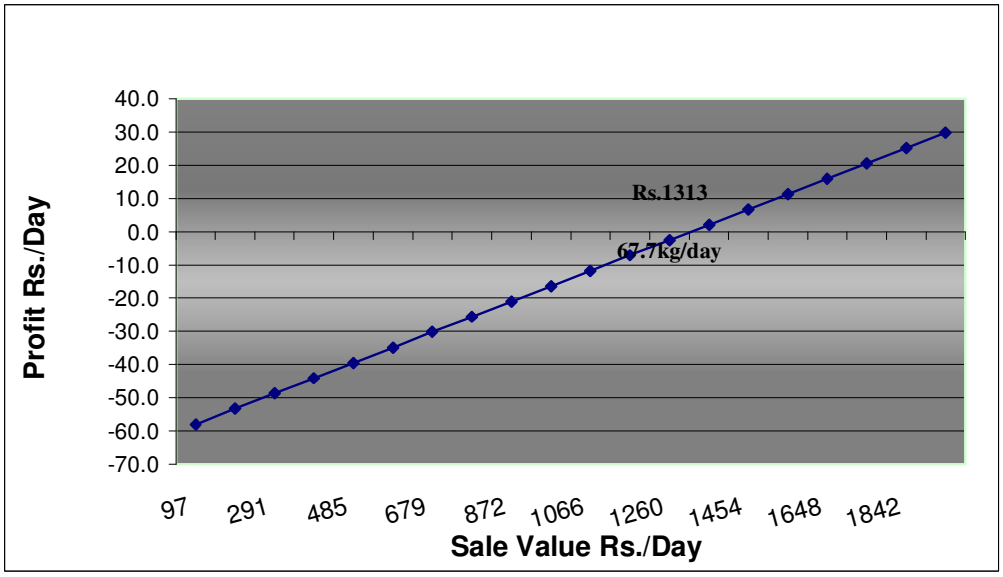

Figure 2. Breakeven point for Feed Unit at irrigated Site

1.5.3.4 Investment Appraisal

One balance feed production unit was installed at village Lodhay that is rainfed in August 2008 and at Chack 105 SB Sargodha. Irrigated site, in September 2008. Both work on electric power. The investment cost includes the cost of Feed mixer, Grinder, weigh machine, electric meter charges, installation charges, cost of building etc. The cost of inputs is already explained in the Table 51 & 52. The total cost of machinery was about rupees 80000. The other cost such as installation and electricity connection were paid by the entrepreneurs. The labour cost, rental charges and output levels were calculated mainly by the information provided by the concerned producers on the number of laborer used per day, wage rate and the number of bags produced per day etc. At present these entrepreneurs were selling the feed mix at no profit no loss base that just cover the input, labor and power cost. For commercial purpose profit @ 5% over the variable cost was used as desired by both the producers. Keeping the sales of around 0.6 tons per day (220 tons per year), the

NPV was positive and the IRR was also very high 205% for feed unit at irrigated site and 225% for feed unit at rainfed site. These two factors provided a good justification for the investment. Although the installed capacity is much higher yet keeping in view the marketing and other unforeseen problems the sale level was kept low at around 50% per working day. The summary of all these cost and the results of investment appraisal are elaborated in Table 53.

Table 53. Investment Appraisal*

	Lodhay (rainfed)	Chack 105 SB (Irrigated)
Variable Cost Rs./Kg	20.35	18.46
Sale Price Rs./Kg	21.37	19.39
Fixed Cost Rs./Day	61.08	62.50
NPV	5,885.16	5,968.22
IRR	225%	205%

*Production of 0.6 tons/day, i.e. below 50% capacity

1.5.3.5 Economic Production Levels

The balance feed was being sold mainly in the project villages at comparatively cheaper prices with the feed available in the market. There are competitors from the private sector in feed mixtures like National Feeds and other companies. Generally farmers used to feed cotton seed cake and this was still considered as good concentrate. However the contact farmer who was managing the unit was hopeful in the business of feed and was of the view that the quality of this feed was much better due to the first-rate formula and good quality inputs than the other concentrates available in the market. Difference in sale and produce price was only about one rupee per kg. The fixed cost and maintenance charges per unit of output decreases as the production level increases therefore main difference in profit may vary with the difference in production levels. The profit ranges with different levels of sale are summarized in Table 54.

Table 54. Profit range according to the sale volume at two sites

Sale Kg/Day	Lodhay (rainfed)	Chack 105 SB (Irrigated)
	Profit Rs./Day	Profit Rs./Day
0	-61.08	-62.5
40	-20.4	-25.6
80	20.3	11.4
200	142.4	122.1
400	345.9	306.8
600	549.5	491.4
800	753.0	676.1
1000	956.5	860.7
1200	1160.0	1045.4
1400	1363.5	1230.0
1600	1567.0	1414.6

1.5.4 Current Sale Levels

In the beginning feed experiments were conducted and feed was provided free to the participating farmers for three months. There were also problems in operating the machine. Feed production and marketing was also a secondary source of income for the selected entrepreneurs and they also lack entrepreneur skill. However due to the constant follow up and demonstration through feed experiments both the interest of the entrepreneurs developed along with it demand had been generated among the community. Therefore the sale of the balance feed had increased from 1.5 tons per month from January 2009 to 4.18 tonnes per month at irrigated site and 17.76 tonnes at rainfed site during October 2009. The concerned person at rainfed site has started marketing outside the village and also supplying at the feed stores in the nearby town market where as the key person at irrigated site was selling only at the production point only.

1.5.5 Farmers' Perception about Balanced Feed

In the opinion of the participating and fellow farmers, balanced feed introduced in the project significantly improved milk yield, body condition of the animals and the level of cash benefits through the sale of additional milk. Farmers reported 0.5 to 2 liters per day increase in milk yield with the use of balance feed. The locally produced balance feed was found cost effective along with better animal productivity over the conventionally used cotton seed cakes. The balance feed was being sold at competitive prices with other available feed rations in the market. There is also saving in terms of time (1-2 hours per visit) and transportation cost (Rs.10-15 per bag) incurred if farmers had to purchase from market. The intervention provided better competitiveness, sustainability, accessibility with inclusiveness of small holders along with scalability option for the entrepreneurs.

2 Theme 2: Technical interventions increasing forage production

2.1 **Winter crops** at the rainfed site

2.1.1 Introducing improved varieties, legume-cereal mixes and improved agronomic practices for winter crops.

Background

There are several primary reasons for the scarcity of green fodder in the dry areas. In addition to small land holdings and moisture scarcity, farmers give least preference to fodder crops and more emphasis to staple food crops for sustaining their families. There is lack of know how about the moisture conservation techniques and about improved fodder production practices.

The majority have no option to feed their animals with green and balanced fodder. Since crop residues are deficient in protein and minerals, the forages grown should preferably be legumes so that poor nutrient crop residues could be better supplemented. In areas with adequate demand and sufficient facilities for marketing liquid milk, agriculture has shifted towards dairying and commercial forage production (Dost, 1994).

Research Method

An area of 164 kanal was sown under pure stand of oats for hay with 42 farmers and 105 kanals, oats + vetch with 34 farmers in the project village area during winter 2008-09 using recommended agronomic practices. The sowing was completed by all the farmers in the first week of November, 2008. Three interventions (i.e. oats + Vetch under lepara land, oats + Vetch under maira land and Oats for hay under maira land) were studied. Green fodder yields with different community farmers' fields were assessed at different times of harvesting. Five farmers were randomly selected under each lepara and maira types of land for oats + vetch mix-cropping intervention and six under maira for oats hay. Under lepara land 2-3 cuttings were received while in maira lands only one cut was taken. A representative plot of 1.2 m^2 was harvested from 3 locations in the same farmers field and averaged to calculate the yield in t/ha.

Results and Discussion

The results recorded during the crop growth period are reported in Table 55. It was recorded that maximum green fodder yield of 85.95 t/ha was recorded under lepara land in 3 cuttings in the field of Mr. Aamar, followed by Mr. Shahid who produced 83.13 t/ha of green fodder under lepara land in also 3 cuttings. In 2 cuttings, 59.05 t/ha of green fodder yield was produced by Mr. Abdul Rauf in lepara land (Table 1).

Under maira land conditions, Mr. Mohammad Hanif recorded the highest average green fodder yield of 28.33 t/ha of 3 different times. Maximum green fodder yield of 44.03 t/ha was recorded when the crop was cut on 19.03.2009.

In maira land also oats for hay intervention, Mr. Arshad recorded the highest average green fodder yield of 25.27 t/ha of 3 different times. Maximum green fodder yield of 39.50 and 39.82 t/ha, respectively were recorded by Mr. Arshad and Wasim when the crop was cut on 19.03.2009.

Table 55. Green fodder yields (t/ha) on community farmers' fields at different harvesting times

Intervention	Type of land	Farmer's name	Harvesting Dates			
			18.01.09 1st cut	19.02.09 2nd cut	19.03.09 3rd cut	Total
Same crop harvested as multicut at different dates/intervals						
Oats + Vetch	Lepara	Aamar	17.5	31.80	36.65	85.95
		Shahid	17.0	27.08	39.05	83.13
		Abdul Rauf	15.7	-	43.35 (2)	59.05
		Ajmal	15.0	-	41.66 (2)	56.66
		Zahid	12.5	20.90	37.70	71.11
Harvested once at different dates/intervals						**Avg.**
Oats + Vetch	Maira	Mohammad Hanif	15.5	25.45	44.03	28.33
		Jahangir	15.0	25.00	43.75	27.92
		Amjad	12.5	26.84	41.66	27.00
		Sadiq	13.1	21.75	39.50	24.78
		Khurram Pervez	12.7	20.00	36.00	22.90
Harvested once at different dates/intervals						**Avg.**
Oats for Hay	Maira	Khurram Manzoor	12.5	19.15	33.33	21.66
		Javed	12.8	18.50	35.40	22.23
		Liaqat	15.0	21.00	37.06	24.35
		Arshad	13.2	23.10	39.50	25.27
		Wasim	11.0	18.00	39.82	22.94
		Sadaat	11.5	19.50	37.50	22.83

Conclusion

It was concluded that maximum green fodder yield potential of oats + vetch mixture can be harvested from lepara land which are near the village than the maira land.

2.1.2 Potential of oats and vetch mixed cropping for fodder and hay under various types of lands.

Research Method

An area of 164 kanal was put under pure oats for hay at 42 farmers and 105 kanals under oats + vetch at 34 farmers' fields in the project area during winter 2008-09 using recommended production practices. The sowing was carried out in the first week of November, 2008. Three interventions (i.e. oats + Vetch under lepara land, oats + Vetch under maira land and Oats for hay under maira land) were studied. Six representative farmers' fields were visited to record green fodder yield under oats for hay, 5 each in oats + vetch under lepara and oats + vetch under maira land. A representative plot of 1.2 m^2 was harvested from 3 locations in the same farmers field and averaged to calculate the yield.

Results and Discussion

Green fodder yields at different community farmers' fields were recorded at different times during the crop growth period. Five farmers were randomly selected under each lepara and maira types of land for oats + vetch mix-cropping intervention and six under maira for oats hay. Under lepara land 2-3 cuttings were received while in others one cut was taken (Table 56).

Table 56. Green fodder yields (t/ha) on community farmers' fields at different harvesting times

Intervention	Type of land	Farmer's name	Harvesting Dates			
			18.01.09 1st cut	19.02.09 2nd cut	19.03.09 3rd cut	Total
Same crop harvested as multicut at different dates/intervals						
Oats + Vetch	Lepara	Aamar	17.5	31.80	36.65	85.95
		Shahid	17.0	27.08	39.05	83.13
		Abdul Rauf	15.7	-	43.35 (2)	59.05
		Ajmal	15.0	-	41.66 (2)	56.66
		Zahid	12.5	20.90	37.70	71.11
Harvested once at different dates/intervals						**Avg.**
Oats + Vetch	Maira	Mohammad Hanif	15.5	25.45	44.03	28.33
		Jahangir	15.0	25.00	43.75	27.92
		Amjad	12.5	26.84	41.66	27.00
		Sadiq	13.1	21.75	39.50	24.78
		Khurram Pervez	12.7	20.00	36.00	22.90
Harvested once at different dates/intervals						**Avg.**
Oats for Hay	Maira	Khurram Manzoor	12.5	19.15	33.33	21.66
		Javed	12.8	18.50	35.40	22.23
		Liaqat	15.0	21.00	37.06	24.35
		Arshad	13.2	23.10	39.50	25.27
		Wasim	11.0	18.00	39.82	22.94
		Sadaat	11.5	19.50	37.50	22.83

It was observed that maximum green fodder yield of 85.95 t/ha was recorded under lepara land in 3 cuttings on the field of Mr. Aamar. It was followed by Mr. Shahid who produced 83.13 t/ha of green fodder under lepars land in also 3 cuttings. In 2 cuttings, 59.05 t/ha of green fodder yield was produced by Mr. Abdul Rauf in lepara land.

Under maira land conditions, Mr. Mohammad Hanif recorded the highest average green fodder yield of 28.33 t/ha of 3 different times. Maximum green fodder yield of 44.03 t/ha was recorded when the crop was cut on 19.03.2009.

In maira land also oats for hay intervention, Mr. Arshad recorded the highest average green fodder yield of 25.27 t/ha of 3 different times. Maximum green fodder yields of 39.50 and 39.82 t/ha, respectively was recorded by Mr. Arshad and Wasim when the crop was cut on 19.03.2009.

Conclusion

It was concluded that maximum green fodder yield potential was harvested by Mr. Aamar and Mr. Shahid who recorded green fodder yields of 85.95 and 83.13 t/ha from oats + vetch mixture under lepara land (near the village) respectively.

Oats and vetch mixtures at the rainfed site

2.1.3 Comparison of oats, barley, wheat, triticale, vetch and *Brassica* cultivars for fodder yield under medium rainfall conditions.

Research methods

Ten winter fodder species/varieties viz. Oats cv. PD2-LV65 & Scott, Barley cv. Jau-83& Snober-96, Wheat cv. C-591& 2KC050, Triticale cv. Bhakkar, Brassica cv. Chakwal Sarson & 03CBN004 and Vetch cv. Languedock were evaluated for fodder yield at Laodhay, Gujjar Khan in medium rainfall area during winter 2008-09. These species were planted in randomized complete block design with three replications at the farmer's field of Mr. Javed, Village Lodhay-Gujjar Khan district Rawalpindi. The gross plot size sown was 6.0m x 1.8m and net plot of 6m x 1.2 m was harvested at 5-10% pod formation stage in vetch at 50% flowering in all the other species/varieties for estimation of green fodder yield. Seed rates of 35, 15 and 80 kg ha^{-1} (vetch, brassica and cereals) were hand drilled by keeping 30 cm row to row spacing. Fertilizer doze applied was 50.-50:0 NPK kg ha^{-1} at sowing. All other cultural practices such as weeding, inter-culturing etc were kept normal and uniform for each species/replication. A plot size of 7.2 m^2 was harvested for estimation of green fodder yield. Representative green fodder samples were drawn from each plot and replication at random, weighed and dried in an oven at 60^o C for 72 hours. The dried samples were again weighed to estimate dry matter yield under each treatment.

Results and Discussion

Green fodder and dry matter yield obtained are presented in Tables 57 and 58.

Table 57. Green Fodder Yield of Winter Species at Lodhay during winter 2008-09.

S. #	Species/Varieties	GFY(t/ha)	DMY(t/ha)
1	Oats cv. PD2-LV65	36.08	9.57
2	Oats cv. Scott	34.00	10.09
3	Barley cv. Jau-83	28.50	9.42
4	Barley cv. Snober-96	33.33	9.00
5	Wheat cv. C-591	25.00	6.93
6	Wheat cv. 2KC050	24.33	6.74
7	Triticale cv. Bhakkar	22.92	7.21
8	Brassica cv. Chakwal Sarson	38.08	6.93
9	Brassica cv. 03CBN004	33.17	6.04
10	Vetch cv. Languedoc	17.08	3.81
	LSD (0.05) CV (%)	3.69 7.36	0.02 0.19

The above table showed significant differences among various winter species for green fodder yield. Brassica cv. Chakwal sarson out yielded by producing 38.08 t/ha of green fodder yield. It was followed by oats cv. PD2-LV65 which produced green fodder yield of 36.08 t/ha. The minimum green fodder yield of 17.08 t/ha was recorded in vetch cv. Languedock. Regarding dry matter yield, both the oats varieties recorded highest dry matter yields (10.09 and 9.57 t/ha) followed by barley varieties (9.42 and 9.00 t/ha) while vetch produced the lowest dry matter yield of 3.11 t/ha (Table 57).

Table 58. Comparison of winter fodder species/varieties for fodder yield under medium rainfall during winter 2007-08.

Name of Species/ Variety	Green fodder yield (t/ha)	Dry matter yield (t/ha)
1. Oats cv. PD2-LV65	42.50	11.80
2. Oats cv. Scott	37.60	10.66
3. Wheat cv. C-591	24.30	6.34
4. Wheat cv. 2K050	22.70	6.35
5. Barley cv. Snober-96	30.50	8.54
6. Barley cv. Jau-83	26.90	7.32
7. Triticale cv. Bhakkar	20.10	5.69
8. Brassica cv. Chakwal Sarson	33.70	5.87
9. Brassica cv. 03CBN004	30.50	5.23
10. Vetch cv. Languedock	15.00	2.67
LSD (0.05)	**1.84**	**0.12**
CV (%)	**3.79**	**0.98**

The above results show significant difference among different winter fodder species/varieties for green fodder yield. Among cereal fodder crops, both the oats varieties PD2-LV65 and Scott recorded the highest green fodder and dry matter yields of 42.50, 37.60 and 11.80, 10.66 t/ha, respectively and lowest by triticale cv. Bhakkar which gave green fodder and dry matter yields of 20.10 and 5.69 t/ha, respectively. Vetch, a legume fodder, variety Languedock produced the lowest green fodder and dry matter yields of only 15.00 and 2.67 t/ha (Table 58).

Conclusion

Oats variety PD-LV65 and Brassica cv Chakwal Sarson were found most promising for high fodder yield in medium rainfall area like Gujjarkhan

Experiment on winter fodder at the rainfed site	**Scientist and farmers recording data at the rainfed site**

2.1.4 Evaluation of vetch lines/varieties for fodder yield under low, medium and high rainfall areas.

Research Method

The experimental material comprised of 7 lines of vetch viz. Sel. 2627, Sel. 2490, Sel. 2604, Sel. 2746, Sel. 2616, Blanciflora and Languedock. These lines along with one check variety (Kohak) were planted in randomized complete block design with three replications at the farmer's field of Mr. Nazakat Ali, Village Lodhay-Gujjar Khan district Rawalpindi during winter 2008-09 under medium rainfall conditions. The gross plot size sown was 6.0m x 1.8m and net plot of 6m x 0.9 m was harvested at 5-10% pod formation stage for estimation of green fodder yield. A seed rate of 35 kg ha^{-1} was hand drilled by keeping 45 cm row to row spacing. Fertilizer doze applied was 50.-50:0 NPK kg ha^{-1} at sowing. All other cultural practices such as weeding, inter-culturing etc were kept normal and uniform for each line/replication. A plot size of 5.4 m^2 was harvested for estimation of green fodder yield. Representative green fodder samples were drawn from each plot and replication at random, weighed and dried in an oven at 60^o C for 72 hours. The dried samples were again weighed to estimate dry matter yield under each treatment.

Results and Discussion:

Green fodder and dry matter yields obtained are presented in Tables 59 and 60. Table 59 indicates that the differences in green fodder yield among different varieties/lines were not significant in winter 2008/2009 (Table 59). However vetch strain Sel-2616 and Kohak produced the highest green fodder yield of 21.5 t/ha each. Vetch cv. Languedock followed these 2 strains by producing 20.83 t/ha of green fodder yield. The minimum green fodder yield of 17.33 t/ha was recorded in vetch cv. Sel-2746.

Table 59. Green Fodder Yield of Vetch at Lodhay (Medium Rainfall) during winter 2008-09

S. #	Varieties #	GFY(t/ha)	DMY (t/ha)
1	Sel-2627	19.42	3.61
2	Sel-20.90	19.42	3.50
3	Sel-2604	20.17	3.80
4	Sel-2746	17.33	3.23
5	Sel-2616	21.50	4.10
6	Blanceflora	19.42	3.57
7	Languedock	20.83	3.92
8	Kohak	21.50	3.99
	LSD (0.05)	**NS**	**0.19**
	CV (%)	**11.86**	**2.94**

Eight vetch lines were tested for green fodder yield during winter 2007-08. It was assessed that vetch Selection 2090 out-yielded the other lines by producing green fodder and dry matter yields of 11.80 and 2.28 t/ha while lowest green fodder and dry matter yields of 7.65 and 1.41 t/ha, respectively were recorded in Selection 2025 (Table 60).

Table 60. Green fodder yield in t/ha of various vetch lines at different dates during winter 2007-08.

Varieties	Green fodder yield	Dry matter yield
Selection 2003	10.23 bc	1.94
Selection 2025	7.65 d	1.41
Selection 2083	10.73 abc	2.00
Selection 2090	11.80 a	2.28
Selection 2556	9.40 c	1.75
Selection 2558	10.38 abc	1.92
Selection 2560	11.38 ab	2.10
Selection 2616	11.70 ab	2.15
LSD (0.05)	**1.49**	**0.22**
CV (%)	**8.20**	**6.40**

Fodder scientist viewing the crop at early stage

Flowering and early pod formation of vetch

In addition to the research carried out with the community in winter season during the project period, three university students were involved to studies the subject intervention in detail and to complete their MSc (Hons) Agri / M. Phil research, a compulsory requirement of thesis writing for the award of degree.

2.1.5 Evaluation of winter cereal-vetch mixtures for fodder yield and quality under rainfed conditions (Master student: Muhammad Nadeem)

Background

The traditional practice of fodder growing in the region is that, brassica crop which is grown in wheat row as mixture after every 10 pure rows of wheat crop. When the crop reaches at knee height stage, farmers start to pull out the brassica for fodder purposes and kept the wheat crop for grain harvest. Some farmers also use a meager quantity of wheat green fodder by mixing it with previous year's wheat straw for dairy animals. Those who have land and irrigation facilities (< 10 % of the total rainfed community) also grow traditional berseem and oats in mixtures. The majority rainfed farmers and livestock rearing farmers community in the area, have no option to feed their animals with green and balanced nutritional fodder. Mixed farming should continue in a situation of small land holding; this has been greatly facilitated by mechanisation. Since crop residues are deficient in protein and minerals, the forages grown should preferably be legumes so that poor crop residues could be better supplemented. In milk-shed areas with adequate demand and sufficient facilities for marketing liquid milk, agriculture has shifted towards dairying and commercial forage production (Dost, 1994).

Under such circumstance, there was dire need to introduce and evaluate the improved and balanced nutritional fodders for rainfed farmers to feed their animals in order to improve their health and productivity. Cereals and legumes grown in mixture as fodder crop have great potential for higher yield and quality under rainfed areas (Drinkwater et al., 1998) as the cereals contains more carbohydrates while legumes tend to have higher protein and mineral contents. The activity to improve the quantity as well as the quality was initiated with following objectives through appropriate improved cereal–legume combinations of fodder crops.

Objectives

To evaluate the latest best improved package of winter forage mixtures for dissemination and demonstration.

Complementary practical on-farm participatory training and capacity building of researchers and farmers.

Master student will complete his thesis and has two years data to be published in scientific journal.

Material and Methods

A study was carried out during the November 2007-08 & 2008-09, under the project "Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia" to evaluate oat (*Avena sativa* L.), barely (*Hordeum vulgare*) and wheat (*Triticum aestivum*) in pure stands (at recommended seed rates) as well as in mixtures of 50: 50 ratios with common vetch (*Vicia sativa* L.) under rainfed conditions of Pothwar to address the problem of nutritious green fodder for livestock in the area. Seeds of the improved cereal-legume crops were sown with and without mixture. The crops were sown with single row hand drill with a row spacing of 30 cm apart. In mixture, the seed of

component crops were mixed thoroughly before sowing. The experiment was laid out in a randomized complete design with three replications and seven treatments (four monocultures of pure stands and three cereal-vetch mixtures). The treatment combinations were as following:

T1 = Oats (monoculture)
T2 = Barley (monoculture)
T3 = Wheat (monoculture)
T4 = Vetch (monoculture)
T5 = Oats + Vetch (mixture)
T6 = Barley + Vetch (mixture)
T7 = Wheat + Vetch (mixture)

The plot size of 3×6 m^2 was used and to separate treatments a buffer zone of 1m^2 was provided. The plant samples were taken in a randomly selected 1m^2 areas of each plot at different growth stages like tillering (45 days), booting (75 days), pre-heading (105 days) and 50 % heading (135days after sowing). These stages were noted with reference to oat crop. The green fodder yield from one square meter was weighed with spring balance and then converted into t ha^{-1}. Crude protein was determined by Kjedahl method**.** One gram dried and ground sample was digested with concentrated H_2SO_4 in the presence of a digestion mixture containing $CuSO_4$ and K_2SO_4 (7:93). The digested sample was diluted with water to volume of 250 ml. 10 ml aliquot of the diluted sample was mixed with NaOH solution (40%) to an excess alkaline reaction and mixture was distilled with steam in the micro- kjeldahl apparatus. The ammonia was collected in red boric acid having two drops of red methyl indicator. The amount of NH_3 entrapped by boric acid was determined by titrating it with standard 0.01 N H_2SO_4. Crude protein was calculated by multiplying the consumed volume of H_2SO_4 value with 6.25.

The rainfall, mean maximum and mean minimum temperature during the study period was recorded from the nearest metrological station (Soil and Water Conservation Research Laboratory, Sohawa) during both the years of experimentation and presented in the Table 61 below.

Table 61. Rainfall and temperature data recorded during the crop growth periods for the year 2007-08 & 2008-09.

Months	2008				2009			
	Rainfall (mm)	Mean Max. Temp. (^oC)	Mean Min. Temp. (^oC)	Mean Temperature (^oC)	Rainfall(mm)	Mean Min. Temp. (^oC)	Mean Max. Temp. (^oC)	Mean Temperature (^oC)
October	0	31.2	12.3	21.8	23.0	16.3	30.8	23.55
November	16.0	25.6	7.7	16.7	1.0	8.8	26.5	17.65
December	1.0	18.4	2.2	10.3	57.0	6.8	21	13.9
January	40.6	14.2	-0.6	6.8	68.0	6.0	18.6	12.3
February	29.2	18.7	2.4	10.6	34.0	7.6	20.4	14
March	2.9	29.3	10.4	19.9	28.0	11.8	26.2	19
April	68.3	29.5	14.3	21.9	72.5	12.3	31.3	21.8
May	12.3	35.5	20.1	27.8	25.4	21.1	36.4	25.275

Total Rainfall (mm) 2007-08 =170.3 (mm)

2008-09 =308.9 (mm)

Statistical analysis

All the data obtained was analyzed for analysis of variance using MSTAT-C software (Michigan State University, 1988). Analysis of variance techniques was employed to test the overall significance of the treatments. Least Significance Difference test at 5% probability level was used to compare the means (Steel *et al*., 1997).

Results and Discussion

Green Fodder Yield (t ha-1)

The quantity and quality was the main objective of this study. Data regarding green fodder yield recorded during the year 2007-08 and 2008-09 is presented in the Table 62 and 63 showed statistically significant difference among treatments means during both the years of experimentation. Overall, higher green fodder yield was recorded during 2008-09 than the year 2007-08 (Figures 3 and 4). The data revealed insignificance difference among the treatment at early growth stages of crops but differ significantly at later stages as crop growth progressed.

In pure stand treatments, maximum green fodder yield (31.58 t ha-1) was obtained by oats crop followed by barley (23.54 t ha-1), wheat (20.01 t ha-1) and lowest by vetch (13.76 t ha-1) during 2007-08 while during the year 2008-09, again maximum green fodder yield (33.89 t ha-1) was produced by oats crop followed by barley (25.29 t ha-1), wheat (24.63 t ha-1) and lowest by vetch (14.75 t ha-1). The trend of both the years results is similar however, the overall yield in all the treatments is better during the years 2008-09 than the year 2007-08. The treatments and growth stages means of both years showed that the year 2008-09 resulted better performance than the year 2007-08. The better performance of second year could be the result of higher rainfall received and frost free days during crop growth period (Table 61). The results of these investigations are in accordance with Canan and Okra (2007) who investigated oat + vetch mixtures in different ratios and recorded highest herbage yield in oat and lowest in vetch in pure stands. The overall green fodder yield recorded from pure stands of crops at different crop growth stages showed ranking of oat, barley, wheat and vetch in descending order. The overall growth rate in all the crops remain slower during December and January while it increased with faster rate from February to April as the temperature and availability of moisture increased with the occurrence of rainfall.

The highest green fodder yield among mixtures was obtained in oat + vetch mixture followed by barley + vetch and lowest in wheat + vetch mixtures during both the years. The results showed that the oat + vetch, barley + vetch and wheat + vetch mixture crops attained 20.23 %, 3.56 % higher and less 25.20 % less green fodder yield during 2007-08. Similarly, results during the year 2008-09 showed 17.08 %, 5.18 % higher and 16.07 % less green fodder yields than their respective cereal crops in pure stands. These results are in line with the findings of Canan and Orak (2007) who reported that mixtures were more productive than pure vetch sowing. He also quoted in another place that highest herbage yield was obtained from mixture of 25% vetch + 75% oat while the lowest herbage yield from pure stands of vetch. In early growth stages barley + vetch mixture produces higher green fodder yield followed by oat + vetch mixture and then wheat + vetch mixture.

Data recorded at different growth stages showed significant difference from each other during both the years of study. With the advancement of growth stages, green fodder yield

increased progressively. The maximum green fodder yield was recorded at 50% heading during both the years and lowest at tillering stage.

Table 62. Green fodder yield (t ha^{-1}) of cereal - vetch mixture at different growth stages during 2007-2008.

Treatments	Growth Stages				Means
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-Heading)	4th harvest 135 DAS (50% Heading)	
Oat	5.73 klm	12.32 jk	49.00 c	59.26 c	**31.58 B**
Barely	5.50 klm	11.54 jkl	35.66 efg	41.45 cde	**23.54CD**
Wheat	6.15 jklm	7.85 jklm	31.33 gh	34.7 efg	**20.01DE**
Vetch	2.29 m	5.12 klm	22.33 i	25.3 hi	**13.76 F**
Oat + Vetch	4.11 lm	11.49 jkl	65.13 ab	71.15 a	**37.97 A**
Barely+Vetch	6.39 jklm	13.47 j	33.33 fg	44.32 cd	**24.38 C**
Wheat +Vetch	4.57 lm	7.38 jklm	22.33 i	39.38 def	**18.42 A**
Means	**4.96 D**	**9.88 C**	**37.02 B**	**45.08 A**	

*=days after sowing
LSD (P≤ 0.05) for treatments mean (T) = 3.842
LSD (P≤ 0.05) for harvest stages (HS) = 2.907
LSD (P≤ 0.05) for T x HS = 7.691

Table 63. Green fodder yield (t ha^{-1}) of cereal - vetch mixture at different growth stages during 2008-2009.

Treatments	Growth Stages				Means
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-heading)	4th harvest 135 DAS (50% heading)	
Oat	6.15 lmn	15.26 jk	52.69 d	61.47 c	33.89 B
Barely	5.86 lmn	14.27 jk	38.46 fg	42.59 e	25.29 C
Wheat	3.19 mn	9.15 l	33.38 h	37.80 fg	24.63 DE
Vetch	2.79 n	7.26 lm	25.49 i	23.46 i	14.75 E
Oat + Vetch	4.98 mn	13.39 k	67.19 b	73.17 a	39.68 A
Barely+Vetch	7.16 lm	17.51 j	36.67 gh	45.05 e	26.60 C
Wheat +Vetch	5.28 lmn	9.18 l	26.45 i	41.78 ef	20.67 D
Means	**5.216 D**	**12.29 C**	**40.05 B**	**46.47 A**	

*DAS=days after sowing
LSD (P≤ 0.05) for treatments mean (T) = 2.042
LSD (P≤ 0.05) for harvest stages (HS) = 1.544
LSD (P≤ 0.05) for T x HS = 4.085

The interaction between treatments and growth stages showed statistically significant results during both the years. In pure stands mean maximum green fodder yield was obtained by oat crops at 50 % heading stage and minimum green fodder yield was attained by vetch at tillering stage while in mixture mean maximum green fodder yield was obtained by oat + vetch at 50 % heading stage and minimum green fodder yield was attained by oat+ vetch at tillering stage during both the years. Green fodder yield showed a positive relationship with the plant height which indicates that an increase in plant height, enhance green fodder yield. The correlation coefficient (r = 0.99) between the green fodder yield were strongly correlated with the plant height during both the years of experimentation (Figure 5).

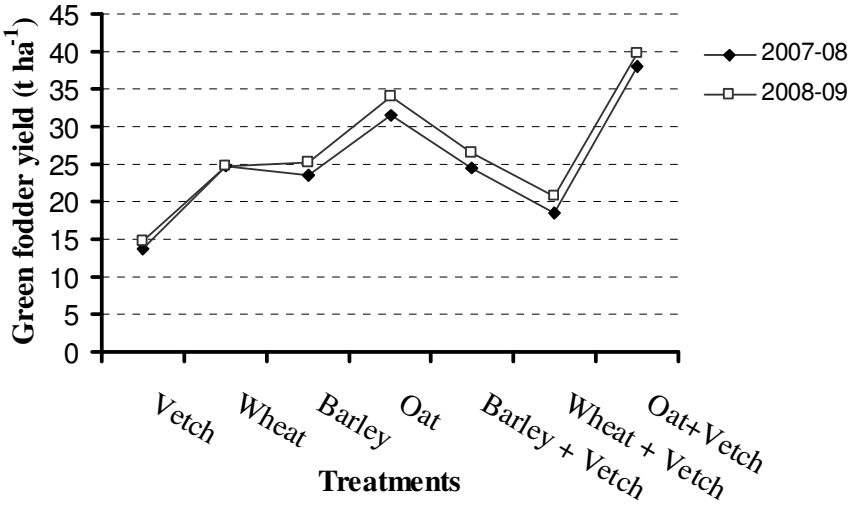

Figure 3. Mean green fodder yield (t ha^{-1}) of cereal - vetch mixtures and their pure stands of all growth stages recorded during the year 2007-08 & 2008-09.

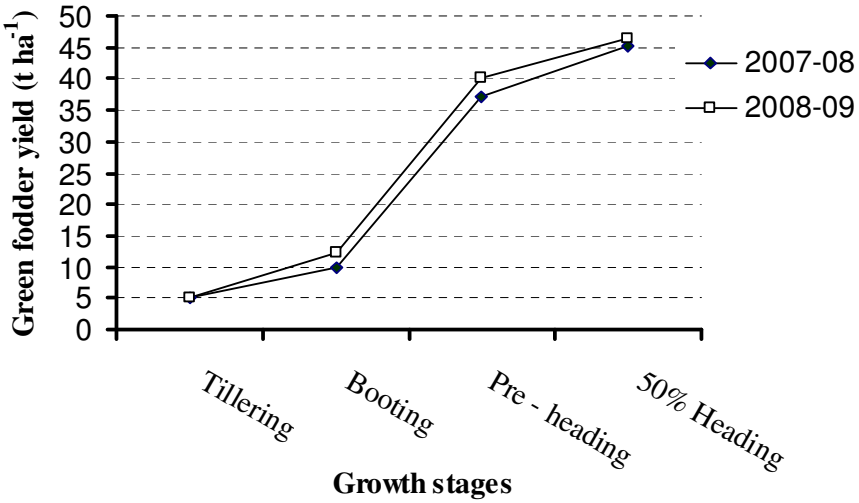

Figure 4. Mean green fodder yield (t ha-1) of cereal - vetch mixtures and their pure stands recorded at different growth stages during the year 2007-08 & 2008-09.

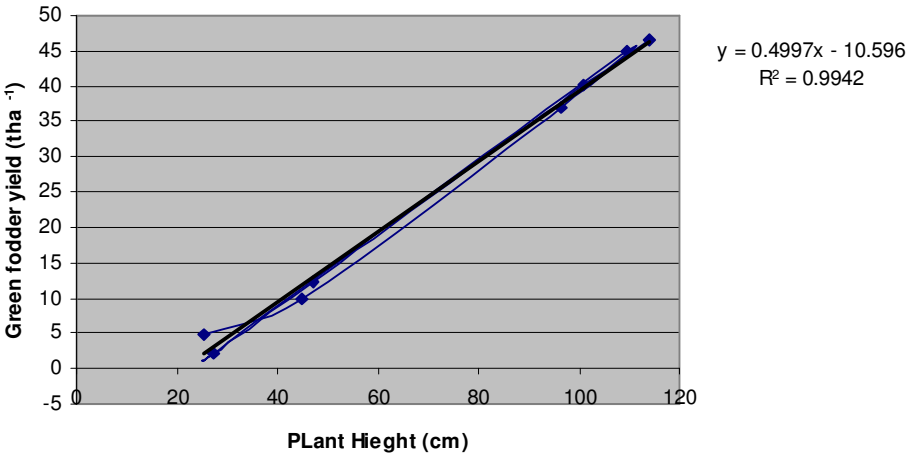

Figure 5. Correlation between plant height and green fodder yield at different growth stages during both the years.

Fodder quality

Crude protein (g kg^{-1}) is one of the most important criteria for fodder quality evaluation. Data regarding crude protein contents recorded during the year 2007-08 and 2008-09 is presented in Table 64 and 65, respectively showed statistically significant difference among treatments during both the years.

In pure stand treatments, maximum crude protein content (47.72 g kg^{-1}) were obtained by vetch crop followed by wheat (41.55 g kg^{-1}), barley (41.19 g kg^{-1}) and lowest by oats (39.96 g kg^{-1}) during 2007-08, while during the year i.e. 2008-09 maximum crude protein content (50.26 g kg^{-1}) were produced by vetch crop followed by barley (43.93 g kg^{-1}), wheat (43.76 g kg^{-1}) and lowest by oats (39.96 g kg^{-1}). In mixtures treatments, maximum crude protein content were produced by wheat + vetch followed by barley + vetch mixture and then oat + vetch during both the years of experimentation. The treatments and growth stages means of both years showed that the years 2008-09 resulted higher protein than the year 2007-08. The results showed that oat + vetch, barely + vetch and wheat + vetch mixtures crops produced higher crude protein content than their respective cereal counter parts which could be the result of efficient utilization of natural resources. The results showed that the oat + vetch, barley + vetch and wheat + vetch mixture crops produced 1.50 %, 7.05 % and 5.50 % higher crude protein contents during 2007-08 while during the year 2008-09 showed 3.15 %, 7.55 % higher and 5.64 % less crude protein contents than their respective cereal crop grown in pure stand respectively. Similar investigations were carried out by Nnadi and Haque (1986) on summer crops and they found higher N content in grain obtained from maize that was intercropped with vetch whereas lablab and clover showed no such effect. It appears that tropical forages legume differs markedly in their ability to benefit associated cereals that have approximately the same growing periods. Two type of beneficial effect have generally been reported: higher nitrogen content and/ or higher grain yield of the intercropped cereals in comparison with the cereal mono culture without any added nitrogen.

Data recorded at different growth stages showed significant difference among each other. With the advancement of growth stages in cereals crude protein content decreased

progressively. The maximum crude protein content in cereals was recorded at tillering stage during both the years and lowest crude protein recorded at 50% heading stage. But in vetch crop with the advancement of growth stage, crude protein contents increase progressively.

The interaction between treatments and growth stages also showed statistically significant results during both the years. In pure stands mean maximum crude protein contents were obtained by wheat at tillering stage and minimum crude protein contents was attained by oat at 50 % heading stage while in mixture treatments mean maximum crude protein contents were produced by wheat + vetch at tillering stage and minimum crude protein contents were produced by wheat + vetch at 50 % heading stage during both the years.

Table 64. Crude protein content (g kg^{-1}) cereal-vetch mixture at different growth stages during 2007-2008.

Treatments	Growth Stages				Means
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-Heading)	4th harvest 135 DAS (50% Heading)	
Oat	53.70 e	38.46 ij	28.38 lm	25.11 mn	**39.96 D**
Barely	57.99cde	41.39ghi	36.98 ijk	28.39 lm	**41.19 C**
Wheat	65.30 ab	44.46 fgh	35.06 jk	21.38 n	**41.55BC**
Vetch	54.37 de	66.46 ab	40.54 hi	29.50 lm	**47.72 A**
Oat + Vetch	59.63 cd	44.55 fgh	31.80 kl	26.12 mn	**40.53 C**
Barely+Vetch	61.97 bc	46.37 fg	38.52 ij	29.50 lm	**44.09 B**
Wheat+Vetch	68.80 a	48.20 f	36.62 ijk	22.22 n	**36.41 D**
Means	**60.25 A**	**41.13 B**	**35.42 C**	**26.03 D**	

*DAS=Days after sowing
LSD (P≤ 0.05) for treatments mean (T) = 2.062
LSD (P≤.05) for harvest stages (HS) = 2.727
LSD (P≤ 0.05) for T x HS = 5.454

Oats and vetch mixture

Vetch in pure stand at flowering stage

Table 65. Crude protein content (g kg^{-1}) cereal – vetch mixture at different growth stages during 2008-2009.

Treatments	Growth Stages				Means
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-Heading)	4th harvest 135 DAS (50% Heading)	
Oat	55.34 f	41.62 jk	34.40 m	28.47 p	**39.96 D**
Barely	59.32 de	45.32 i	39.39 jkl	31.68 mno	**43.93 C**
Wheat	65.15 b	47.17 hi	37.87 l	24.87 q	**43.76 C**
Vetch	57.51 ef	71.25 a	42.14 j	30.12 op	**50.26 A**
Oat + Vetch	61.57 cd	47.18 hi	33.37 mn	28.15 p	**42.57 C**
Barely+Vetch	63.11 bc	49.60 gh	39.65jkl	30.70 nop	**45.76 B**
Wheat+Vetch	71.31 a	51.47 g	38.58 kl	24.78 q	**46.54 B**
Means	**61.90 A**	**50.52 B**	**37.91 C**	**28.40 D**	

*DAS= Days after sowing
LSD (P≤ 0.05) for treatments mean (T) = 1.535
LSD (P≤ 0.05) for harvest stages (HS) = 1.160
LSD (P≤ 0.05) for T x HS = 3.07

Oats and vetch mixture	**Barley crop at heading stage**
Wheat and vetch at heading stage	**Oats in pure stand at pre-heading stage**
Students recording data at farmer's field	**Students carrying out chemical analysis in the laboratory**

2.1.6 Mixed cropping of nontraditional winter legumes and oats for sustainable forage productivity (Master student: Mr. Adeel Anwar)

Background

During winter season, there are very little options for livestock rearing farming community to have rainfed legumes to be incorporated in to the cropping / forage systems in order to improve the animal health and soil fertility. The two major winter legume fodder crops such as berseem and alfalfa are restricted only to irrigated areas of the country. The choice of a legume species is not only valuable for high forage yields and quality by mixing with cereals but is unavoidable for animal nutrition and soil fertility as well (Altinok *et al.*, 1997). Forage legumes have significant role in agriculture and they are often integrated in the mixed farming systems to enhance crop yield through their ability of fixing nitrogen as well as being used for higher quality of feed for intensive livestock systems (Drinkwater *et al*., 1998).
Oats provide an excellent choice to achieve high green fodder yield among the winter cereals and can be grown both under irrigated and rainfed conditions (Naeem *et al*., 2006). Literature consulted revealed that intercropping of forage cereals with legumes has not only improved the quantity and quality of fodder but also improved livestock production considerably (Umunna *et al*., 1995). Increasing the use of annual legumes in cereal cropping systems can improve sustainability through biological N fixation, reduction of weed competition, and increased soil organic matter (Izaurralde *et al*., 1993). Quality of mixed fodders is enhanced especially by the legume component with a consequent increase in livestock productivity (milk and meat). Evaluation of cereal/legume forages alone for milk and beef production revealed insufficient intakes of organic matter (OM) and crude protein (CP) and thus limited animal performance (Khalili *et al*., 1994; Umunna *et al*., 1995). Forage quality of cereal is usually lower than that required to meet satisfactory production levels for many categories of livestock. In mixtures, companion cereals provide structural support for common vetch growth, improve light interception, and facilitate mechanical harvest, whereas common vetch in mixtures improves the quality of forage (Thompson *et al*., 1992).

Vetch, medics, and sinji are very good pasture crops that can be grown during winter months. Being the leguminous, these crops have the potential to improve soil fertility through biological nitrogen fixation and to provide nutritive fodder. These crops can be grown to produce fodder, hay, grain or green manure while providing the rotational benefits of legumes (Siddique *et al*., 1996).

In view of the scarcity of nutritional fodder for livestock in Pothwar region and to improve the animal and soil health, a study was carried out to evaluate the non-traditional legumes i.e. medics, senji and vetch under rainfed conditions with following objectives:
The objectives included:

- To identify the suitable winter legume cereal mixture and its ideal cutting stage for maximum yield and quality of fodder.
- Complementary practical on-farm participatory training and capacity building of student and researchers.
- Master student completed his thesis and has two years data to be published in scientific journal.

Materials and methods

Field study of "mixed cropping of non-traditional winter legumes and oats for sustainable

forage productivity" was carried out to evaluate the various combinations of legumes with oats on yield and quality of forage at different growth stages during the year 2007-09. The experiment was conducted in the 1st week of November 2007 and 2008 under the theme of forage production in the project of "Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia". Oat, vetch, senji, medics, were sown as monoculture as well as in mixture. The seed rates for oat was 80 kg ha^{-1} and for senji, medics and vetch 45 kg ha^{-1} while the seed rate for mixtures of oat + senji, oat + medics and oat + vetch was in ratio of 50:50. Nitrogen fertilizer @ 80 kg ha^{-1} and phosphorous @ 57 kg ha^{-1} were incorporated at the time of seedbed preparation. The crop was sown with single row hand drill with a row spacing of 30 cm apart. In mixtures, the seed of both crops was homogenized before sowing. A randomized complete block design was applied consisting of seven treatments (four monoculture and three mixtures of legumes with oat) and three replications. The treatment combinations were as follows:

T_1- Oat alone (Cv. PD_2-LV_{65})
T_2- Senji alone
T_3- Medics alone
T_4- Vetch alone (Cv. Languedock)
T_5- Oats + Senji
T_6- Oats + Medics
T_7- Oats + Vetch

The net plot size was 18 m^2 and the plots were separated from each other, by a buffer zone of 45 cm. Rest all the procedure adopted in this study was similar to that of 6.2.1a.

Results and Discussion

Green fodder yield (t ha^{-1})

Green fodder yield is most important for farming/livestock dependent community especially in drier regions to feed their animals as they have to manage the wheat grains for their family only once a year from the irrigated areas if not sufficient wheat is grown in the rainfed region but it is very difficult for them to manage daily green fodder for their animals from the irrigated area as the transportation charges goes beyond their affordability power.

Data regarding green fodder yield from different treatment means showed statistically significant difference among each other during both the years i.e. 2007-08 and 2008-09 (Table 66 and 67). In pure stand treatments, mean maximum green fodder yield of two years showed that oat crop produced 35.13 t ha^{-1} of green fodder followed by vetch crop (16.31 t ha^{-1}) then medics (9.83 t ha^{-1}) and lowest in senji (7.65 t ha^{-1}) while in mixture treatments, highest green fodder yield was produced by oat + vetch (40.26 t ha^{-1}) followed by oat + medics (33.48 t ha^{-1}) and lowest in oat + senji (30.25 t ha^{-1}). These results showed that highest green fodder yield was produced by oat + vetch mixture. When the comparison of oat fodder yield was made with the sole legume crops, it appeared that oats produced 359.21 %, 257.37 % and 115.38 % more green fodder yield than senji, medics and vetch crops respectively. Similarly, among mixtures oat + vetch produced 33.09 % and 20.25 % more green fodder yield than oat + senji and oat + medics respectively. When individual yield difference of oat crop was compared with its mixture with vetch, it resulted 14.60 % more green fodder than oat in pure stand which could be the result of mutual benefit of companion crop received from each other. Similar results were reported by Sachanski and Kirilov (1988) who concluded that the sowing of oats in a mixture with vetch has a dual effect. The presence of oats minimizes the lodging of vetch, thus decreasing the harvest

losses and increasing the average height resulting to higher yield and overall nutritive value of the forage.

From the data recorded at different crop growth stages during both the years, it appeared that mean maximum and significant green fodder yield was obtained by all the treatment at 50 % heading stage (45.63 t ha^{-1}) and lowest (4.07 t ha^{-1}) at tillering stage. Data recorded at different crop growth stage clearly showed that 50 % heading stage received 15.92 %, 368.48 % and 1021.13 % more green fodder yield than pre-heading, booting and tillering stage respectively.

Table 66. Green fodder yield (t ha^{-1}) recorded from pure stands of non-traditional legumes and their mixtures with oat at different crop growth stages during rabi 2007-08

Treatments	Growth Stages				Mean
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-heading)	4th harvest 135 DAS (50% Heading)	
Oat	6.210 jk	14.12 hi	54.24 cd	62.37 b	**34.24 B**
Senji	0.5467 m	1.060 lm	11.46 i	16.33 h	**7.348 G**
Medics	0.9533 lm	1.937 lm	13.48 hi	21.43 g	**9.452 F**
Vetch	2.840 klm	6.237 jk	25.49 f	28.16 f	**15.68 E**
Oat + Senji	4.387 jkl	12.31 i	46.00 e	53.65 d	**29.09 D**
Oat + Medics	5.673 jk	13.58 hi	52.77 d	56.74 c	**32.19 C**
Oat + Vetch	6.750 j	16.78 h	63.19 b	70.36 a	**39.27 A**
Mean	**3.909 D**	**9.431 C**	**38.09 B**	**44.15 A**	

Any two means sharing same letter are not significantly different (P< 0.05)

LSD (P=0.05) for treatments mean (T) = 1.762

LSD (P=0.05) for harvest stages (HS) = 1.465

LSD (P=0.05) for T x HS = 3.523

Table 67. Green fodder yield (t ha^{-1}) recorded from pure stands of non-traditional legumes and their mixtures with oat at different crop growth stages during winter 2008-09

Treatments	Growth Stages				Mean
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-Heading)	4th harvest 135 DAS(50% Heading)	
Oat	6.83 j	14.83 hi	56.95cd	65.49 b	**36.02 B**
Senji	0.59 m	1.14	12.38 i	17.64 h	**7.94 G**
Medics	1.03 lm	2.10 lm	14.56 h	23.14 g	**10.21 F**
Vetch	3.07 kl	6.74 jk	27.53 f	30.41 f	**16.94 E**
Oat + Senji	4.74 jkl	13.29 i	49.68 e	57.94 d	**31.42 D**
Oat + Medics	6.13 jk	14.67 hi	56.99 d	61.28 c	**34.77 C**
Oat + Vetch	7.16 j	17.62 h	66.35 b	73.88 a	**41.25 A**
Mean	**4.22 D**	**10.06 C**	**40.64 B**	**47.11 A**	

Any two means sharing same letter are not significantly different (P< 0.05)

LSD (P=0.05) for treatments mean (T) = 1.939

LSD (P=0.05) for harvest stages (HS) = 1.465

LSD (P=0.05) for T x HS = 3.877

The interaction between treatments and growth stages showed statistically significant difference between both the years (Table 68 and 69). The mean maximum green fodder yield during both the years was produced by oat + vetch (72.12 t ha^{-1}) at 50 % heading stage and lowest (6.95 t ha^{-1}) at tillering stage in mixtures, while in pure crop stands, maximum green fodder yield during both the years was produced by oat crop (63.93 t ha^{-1}) at 50 % heading stage and lowest (6.52 t ha^{-1}) at tillering stage. The treatments and growth stages means of both years showed that the years 2008-09 resulted better performance than the year 2007-08. Similar results were reported by Anwar *et al.* (2009) whose results revealed that oat + vetch mixture produced 16 % and 18 % higher green fodder yield compared with oat + medics and oat + senji mixtures, respectively, while in pure stands maximum green fodder yield was obtained from oat crop which was 51 %, 66 % and 80 % higher than vetch, medics and senji legumes, respectively. Similarly, Hussain *et al*. (2004) concluded that harvest at 50 % heading stage resulted superior forage and dry matter yields.

Fodder quality

Crude protein is the usual criteria for evaluation of the fodder quality. Data regarding crude protein (g kg^{-1}) content during 2007-08 and 2008-09 is presented in Tables 68 and 69 showed statistically significant difference among treatments during both the years of experimentation. In pure stand treatments, mean maximum crude protein content were obtained by vetch (54.29 g kg^{-1}) crop followed by medics (50.45 g kg $^{-1}$), senji (48.67 g kg^{-1}) and lowest by oats (37.42 g kg^{-1}) while in mixture treatments, highest crude protein were obtained by oat + vetch (45.81) followed by oat + medics (41.85 g kg^{-1}) and lowest in oat + senji (40.57 g kg^{-1}). These results showed that highest crude protein was produced by vetch crop, so incorporation of vetch is beneficial for livestock to supplement their protein

requirements. Similar results were reported by Giacomini *et al.* (2003) who conclude that the CP content increased as common vetch seeding proportion increased. Monoculture of common vetch had the highest CP content followed by the mixture of common vetch with oat. While, Kuusela *et al.* (2004) concluded that incorporation of legumes in the intercropping system significantly increased the CP protein that was harvested per ha.
Data recorded at different growth stages showed significant difference among each other. With the advancement of growth stages in cereals crude protein content decreased progressively. The maximum crude protein content in cereals were recorded at tillering stage (58.77 g kg^{-1}) during both the years and lowest crude protein were recorded at 50% heading stage (28.07 g kg^{-1}). But in vetch crop with the advancement of growth stage crude protein content increase progressively.

Table 68. Crude protein (g kg^{-1}) recorded from pure stands of non- traditional legumes and their mixtures with oat at different crop growth stages during rabi 2007-08

Treatments	Growth Stages				Means
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-Heading)	4th harvest 135 DAS (50% Heading)	
Oat	52.16	39.52	30.15	24.21	**36.51 F**
Senji	58.52	60.52	40.06	30.85	**47.49 C**
Medics	59.31	62.41	42.52	32.64	**49.22 B**
Vetch	61.26	68.83	49.26	32.51	**52.97 A**
Oat + Senji	55.73	48.20	34.33	20.06	**39.58 E**
Oat + Medics	56.35	50.00	35.64	21.31	**40.83 D**
Oat + Vetch	58.04	52.00	38.59	30.13	**44.69 D**
Means	**57.34 A**	**54.50 B**	**38.65 C**	**27.39 D**	**44.47**

Any two means sharing same letter are not significantly different (P< 0.05)

LSD (P=0.05) for treatments mean (T) = 2.042

LSD (P=0.05) for harvest stages (HS) = 2.743

LSD (P=0.05) for T x HS = 5.261

Table 69. Crude protein (g kg^{-1}) recorded from pure stands of non-traditional legumes and their mixtures with oat at different crop growth stages during rabi 2008-09

Treatments	Growth Stages				Means
	1st harvest 45 DAS* / (Tillering)	2nd harvest 75 DAS / (Booting)	3rd harvest 105 DAS / (Pre-Heading)	4th harvest 135 DAS (50% Heading)	
Oat	54.77	41.50	31.66	25.42	**38.34 F**
Senji	61.45	63.55	42.06	32.39	**49.86 C**

Medics	62.28	65.53	44.65	34.27	**51.68 B**
Vetch	64.32	72.27	51.72	34.14	**55.61 A**
Oat + Senji	58.52	50.61	36.05	21.06	**41.56 E**
Oat + Medics	59.17	52.50	37.42	22.38	**42.87 D**
Oat + Vetch	60.94	54.60	40.52	31.64	**46.92 D**
Means	**60.21 A**	**57.22 B**	**40.58 C**	**28.76 D**	**46.69**

Any two means sharing same letter are not significantly different (P< 0.05)
LSD (P=0.05) for treatments mean (T) = 1.436
LSD (P=0.05) for harvest stages (HS) = 1.160
LSD (P=0.05) for T x HS = 3.09

Oats at heading stage

Vetch at flowering stage

Medics crop at flowering stage

Senji crop at flowering stage

Student and farmer collecting data

Students conducting chemical analysis

The interaction between treatments and growth stages showed statistically significant difference between both the years. The mean maximum crude protein during both the years was produced by vetch (70.55 g kg^{-1}) at booting stage (flowering stage) and lowest (33.32 g kg^{-1}) at 50 % heading stage (pod filling stage) while in case of oat crop mean maximum crude protein were obtained (53.46 g kg^{-1}) at tillering stage and lowest (24.81 g kg^{-1}) at 50 % heading. As early harvesting resulted into better quality yield but yielded low herbage tonnage, therefore, cannot be practical options for the farmers to harvest at this stage.

2.1.7 Evaluation of different oat-vetch mixture ratio for forage yield under rainfed conditions (Master student: Sabir Sattar)

Background:

The Pothowar plateau spans over 1.82 million hectare (m. ha) and constitutes a major rainfed tract in the north part of the Punjab province of Pakistan (Rashid, 2007). Being a rainfed tract, livestock promotion is facing serious hurdle because of scarcity of fodder. The reason of slower growth rate of livestock sector in the region is mainly the non-availability of adequate fodder, which adversely affects the health and productivity of animal. Adequate nutritious fodder quality has direct effect on animal performance in the form of milk and meets production for profits and economics return. It has been shown that ruminants tend to eat more of mixed than single forage rations (Huhtanen et al., 2007) and that animal production can be improved when energy- and protein-rich crops are intercropped and used as feed (Salawu et al., 2001). Cereals like oat are also important contributor to animal feeding both as grain and forage. The incorporation of legumes in forage mixtures with grasses or cereals is an important both for animal nutrition and soil fertility. Furthermore, oat can provide a climbing frame for the vetch and to increase the bulk of feed produced (Tuna *et al*., 2007). Kokten et al., (2009) found from the study of pure stands of vetch and triticale and their seed mixtures (80% vetch +20% triticale, 60% vetch + 40% triticale, 40% vetch + 60% triticale, 20% vetch + 80% triticale) in East Mediterranean rainfed conditions of Turkey and reported that the seed mixture containing 20% vetch and 80% triticale gave highest dry matter yield with an average vetch content of 23.5%. Similarly, Canan and Adnan (2007) conducted an experiment under ecological condition of Turkey with three levels of different mixture of Vetch (*Vicia sativa* L.) and oat (*Avena sativa* L.) i.e. (25 %+75 %, 50 %+50 %, 75 %+25 %) along with the pure stand of common vetch and oat. The result showed that highest green and dry herbage yields were obtained from 25 % vetch+75 % oat.

The previous studies carried out in the department showed that oat-vetch mixtures performed better than all the other combinations tested under rainfed conditions. In this study, it is tried to evaluate the different mixture ratios of oat-vetch under rainfed conditions of Pakistan to give recommendations to the farming community to harvest maximum benefit from this technology.

Materials and Methods

A field study was carried out to evaluate the winter oat- vetch mixture for higher fodder yield and quality under rainfed conditions. Improved varieties of both oat (PD_2LV_{65}) and vetch (Longvedock) were used for the purpose of investigation. The crop was sown with single row hand drill with a row spacing of 30 cm apart. In mixture the seed of both crops were mixed before sowing. Three levels of different mixtures Oat (*Avena sativa* L.) and vetch (*Vicia sativa* L) (55% oat + 45% vetch, 70% Oat + 30% vetch, 85% oat + 15% vetch) and pure Oat (100% oat + 0% vetch), pure common Vetch (100% vetch + 0% oat) were

used as experimental treatments. A randomized complete design was applied with three replications. The net plot size of each treatment was 3×6 m^2 and to separate treatments a buffer zone of 60 cm was provided. The plant sample was taken in a randomly selected $1m^2$ area of each plot at different growth stages (tillering, booting and heading) to determine the green forage yield.

Results and Discussion

The study carried out in the field during the winter season of 2008-09 under the project "Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia" showed significant effect of different oat-vetch mixtures on green fodder yield. The data presented in table 70 clearly showed that there is significant difference among treatments at all growth stages.

Treatment mixture of 70 % oat with 30 % vetch produced higher fodder yield than all the other mixture ratios and pure stands tested in the experiment at all the growth stages. At 1st harvest treatment T2 (70:30) mixture showed statistically highly significant difference from the pure stand of vetch and 80:20 mixture ratio of oat and vetch respectively. Similarly, at growth stage 2nd and 3rd 70:30 oat –vetch mixture ratio proved statistically higher yielder. With the progress of growth stage, difference among mixture ratios and pure stand gets more dominant and clear. These results are in agreement with Kokten et al., (2009) and Canan and Adnan (2007) who found that the seed mixture containing 20% vetch and 80% triticale and 25 % vetch+75 % oat gave highest dry matter yield respectively under with ecological condition of Turkey.

<table>
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<tr><td>An early view of the 70% Oat + 30% vetch,</td><td>A view of 55% oat + 45% vetch treatment</td></tr>
<tr><td>
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</td></tr>
<tr><td>Fodder scientist, student and site facilitator viewing the experiment.</td><td>Student observing crop at heading stage</td></tr>
</table>

Student putting samples in oven for dry matter yield.	Student engaged in destructive sampling

Table 70. Effect of different oat-vetch mixture ratios on forage yield under rainfed conditions

Treatments		1st harvest	2nd harvest	3rd harvest
T1	55% oat+ 45% vetch	5.50	10.10	22.97
T2	70% oat+ 30% vetch	5.77	24.27	26.60
T3	85% oat+ 15% vetch	3.90	15.00	26.37
T4	100% oat	5.73	13.76	17.87
T5	100% vetch	1.50	3.26	10.97
	LSD 5 %	0.785	5.101	8.242
	LSD 1%	1.142	7.421	11.991

Conclusions

The two years field study carried out to assess the performance of monoculture and mix cropping of traditional, non-traditional cereal -legumes crops and on their ratios resulted following conclusions.

1. In oat (*Avena sativa* L.), barely (*Hordeum vulgare*) and wheat (*Triticum aestivum*) with and without common vetch (*Vicia sativa* L.) showed that oat-vetch mixture consistently performed better. The same combination i.e. oat-vetch mixture in non-traditional winter legumes i.e. common vetch (*Vicia sativa* L.), medics (*Medicago polymorpha* L.) and Senji (*Melilotus indica* L.) endorsed the investigation under taken in cereal-legume mixture experiment. On the basis of these field investigations, oat – vetch mixture can be recommended for higher biomass and quality fodder under rainfed conditions of Pothowar-Pakistan.
2. With the advancement of the growth stage, fodder yield found to be increased in cereal fodders and maximum fodder tonnage was recorded at 50% heading stage while protein contents declined as against the legumes crops in which both yield and

protein found to be increased with the advancement of the growth stage i.e till pod formation stage.

3. The interaction of growth stages and treatments showed that in pure stands maximum green fodder yield was obtained by oat crops at 50 % heading stage and minimum green fodder yield was attained by vetch at tillering stage while in mixture mean maximum green fodder yield was obtained by oat + vetch at 50 % heading stage and minimum green fodder yield was attained by oat+ vetch at tillering stage during both the years of investigations.
4. In quality evaluation of pure stand crops, maximum crude protein contents, were obtained by vetch crop but has low tonnage when compared to cereals, thus its mixture with oat which resulted higher biomass as well as crude protein is recommended for general cultivation in the dry areas for nutritional fodder for the livestock.
5. The evolution of oat-vetch mixture ratio studies showed that the maximum herbage yield was obtained from 70% oat (*Avena sativa* L.) + 30% vetch (*Vicia sativa* L) ratio than all the other ratios tested.
6. From the overall results of thee experiment during the course of project clearly indicated that oat + vetch mixture can be recommended with 70 % oat and 30 % vetch for maximum yield and quality fodder during winter months which is also beneficial for soil fertility point of view and to reduce the heavy burden of fertilizer application on farmers shoulders for the proceeding crops.

2.2 Winter crops at the irrigated Sites

2.2.1 Introducing improved varieties, legume-cereal mixes and improved agronomic practices for winter crops

2.2.1.1 Year 2007

Methodology

Newly developed fodder corps varieties and associated agronomic packages were demonstrated on farms using farmer's varieties and their agronomic practices as control. Each variety or packages were demonstrated on 16 farms in each of the two village's 74/SB and 105/SB to enable statistical comparison of treatments.

The 21 farmers selected in 74/SB and 16 farmers selected in 105 /SB were provided with improved fodder crop varieties seed for planting 15 acres in each village for fodder/ feeding trials while rest of the farmers were kept as control. The fodder production activities were started during winter season. Berseem (Egyptian clover) variety "Berseem pachaiti" in legumes and Oats variety "S-2000" in cereals were sown with 21 farmer's fields in 74/SB and 16 farmers in 105/SB each at 15 acres in three combinations, i) Berseem sole, ii) Oats sole iii) Berseem + Oats (mixed) using improved varieties and improved production technology. One acre of improved fodder crop was sown with each of the 10 farmers, (¼ acre Berseem, ¼ acre Oats and ½ acre of Berseem + Oats mixed), 9 farmers (1/8 acre Berseem, 1/8 acre Oats and ¼ acre of Berseem + Oats mixed) and 2 farmers (1/16 acre Berseem,1/16 acre Oats and 1/8acre of Berseem + Oats mixed) at 74/SB and with 1 acre (¼ acre Berseem, ¼ acre Oats and ½ acre of Berseem + Oats mixed) each with 14 farmers and ½ acre (1/8 berseem, 1/8 oats and ¼ acre berseem + oats (mixed) with 2 farmers were

planted at 105/SB. While rest of the farmers planted local Berseem and oats crop using traditional production technology. The data on green fodder yield were recorded. In Berseem five cuts of green fodder were harvested, whereas in oats green fodder was harvested when crop was at 50% heading stage, while in mixed crop the oats and Berseem were harvested in first cut and second cut, later-on Berseem alone was harvested in three more cuts. Fodder and food legumes were integrated into the traditional wheat/maize and wheat/fallow systems to increase the availability of fodder and to improve soil fertility. Fodder production from different cereals and cereal legume combinations such as oats + berseem were compared. Each system was established on 4 farms using recommended agronomic practices. Fodder was harvested at 50% flowering and fed as green to growing or lactating small and / or large ruminants for 30-60 days. Stagger planting of fodders were done to feed fodders at a stage of high nutritive value.
Data collected was crop germination, plant height at booting stage, green fodder yield at 50% heading stage.

Results and Discussions
The data of green fodder yield is presented in Tables 71 and 72.

Table 71. Comparison of green fodder yields of improved fodder crop varieties at Chak No.74/SB

Farm-ers	Berseem GFY (t/ha)	Oats GFY (t/ha)	Berseem+ Oats GFY (t/ha)	Farm-ers	Berseem GFY (t/ha)	Oats GFY (t/ha)	Berseem+ Oats GFY (t/ha)	Farmers	Berseem GFY (t/ha)	Oats GFY (t/ha)	Berseem+ Oats GFY (t/ha)
1.	110	80	140	8.	107	80	126	15	120	78	127
2.	135	60	120	9.	116	80	127	16	125	70	137
3.	105	70	135	10.	125	60	138	17	137	65	120
4.	115	80	140	11.	107	80	135	18	125	77	120
5.	135	80	120	12.	130	65	112	19	122	65	109
6.	110	70	110	13.	120	70	120	20	120	110	100
7.	120	70	100	14.	120	75	120	21	90	110	100

The data revealed that the green fodder yield of improved variety of berseem (pachaiti) planted with 21 farmers of Chak No.74/SB ranged from 90-135 t/ha, the average green fodder yield of oats variety (S-2000) ranged from 60-110 t/ha, while the average green fodder yield of berseem + oats (mixed) ranged from 100-140 t/ha.

Table 72. Comparison of green fodder yields of improved fodder crop varieties at Chak No.105/SB

Farmers	Berseem GFY (t/ha)	Oats GFY (t/ha)	Berseem + Oats GFY (t/ha)	Farmers	Berseem GFY (t/ha)	Oats GFY (t/ha)	Berseem + Oats GFY (t/ha)
1.	115	60	132	9.	130	61	130
2.	115	60	132	10.	130	57	135
3.	122	70	103	11.	132	61	125
4.	127	60	129	12.	132	72	120
5.	120	70	140	13.	103	65	128
6.	117	60	135	14.	129	66	140
7.	114	63	124	15.	140	70	131
8.	130	65	129	16.	135	70	125

Similarly, the green fodder yield of improved variety of berseem (Pachaiti) planted with 16 farmers of Chak No.105/SB ranged from 114 - 140 t/ha, the average green fodder yield of oats variety (S-2000) ranged from 57 – 70 t/ha, while the average green fodder yield of berseem + oats (mixed) ranged from 103 – 140 t/ha. The average green fodder yields of improved and local varieties was compared to see the impact of newly developed fodder crop varieties and associated agronomic packages.

Table 73. Comparison of average green fodder yield of improved vs. local berseem

Village	No. of farmers	Berseem Improved GFY (t/ha)	Berseem (local) GFY (t/ha)	Percent increase
74/SB	21	119	89	33.7
105/SB	16	124	95	30.5

The data of green fodder yield in berseem improved versus local berseem grown at both the villages revealed that the improved berseem gave 33.7 and 30.5% higher yields as compared to local berseem in village 74/SB and 105/SB, respectively. The increase in average green fodder yield of berseem in Chak No. 74 SB was slightly higher as compared to Chak No 105/SB.

Table 74. Comparison of average green fodder yield of improved vs. local oats.

Village	No. of farmers	Oats (Improved) GFY (t/ha)	Oats (local) GFY (t/ha)	% increase
74/SB	21	76	44	72.7
105/SB	16	65	35	85.7

The data of green fodder yield in Oats improved versus local Oats grown at both the villages showed that the improved Oats gave 72.7 and 85.7% higher yields as compared to Local Oats in villages 74/SB and 105/SB respectively. The average increase in green fodder yield of Oats in Chak No. 105/SB was higher as compared to Chak No 74/SB. This was because some of the farmers in Chak No. 105 SB planted wild oats as local oats.

Table 75. Average green fodder yield of improved berseem and improved berseem + oats.

Village	No. of farmers	Berseem Improved GFY (t/ha)	Berseem + oats improved GFY (t/ha)	% increase
74/SB	21	119	122	2.5
105/SB	16	124	127	2.4

The data of green fodder yield in improved Berseem sole versus improved Oats and improved Berseem (mixed) grown at both the villages showed that the improved Berseem and improved oats mixed gave 2.5 and 2.4% higher yield as compared to improved Berseem sole at villages 74/SB, 105/SB, respectively. The average increase in green fodder yield of improved Oats and improved Berseem (mixed) in both the villages was at par with each other. The missed planting of berseem and oats produced more fodder during first cut then in sole crop of berseem and also it produced better quality fodder of legume + cereals than berseem alone.

Conclusion

The wide range of average green fodder yields of improved varieties revealed that there exists variation in soil and crop management from farmer to farmer at both the villages Chak No. 74 SB and 105 SB.

2.2.1.2 Year 2008

Methodology

During Winter 2007-08 (2nd year of study, 15 farmers selected each in 74/SB and 105/SB were provided seed of improved berseem and oats fodder varieties for planting as pure stand and as cereal-legume mixture at 15 acres in each village keeping 15 farmers in each village as control treatment. The sowing of winter fodder crops in both the villages was completed during the month of October-November, 2007. The following treatments were studied as pure stands and their combinations in both the villages.

Treatments	Crops
T1	Improved Berseem
T2	Improved Oats
T3	Improved Berseem + Oats
T4	Berseem (farmer's varieties and farming practice)
T5	Oats (farmer's varieties and farming practice)

15 farmers were kept in trial under treatment T1-T3 (5 in each treatment) and 10 as control, 5 for T4 and 5 for T5, were considered as local berseem and oats mixture but due non tradition of local mixture 5 acres of mixture was deleted

The data regarding germination, plant height, root shoot ratio and finally green fodder yield were recorded. The rainfall received during the whole winter season was only 56 mm in February.

Results

Table 76. Morphological and fodder yield from winter fodder crop recorded from different cuts at chak no 74/SB

Treatment	Germination %	No. of cuts	Plant Height (cm)	Root:shoot	GFY (t/ha)	Total of 5 cuts
T1- Berseem	85.25	cut I	33.08	1: 2.43	26.50	171.15
		cut ii	42.30	1: 3.20	37.50	
		cut iii	37.50	1:2.10	42.25	
		cut iv	39.10	1:1.90	38.50	
		cut v	32.25	1:1.80	28.40	
T2 – Oats	92.24	Cut i	110.34	1:5.43	97.6	97.60
T3 – Berseem +oats	86.63 + 88.89	cut I	30.94 B	1: 2.40	22.10	218.95
		cut ii	42.40 + 72.89 B+O	1: 3.65 + 1:4.35	71.30	
		cut iii	35.50+ 52.40 B+O	1:3.20 +1:3.25	62.30	
		cut iv	39.40	1:2.40	38.00	
		cut v	27.80	, 1:1.75	25.25	
T4- Berseem local	84.22	cut I	41.11	1:2.75,	18.00	97.50
		cut ii	39.11	1: 3.75,	28.00	
		cut iii	42.00	1:3.40,	32.00	
		cut iv	26.00	1:2.25	19.50	
T5 – Oats local	87.65	Cut i	89	1:4.25	70.30	70.30

The data from Chak No. 74 /SB revealed that germination ranged from 84-92%. The plant height ranged from 41–52 cm in berseem plots, 72 –110 cm in oats plots. The highest green fodder yield of 218.95 t/ha was recorded in mixture of oats with berseem improved varieties followed by the yield of 171t/ha produced by oats improved variety. Lowest yield of 97.50 t/ha from local berseem and 70.30 t/ha from local oats were obtained by farmer's practice. The yield of berseem was higher than oats crop.

Table 77. Morphological and fodder yield from winter fodder crop recorded from different cuts at chak no 105/SB

Treatment	Germination%	No. of cuts	Plant Height (cm)	Root: shoot Ratio (%)	GFY (t/ha) from five cuts	Total
T1- Berseem	89.35	cut i	35.88	1: 3.10	22.80	169.05
		cut ii	46.35	1: 3.35	37.80	
		cut iii	48.25	1:2.70	42.75	
		cut iv	34.40	1:2.90	39.30	
		cut v	20.35	1:1.80	26.40	
T2 - Oats	92.24	Cut i	108.34	1:5.33	106.6	106.6
T3 –Berseem + Oats	88.63 + 84.89	cut i	38.94	1: 2.55	25.50	225.23
		cut ii	45.50 + 75.90,	1: 3.40+ 1:4.22	81.33	
		cut iii	38.50+ 56.00	1:3.10 + 1:3.80	58.40	
		cut iv	34.40	1:2.34	35.00	
		cut v	24.60	1:1.15	25.00	
T4-Berseem local	83.22	cut i	39.11	1: 3.55	15.40	100.60
		cut ii	42.00	1:3.54	27.00	
		cut iii	36.00	1:2.54	24.50	
		cut iv	21.00	1:1.20	21.20	
		cut v	21.00	1:1.20	12.50	
T5 -Oats local	78.65	Cut ii	71.66	1:4.10	66.8	66.80

The data from Chak No. 105 /SB revealed that germination ranged from 78-92%. The plant height ranged from 39 –46 cm in berseem plots, 71 –108 cm in oats plots. The highest green fodder yield of 225.23 t/ha was recorded in improved oats + berseem mixed crop followed by the yield of 169.051 t/ha produced by improved pure stand of oats. Lowest yield of 66.80 t/ha was obtained from local oats grown with farmer's practice.

Conclusions

The improved berseem and oat crops produced 75 % and 39% higher green fodder yields than the local varieties respectively. The good establishment stand and increased height attributed toward high green fodder yield.

The improved berseem and oat crops produced 68 % and 60% higher green fodder yields than the local varieties respectively. The better crop establishment and height gained by the improved crops attributed towards high green fodder yields.

2.2.1.3 Year 2009

Methodology

During 1st year evaluation of improved fodder crop were sown using improved production technologies, comparing with local traditional varieties and technologies. During 2nd year the improved fodder crop varieties sown as sole and were compared with mixture sown of cereal and legumes comparing with local traditional practice of the farmers. Having got the progressive results from improved varieties, production seed of newly developed fodder crop varieties were obtained and demonstrated with farmer's participation for its sustainability. During winter improved varieties of berseem and oats fodder crops were sown at area of 15 acres (6.07 ha) in each village with 21 farmers in Chak No. 74/SB and 18 in Chak No.105/SB,.

Results and discussions

The data revealed that the mixed crop of berseem and oats improved gave highest green fodder yield followed by berseem sole improved. The improved varieties of both the fodders gave higher yield than local varieties. The green fodder yield among the farmers and between both villages varied which was due to variation in crop management.

Table 78. Green fodder yield of berseem and oats at farmers' field

S.No	Crop	Average GFY at 74/SB (t/ha)	Average GFY at 105/SB (t/ha)	Average GFY of both villages (t/ha)
1	Berseem Improved	132	122	127
2	Oats Improved	70	76	73
3	Berseem+oats improved (mixed)	137	145	141
4	Berseem local	87	91	89
5	Oats local	32	40	36

Conclusion

The yields of mixed cropping were higher than sole crops. The better crop establishment and plant height attained in mixtures attributed towards high green fodder yields which could be the result of nitrogen fixation from the air by legume crop i.e. cowpea and benefiting the companion crops.

2.3 Summer crops at the rainfed site

2.3.1 Introducing improved varieties, legume-cereal mixes and improved agronomic practices for summer crops.

Research method

This intervention was carried out at 37 farmers' fields in the project area during summer 2008 using recommended production practices. The sowing was carried out in the first week of July, 2008. Following 12 farmers' sites were visited to record observations on fodder yield in the month of September 2008.

1. Awais	2. Nazakat Ali	3. Saqib	4. Master Lal Hussain
5. Sufi Javed	6. M. Ajmal	7. Khurr. Manzoor	8. Qamar-uz-Zaman
9. Zahid	10. Liaqat	11. Sadiq	12. Amjad

During the year 2009, seven improved sowing treatments were compared with farmers' summer cereal varieties (sorghum and millet) for fodder yield potential on farmers' fields at Village Lodhay, Tehsil Gujjar Khan, District Rawalpindi under rainfed conditions during the month of July. The treatments were comprised of i) sorghum + guar at lepara; ii) sorghum + guar at maira; iii) sorghum alone at maira; iv) millet + guar at lepara; v) millet + guar at maira; vi) millet alone at maira; vii) guar alone at maira; viii) farmers' practice sorghum alone; and ix) farmers' practice millet alone. The approved varieties viz. JS-2002, MB-87 and BR-99 of sorghum, millet and guar were used in this study while farmers used their local varieties of sorghum and millet. Out of fifty eight farmers' fields, 5 in each treatment were selected to record fodder yield data. Harvesting for green fodder was carried out in the month September 2009. Except guar alone treatment, all the pure stands and mixed treatments were harvested for fodder when the cereals flowered 50 percent. The pure stand of guar was cut at 5-10 percent pod formation for fodder purpose. A plot size of 1.2 m^2 was harvested for estimation green fodder yield. Representative green fodder samples were drawn from each treatment/plot at random, weighed and dried in an oven at 60^o C for 72 hours. The dried samples were again weighed to estimate dry matter yield under each treatment. The samples on one replication were ground and sent to Animal Nutrition Laboratory for determination of forage quality.

Results and Discussion

Green fodder and dry matter yield obtained under different treatments during the year 2008 and 2009 is presented in Tables 79 and 80, respectively.

Table 79. Green fodder yield (t/ha) of sorghum, millet and guar grown alone or in mixtures during summer 2008.

Treatment/intervention	Green fodder yield	Dry matter Yield
Sorghum alone	29.37	8.20
Millet alone	31.25	8.70
Guar alone	25.82	5.51
Sorghum + Guar	27.07	6.02
Millet + Guar	31.45	6.89
LSD (0.05)	NS	0.13
CV (%)	25.59	1.03

From the results, it appeared that all the treatments produced similar green fodder yields statistically. Millet alone (31.25 t/ha) and Millet + Guar mixture (31.45 t/ha) recorded the highest green fodder yields. The highest dry matter yield of 8.70 was recorded in pure stand millet. The yield of cereals with mixture of legumes remained lowest as the legumes overshadowed by the tall summer cereal legumes. Among mixtures, sorghum + guar gave the maximum dry matter yield of 6.89 t/ha.

Table 80. Green fodder yield (t/ha) of sorghum, millet and guar grown alone or in mixtures during summer 2008.

Treatment	GYT (t/ha)	DYT (t/ha)	CP %	CF %
Sorghum +guar (Lepara land)	64.80	19.82	14.78	24.59
Sorghum +guar (Maira land)	45.06	13.54	14.04	25.48
Sorghum alone Improved	44.54	14.30	12.68	30.24

Millet + Guar (Lepara land)	51.46	15.44	14.21	29.76
Millet + Guar (Maira land)	41.33	12.29	13.65	30.05
Millet alone Improved	40.80	13.10	13.57	30.89
Guar alone Improved	28.54	6.62	17.34	23.52
Sorghum Local	43.37	13.92	10.32	31.20
Millet Local	33.86	10.86	11.09	31.07
LDS (0.05) CV (%)	5.54 9.82	1.60 9.33		

Statistically significant differences were observed among treatments for green fodder and dry matter yields during the year 2009. The highest green fodder yields of 64.80, 51.46 t/ha and dry matter yields of 19.82, 15.44 t/ha were recorded in sorghum + guar and millet + guar, respectively both planted at lepara land. The farmers' varieties could not compete with approved cereal varieties grown alone or in mixed with guar. Farmers' local varieties of sorghum and millet produced only 43.37 and 33.86 t/ha green fodder yield and 13.92 and 10.86 t/ha of dry matter yield. As legume fodder was mixed in cereals, ultimately nutritive value of the feed in these treatments was also improved. The highest crude protein contents of 14.78 and 14.04 percent were recorded in sorghum + guar planted on lepara and maira land, respectively. The farmers' local varieties of sorghum and millet produced 10.32 and 11.09 percent crude protein contents. In mixed cropping lower crude fibre contents were observed as compared to cereals planted alone. The maximum crude fibre contents of 31.20 and 31.07 percent were recorded in farmers, local varieties of sorghum and millet. In the light of above findings, it is recommended to plant approved varieties of sorghum and millet and mix guar in them to harvest high tonnage of better quality feed for healthy livestock industry. In this way nitrogen status of the soil will also be improved through induction of legume in cereal fodder crops.

Conclusion

Millet + Guar mixture was found good option for fodder yield and quality during summer 2008 under rainfed conditions of medium rainfall area. During summer 2009, sorghum + guar mix cropping under lepara land showed best compromise of fodder yield and forage quality.

During summer season, two Msc. (Hons) agronomy students were involved and brief research work undertaken by them is reproduced below.

2.3.2 Introducing improved varieties, legume-cereal mixes and improved agronomic practices for summer crops

Background

Grass-legume mixtures are always desirable because of their complementary functions in providing nutritive, succulent, palatable forage for the animals. In addition, they are capable of creating much greater quantities of digestible dry matter and protein throughout the growing season than either component. Legumes usually maintain their quality better than grasses even at maturity and being rich in protein, enhance the forage value and also add substantially the much needed nitrogen to the soil. The mixtures also improves the physical conditions of the soil, check soil erosion, resist the encroachment of weeds and withstand the vagaries of weather better than pure stands. Mixed cropping especially with legumes can improve both forage quality and yield because legumes are good source of protein (Moreira, 2007).

Cyamopsis tetragonoloba L. commonly known as guar is an indigenous, annual kharif legume grown for feed, green fodder, vegetable green manuring and gum extraction. Being drought hardy, it is grown mainly under rainfed conditions in subcontinent and diversified uses in textile, paper, and food industries. Guar has diversified uses such as; it provides nutritious fodder, fibreless green pods for vegetable, guar gum and guar meal (concentrate) to the livestock, adds fertility to soil by fixing a considerable amount of atmospheric nitrogen and adding organic matter. Like other legumes, guar is an excellent soil-building crop with respect to available nitrogen. Root nodules contain nitrogen-fixing bacteria, and crop residues, when plowed improve yields of succeeding crops (Undersander *et al*., 2009). There is a need for a summer legume which, when mixed planted with cereal fodder crops, would produce a higher protein forage. Guar could be grown with forages to increase the protein production per acre without reducing forage yields. The mixture would result in a more nutritious for livestock feed (Thompson, et al., 1992). Being drought hardy crops guar will be sown as sole and along with other seasonal fodder crops such as maize, millet and sorghum to improve the yield and quality in order to overcome the problem of quality fodder in rainfed regions (Wetselaar, 2005).

For obtaining a good fodder of improved quality, an accurate balance of legumes and non-legumes in a mixture is very essential. In view of the scarcity of quality fodder, the present study was carried out under the project "Community Action in Integrated and Market Oriented Feed-Livestock Production in Central and South Asia" being implemented by ICARDA to improve the nutritional status of summer fodders for livestock in order to increase the production of milk, meat and other dairy products in rainfed region. The present study had the following objectives:

- To identify the appropriate summer legume fodder mixtures for both yield and quality.
- To identify the best cutting stage for maximum yield and quality of different forage crops and their mixtures.
- To disseminate and demonstrate the latest best improved package of forage mixtures.
- To provide an opportunity for complementary practical on-farm participatory training and capacity building of researchers and farmers.

Materials and methods

Location, treatments and management

An experiment "Evaluation of summer cereal-legume mixtures for fodder yield and quality under rainfed conditions**"** was carried out at farmer's field (33.24º N and 42.72o E) at Village Lodhay in Rawalpindi district during the summer season 2008 The experiment consisted of three summer cereals i.e. sorghum, millet and maize which were sown as mixture with guar legume at 50:50 ratio and in pure stands. The experiment was sown in complete randomized block design in plot size 6×2.10 m^2 with three replication and seven treatments. The treatments were as follows.

T_1 - Sorghum (JS-263)
T_2 - Millet (BS-2000)
T_3 - Maize (S-2002)
T_4 - Guar (BR-99)
T_5 - Sorghum + Guar (JS-263 + (BR-99)
T_6 - Millet + Guar (BS-2000 + BR-99)
T_7 - Maize + Guar (S-2002 + BR-99)

The seed of improved fodder varieties such as sorghum (Sargodha-2002), millet (JS-263), maize (BS-2000) and guar (BR-99) was obtained from Fodder Research Institute, Sargodha and sown at the seed rate of 80, 10, 125 and 40 kg / ha, respectively. The crops were sown on 26 June, 2008 with single row hand drill keeping a row spacing of 30 cm in a randomized complete block design with three replications. In mixtures, the seed rates of component crops were homogenized well before sowing. All other agronomic practices were kept normal and uniform in all the plots.

Similarly, sorghum, millet and guar were planted by 37 participatory community farmers at their fields during the 1st week of July, 2008. Fertilizer nitrogen @ 80 kg / ha and phosphorous @ 57 kg / ha in the form of Urea and DAP, respectively, were incorporated in the soil at the time of seedbed preparation. The plot size of 6 m × 2.1 m was used for each treatment and to separate treatments, a buffer zone of 1m was provided.

Plant sampling

The plant samples were taken from randomly selected $1m^2$ areas of each plot at pre-booting (40 DAS), booting (60 DAS), and 50 % heading stage (75 DAS) for recording green fodder yield and dry matter yield. Harvesting by participating farmers was carried out when cereal fodders and their mixtures with guar flowered 50 percent in the month of September, 2008. Guar in pure stands was harvested at 5-10 percent pod formation stage. One m^2 quadrate was used in each treatment / farmer to record green fodder yield per unit area and then converted it into t / ha. After taking fresh biomass, all these samples were chopped separately and dried in an oven at 65°C. The samples were again weighed and dry matter yield was calculated.

Soil and meteorological data

Soil samples were taken before sowing (26th June, 2008) and after the harvest (9th September, 2008) of the crop in order to evaluate the effect of treatments on soil fertility and other physio-chemical properties of the experimental site. Meteorological data recorded during the crop growth period are presented in Figure 6.

Statistical Analysis

Analysis of variance was performed for the data using MSTAT-C software (Michigan 1988) to test the significance and to compare the treatments means by using least significance difference (LSD) test at 5% probability level (Steel *et al.,* 1997).

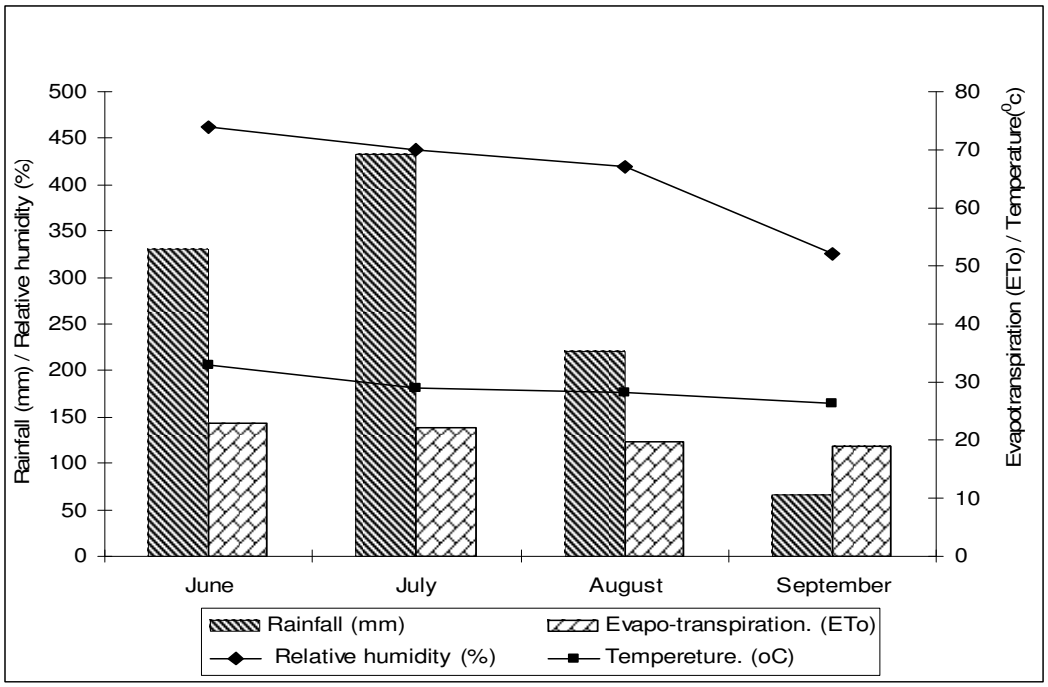


Figure 6. Meteorological data recorded during summer cropping season in 2008

Results

Green fodder yield (t ha^{-1})

Green fodder yield is the palatable and cheap source of animal feed. A crop with more plant height, no of leave plant^{-1}, leave area and stem thickness etc have more green fodder yield. In this study maize plant produced taller height, having more leave area, more stem thickness and thus produced more green fodder yield then followed by millet, sorghum and guar, Similarly, in mixtures, maize + guar produced more green fodder then millet + guar and sorghum + guar mixture (Table 81).

Green fodder yield data recorded at pre-booting, booting and 50% heading crop growth stages showed statistically significant difference among various treatments, growth stages and interaction between treatments × growth stages. Maize grown alone produced significantly highest mean green fodder yield (48.61 t ha^{-1}) followed by millet (44.43 t ha^{-1}), sorghum (39.67 t ha^{-1}) and in guar (14.13 t ha^{-1}). In mixture treatments, maize + guar produced more green fodder yield (36.34 t ha^{-1}) followed by millet + guar (31.78 t ha^{-1}) and lowest sorghum + guar (27 t ha^{-1}). This increased in quantity of green fodder yield under rainfed condition was due to timely availability of rainfall water (262 mm) and mean optimum temperature (28.5 ^{o}C) during growth period of kharif-legume, sole and mixture crop.

The reduction in green fodder yield (t ha^{-1}) occurred in mixture treatments was 23 % in maize + guar mixture compare with sole maize followed by millet + guar and sorghum + guar mixture in which mean green fodder yield was reduced 22 % and 21 % t ha^{-1} when compared with pure stand of millet and maize crop. This reduction in green fodder yield was the result of mixing of guar crop which had less plant height and small stem thickness and thus lead to less green fodder yield. Similarly in different crop growth stages, 50% heading stage produced significantly maximum mean green fodder yield of 49.01 t ha^{-1}

followed by booting stage with mean green fodder yield of 42.43 t ha^{-1} and lowest production of green fodder yield 19.03 t ha^{-1} was recorded at pre-booting stage.

Interaction between treatment means and growth stages also showed statistically significant difference. In case of pure crop stands × growth stages interaction, maize pure harvested at 50% heading stage showed significantly higher mean green fodder yield (65.66 t ha^{-1}) followed by millet and sorghum harvested at the same stage with 58.66 & 54.33 t ha^{-1} and the minimum mean green fodder yield was recorded in guar pure stand (14.13 t ha^{-1}) harvested at pre-booting stage. Among mixture treatments × growth stages interaction, maize + guar harvest at 50% heading stage gave significantly higher mean green fodder yield (51.93 t ha^{-1}) followed by millet + guar harvested at the same growth stage (44.50 t ha^{-1}) and the minimum mean green fodder yield was recorded in sorghum + guar mixture (18.33 t ha^{-1}) harvested at pre- booting stage. The results are in agreement with the findings of Rashid (2003), Ahmad *et al.* (2007) and Ibrahim *et al*. (2006) which reported that highest green fodder yield was obtained in maize and lowest in guar in pure stand and in mixture highest green fodder yield was recorded in maize + guar than other summer cereal legume mixtures in comparison.

Table 81. Effect of cereal-guar pure stands and their mixtures on mean green fodder yield (t ha^{-1}) recorded at different crop growth stages during kharif 2008

	Growth stages			
Treatments	**Pre-Booting**	**Booting**	**50% heading**	**Mean**
Sorghum	19.33 k	45.33 f	54.33 c	**39.67 C**
Millet	23.96 j	51.66 c	58.66 b	**44.43 B**
Maize	25.83 ij	54.33 b	65.66 a	**48.61 A**
Guar	14.13 l	28.33 i	31.33 h	**24.60 G**
Sorghum + Guar	18.33 k	33.00 g	38.66 f	**29.00 F**
Millet + Guar	21.16 k	37.66 f	44.50 e	**34.78 E**
Maize + Guar	19.43 k	43.66 e	51.93 d	**37.34 D**
Mean	**19.03 C**	**42.43 B**	**49.01 A**	

LSD (P≤0.05) for treatments (T) = 1.731
LSD (P≤0.05) for harvest stage (HS) = 1.133
LSD (P≤0.05) for T x HS = 2.999

Fodder Quality

Crude protein estimates the nitrogen content of a sample. Production of quality forages can play a profound effect on animal performance and consequently on profits. Production of high quality forages is, unfortunately, illusive. It is much easier to produce large amounts of poor quality roughage than moderate or even low amounts of that which is of high quality. In general, a reduction in forage quality can have a very significant effect on the overall nutritional plan of the animal. As forage quality decreases (in other words the total percentage of fiber increases), forage digestibility is reduced and feed intake (especially in ruminants) will also decrease AOAC (1994). Crude protein content plays a vital role in

determining the quality of green fodder. Mean crude protein content recorded in sorghum, millet, maize and guar grown alone or in mixture of cereal guar was presented in Table 82.

The differences among various treatments, growth stages and treatments × growth stages interaction were statistically significant. Guar grown alone produced significantly highest mean crude protein content (18.77 %) followed by sorghum (8.41 %) then maize (8.11 %) and lowest in millet (7.71 %). In mixture treatments maize + guar produced more crude protein contents (14.50 %) followed by sorghum + guar (13.70%) and then millet + guar (11.54 %).

The increased in crude protein content in mixture treatments was 45 % in maize + guar mixture when compared with sole maize crop followed by millet + guar and sorghum + guar mixture in which mean crude protein content increased 40 % and 35 % compared with the crude protein contents of millet and maize when grown as a sole crop. This increase in crude protein content was the result of addition of guar crop which have the ability to fix atmospheric nitrogen more crude protein content with the advancement of growth stage.

During various crop growth stages, booting stage produced significantly maximum mean crude protein contents 15.50 % followed by pre-booting stage with mean crude protein content of 11.86 % and lowest crude protein contents 8.61 % were recorded at 50 % heading stage.

Interaction between treatment mean and growth stages also showed statistically significant results. In case of pure crop stands × growth stages interaction, guar pure harvested at booting stage showed significantly higher mean crude protein content (28.29 %) followed by guar harvested at pre-booting stage (17.75 %) and the minimum mean crude protein content was recorded in millet pure stand (5.65 %) harvested at 50 % heading stage. Among mixture treatments × growth stages interactions, maize + guar harvest at booting stage resulted significantly higher mean crude protein contents (18.65 %) followed by sorghum + guar harvested at the same growth stage (16.34 %) and the minimum mean crude protein content were recorded in millet + guar mixture harvested at 50 % stage (10.44 %). Similar results were reported by Azraf *et al*. (2007) and Bareeba (1997) that legume crop produced more crud protein as compare to cereal and when mixed with cereal crop, it increased the crude protein percentage in cereal crop.

Table 82. Effect of cereal-guar pure stands and their mixtures on mean crude protein percentage recorded at different crop growth stages during kharif 2008.

Treatments	Growth stages			Mean
	Pre-Booting	Booting	50% heading	
Sorghum	8.907 i	10.59 g	5.740 l	**8.412 E**
Millet	6.657 k	9.950 h	5.657 l	**7.701 G**
Maize	7.847 j	9.837 h	6.847 k	**8.177 F**
Guar	17.75 c	28.29 a	10.3 g	**18.77 A**
Sorghum + Guar	13.93 f	16.34 d	10.8 g	**13.70 C**
Millet + Guar	13.62 f	14.89 e	10.44 g	**11.54 D**
Maize + Guar	14.35 e	18.65 b	10.57 f	**14.50 B**
Mean	**11.86 C**	**15.50 B**	**8.61 A**	

LSD (P≤0.05) for treatments (T) = 0.2314
LSD (P≤0.05) for harvest stage (HS) = 0.1448
LSD (P≤0.05) for T x HS = 1.4008

The result of soil analysis (not reported) indicated that soil organic matter % and total nitrogen was increased significantly in pure stand of guar (3.93 %) crop plots when compared with pure millet (1.71 %), sorghum (1.68 %) and maize (1.65 %) crop plots. In mixture treatments maize + guar (2.76 %) plots resulted more nitrate nitrogen as compare to sole maize plot and followed by millet + guar (2.52 %) and sorghum + guar (2.62 %). This indicated that guar fixed more nitrogen in soil while non significant effect of guar was observed on available phosphorous, available potassium when compared with before sowing soil analysis data.

Fodder scientist observing the millet +guar mixture

Millet + guar mixture

Millet + guar mixture

Millet in pure stand

Sorghum in pure stand

Sorghum in pure stand in another field

Rural women engaged in different fodder processing activities

Conclusion

The results of the experiment consisting of kharif cereal such as maize, millet, sorghum grown with and without guar legume for fodder yield and quality showed that fodder yield characteristic such as, plant height, stem thickness, number of leaves plant^{-1}, leaf area, fresh weight plant^{-1}, dry weight plant^{-1} and finally green fodder yield and dry matter yield showed significant difference among all the treatments at all the growth stage such as pre-booting, booting, and 50 % heading stages. Similarly, the quality variables such as brix value, crude protein content and crude fiber contents showed significant difference among treatments at all stages of crops growth. The results of the study showed that maize-guar is best fodder crops for higher yield and quality in wet years while sorghum and guar in dry seasons.

2.3.3 Effect of cutting and post cutting intervals on hydrogen cyanide in sorghum forage grown under rainfed conditions (Master student: Adnan Zahid)

Background

Sorghum (*Sorghum bicolor* L. Moench) is becoming an increasingly important forage crop in many regions of the world with warming climate conditions (Zerbini and Thomas, 2003). Its high resistance to drought makes it more suitable fodder crop to grow in semi-arid areas especially due to its higher productivity under dry conditions compared to corn (Tabosa *et al.,* 1999). Sorghum is one of the most important fodder crops which are largely cultivated throughout the Pakistan during the summer season to meet out both green as well dry fodder requirements of the livestock. Proper growth stages for feeding to livestock, adequate fertilization, suitable and low HCN content varieties are major factors limiting the fodder sorghum production in our country (Hingra *et al.,* 1995 and Hanuman *et al,* 2008).

Sorghum species are known to be cyanogenic, because of the presence of cyanogenic glycosides, which yields HCN on hydrolysis (Seigler, 1991). The contents of the HCN in sorghum vary depending on plant growth stage, genotype (variety) and environmental conditions i.e. drought and frost etc. Any stress that disrupts normal growth can contribute toward increased HCN toxicity. Probably the most common cause of HCN in sorghums is drought. Leaves of forage crops are the precious part of the plant which are liked by the animals due to its palatability and is affected earlier by drought than any other part of the plant (Vough and Cassel 2000).

The plant produces cyanide could be poison to livestock if taken greater than permissible limit (50 to 100 mg / 100 g). Levels of 0 to 25 mg HCN / 100 g have been considered safe for grazing, levels of 50 to 75 mg / 100 g as doubtful and concentrations of greater than 100 mg / 100 g as highly dangerous. The cyanide poisoned animal shows an increased rate of respiration, increased pulse rate, gasping, muscular twitching or nervousness, trembling, foam from the mouth, blue coloration of the lining of the mouth, and spasms or convulsions, death occurs from respiratory paralysis (Vough and Cassel, 2000).

Therefore, it is very important for farmers of livestock dependent community of warm climate to identify suitable and low HCN content sorghum varieties and proper growth stage of crop at which they safely feed to their animals. The objective of this study is to identify the appropriate cutting and post cutting intervals with minimum health hazard risks of HCN to animals.

The objectives was to determine the HCN level of sorghum forage at different growth stages and post cutting intervals for safe feeding to livestock.

Material and Method

Three varieties of sorghum viz. JS-2002, Chakwal sorghum and local variety were planted at the Research Farm Koont, Pir Mehr Ali Shah, Arid Agriculture University, Rawalpindi during the Kharif 2008. The soil of the experimental field was loamy in texture with available P 12.15 mg / kg and available K 160 mg / kg and in reaction with pH of 7.5. The experiment was sown on 1st August, 2008 in randomized complete block design with three replications. Each plot consisted of 10 rows with 6 m long and 30 cm apart thus having a plot size of 18m^2. Seed rate used was 75 kg ha^{-1} of each variety. Plant samples were taken at three growth stages i.e. 3rd leaf, pre-booting and 50% heading from each plot to be analyzed for hydrogen cyanide contents by picrate method (Andersen, Andersen, and Brimer 1988)

as fresh leaves and after 06, 12, and 18 hours after cutting. The results were analyzed by using MSTATC statistical computer package program (ANONYMOUS, 1982).

HCN determination

Leaves sample were chopped up with scissor and the small pieces immediately ground up in a mortar and pestle. 100 mg of ground up leaves was taken using an analytical balance immediately to add in flat bottomed plastic bottle having filter paper disc loaded with buffer at pH 6 in it then 1ml of distilled water was added. Then immediately a yellow picrate paper attached to plastic strip will be inserted. Care was taken that the picrate paper was not touch the liquid and close the bottle.

Another sample was prepared as above but with no leaves, which serve as a blank. As a control to check on the method, a filter paper disc loaded with buffer and linamarase was placed in a bottle, and then standard linamarin paper, 0.5 ml water and a yellow picrate paper was added. The bottle was closed with a screw cap lid. The bottle was kept in standing position for 24 hours at room temperature (20-35 ^{o}C). After that the bottles was opened and match the colour of the paper against the colour chart. From the colour chart, the amount of total cyanide in ppm in the leaves was recorded. Also, it was checked that the blank corresponds to zero and the standard paper gives 50 ppm. The results were compared with the help of spectrophotometer by removing plastic backing sheet was removed from the picrate paper very carefully. The picrate paper was immersed in 5ml of water for about 30 minutes with occasional gentle shaking. The plastic sheet of the blank picrate paper was removed and was immersed in 5 ml of water for about 30 minutes then the absorbance at 510 nm of the picrate solution was measured. The total cyanide content in ppm was calculated by the equation

Total cyanide content (ppm) = 396×absorbance

Total cyanide content in ppm was converted into mg per 100 g with the given formula

$$\text{Milli gram per 100 gram} = \frac{\text{HCN contents in ppm}}{10}$$

Results and Discussion

The HCN contents are main contributors toward the risk related with sorghum fodder for the livestock. HCN contents recorded in sorghum leaves at different growth stages of the crop are shown in the Table 83 below.

Table 83.

Treatments	Fresh				06hours				12hours				18hours			
	GS_1	**GS_2**	**GS_3**	**Mean**	**GS_1**	**GS_2**	**GS_3**	**Mean**	**GS_1**	**GS_2**	**GS_3**	**Mean**	**GS_1**	**GS_2**	**GS_3**	**Mean**
JS-2002	71.26a	11.55 e	5.63f	**29.48 C**	69.66b	10.47 e	4.58f	**28.24 A**	63.80 b	10.40e	4.21f	**26.13 C**	60.91 b	7.98 f	3.25g	**24.04C**
Chakwal Sorghum	71.42a	17.37 c	11.01 e	**33.26 B**	71.39a b	15.83 d	9.27e	**32.49 C**	64.8 ab	14.98d	8.82e	**29.52 B**	62.87 b	13.15 d	7.98 f	**28.00 B**
Local Variety	72.33a	20.96 b	12.57 d	**35.28 A**	72.29a	19.87 c	11.82e	**34.66 B**	65.76a	18.96c	11.21 e	**32.31 A**	63.73 a	17.62 c	10.42 e	**30.59A**
Mean	**71.67 A**	**16.63 B**	**9.47 C**		**71.11 A**	**15.39 B**	**8.59 C**		**64.1A**	**14. 9B**	**8.08C**		**62.5A**	**12.91 B**	**7.22C**	

GS_1= 3rd leaf growth stage, GS_2= Pre-booting stage, GS_3= 50% heading stage

The HCN contents of sorghum crop significantly influenced by genetic makeup of the cultivars. The results after fresh cutting interval showed that mean maximum HCN contents (35.28 mg / 100 g) were recorded in local variety followed by Chakwal sorghum (33.26 mg / 100 g) and minimum HCN contents (29.48 mg / 100 g) were found in JS-2002 sorghum cultivar. Sorghum cultivar JS-2002 produced HCN contents 16% less than local cultivar while 11% from Chakwal sorghum. The results of fresh cutting investigations revealed that improved sorghum cultivar JS-2002 produced less HCN contents than other cultivars tested in the experiment. The differential behaviors of these cultivars could also be explained by the variation in their genetic makeup as reported by Hanuman *et al.* (2008). At early growth stage (GS_1), all the sorghum cultivars produced highest HCN contents, which decreased with the advancement of the crop growth stage. HCN contents recorded at 3rd leaves stage in local sorghum cultivar were 72 mg / 100 g while it was 71 mg / 100 g in improved tested sorghum cultivars which clearly indicate higher HCN contents in all the sorghum cultivars than the lethal limit i.e. 70 mg / 100 g. At pre-booting and 50% heading stage, the HCN contents were reduced to 17 mg /100g and 10 mg /100g in sorghum leaves respectively. Interaction between the growth stages and varieties showed that maximum HCN contents (72.33 mg / 100 g) were recorded in local variety at GS_1 (3rd leaves stage) and minimum HCN contents (5.63 mg / 100 g) in JS-2002 at GS_3 (50% heading stage). The mean HCN reduction was 78% from GS1 to GS_2 i.e. when crop shifted from 3rd leaf stage of pre-booting stage and the reduction was 86% from GS_1 to GS_3 i.e. when crop shifted from 3rd leaf stage to 50% heading stage, whereas from pre-booting stage to 50% heading stage, HCN reduction was 41%. This indicates reduction (%) is more at early stage than the later ones, which could be the result of high HCN hydrolysis due to enzymatic process. These results clearly indicate that pre-booting is the stage after which farmers can safely feed sorghum forage to their livestock. Similar, finding were reported by Haque and Bradbury, 2001 and Pistosia et al, 2003, who stated that total cyanide contents of sorghum leaves were 74 mg / 100g one week after germination but reduced to 16 mg / 100g three weeks later.

The HCN contents recorded after 06 hours of post-cutting interval at different crop growth stages were presented in Table 83. The mean maximum HCN contents produced by local variety during the crop growth period (mean of GS1, GS2 and GS3) were 34.66 mg / 100 g followed by Chakwal sorghum i.e. 32.16mg /100g and lowest i.e. 28.24 mg / 100g by JS-2002 sorghum cultivar. The comparison of all the three cultivars among themselves showed that JS-2002 produced 19% less HCN contents from local cultivar and 13% from the Chakwal sorghum while the Chakwal sorghum showed 6.3% reduction in HCN contents when compared with local cultivar. Similarly, Takamistsu (1973) reported that the HCN contents decreased in sorghum cultivar by 2% and 12% by storing the plants in refrigerator for 24 hours and exposure in the shade for 6 hours respectively. At 3rd leaf growth stage ($GS_{1)}$, mean HCN contents found were 71 mg / 100 g of sorghum forage leaves which is higher than the lethal limit i.e. 70 mg / 100 g, while at pre-booting (GS_2) and 50% heading stage (GS_3), the HCN contents were reduced to 15.05 and 8.89 mg / 100 g of the sorghum forage respectively. Interaction between the growth stages and varieties showed that maximum HCN contents (72.29 mg / 100 g) were recorded in local variety at GS_1 and minimum HCN contents (4.58 mg /100g) in JS-2002 at GS_3. The reduction of HCN contents was 88% from GS_1 to GS_3 whereas, 78% HCN reduction was recorded when crop shifted from GS_1 to GS_2, while from GS_2 to GS_3, reduction in HCN contents was 44%. The drastic reduction was observed from early stage to 50% heading stage, which could be the result of enzymatic process that takes place with the advancement of crop growth and development.

The HCN reduction after 06 hours post-cutting intervals with comparison to fresh cutting of all the tested sorghum cultivars at three growth stages is shown in Figure 7. At GS1, sorghum

cultivar JS-2002, Chakwal sorghum and local cultivar showed HCN reduction of 2%, 1% and 0.1% respectively. At GS_2, reduction in HCN contents was found to be 9.4% in sorghum cultivar JS-2002, 8% in Chakwal sorghum and 5% in local cultivar with comparison to fresh cuttings while at GS3, reduction in HCN contents was 14%, 7% and 6% in sorghum cultivar JS-2002, Chakwal sorghum and local cultivar respectively. More disparity in the cultivars was observed with the advancement of growth stage (Figure 7), which shows that different cultivars exhibit different morphological, physiological and chemical expression under the same set of environment and thus explains the variation that exist among the tested cultivars. Reduced HCN contents were recorded in sorghum cultivar JS-2002 followed by Chakwal sorghum and then local cultivar at all growth stages (Figure 7).

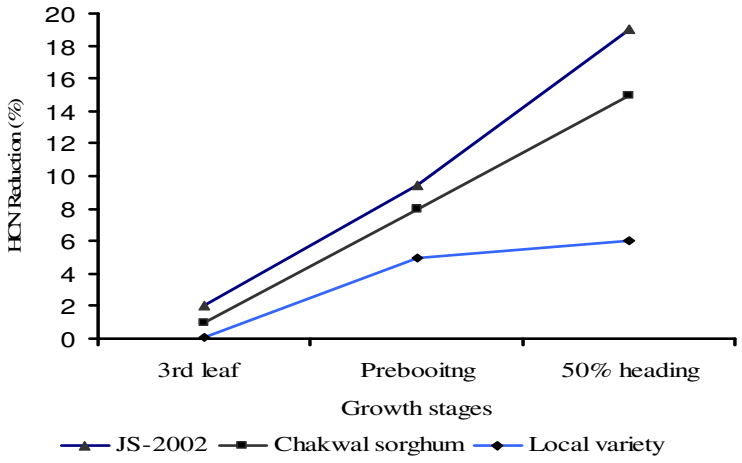


Figure 7. Reduction of HCN contents (5) after 6 hours post-cutting as compared to fresh cutting of sorghum cultivars at different crop growth stages.

The HCN contents recorded after 12 hours of post-cutting intervals at different crop growth stages were also presented in Table 83. The mean maximum HCN contents recorded during different crop growth were 32.31mg / 100 g in local variety followed by Chakwal sorghum i.e. 29.68 mg / 100 g and minimum HCN contents i.e. 26.15 mg / 100 g were found in JS-2002 improved sorghum cultivar. HCN reduction in sorghum cultivar JS-2002 with comparison to local cultivar was 20%, whereas from Chakwal sorghum, the reduction was 12%. Chakwal sorghum in turn showed 9.2% HCN reduction when compared with local cultivar. The results of HCN reduction showed that sorghum cultivar JS-2002 consistently has less HCN contents compared with other cultivars tested in this study. At GS_1, HCN contents were 65.10 mg / 100 g of sorghum fodder while at GS_2 and GS_3, the reduction in HCN contents was 14.62 and 8.41 mg / 100 g of sorghum forage leaves respectively. Interaction between the growth stages and varieties after 12 hours of post-cutting intervals showed that maximum HCN contents (66.76 mg / 100 g) recorded in local variety at GS_1 and minimum HCN contents (4.21 mg / 100 g) in JS-2002 at GS_3. Overall, the HCN reduction was 87% when crop shifted from GS_1 to GS_3 whereas, 77% HCN reduction occurred when crop shift from GS_1 to GS_2, while from GS_2 to GS_3, HCN reduction was 45%. The drastic reduction occurred from early to late stage seems to be the result of changes in the physico-morphic characteristics of the varieties tested in this study with the advancement of the growth stage. The results are in close conformity with the finding of Smeathers *et al.* (1973) who reported that after post-cutting intervals of 2 hours up to 48 hours, the HCN contents were reduced but not significantly in black cherry (*Prunus serotina.* L).

The HCN reduction percentage of three sorghum cultivars at different growth stages after 12 hours of post-cutting intervals with respect to fresh cutting is shown in Figure 8. The maximum reduction of HCN contents i.e. 10% was obtained in sorghum JS-2002 followed by Chakwal sorghum (9%) and lowest HCN contents i.e. 7% were recorded in local cultivar. At GS2 and GS3, maximum reduction of HCN contents i.e. 13% and 25% was found in sorghum cultivar JS-2002, followed by Chakwal sorghum i.e.14% and 20% whereas, the minimum reduction of HCN was recorded in local cultivar i.e. 10% and 12% respectively. More disparity among cultivars regarding HCN reduction occurred after prebooting stage as is shown in Figure 8. These results are in close conformity with the finding of Smeathers *et al.* (1973) who reported that after post-cutting intervals of 2 hours up to 48 hours the HCN contents were reduced but not significantly in black cherry (*Prunus serotina*. L).

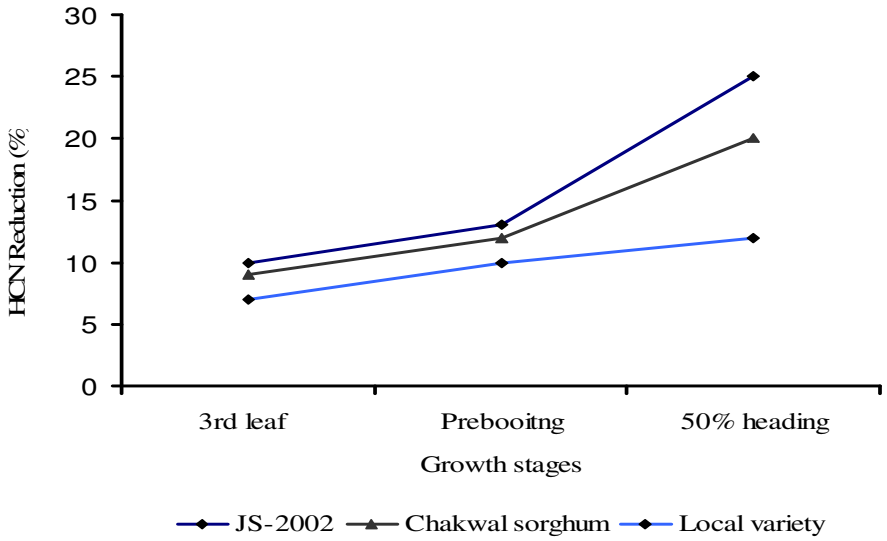


Figure 8. Reduction of HCN contents 12 hours post-cutting as compared to fresh cutting of sorghum cultivars at different crop growth stages.

The HCN contents recorded after 18 hours of post-cutting intervals at different growth stages were presented in Table 83. The mean maximum HCN contents (30.59 mg / 100 g) were recorded in local variety followed by Chakwal sorghum (28.36 mg / 100 g) and minimum HCN contents (24.04 mg /100g) were found in improved sorghum variety, JS-2002. The reduction of HCN recorded in sorghum JS-2002 was 21% when compared with local cultivar and 14% when compared with Chakwal sorghum while Chakwal sorghum showed 8.5% reduction when compared with local cultivar. At GS_1, the HCN contents were 62.50 mg /100g of sorghum fodder leaves while at GS_2 and GS_3, the HCN contents were reduced to 12.91 and 7.58 mg / 100 g of the sorghum forage leaves respectively. Interaction between the growth stages and varieties showed that maximum HCN contents (66.76 mg / 100 g) were recorded in local variety at GS_1 and minimum 4.21 mg / 100 g in JS-2002 at GS_3. Overall, the HCN reduction was 88% from GS_1 to GS_3 whereas 72%, when crop shifted from GS_1 to GS_2, while HCN reduction was 44% when crop moved fromGS_2 to GS_3. From the results, it appeared that fast reduction in HCN contents were occurred at early growth stages, when the crop shifts from early to prebooting stage but further reduction from pre-booting to 50% heading stage is comparatively slow. The HCN contents in sorghum are largely determined by transcriptional regulation of the biosynthetic enzymes CYP79 A1 and CYP79 E1. HCN development, the activity of CYP79 A1 is lower than the activity of CYP79 E1, suggesting that CYP79 A1 catalyzes the rate limiting setup in HCN synthesis. So, it is very important for farmers to

know that after how much time the HCN content was reduced so that can be feed sorghum forage to their livestock.

HCN reduction (%) during 18 hours of postcutting intervals with respect to fresh cutting of three sorghum cultivars at different growth stages is shown in Figure 9. The reduction of HCN contents was At GS_1, the reduction of HCN contents in sorghum cultivars JS-2002, Chakwal sorghum and local cultivar was 15%, 13% and 12% respectively. Similarly, at GS_2, HCN was 31% in improved sorghum JS-2002, 28% in Chakwal sorghum and 13% in local cultivar after 18 hours of post-cutting intervals when compared with fresh cutting. At GS_3, HCN reduction was 43%, 18% and 17% in sorghum JS-2002, Chakwal sorghum and local cultivar respectively. These results are in accordance with the finding of Busk and Moller (2002) who reported that with change of enzymatic reaction, HCN contents decreased.

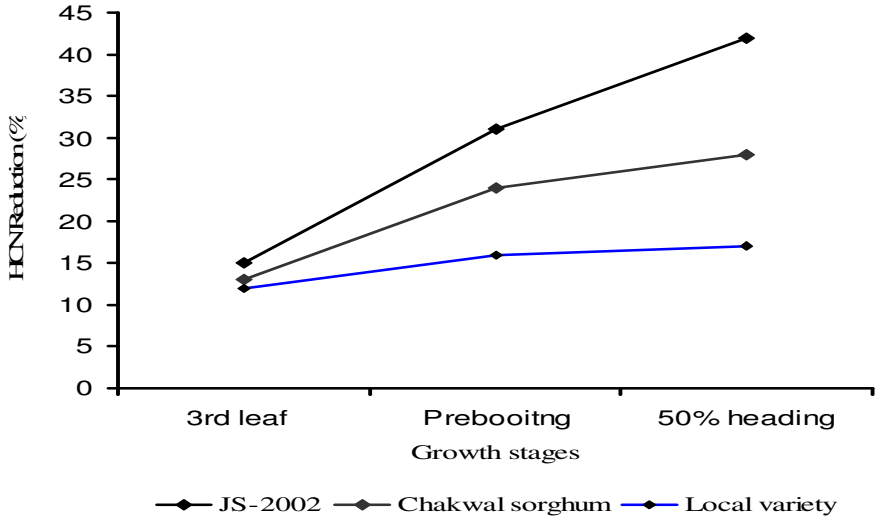


Figure 9. Reduction of HCN contents after 18 hours of post-cutting intervals with comparison to fresh cutting of sorghum cultivars at different crop growth stages.

Hanuman *et al*. (2008) reported that increase in the protein contents, the activity of enzymes which correlated with the HCN contents decreased. So, increase in crude protein results decrease in HCN contents. The HCN contents of all the three tested sorghum cultivars in this study showed highly significant negative relationship with the crude protein which indicates that HCN contents decreases with the increase of crude protein. For example a negative correlation coefficient (r = -0.90) between the crude protein was found for the local sorghum cultivar (Figure 10)

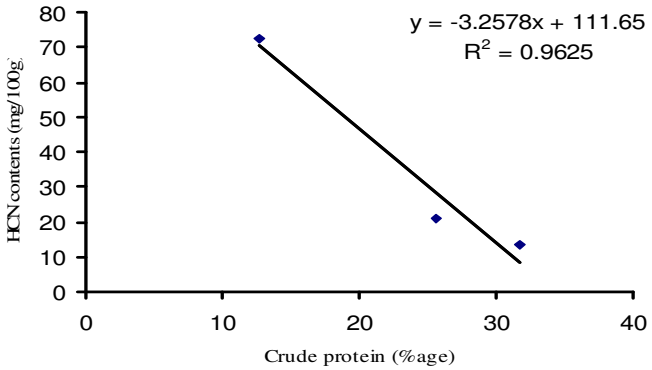


Figure 10. Relationship between HCN contents and crude protein for the local sorghum cultivar

Conclusion

The result of this applied nature study showed that at early stage of plant growth, all the sorghum cultivars exhibited more HCN contents than the lethal limit for animals. With the advancement of growth stage i.e. pre-booting and 50% heading stage, the HCN contents reduced to non toxic limit and thus the sorghum forage can be fed to animals safely on these stages. In post-cutting intervals, the study revealed that the HCN contents decreased as the interval increased at all growth stages. Post-cutting intervals although did not show significant affect on the HCN reduction. However, it was found that there is marked reduction in HCN contents after 12 hours of post cutting intervals. The results showed that farmers should avoid grazing at early stages of the sorghum forage and should feed after pre-booting stage and detailed results will be presented in the conference.

2.4 Summer crops at irrigated sites

2.4.1 Introducing improved varieties, legume-cereal mixes and improved agronomic practices for summer crops

Summer crops 2008

Methodology

During July-August 2008 (summer) fifteen farmers having an area of one acre with each were selected from both the villages i.e. 74/SB and 105/SB and were provided seed of improved fodder crop varieties such as sorghum, pearl millet, maize and cowpeas for planting as pure as well as in cereal-legume mixture combinations. The total area in each village for green fodder production was 15 acres along with 5 farmers in each village were kept as control with an area of almost fifteen acres. 5 farmers and 5 acres in each treatment, T1-T3 = improved varieties (15 farmers). The following treatments as pure stand as well as in mixtures were studied.

Treatments	Crops
T1	Sorghum + Pearl millet + Maize + Cowpeas
T2	Sorghum+ Pearl millet
T3	Maize alone
T4	Sorghum local

Results

Table 84. Germination, plant height and green fodder yield under different treatments in Chaka No. 105/SB

Treatments	Crop	Germination (%)	Plant height (cm)	GFY (t ha-1) Chaka 105/SB
T1	Sorghum + Pearl millet + Maize + Cowpeas	92	272+235+182+116	104
T2	Sorghum + Pearl millet	90	282+238	78
T3	Maize alone	91	182	72
T4	Sorghum (farmer's variety and farming practice)	86	132	52

The germination ranged from 86-92 % and plant height from 132 cm–282 cm in sorghum, 235-238 cm in pearl millet, 182 cm in maize plots and 116 cm in cowpeas crop (Table 84). The highest green fodder yield of 104 t/ha was obtained from plot sown with a mixture of sorghum + millet + maize + cowpea followed by sorghum + pearl millet (78 t/ha). The lowest yield of 52 t/ha was obtained from T4 (farmer's variety and farmer's practice). The yields of mixed cropping were higher than sole crops. The better crop establishment and plant height attained in mixtures attributed towards high green fodder yields which could be the result of nitrogen fixation from the air by legume crop i.e. cowpea and benefiting the companion crops.

Table 85. Germination, plant height and green fodder yield under different treatments in Chaka No. 74/SB

Treatments	Crop	Germination %	Plant height cm	GFY (t ha^{-1})
T1	Sorghum + pearl millet + maize + cowpeas	87	267 +225 +174 +95	92
T2	Sorghum + pearl millet	90	277 + 257	74
T3	Maize alone	85	196	66
T4	Sorghum (farmer's variety and farming practice)	80	132	42

The germination ranged from 80-90% while the plant height ranged from 132 cm–277 cm in case of sorghum, 225-257cm in Pearl millet, 196 cm in maize and 95 cm in cowpea crop (Table 85). The highest green fodder yield of 92 t/ha was obtained from plot sown with a mixture of sorghum + millet + maize + cowpeas followed by sorghum + pearl millet mixture i.e. 74 t/ha. The lowest yield of 42 t/ha was obtained from the check i.e. farmer's sorghum variety and production technology being followed by the farming community in the area. It has been observed that mixture produced higher yield than pure crop stand which could be the result of nitrogen fixation of legume crop and benefiting the companion cereal crops. The good crop establishment and plant height achieved attributed towards high biomass of fodder crops.

Table 86. Green fodder yield at Chaka No. 74/SB and 105/SB

Treatments	Crop	Chaka 74/SB GFY (t ha^{-1})	Chaka 105/SB GFY (t ha^{-1})	Av. Of both villages GFY(t ha^{-1})
T1	Sorghum + pearl millet + maize + cowpeas	92	104	98
T2	Sorghum + pearl millet	74	78	76
T3	Maize alone	66	72	69
T4	Sorghum (farmer's variety and farming practice)	42	52	47

When considering the average of both the villages it revealed that the highest green fodder yield of 98 t/ha was obtained from plot sown with a mixture of sorghum + millet + maize +cowpeas followed by sorghum + pearl millet (76 t/ha) (Table 86). This indicates that mixture of cereal and legumes produced 29 % higher yield than by only mixing the cereals. The lowest yield of 47 t/ha was obtained from farmer's sorghum variety and farmer's practice. The yields of mixed cropping were higher than sole crops. The good germination and plant height attributed towards high green fodder yields.

Conclusions

This indicates that mixture of cereal and legumes produced 29 % higher yield than by only mixing the cereals. The lowest yield of 47 t/ha was obtained from farmer's sorghum variety and farmer's practice. The yields of mixed cropping were higher than sole crops. The good germination and plant height attributed towards high green fodder yields.

Summer crops in 2009

During summer 2009 improved varieties of Sorghum, Pearl Millet, and maize and mixes with cowpeas were sown on an area of 15 acres (6.07 ha) in each village with 20 farmers in Chak no. 74/SB and 15 acres in Chak no.105/SB (Table 87).

Table 87. Green Fodder Yield under various treatments Chaka No. 74/SB and 105/SB

Treatments	Crop	Chaka 74/SB GFY (t ha^{-1})	Chaka 105/SB GFY (t ha^{-1})	Av. both villages GFY (t ha^{-1})
T1	Sorghum + pearl millet + maize + cowpeas	75	88	81.5
T2	Sorghum +Maize + cowpeas	62	67	64.5
T3	Sorghum	58	60	59
T4	Pearl millet	55	57	56
T5	Maize	42	48	45
T6	Sorghum (farmer's variety and farming practice)	31	34	32.5

The data on green fodder yield of improved varieties of sorghum, pearl millet and maize sole and in mixture was recorded and compared with local varieties sole and mixture. The data revealed that the mixture of sorghum +pearl millet+ Maize+ Cowpeas gave the highest green fodder yield of 88 t/ha followed by Sorghum+ Maize+ Cow peas (improved varieties mixed), Sorghum, Maize and Cow peas sole (Improved varieties) and local varieties with green fodder

yield of 67, 60, 57, 48 and 34 t/ha respectively in chak No. 105/SB.The green fodder yields of the improved sorghum variety was higher than the local varieties.

Similarly in chak No74/SB the green fodder yield data showed that the mixture of sorghum +pearl millet+ Maize and Cowpeas gave the highest green fodder yield of 75 t/ha followed by Sorghum+ Maize+ Cow peas (improved varieties mixed), Sorghum, Maize and Cow peas sole (Improved varieties) Sorghum, Maize and Cow peas sole (Improved varieties) and local varieties with green fodder yield of 62, 58, 55, 42 and 31 t/ha respectively. The green fodder yields of improved varieties were higher than local varieties at farmer's fields.

While studying the average of both the villages the data revealed that the mixture of sorghum +pearl millet+ Maize+ Cowpeas gave the highest green fodder yield of 81.5 t/ha followed by Sorghum+ Maize+ Cow peas (improved varieties mixed), Sorghum, Maize and Cow peas sole (Improved varieties) and local varieties with green fodder yield of 64.5, 59, 56, 45 and 32.5 t/ha respectively in both the villages The green fodder yields of improved varieties were higher than local varieties at farmer's fields.

Conclusions

This indicates that mixture of cereal and legumes produced higher yield than by only sole cereals or sole legumes. The lowest yield was obtained from farmer's sorghum variety and farmer's practice. The yields of mixed cropping were higher than sole crops. The good germination and plant height attributed towards high green fodder yields.

Pure stand of improved sorghum variety JS 2002

Millet pure stand

Sorghum in pure stand at heading stage

Cow pea in pure stand

2.5 Introducing village based seed production of improved winter and summer fodder crop / varieties.

2.5.1 Rainfed site

Research Method

Introduction of improved seed was very much appreciated by the livestock community and showed interest to produce the seed at their own farms as they have certain the limitation to visit the research organizations for the purpose of seed. In view of the keen interested of the farmers, five community farmers in winter 2008-09 and seven in summer 2009 were selected to produce seed of improved fodder crop in the project area for sustainable production of fodder seed enterprises. The activity was started with the view that farmers himself will use the seed of improved varieties and the surplus seed will be sold to the neighboring farmers of the area.

Results and Discussion

The area planted under each crop and seed produced are given in the following Table 88 and 89.

Table 88. Community based oats seed production during winter 08-09

S. #	Name of farmer	Area planted Kanal - Marlas	Qty. of seed (kg)
1	Waseem Razzaq	2 - 14	345
2	Javed	5 - 00	559
3	Khurram Manzoor	1 - 06	230
4	Liaqat	3 - 00	253
5	Zahid Ghaus	1 - 10	161
	Total	**13 - 10**	**1548**

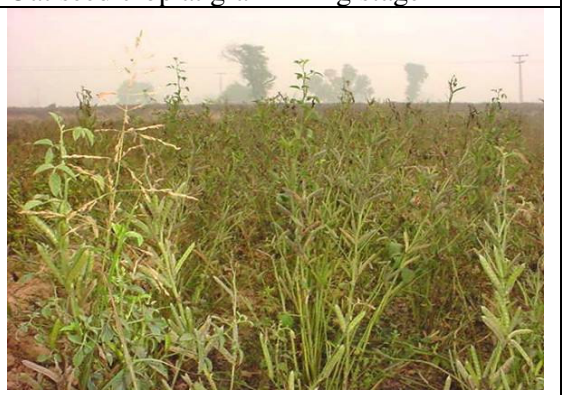
Table 89. Community seed production of summers (sorghum, millet and guar) fodder crops during the crop growth season 08-09

S. #	Name of farmer	Sorghum		Millet		Guar	
		Area (K)	Seed (kg)	Area (K)	Seed (kg)	Area (K)	Seed (kg)
1	Taj	1	36			1	13
2	Amjad	1	44	1	9		
3	Saqib Karim	1	20				
4	Khurram Pervez	2	61	2	18	2	26
5	Javed	2	40	2	6	8	40
6	Amir Zaman	2	78			2	56
7	Nazir	1	36			1	16
	Total	10	215 (7f)	5	33 (3f)	14	151 (5f)

Improved fodder varieties seed production was introduced and encouraged for sustainable fodder production in the project area. One thousand five hundred and fifty (1550) kg seed of improved oats variety 'PD_2-LV_{65}' and 450 kg of summer cereal (sorghum, millet) and legume (guar) was produced during the year 2009. The maize seed of 165 kg was produced by master Lal. Hussain on his farm from an area of two kanals.

Conclusion

The farmers of the area started to produce improved fodder crops varieties seed which certainly not only ensured the local availability of improved quality of fodder seeds to the project villagers but also to the surrounding village farmers. This will helpful to develop the healthy livestock industry in the area to fulfill the domestic and urgent needs of the rural based livestock farmers of the area.

Maize variety S-2000 for seed production	Farmers/ scientists/Site facilitator observing the seed crop
Oat seed crop.	Oat seed crop at grain filling stage
	
Oat seed crop at maturity	Guar seed crop

Scientist observing the millet seed crop	Millet crop

2.5.2 Irrigated Site

Methodology

During winter 2007, four farmers having an area of one acre with each in both villages i.e. 74/SB and 105/SB were selected and provided seed of improved fodder crop varieties such as berseem and oats for seed multiplication. The objective was to produce the seed of improved fodder crop / varieties at the farmer's field for sustainable seed production and its availability. Total four acres in each village were sown for the purpose.

Results and Discussions for Year 2007

Table 90. Seed Produced on Farmer's Field at Chak No.74/SB and Chak No.105/SB

S. No.	Crop	Chak No.74/SB	Chak No.105/SB	Av. Both villages Seed yield/ acre (kg)
		Seed yield/ acre (kg)	Seed yield/ acre (kg)	
1	Berseem	160	220	190
2	Oats	1100	1300	1200

The results of seed produced showed that 190 kg/ acre berseem seed and 1200 kg / acre oats seed was produced in Chak No. 74/SB and Chak No.105/SB, which were sufficient to sow an area of 126 and 150 acres of berseem and oats respectively in coming season (Table 90).

Table 91. Income from oat and berseem seed crop at Chak No.74/SB and Chak No.105/SB.

S. No	Crop	Rate/kg (Rs)	Av.Seed Yield / acre (Rs)	Av.Income/acre (Rs)	Exp/acre (Rs)	Net income (Rs)
B	Berseem	100/-	469 kg	46900/- (seed) 65208/-(fodder)	17043/-	95065/-
2	Oats	25/-	2717 kgs	67925/-	18440/-	49485/-

The results showed that net income received from berseem seed production was Rs 95065/- acre and Rs 49485/- from oats seed at both the villages (Table 91).

Results and Discussions for Year 2008

Table 92. Seed Produced on Farmer's Field at Chak No.74/SB and Chak No.105/SB

S. No.	Crop	Chak No.74/SB	Chak No.105/SB	Av. Both villages Seed yield/ acre (kg)
		Seed yield/ acre (kg)	Seed yield/ acre (kg)	
1	Berseem	160	220	190
2	Oats	1100	1300	1200

The results of seed produced showed that 190 kg/ acre berseem seed and 1200 kg / acre oats seed was produced in Chak No. 74/SB and Chak No.105/SB. which were sufficient to sow an area of 126 and 150 acres of berseem and oats respectively in coming season (Table 92).

Table 93. Income from oat and berseem seed crop at Chak No.74/SB and Chak No.105/SB.

S. No	Crop	Rate/kg (Rs)	Av.Seed Yield / acre (Rs)	Av.Income/acre (Rs)	Exp/acre (Rs)	Av. Net income (Rs)
B	Berseem	100/-	469 kg	46900/- (seed) 65208/-(fodder)	17043/-	95065/-
2	Oats	25/-	2717 kgs	67925/-	18440/-	49485/-

The results showed that net income received from berseem seed production was Rs 95065/- acre and Rs 49485/- from oats seed at both the villages (Table 93).

Results and Discussions for Year 2009

Table 94. Fodder seed produced at Chak No.74/SB and Chak No.105/SB

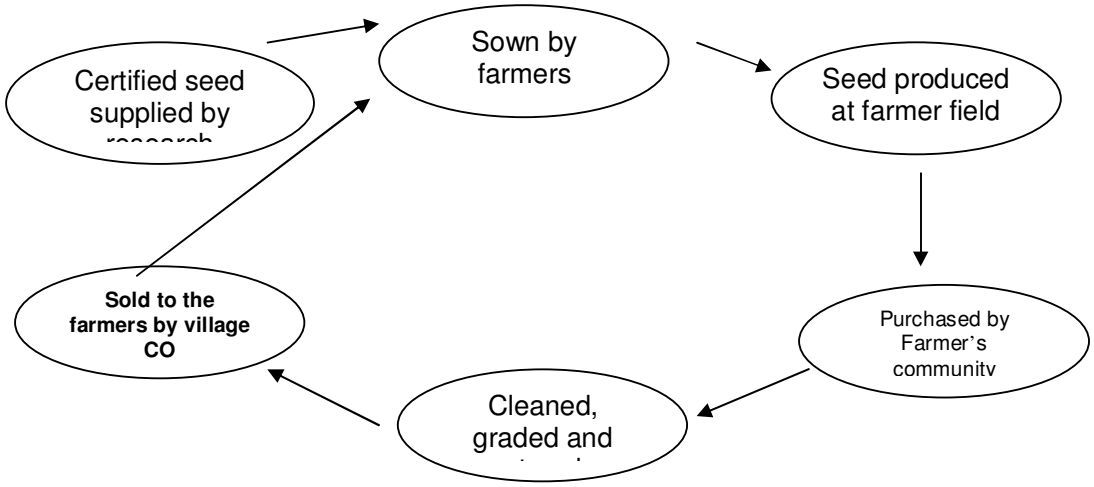
S. No.	Crop	Chak No.74/SB	Chak No.105/SB	Av. Both villages Seed yield/ acre (kg)
		Seed yield/ acre (kg)	Seed yield/ acre (kg)	
1	Berseem	92	122	107
2	Oats	845	765	805

The results of seed produced showed that 107 kg/ acre berseem seed and 805 kg / acre oats seed was produced in Chak No. 74/SB and Chak No.105/SB (Table 94).

Proposed STRATIGIES FOR SUSTAINABLE SEED PRODUCTION

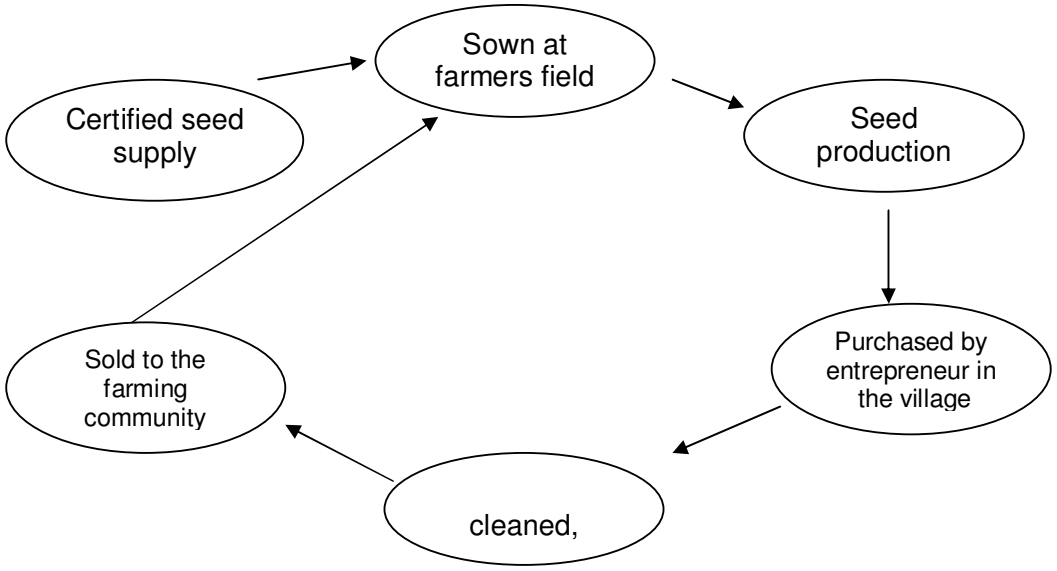
Strategy1

THROUGH FARMERS COMMUNITY ORGANIZATIONS



Strategy2

THROUGH LOCAL ENTREPRENEURS



The model evaluated at village level showed success in berseem, oats, maize and cowpeas whereas in case of sorghum variety was not good for seed production whereas in pearl millet birds were the main constraint. The association members performed well in seed purchase and redistribution rather than any middle man investor.

The results of seed produced showed that berseem seed and oats seed produced in Chak No. 74/SB was sufficient for sowing berseem and oats in coming season.

2.6 Introducing green fodder selling enterprises

2.6.1 Rainfed site using dug-well irrigation

Background

With the increasing demand of milk in the big cities, the livestock farmers shift their animals near the cities but face great problem to fulfill the animal feed requirement. They usually buy wheat straw, green fodder and concentrate from the central and southern Punjab i.e. irrigated areas. The fodder selling is becoming a commercial activity near the big cities. Therefore, in the project an effort is made to demonstrate the farmers having irrigation facilities to produce fodder at their farms in greater area and sell it in the market to earn more money. The below pictures show the green fodder selling activities at Gujar khan, Rawalpindi road which is 25 km from the project village.

2.6.1.1 Winter season in 2009

Material and Method

During RRA, it was found that there are twenty dug wells in the project area which provide irrigation water to about 40 acres land. The fodder selling enterprise was started with the background to raise the income of the rural farmers and to get the benefit from the local market of Rawalpindi and Gujar Khan where most of the fodder is fetched from the irrigated area of the province to fulfill the livestock demand in the urban areas. Therefore, under fodder selling enterprise typology fodder crops were grown with three farmers for market purposes at pilot basis and the result presented here calculated at one acre basis.

Results and Discussion

Detail of the cost of oats fodder production is given in Table 95. It was found that spending Rs 24,000 as input cost on fodder oat crop under irrigated conditions of Lodhy, a farmer can earn a net income of Rs 56,000 per acre.

Table 95. Cost of production of oats grown on one acre under irrigated conditions of village Lodhy, Tehsil Gujar khan, district Rawalpindi.

S. No.	Production Technology	Cost (Rs.)
1.	Land rent (one acre)	10000
2.	Land preparation	1600
3.	Farm Yard Manure	4000
4.	Fertilizer (single super phosphate 3 bags)	1500
5.	Fertilizer (urea 2 bags)	1100
6.	Irrigation (1^{st})	2000
7.	Irrigation (2^{nd}, 3^{rd}, 4^{th})	3000
8.	Labour	800
Total		24000
Crop was sold for Rs. 80000		
Net Income Rs. 56000		

2.6.1.2 Summer season 2009

Methodology

The feasibility and profitability of spring maize fodder selling enterprises was tested at the farm of Mr. Nazakat with improved agronomic practices which the farmers were explained before the start of crop sown. Maize cv. Sargodha 2002 was sown during spring 2009 in first week of March. Gujjar Khan and Rawalpindi markets were compared with the selling of maize fodder during May, 2009. The green fodder yield tonnage, gross benefit, cost of fodder production, net benefit and price of green fodder per 40 kg under 3 selling markets were recorded. Harvesting was carried out in the third week of May 2009 for Gujar Khan and Rawalpindi markets.

Results and Discussion

Cost of Production/11 Kanal Area:

Rent of land for 11 kanals area @ Rs. 450/-_____Rs. 4950/-
Cultivation charges 3 @ Rs. 900/- _____Rs. 2700/-
Fertilizer 2 bags urea @ Rs. 1000/-_____Rs. 2000/-
FYM 1 ½ Trolleys @ Rs. 1500/- _____Rs. 2250/-

Seed 55 kg @ Rs. 25/- _____Rs. 1375/
Sowing Drill Charges _____Rs. 1000/-
Irrigations 4 @ Rs. 400/- _____Rs. 1600/-
Total _____Rs. 15875/-
Per kanal cost of production (COP) (15875/11) _____Rs.1443/-

Table 96. Comparison of local maize fodder selling with nearest markets and cost benefit to the farmers of the project area at rainfed site.

S. #	Particulars	Local selling	Gujjar Khan	Rawalpindi
1	Green fodder yield/kanal (in Mds.)	77	77	77
2	Selling rate/md (in Rs.)	-	80	110
3	**Gross income/kanal (in Rs.)**	**4500**	**6160**	**8470**
4	Labor (L) cost for fodder cutting/kanal (in Rs.)	-	940	940
5	Transportation (T) charges/kanal (in Rs.)	-	1560	3000
6	L + T Cost (4+5) (in Rs.)	-	2500	3940
7	Gross Benefit/kanal (3-6) (in Rs.)	4500	3660	4530
8	COP/kanal (in Rs.)	1443	1443	1443
9	Net Benefit/kanal (7-8) (in Rs.)	3057	2217	3087
10	Net Benefit/acre (in Rs.)	24456	17736	24696

It was found that maximum net benefit (Rs. 24696) was recorded when the fodder was sold in Rawalpindi market (Table 96). It was followed by local selling under which net benefit of Rs. 24456/- was received. The lowest net benefits of Rs. 17336/- was recorded under selling of fodder in Gujjar Khan Market.

Conclusion
In winter oats fodder selling was found better option than other crops. In summer, maize fodder selling in Rawalpindi market was found most suitable because of vacation of land 3-4 weeks earlier than the local selling.

2.6.2 Irrigated site

Green fodder obtained from different treatments was sold to the nearest town market and within the village to the livestock holders. The detail of the green fodder selling enterprise is given below in the Table 97

Table 97. Cost benefit from sale of green fodder at Chak No. 74/SB and Chak No. 105/SB in Town Market

Treatment	Crops	Total expend./ ha	Av. GFY (t/ha)	Av. Gross Income/ha	Av. Net Income
T1	Berseem	31369	171	128325	96956

T2	Oats	30875	102	76350	45475
T3	Berseem + Oats	29887	222	166500	136613
T4	Berseem local	22675	99	740625	717950
T5	Oats local	30875	68	51112	20237

The data of net income from the sale of green fodder from Chak No. 74/SB and Chak No. 105/SB revealed that the maximum income was received from berseem + oats mixture (136613/-) followed by improved berseem variety (96956/-) per hectare whereas the lowest income of 20237/- was obtained from the sale of local oats.

Table 98. Cost benefit from sale of green fodder at Chak No. 74/SB. and Chak No. 105/SB under Livestock holders

Trt.	Crops	Total expenditure/ ha	Sale Rate/ Kanal	Gross Income/ha	Net Income/ ha
T1	Berseem	17043	3300	65208	48165
T2	Oats	17043	1900	37544	20501
T3	Berseem+ Oats	17537	3550	70148	52611
T4	Berseem local	12795	1800	35568	22773
T5	Oats local	17043	1000	19760	2717

The green fodder was also sold to livestock holders of the village (Chak No. 74/SB) and Chak No. 105/SB rates were fixed on per canal (0.05 ha) bases. By selling the fodder to the neighbor farmers, cutting, loading and transportation charges were saved but in this practice, fodder selling fetches lower income than by selling in the market. The data showed that the maximum net income (52611) was received from oats + berseem mixed crop followed by berseem improved variety (48165; Table 98). The minimum income was received from the sale of local oats.

The income earned from the sale of green fodder in the town market was much higher as compare to sale in the village. However, farmer prefer to sell the fodder to the neighboring livestock producers because of lack of facilities and to avoid the botheration of cutting, loading and transportation etc.

2.7 Introducing hay making to conserve forages for lean periods

Hay is very good feed insurance for lean period. Usually, the green forage and pasture crops are dried enough to permit their safe storage without spoilage or serious loss of nutrients. About 80 to 90 percent of water present in standing crop at mowing is condensed to 20 percent by sun and wind without adversely affecting nutritive value and protecting from bacteria and fungi. Therefore it allows for sustained livestock production. It provides a good reserve stalk during drought and inclement weather conditions that often prevails in drought prone areas. During lean period, near Rawalpindi and Islamabad, it has become a big business that the people start wheat straw, rice straw and concentrates activities as they earn more from this business. The livestock owner near the cities have no alternate to buy the costly feed for their animals. From the pictures below, it is quite clear that the different shop keeper get

involved in animals feed enterprises. Therefore, in project effort is made to train the farmers to make nutritious hay for their animal during the fodder scarcity period and safe themselves from the seasonal middleman to purchase the poor nutritious wheat straw.

2.7.1 Rainfed site: Hay-making in the summer cropping season

Research method

During summer 2009, summer cereal fodders alone and mixtures of sorghum + guar, millet + guar and maize + guar were planted at fifty eight farmers fields of Gujjar Khan for fodder yield estimation. Thirty three farmers produced hay for feeding during lean fodder period of December-January. The crop was harvested at early to mid-flowering stage on the moisture contents between 70-90% in the month of October 2009. The harvested material was dried in the sun light reducing moisture contents between 18-20% with the following indications: 1) hay rustles readily; 2) leaves shatter; 3) nodes or joints shrivel; 4) the bark on the stem cannot be lifted with fingernail.

Results and discussion

The following farmers participated in haymaking activity in the project area. The area planted by each farmer for hay making from summer fodder mixtures is written against their names Table 99.

Table 99. Area sown (kanals) for hay production by different farmers at rainfed site during summer season

S. #	Farmer's Name	Area sown		S. #	Farmer's Name	Area sown	
		Sorghum + Guar	Millet + Guar			Sorghum + Guar	Millet + Guar
1	Abdul Rauf	4.5	2	27	Khurram Pervez	4	4
2	M. Hanif	4.5	2	28	Yasar Manzoor	2	2
3	Liaqat Ali	4.5	2	29	Sakhawat Hussain	2	2
4	Taj	4.5	2	30	Ulfat/Zubda	-	2
5	Nazakat	2.5	1	31	Rafiq	4	2
6	K. Manzoor	4.5	4	32	Javed	8	8
7	Waseem/Aadal	1.5	1	33	Qamar	2	2
8	Ajmal Nawaz	4.5	2	34	Jahanjir	4	2
9	Arshad	4.5	6	35	Adalat	2	2
10	Amjad Ali	4.5	1.5	36	Zubair	2	2
11	Saqib Karim	4.5	1	37	Raheel	2	2
12	Zubair/Safeer	4.5	2.5	38	Anwar Sadat	2	2
13	Aamar Hussain	2	1	39	Qaisar	4	2
14	Awais Ali	2	4	40	Ghazanfar Ali	2	2
15	Imtiaz	2	2	41	Liaqat Khan	4	2
16	Ali Khan	-	2	42	Nazakat Hussain	2	2
17	Shahid Riyasat	4	2	43	Nazir	2	2
18	M. Banaras	2	2	44	Amir Afzal	2	2
19	Sher Zaman	2	2	45	Mazhar	2	2
20	Hasnain	2	2	46	Azmat	2	2
21	Sheraz	2	2	47	Mir Zaman	2	2

22	Sadaq	4	2	48	M. Riaz	2	2
23	Aamar Sajjad	4	4	49	M. Idrees	2	2
24	Waseem Razzaq	2	2		**Total area**	**144**	**114**
25	Zahid Ghaus	4	4		**Total farmer**	**47**	**49**
26	Irfan Ali	2	2				

Out of 49 farmers, the largest quantity of hay (1320 kg) was produced by Mr Khurram Manzoor from sorghum + guar and millet + guar mixture during summer 2009. Twenty nine farmers made hay 600 to 900 kg each and 03 farmers made hay >200 kg each.

Conclusion

The farmers took a high interest in making hay: as indicated above the majority of the farmers produced more than 600 kg hay each which helped them in minimizing the feed shortage in the lean period.

2.7.2 Irrigated Sites

2.7.2.1 Year 2008

Methodology

Hay making activity was carried out with seven farmers with an area of 16 canal (0.81 ha) of Berseem and 18 kanals (0.91 ha) of Oats at Chaka no.74/SB while at Chaka no.105/SB, this activity carried out with six farmers having an area of 9 canal (0.46 ha) of berseem and 12 kanals (0.61 ha) of oats.

Results and Discussion

The results recorded during the course of study are given below in Table 100.

Table 100. Hay making of oat and berseem at different Farmer's Field at Chaka No.74/SB and Chaka No.105/SB

S. No	Crop	Area harvested (Kanals)	Av.Green fodder yield		Hay yield (ton)
			Yield (t/ha)	Total yield (ton)	
1	Berseem	10	166	160	32
2	Berseem	8	173	136	26
3	Berseem	7	183	134	26
4	Oats	12	75	88	25
5	Oats	9	91	77	23
6	Oats	6	83	46	14
7	Oats	3	90	34	9

The results of hay activity revealed that out of 430 ton green fodder of berseem 84 ton hay was produce and in case of oats, 71 ton of hay was produced from 245 ton green fodder at Chakno74/SB and Chak No. 105/SB 20

Table 101. Quality of berseem and oats fodder under different harvesting stages

Crop	Crop Stage	DM	percent of dry matter				
			CP	EE	CF	ASHES	NFE
Berseem	Berseem (early Vegetative)	11.60	23.70	5.09	21.85	13.64	35.63
	Berseem (Early Bloom)	15.17	19.20	4.14	22.67	12.83	11.16
	Berseem (Full Bloom)	22.65	16.09	3.21	33.85	10.94	35.91
	Berseem (Late cut)	30.50	13.54	2.94	36.78	8.92	37.82
Oats	Oats (Early Bloom)	14.36	12.10	2.93	22.89	13.31	48.77
	Oats (Full Bloom)	20.46	8.25	2.58	24.13	10.43	54.61
	Oats (Milk Stage)	29.20	5.36	2.48	27.51	11.27	53.38

2.7.2.2 Year 2009

Assessment for green fodder yield and hay yield/ hay making was carried out at Chak No.74/SB and 105/SB. The fodder hay trial was sown at 10 acres with 10 farmers at Chak No. 74/SB and 10 acres with 12 farmers at Chak No. 105/SB using two treatments berseem sole and oats sole. The green fodder was harvested in berseem crop in 5 cuts up to full bloom and hay was made in field conditions where as hay from oat crop was made at blooming. The samples were collected and analyzed to test quality of hay at different stages. The results are presented in Tables 102 to 105.

Table 102. Hay production from berseem crop at farmer field at Chak No. 74/SB AND Chak No. 105/SB.

S No.	Crop	Chak No. 74/SB and Chak No.105/SB				
		No of farmers	Average GFY (t)	Average GFY (t/ha)	Average hay yield (t)	Average hay (t/ha)
1	Berseem	20	53	106	11.28	22.55

Table 103. Quality analysis of Berseem Crop at different Growth Stages.

S. No.	Crop	Crop stage	DM %	……..Percent of Dry Matter……				
				CP%	EE %	CF %	CA %	NFE %
1	Berseem	Early Vegetative	11.60	23.7	5.09	21.85	13.64	35.63
2		Early Bloom	15.17	19.2	4.14	22.67	12.83	11.16
3		Full Bloom	22.65	16.09	3.21	33.85	10.94	35.91
4		Late cut	30.5	13.54	2.94	36.78	8.92	37.82

Table 104. Hay production from oats crop at farmer field at Chak No. 74/SB and Chak No.105/SB.

S. No.	Crop	Chak No. 74/SB				
		No of farmers	Average GFY (t)	Average GFY (t/ha)	Average hay yield (t)	Average hay (t/ha)
1	Oats	20	36	72	8.80	17.60

Table 105. Quality analysis of oats Crop at different Growth Stages.

S.No.	Crop	Crop stage	DM %	Percent of Dry Matter				
				CP%	EE %	CF %	CA %	NFE %
1	Oats	Early Bloom	14.36	12.1	2.93	22.89	13.31	48.77
2		Full Bloom	20.46	8.25	2.58	24.13	10.43	54.61
3		Milk Stage	29.2	5.36	2.48	27.51	11.27	53.38

Assessment for green fodder yield and hay yield/ hay making was carried out at Chak no.74/SB and 105/SB. The fodder hay trial was sown at 20 acres with 20 farmers at chak No. 74/SB and chak No. 105/SB using two treatments berseem sole and oats sole. The green fodder was harvested in berseem crop in 5 cuts up to full bloom and hay was made in field conditions where as hay from oat crop was made at blooming. The samples were collected and analyzed to test quality of hay at different stages. The results revealed are presented in Tables 106 to 113.

Table 106. Hay production from sorghum crop at farmer field at Chak No. 74/SB and Chak No.105/SB.

S No.	Crop	Chak No. 74/SB and Chak No.105/SB.			
		Average GFY (t)	Average GFY (t/ha)	Average hay yield (t)	Average hay (t/ha)
1	Sorghum	53	106	11.28	22.55

Table 107. Quality analysis of sorghum crop at different growth stages.

S.No.	Crop	Crop stage	DM %	Percent of Dry Matter				
				CP%	EE %	CF %	CA %	NFE %
1	Sorghum	Full Bloom	17.70	9.05	3.40	41.70	11.95	33.90
2		Early Bloom	20.78	7.77	2.21	36.86	10.10	43.08
3		Milk Stage	28.40	5.96	2.39	31.89	10.95	48.81

Table 108. Quality analysis of Sorghum-sudan grass hybrid (Sadabahar) crop at different growth stages.

S.No.	Crop	Crop stage	DM %	Percent of Dry Matter				
				CP%	EE %	CF %	CA %	NFE %
1	Sadabahar	Full Bloom	14.70	12.20	2.49	25.70	7.57	52.04
2		Early Bloom	15.40	9.44	2.94	33.21	11.50	42.91
3		Milk Stage	21.45	8.94	1.92	35.34	7.10	46.70
4			37.80	5.30	1.72	38.33	8.59	46.06

Table 109. Hay production from oats crop at farmer field at Chak No. 74/SB and Chak No. 105/SB

S No.	Crop	Chak No. 74/SB and Chak No. 105/SB			
		Average GFY (t)	Average GFY (t/ha)	Average hay yield (t)	Average hay (t/ha)
1	Maize	36	72	8.80	17.60

Table110. Quality analysis of Maize Crop at different Growth Stages.

S.No.	Crop	Crop stage	DM %	Percent of Dry Matter				
				CP%	EE %	CF %	CA %	NFE %
1	Maize	Full Bloom	16.07	11.42	1.92	36.89	8.92	40.85
2		(Milk Stage)	20.40	9.46	2.39	32.10	6.41	49.64
3		(Late Cut)	29.30	7.76	2.14	30.53	7.51	52.06

Table 111. Hay production from Pearl millet crop at farmer field at Chak No. 74/SB

S No.	Crop	Chak No. 74/SB and Chak No. 105/SB				
		No of farmers	Average GFY (t)	Average GFY (t/ha)	Average hay yield (t)	Average GFY (t/ha)
1	Pearl millet		37	74	9.25	18.50

Table 112. Hay production from Cowpeas crop at farmer field at Chak No. 74/SB

S No.	Crop	Chak No. 74/SB and Chak No. 105/SB				
		No of farmers	Average GFY (t)	Average GFY (t/ha)	Average hay yield (t)	Average GFY (t/ha)
1	Cowpeas		37	74	9.25	18.50

Table 113. Quality analysis of Cowpeas Crop at different Growth Stages.

S.No.	Crop	Crop stage	DM %	Percent of Dry Matter				
				CP%	EE %	CF %	CA %	NFE %
1	Cow peas	Early Bloom	15.07	16.88	2.65	22.12	13.05	15.30
2		Full Bloom	23.00	12.50	1.74	34.66	12.53	38.55

.

Conclusions

The oat crop produced higher %age of hay compared to berseem crop which indicates that berseem fodder holds higher %age of water in it. The sorghum, pearl millet maize and cowpeas are good for hay making. At farmer level hay for the harvesting of maximum nutrition proper stage must be kept in view.

Farmers at rainfed site are busy storing the oat hay at the roof of their house	Sorghum hay at rainfed site
Review mission visiting the hay at rainfed site	A view of Maize and Guar hay
Oat hay at irrigated site	Review mission observing oat hay at irrigated site

2.8 Introducing irrigated multi-cut hybrids for lean periods

2.8.1 Year 2008

Methodology

December, January in winter and May, June in summer are considered lean fodder months during the year round. To address the problem of summer lean period, three fodder crops Maize, Sorghum-Sudan grass hybrid, Mott grass and sorghum local variety as check were sown during the month of March with ten farmers selected each in village 74/SB and 105/SB, to evaluate the performance of these forage crops under irrigated conditions of Sargodha. The following treatments of fodder crops were studied.

Treatments	Crops
T1	Improved Maize crop variety
T2	Improved sorghum-sudan grass hybrid variety
T3	Improved Mott grass variety
T4	Local sorghum variety

Results and Discussion

The data regarding green fodder yield per hectare recorded from different test crops sown for lean period is given below in Table 114.

Table 114. Germination and Green fodder yields of summer fodder crops at both the project sites.

Trt.	Crop	ChakNo.74/SB		ChakNo.105/SB		Average	
		Germina-tion (%)	GFY (t/ha)	Germina-tion (%)	GFY (t/ha)	Germina-tion (%)	GFY (t/ha)
T1	Maize	85.25	72	78.35	62	81.8	67
T2	S-S hybrid	88.24	85	65.25	74	76.75	79.5
T3	Mott grass	86.63	125	84.65	141	85.64	133
T4	Local Sorghum	84.22	35	77.15	28.0	80.69	31.5

The data regarding green fodder yield showed that Mott grass gave higher tonnage (125 t/ha) during the lean period followed by S-S hybrid with 85 t/ha. The lowest green fodder yield i.e. 35 t/ha was produced in case of sorghum local at Chaka 74/SB. In Chaka No. 105/SB, the highest green fodder yield was obtained from Mott grass (141 t/ha) followed by S-S hybrid (74 t/ha) and the lowest yield was recorded in sorghum local variety i.e. 28 t/ha.

Conclusions

The maize crop and sorghum produced single cut whereas Mott grass and S-S hybrid gave multi cuts and thus produced higher yield than the single cut crops. It is worth to note that the data recorded for comparison of green fodder yield is for the same period of time i.e. July to August. The monitory benefit received from different fodder crops is given in the Table.

2.8.2 Year 2009

Results

The data regarding green fodder yield per hectare recorded from different test crops sown for lean period is given below in the Table 115.

Table 115. Germination and Green fodder yields of summer fodder crops at both the project sites

Treatments	Crop	ChakNo.74/SB		ChakNo.105/SB		Average	
		Germination (%)	GFY (t/ha)	Germination (%)	GFY (t/ha)	Germination (%)	GFY (t/ha)
T1	Maize	85.25	72	78.35	62	81.8	67
T2	S-S hybrid	88.24	85	65.25	74	76.75	79.5
T3	Mott grass	86.63	125	84.65	141	85.64	133
T4	Local Sorghum	84.22	35	77.15	28.0	80.69	31.5

The data regarding green fodder yield showed that Mott grass gave higher tonnage (125 t/ha) during the lean period followed by S-S hybrid with 85 t/ha. The lowest green fodder yield i.e. 35 t/ha was produced in case of sorghum local at Chaka 74/SB. In Chaka No. 105/SB, the highest green fodder yield was obtained from Mott grass (141 t/ha) followed by S-S hybrid (74 t/ha) and the lowest yield was recorded in sorghum local variety i.e. 28 t/ha.

Conclusion

The maize crop and sorghum produced single cut whereas Mott grass and S-S hybrid gave multi cuts and thus produced higher yield than the single cut crops. It is worth to note that the data recorded for comparison of green fodder yield is for the same period of time i.e. July to August.

Mot grass

Sorghum-sudan grass hybrid

3 Theme 3: Technical interventions improving livestock productivity

3.1 Rainfed site: Effect of improved feeding on milk production of cattle and buffalo

3.1.1 Background

Livestock is the most important sub-sector of Agriculture and contributes more than 50 percent of the agricultural value added and about 12 percent of the GDP. Under the rainfed conditions of farming, livestock are even more important because they act as insurance in case of crop failure due to drought in certain years.

Pakistan is the fourth largest producer of milk in the world. Cattle and buffaloes produce about 34 billion liters of milk per year from a total herd size of about 28 million dairy animals. Total meat production of Pakistan is about 2578 million tons. In livestock production, nutrition is of crucial importance, because 60 to 70 percent of expenditure of livestock raising is on nutrition only. There is roughly 50% deficiency of both energy and proteins in the feed for livestock in the country. This nutritional deficiency is increasing every day because number of animals is increasing and land available for fodder production, grazing, etc. is shrinking. To overcome this problem, we need to decrease the number of low producing animals, increase their productivity through better breeding, feeding, management, marketing and disease control. There is dire need to enhance the fodder production through improved management strategies and inputs to fullfil the basic need of the animals and to develop the livestock industry on sound footings. There is also need to improve fodder utilization as well as improve the concentrate formulation and utilization.

Cattle and buffaloes are mainly raised on green fodders and dry roughages. However, to get more production from low producing animals or to maintain the production of high producer animals, supplementation of fodders with concentrates has becomes essential. Majority of the farmers use conventional concentrates viz. cotton seed cake (CSC) and wheat bran (WB). However, in recent past commercial concentrates' use has been increasing, and these concentrates contain a variety of grains and industrial by-products, which make them more balanced as well as more economical.

Most of the roughages are fed under cut and carry system, which makes it impossible for the farmers to feed all the roughages at the best nutritional stage; because, generally as the roughages mature, their digestibility and nutritional value decreases proportionally. Dry roughages like wheat straw and stalks of sorghum, millet and maize are also very common feed for ruminants. These roughages are very high in crude fiber, low in nutrients and digestibility, and are not very palatable, resulting in low productivity of livestock. Normally cereals and grasses are the major roughages and trend of mixed growing of cereal plus legumes is not very common in Pakistan.

There are two lean periods of roughages during the year i.e. December-January and May-June. During these times low quality dry roughages like straws and stovers are the main feed for the livestock. In these lean periods, the health and productivity of animals is adversely affected. The custom of hay making is not common with small farmers. Fodder availability during the year round can be seen in 1re 10 below.

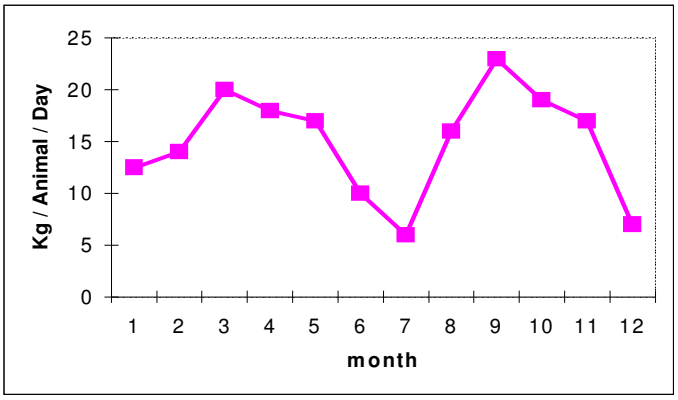


Figure 11. Feed availability in Pakistan (note the two 'lean' periods)

Keeping in view the above stated background, it was planned to improve the productivity of livestock through the introduction of high yielding cereal + legume fodder mixtures and the conversion of extra green fodders to hay during surplus months by cutting at the proper stage. The fodders harvested for hay purposes were properly cured, stored, and then fed to animals during the green fodder scarcity periods.

It was also planned to improve the quality of the concentrate by including some additional feed ingredients especially the agro-industrial by-products. It was also planned to demonstrate to the farmers the benefits of improved feeding by comparing the conventional feeding practices with the improved ones.

For the popularization of commercial concentrates with the farmers, installation of a small pilot feed mill was also planned.

There is lack of feedlot fattening practices in Pakistan. Most of the meat is obtained through traditional feeding practices, which results in low meat production per animal.

In this project we planned to see the possibility of feedlot fattening with the farmers, which was again based on improved roughage and concentrate supplementation in comparison with traditional feeding practices.

For getting the maximum benefits of these trials or demonstrations, training and knowledge enhancement of the livestock farmers is very important. Unless farmer is convinced and confident about the benefits o the new technology, he may not follow it with full spirit. For this purpose we planned formal and informal farmers' trainings for their knowledge and capacity enhancement. Keeping all in view, experiments were carried out with farmers during the course of project at rainfed site, Lodhy and their brief description is summarized below.

3.1.2 Experiment No. 1: Effect of feeding improved fodder and concentrates on milk and beef production of buffaloes and cattle

Materials and Methods

Following is the detail of various experiments/demonstrations undertaken at various times with various farmers.

First experiment/demonstration was undertaken in the months of December 2007 to February 2008 with buffaloes (60 days) of Nili-Ravi breed. In this experiment sorghum plus guar hay

was the improved fodder (treatment group), while wheat straw was the traditional fodder (control group). In the treatment group 14 lactating buffaloes of 10 farmers were used as experimental animals, while 10 buffaloes of the 5 farmers were in the control group. Daily roughage intake and milk produced was recorded by the farmer, while the site facilitator recorded the feed intake and milk production of each animal per week. Roughages were offered free choice, while the improved concentrate was offered at 1 kilogram concentrate for every 2 liters of milk produced. All the animals were weighed at the start and end of experiment to calculate weight gain or loss.

For growing forage for hay making, seeds of sorghum plus guar were supplied to the farmer after mixing both the seeds in a 50:50 ratio. The roughages were cut either at flowering stage or at the dough stage of the grain formation, and were sun-dried in the fields. The storage of the hay varied form farmer to farmer. Some farmers stored the baled hay under cover saving it from direct exposure of sun, rain, wind, etc; and hay was chaffed before offering to the animals. Some farmers stored the hay under the open sky and offered to the animals after chaffing every day. This type of hays lost some of the nutritional value, as well as minor fungal growth spots were also observed. Some farmers chaffed the whole hay and stored in sacks or in some room in chaffed form. Sowing of the sorghum plus guar for hay making was done in the traditional manner, and the crops were totally dependent on rain and no artificial irrigation was provided. All the participatory farmers were provided weighing balances for recording the weights of feeds offered, refused as well as milk produced. One big electronic weighing balance was provided to the whole village for weighing their animals (view the picture in capacity building section), and this weighing balance was maintained by site facilitator. The feed ingredients of both the traditional and improved concentrate were purchased locally and were provided to the treatment group of farmers free of charge. Farmers were told the ratios of different feed ingredients to be mixed and the level of their use. The control group farmers used their traditional concentrate, according to their own choices. The field prices of the feed ingredients were used in the economic analysis. The sale prices of the milk was used as Rupee 28 per liter (1 US$ = 80 Pak rupees) and the live weight gain price of the Rs. 82 per kilogram was used. The prices of feed ingredients (Rs/kg) were: wheat straw = 3.5, sorghum + guar hay = 1.75; treatment concentrate = 13.55; control concentrate = 15.22; Dicalcium phosphate (DCP) = 35.

While selecting the buffaloes for both treatment and control group, it was tried that both groups are alike in terms of age, lactation number, body weight, stage of lactation and lactation number. Animals were fed twice a day and were also milked twice a day. Animals were weighed at start and end of the experiment.

The treatment group concentrate percent feed ingredient formula was: cotton seed cake=62.5; wheat bran=25, mustard seed cake (MSC) = 12.5 and 50 grams di-calcium phosphate (DCP) per buffalo per day. The first three ingredients were normally soaked in water for few hours and then this soaked material was mixed with hay and offered to the animal. The control group percent feed ingredient formula was: cotton seed cake=67 and wheat bran=33.

Results and Discussion

The results of this experiment are given in Table 116.

Table 116. Feed intake, milk production and cost benefit of buffaloes offered sorghum plus guar hay versus wheat straw as roughages

Parameters	Improved Feeding (Treatment Group)	Traditional Feeding (Control Group)	Significance
No. of animals	14	10	
Average Milk Produced (lit/h/d)	10.46 ± 0.24	8.89 ± 0.18	0.05
Average roughage intake (kg/h/d)	11.11 ± 0.10	10.95 ± 0.09	NS
Average concentrate intake (kg/h/d)	5.60 ± 0.03	6.10 ± 0.03	NS
Average live weight gain (g/h/d)	375 ± 25	236 ± 18	0.05
Financial benefit (Rs/h/d)	212	126	

From the results presented in table-1 showed that average milk and weight gain significantly increased in animals that were offered improved feed compared with the animals which were kept on traditional feeding. When the cost benefit analysis of both group of animals was carried out, it showed net benefit of Rs 86 ($=1) per day per animal. This profit is quite convincing to adopt the improved feedings by the farmers for their animals.

3.1.3 Experiment No. 2: Comparison of improved feeding with traditional feeding for cow milk production

Materials and Methods

This experiment was undertaken from June to August 2008 for a period of 60 days, in which 8 cows of the 6 farmers were under improved feeding and 5 cows of the 5 farmers were under conventional feeding. The improved concentrate formula was; cotton seed cake=62.5%; wheat bran=25%, mustard cake=12.5% and di-calcium phosphate (DCP) was offered @ 100 grams/h/d; and roughages were offered free choice. The conventional concentrate formula was: cotton seed cake=50%; wheat bran=25% and cracked wheat=25%; and was offered according to each farmer's own wish. The feed ingredients' prices (Rs/kg) were: wheat straw=4.5; oats + vetch hay = 6.5; improved concentrate= 18.75; conventional concentrate=18.33; and DCP=35. Milk was sold @ Rs.31/liter. Daily feed intake and milk production data was recorded by each farmer and site facilitator took data of each animal once a week. The cows used in the experiment were not of any specific breed. Milk production, feed consumption and benefits data of this experiment/demonstration are given in Table 117. The hay making and sowing plus harvesting and concentrate feeding procedures were almost same as mentioned in experiment No. 1

Results and Discussion

Table 117. Milk Production, feed consumption and net benefits of cows offered oats plus vetch hay versus wheat straw as the roughage.

Parameters	Oats + Vetch Hay Group	Wheat Straw Group	Significance
Average milk produced (l/h/d)	9.98 ± 0.22	7.50 ± 0.19	0.05
Average roughage +concentrate intake (kg/h/d)	9.01 ± 0.06	12.04 ± 0.09	NS
Net benefits (Rs/h/d)	234	98	

Although the results of this experiment were also encouraging in terms of milk production and net benefits, however, farmers have some reservation about the mixing of vetch with oats. The reasons for this reservation was that vetch is not good in re-growth and can provide only one cutting, while if water and other inputs are optimum, oats can easily give more than one cuttings. The proper stage of cutting for hay making also does not match well in case of these 2 crops, therefore, their combination for hay making may not hold a good promise. However, if they are to be fed as green fodder, then combination is very much liked by the farmer, and farmer gets premium price of green fodder when vetch plus oats are grown as a mixture.

3.1.4 Experiments No. 3 and 4: Comparison of improved feeding with traditional feeding for milk production in buffaloes and feed lot fattening of young cattle calves

Materials and Methods

Two experiments were conducted to compare the effects of traditional (control groups) versus improved roughages and concentrates (treatment groups) on milk production of buffaloes and in feedlot fattening of young cattle calves. The improved roughage was the hay of sorghum + guar cut and processed at the flowering or dough stages of the green fodder and conventional roughage was wheat straw and both were fed ad-libitum. The traditional concentrate was cotton seed cake 1 part + wheat bran 1 part + mustard seed cake 0.25 parts, and fed to lactating buffaloes on the basis of individual judgment of the farmer and improved concentrate was a combination of various agro-industrial by-products, which were properly processed and mixed and fed at the rate of about one kilogram concentrate for every two liters of milk produced by the buffaloes. The percent ingredient formula of improved concentrate is: Cotton seed cake=14; wheat bran=19; maize oil cake=20; mustard seed cake=5, mustard oil=0.5; corn gluten feed=40 and DCP=1. Feedlot fattening cattle calves ages ranged between 8 to 18 months and were fattened for 90 days, by offering completely mixed ration (50% concentrate : 50 % roughage) fed ad-libitum; while the lactating buffaloes experiment was of 60 days. In the dairy animals experiment there were 25 buffaloes in the treatment group and 9 in the control group. While in the feedlot fattening there were 40 cattle calves in the treatment group and 22 in the control group.

Results and Discussion

Daily milk production was 10.43 $\pm$ 0.28, and 8.94 $\pm$ 0.23 liters per head for treatment and control groups, respectively, and differed significant ($P < 0.05$) as shown in Table -3.

Daily roughage intake was 11.62 $\pm$ 0.23 and 10.91 $\pm$ 0.30 kilogram per head for treatment and control groups, respectively. Daily concentrate intake was 4.96 $\pm$ 0.16 and 5.44 $\pm$ 0.32 (kg/h) for treatment and control groups, respectively. The daily weight gain was found to be 317 $\pm$ 59 and 149 $\pm$ 38 (grams/head) for treatment and control groups, respectively. Statistically, there was no significant difference between treatment and control groups in feed intake and weight gain ($P > 0.05$) however, the daily net benefit of milk production was found to be rupees 212 for treatment and rupees 109 for control group.

In the cattle feedlot fattening experiment average daily weight gain in the treatment group was found to be 474 $\pm$ 27 grams per head and 209 $\pm$ 12 grams per head in the control group and differences were significantly different ($P < 0.01$). The animals of the treatment group consumed total mixed ration of 3.87 kg/h/d, while in the control group because of grazing plus supplementation, the total feed intake could not be measured. Therefore, under the prevailing prices, a farmer can only earn from fattening if his cattle obtain a daily live body

weight gain of more than 670 grams, with the feed intake of less than 3.87 kilograms per head daily having 50: 50 ratio of roughage to concentrate. The results of these two experiments are summarized in Table 118.

Table 118. Milk production of buffaloes and feedlot fattening of cattle calves fed sorghum plus Guar hay versus wheat straw as the roughages, along with improved and traditional concentrates

Parameters	**Guar + Sorghum Group**	**Wheat Straw Group**	**Significance**
Milk Production (l/h/d)	10.43 ± 0.28	8.94 ± 0.23	0.05
Roughage Intake (kg/h/d)	11.62 ± 0.23	10.91 ± 0.3	NS
Concentrate Intake (kg/h/d)	4.96 ± 0.16	5.44 ± 0.32	NS
Buffaloes live weight gain (g/h/d)	317 ± 59	149 ± 38	NS
Daily Net Benefit (Rs/h)	212	109	-
Cattle Calves ADG (g/h)	474 ± 27	209 ± 12	0.01
Feed Intake by Calves (kg/h/d)	3.87 ± 0.21	-	-

Partial budget calculations of the first three experiments is given in Table 119.

Table 119. Partial Budget of Three Experiments in Lactating Cows and Buffaloes

S. No	Parameters	First Experiment (2007-08) (Sorghum+ Guar)		Second Experiment (2008) (Oats+Vetch)		Third Experiment (2009) (Sorghu+guar?)	
		Treatment Group (TG)	Control Group (CG)	TG	CG	TG	CG
	Number of Animals	14	10	8	5	25	9
1	Average Milk Production (l/h/d)	10.46 ± 0.24	8.89 ± 0.18	9.98±0.22	7.5±0.19	10.43±0.28	8.94+0.23
2	Average Adjusted Yield (5% lower)	9.94	8.45	9.48	7.12	9.90	8.49
3	Field Price of Milk (Rs/l)	28	28	31	31	35	35
4	Benefits From Milk (Rs/h/d)	278	236	294	221	347	297
5	Average Daily Weight Gain (ADWG) (g/h/d)	375±25	236±18	390±30	215±16	317±59	149±38
6	Field Price of Live Weight (Rs/gram)	0.082	0.082	0.085	0.085	0.090	0.090
6 A	Benefit from ADWG (Rs/h/d)	31	19	33	18	28	13
7	Gross Field Benefits (Rs/h/d)	309	255	327	239	375	310
8	Hay Consumed (kg/h/d)	11.11±0.10	10.95±0.09	4.86±0.09	6.44±0.12	11.62±0.23	10.91±0.3
9	Field Price of Hay (Rs/kg)	1.75	3.5	3.75	5.5	4	7.25
10	Total Cost of Hay (Rs/h/d)	19	38	18	35	46	79
11	Concentrate Consumed (kg/h/d)	5.6±0.03	6.10±0.03	4.15±0.04	5.6±0.07	4.96±0.16	5.44±0.32
12	Field Price of Concentrate (Rs/kg)	14	15	18	19	23.5	25
13	Total Cost of Concentrate (Rs/d/h)	78	91	75	106	117	136
14	Total Cost that Vary (TCV) (Rs/h/d)	97	129	93	141	163	215
15	Net Benefit (Rs/h/d)	212 (86)	126	234 (136)	98	212 (117)	109

3.1.5 Experiments No. 5 and 6: Milk production of buffaloes and cows fed on improved versus traditional roughages and concentrates

Background

There are great seasonal fluctuations in the livestock milk production which vary from animal to animal and farmer to farmer depending upon the management and availability of feed to animals. Milk production increases in winter due to the calving pattern of buffaloes and cows, but at the same time the price of milk decreases in the open market without benefiting to consumers. In summer, the government spends huge amounts of foreign exchange every year on the purchase of dry milk powder to meet the demand of existing human population. Therefore, experiment were carried out during the project time in the village to see the performance of improved feed on milk production of buffaloes and cows.

Materials and Methods

This experiment was undertaken from October to December 2009 on milking buffaloes and cows in which the hay was of sorghum or millet plus guar in the improved feeding group, while the improved concentrate's ingredient formula was: Cracked maize = 5%; CSC = 31.5%; WB = 50%; Mustard Cake = 10%; DCP = 1%; Salt = 1%; Urea = 1% and limestone = 0.5%. In this case milk was sold @ Rs.35 per liter for buffaloes and rupees 32 per liter of cow's milk. All the procedure adopted in both these experiments was similar to prescribed in previous experiment 1&2.

Results

The summary of results of the buffalo experiment is given in Table 120, and of cows in Table 121.

Table 120. Performance of buffalos feed on improved versus traditional roughages and concentrates.

Parameters	Hay Goup	Wheat Straw Group	Significance
Milk Production (l/h/d)	10.8 $\pm$ 0.29	9.35 $\pm$ 0.25	0.05
Roughage Intake (kg/h/d)	11.1 $\pm$ 0.34	11.3 $\pm$ 0.30	NS
Concentrate Intake (kg/h/d)	5	5	-
Live weight gain (g/h/d)	250 $\pm$ 45	175 $\pm$ 39	0.05
Net Benefit (Rs/h)	229	132	-

Table 121. Performance of cows fed on improved versus traditional roughages and concentrates.

Parameters	Hay Group	Wheat Straw Group	Significance
Milk Production (l/h/d)	12.66 $\pm$ 0.39	10.66 $\pm$ 0.79	0.05
Roughage Intake (kg/h/d)	10.1 $\pm$ 0.5	9.95 $\pm$ 0.49	NS
Concentrate Intake (kg/h/d)	5	4	NS
Liveweight gain (g/h/d)	200 $\pm$ 34	- 100 $\pm$ 27	NS
Net benefit (Rs/h/d)	235	155	-

Overall, five experiments on milk production were carried during the project period to evaluate the performance of improved vs traditional roughages and concentrates. Out of these five experiments, three were carried out on buffaloes and two on cows. In all the experiments, improved concentrates and roughages showed superiority over the traditional feedings. A net benefit of RS 86 to 103 per

day per animal was recorded in case of buffaloes while this benefit ranges from 80 to 146 per day per animal.

Feeding Lactating Buffalos (socioeconomic evaluation)
Purpose of this trial was to improve the milk productivity of buffaloes. Number of farmers who performed this trail was seven and total duration of the trial was 60 days. Average quantity of ration used per day was 13.8 kg. Fellow farmers view about the trial was positive. Increase in cost with the use of ration was about 11 percent which resulted into an increase in milk yield of 15 percent.

3.2 Irrigated Site: Effect of improved feeding on milk production of cattle and buffalo

3.2.1 Year 2007

Methodology
The feeding trials were started during 2007 to test the effect of feeding regimes on milk production in buffalos and cows. The animals of chak No. 74/SB were divided into three feeding regime groups. 1st group of 14 buffaloes and 8 cows were fed with green fodder of improved varieties supplemented with concentrates (Balanced ration) second group of 12 buffaloes and 5 cows were fed with green fodder of improved varieties with or without traditional cotton seed cakes and third group of 10 buffaloes and 4 cows were fed with local fodder with or without traditional cotton seed cakes.

The animals of Chak No. 105/SB were also divided into three feeding regime groups. 1st group of 13 buffaloes and 3 cows were fed with green fodder of improved varieties supplemented with concentrates (Balanced ration) second group of 12 buffaloes and 4 cows were fed with green fodder of improved varieties with or without traditional cotton seed cakes and third group of 4 buffaloes and 1 cows were fed with local fodder with or without traditional cotton seed cakes.

The selected farmers were divided into following 4 typology groups
T1 Relatively large land / livestock holding / income.
T2 Medium land / livestock holding / income.
T3 Small land / livestock holding / income.
T4 Smallest land / livestock holding / income.
The animals were divided into 3 feeding regime groups.
G1 Fodder of improved varieties + concentrate (balanced ration)
G2 Fodder of improved varieties with or without cotton seed cakes (CSC)
G3 Local fodder with or without cotton seed cakes.

The data on milk production were grouped under different typology groups to see the effect of typologies on milk production.

Results and Discussion
There was no effect of typology groups on milk production because milk production was affected by many factors like potential of the animals, lactation stage, age of the animal and variation in animal husbandry which dominated the effect of typology groups (Table 122).

Table 122. Average buffalo milk yield among different typologies groups at Chak No. 74 SB and Chak No. 105/SB.

Typologies	AV. Milk yield Chak # 74/SB	AV. Milk yield Chak # 105/SB	AV. Milk yield in both villages
T1	6.7	7.0	6.85
T2	5.9	7.7	6.8
T3	6.4	6.6	6.5
T4	6.1	7.9	7

The milk yield produced during different months was pooled to see variation in milk production during different feeding months (Table 123).

Table 123. Buffalo milk production during different months at Chak No. 74 SB and 105/SB

Village	January	February	March	April	May
Chak No. 74 SB	6.7	6.7	6.0	5.2	4.2
Chak No. 105 SB	6.8	6.8	6.2	5.3	4.2

The data on buffalo milk yield production revealed that milk production gradually dropped with the advancement of the feeding period from January to May because of advancing of lactation stage, increasing temperature and decreasing availability of fodders (Table 124).

Table 124. Buffalo milk production during different feeding months under 3 feeding regimes of both Chak No. 74 and 105 SB

Feeding Groups	Milk yield / day/ animal (Liters)					
	January	February	March	April	May	AV. Milk yield/day
G1	6.4	6.1	5.5	4.9	4.0	5.38
G2	5.6	5.4	4.8	4.1	3.3	4.64
G3	5.3	4.8	4.0	3.4	2.4	3.98

The drop in Buffalo milk production from January to April was found higher in all 3 feeding regimes. The milk production among different farmers of feeding regime improved fodder plus concentrate (balance ration) during different feeding months was studied (Table 125).

Table 125. Variation of buffalo milk production under fodder regime improved fodder plus concentrate during different feeding months at Chak No. 74 SB. and Chak No. 105 SB.

Farmer	Av. milk yield /animal/day(liter)				
	January	February	march	April	may
1	7.3	7.4	6.7	5.9	4.8
2	7.3	7.4	6.8	6.2	5.1
3	5.7	5.8	5.4	4.8	4.2
4	7.3	7.1	6.6	3.6	4.5
5	7.8	7.7	7.1	6.3	5.1
6	6.6	6.0	5.1	4.1	3.1
7	6.6	6.6	5.8	4.8	3.9
8	5.0	4.8	4.3	3.0	1.8

The data revealed that feeding with balanced ration (fodder + concentrates) improved the milk production followed by feeding with improved fodder varieties.. The milk data clearly indicated that even under one feeding regime of improved fodder plus concentrate, the milk production greatly varied from farmer to farmer which indicated that the factors other than feeding were also present. Moreover it was confirmed that the milk production gradually decreased from January to May even in the feeding regime of improved fodder + concentrates.

3.2.2 Year 2008

At two project sites Chaka No. 74/SB and Chaka No. 105/SB feeding of animals was divided into three groups. First fed with green fodder improved varieties of sorghum, pearl millet, maize and cow peas and supplemented with concentrates (Balanced ration), second fed with green fodder improved varieties of sorghum, pearl millet, maize and cowpeas, with cotton seed cake (CSC) and third treatment was fodder of local varieties with cotton seed cake.

Treatment 1: Fodder of improved varieties + concentrate (balanced)
Green fodder of different species for each season:
Winter
i) Berseem (variety, Berseem Agaiti) and species
ii) oats (variety, S-2000) feeding was done with berseem and oats mixed

Summer
i) Sorghum (cv. JS2002, Hegari and JS263)
ii) Pearl millet (cv. 18-BY, MB-87 and AF-Pop)
iii) Maize (variety S-2000)
iv) Cowpeas (cv. Rawan-2003, CP-95)

Lean period
i)Maize (cv. S-2000)
ii) Sorghum-sudan grass hybrid (Pak-Sudax)
iii) Mott grass (variety Smooth)

Concentrate: the composition was 8 kg maize grain, 8 kg maize gluten, 8 kg cotton seed cake, 2 kg molasses, 2 kg NaCl, 0.5 kg Urea, 2 kg Brassica seed cake, 7 kg Wheat bran, and 1 kg DC Powder. The quantity of concentrate fed was 4 kg per milking animal

Treatment 2: Fodder of improved varieties with cotton seed cake
Fodder: Mix of green fodder of i) Berseem (variety, Berseem agaiti) and ii) oats (variety, S-2000)
Concentrate: 2 kg cotton seed cake per animal

Treatment 3: Fodder of local varieties with cotton seed cake
Fodder: Berseem local variety called Desi/ Miscavi, Egyptian varieties/ Iraqi imported varieties where as in oats local variety called Desi, fed by the farmers as sole and mixed
Concentrate: 2 kg cotton seed cake per animal

Average milk yield of each animal was recorded separately. The milk data of animals of similar lactation stage was recorded for comparison of three feeding regimes in both the villages in order to determine the effect of improved feeding (fodder and ration) on milk yield of animals Maximum milk yield of 8.67 liters per buffalo / day was recorded under the feeding regime of improved fodder + concentrate followed by 7.16 liters by improved fodder + CSC while lowest milk yield of 6.66 liters was received from feeding regime of local fodder + CSC (Table 126). An increase of 30.60 % was recorded in feeding of improved fodder + concentrate and 6.09 % in improved fodder + CSC over local fodder + CSC.

Table 126. Average buffalo milk yield in Chak No. 74/SB and Chaka No. 105/SB.

Feeding group	Farmers	No of animals	Av. milk yield (liters)	Increase (%)
Improved Fodder + Concentrate	11	29	8.67	30.60
Improved Fodder var. with cotton seed cake	14	28	7.16	6.09
Local Fodder with cotton seed cake	12	18	6.66	-

Maximum milk yield of 7.59 liters per buffalo / day was recorded under the feeding regimes of improved fodder + concentrate followed by 6.68 liters with improved fodder + CSC (Table 127). Lowest milk yield of 6.08 liters was received from feeding regime of local fodder + CSC. An increase of 24.82 % was recorded in feeding of improved fodder + concentrate and 10.64 % in improved fodder + CSC over local fodder + CSC.

Table 127. Average milk yield of buffaloes from both the villages under improved vs. local ration.

Crops	Animals	No of animals	Avg. Milk yield (lit)	% increase
Improved Fodder + Concentrate	15	34	7.59	24.82
Improved Fodder with cotton seed cake	17	32	6.68	10.64
Local Fodder with cotton seed cake	17	24	6.08	

Maximum milk yield of 6.6 liters per cow / day was recorded under the feeding regime of improved fodder + concentrate followed by 5.8 liters for improved fodder + CSC (Table 128). Lowest milk yield of 5.3 liters was recorded from feeding regime of local fodder + CSC.

Table128. Average milk yield of cows in Chaka No. 74/SB and Chak No. 105 SB. under improved versus local ration.

Feeding group	Farmers	No of animals	Av. milk yield (liters)	Increase (%)
Improved Fodder + Concentrate	16	19	6.6	24.66
Improved Fodder var. with cotton seed cake	17	22	5.8	9.17
Local Fodder with cotton seed cake	15	16	5.3	

3.2.3 Year 2009

Buffaloes fed with Treatment 1 during summer crop season gave 25.5% more milk yield (9.35 liter/day) than fed with Treatment 3 (traditional farmer practice; Table 129). Feeding with Treatment 2 gave 9.8% higher milk production (8.18 liter/day) than Treatment 3 (7.45 liter/day).

Table 129. Average milk yield of buffaloes from both the villages under improved vs local ration during summer.

Crops	Farmers	No of animals	Av. milk yield /day (liters)	% increase
Green Fodder + Concentrate	11	29	9.35	25.50
Hay + Low Cost Concentrate	14	28	8.18	9.80
Green Fodder Local with/ without CSC	12	18	7.45	

The results revealed that for the summer crop season cows fed with Treatment 1 gave 23.4 % higher milk yield (9.5 liter/day) than Treatment 3 (traditional farmers practice: 7.7 liter/day) followed by Treatment 2 with 9.1% higher milk yield (8.4 liter/day; Table 130).

Table 130. Average milk yield of cow from both the villages under improved vs local ration during summer.

Crops	Farmers	No of animals	Av. milk yield /day (liters)	% increase
Green Fodder + Concentrate	10	12	9.5	23.38
Hay + Low Cost Concentrate	10	13	8.4	9.09
Green Fodder Local with/without CSC	10	12	7.7	

The buffaloes fed with improved fodder supplemented with concentrate during winter, summer and lean period gave more milk with a higher milk fat percentage as compared to local traditional feed followed by feeding with improved fodder crop varieties (Table 131).

Table 131. Average fat percentage of buffalo milk from both the villages under improved vs local ration during summer.

Crops	Farmers	No of animals	Av. milk yield /day (liters)	% increase
Green Fodder + Concentrate	11	29	7.1	16.39
Hay + Low Cost Concentrate	14	28	6.6	8.20
Green Fodder Local with/ without CSC	12	18	6.1	

3.3 Effect of improved feeding on meat production of cattle and buffalo

3.3.1 Rainfed site

Materials and Methods

This feedlot fattening trial was carried out from March to May 2008, in which 35 cattle calves were offered oats plus vetch hay along with concentrate having CSC (cotton seed cake) 62.5%, WB (wheat bran) =25% and mustard cake = 12.5%. At the start of experiment the ratio of concentrate to roughage 30:70 in the first week; 40:60 in second week; 50:50 in third week and 60:40 from 4th week onward. In the control group 18 cattle calves were used and the animals were offered wheat straw as roughage while improved concentrate contained CSC 50% and WB=50% and the ratio of the concentrate: roughage was 50:50. All the animals were offered free choice this total mixed ration (TMR). Animals were weighed at start, middle and end of experiment. Feed intake of the animals was recorded daily.

Results and Discussion

The performance of both groups is given in Table 132 below.

Table 132. Feedlot fattening performance of cattle calves fed oats+vetch hay versus wheat straw as roughage.

Parameters	Hay Group	Wheat Straw Group	Difference
Feed Intake (kg/h/d)	2.98 $\pm$ 0.04	2.73 $\pm$ 0.09	NS
Weight Gain (g/h/d)	402 $\pm$ 45	317 $\pm$ 41	NS
Loss	8.53	9.69	

The experiment has revealed that under the prevailing situation there is little scope for feedlot fattening. However, if farmers start getting premium prices for the young and fattened calves it might become economical to fatten the animals. The other possibility is the export of the good quality fattened animals' beef, which may fetch higher prices and make feedlot fattening economical.

Socioeconomic evaluation of the feedlot fattening trial

Purpose of the trial was dissemination of improved fattening feed. Feedlot fattening trial was performed by six farmers. Trial duration was 60 days. All the farmers had knowledge about ingredients of the feed. Seventy percent of them replied that equivalent feed was available in the local market. Majority of them (70%) showed their concern about more labor requirement for feedlot fattening activity. Seventy five percent of them reported to mange extra labor by hiring it. Both male and female laborers were engaged for the activity. Average increase in the weight of

buffalo calves at the farms of farmers who were involved in the trail was 30.5 kg and the farm of the control group farmers was 30.8 kg. Thus weight gain was same at the farms of farmers who were involve in the trail and at the farms of control group farmers. Similarly the weight gain in case of cow calves was quite same at both types of farms. It was 31.4 kg and 31.8 kg at the farms of participating and control group farmers respectively. Majority of the farmers (75%) were not satisfied with the performance of the trial and informed that they would not be ready to continue it any more. Reasons for discontinuation of the practice expressed by the farmers were poor performance of the animals offered improved feed and more labor requirement than conventional calf fattening.

3.3.2 Irrigated Site

The experiment of fattening of buffalo and cow calves was carried out at Chak No 74SB and 105 SB the calves were divided into two groups on the basis of their ages. In buffaloes the age groups were of 6 and 12 months while in cows age groups were 4 and 8 months. The live weight of each calf was recorded separately before controlled feeding and after every sixty days. The weight gain was assessed for comparison of there feeding regimes launched at both the villages to estimate the effect of improved feeding (fodder and ration).

During summer crop season buffalo calves fed with Treatment 1 exhibited 65.1 % more weight gain (685 g/day) than Treatment 3, followed by Treatment 2 with 42.2% higher weight gain (590 g/day) than traditional farmers 415 g/day; Table 133).

Table 133. Average of fattening of buffaloes calves for both villages during summer.

Sr. No.	Feeding Regimes	Number of Animals	Weight Gain (gm/day/calf)	% increase in Weight Gain (gm/day/calf)
1	Green Fodder + Concentrate	11	685	65.06
2	Hay + Low Cost Concentrate	7	590	42.17
3	Green Fodder Local with/ without CSC	8	415	

During summer crop season cows calves fed with Treatment 1 exhibited 65.8 % more weight gain (572 g/day) than Treatment 3 followed by Treatment 2 with 58.0 % higher weight gain (545 g/day) than traditional farmers (345 g/day; Table 134).

Table 134. Average of fattening of cow calves for both villages during summer.

Sr. No.	Feeding Regimes	Number of Animals	Weight Gain (gm/day/calf)	% increase in Weight Gain (gm/day/calf)
1	Green Fodder + Concentrate	3	572	65.80
2	Hay + Low Cost Concentrate	3	545	57.97
3	Green Fodder Local with/ without CSC	3	375	

3.4 Adding value through improved milking hygiene and dairy processing

3.4.1 Rainfed site: Clean Milk Production and Mastitis Control Program

Background

As formal milk hygiene and dairy processing were relatively new concept for the farmer community in the project area, a detailed program was introduced phase-wise which included various measures and trainings on milk hygiene practices and milk handling and processing techniques adaptable at household or cottage level. These measures directly added value to milk both in raw and processed form. To meet these objectives rapid rural appraisal was carried out in the very early lap of the project. Then community mobilization and awareness about milk hygiene and milk processing were brought through various community sessions. Clean milk production that includes both milking and handling of milk before processing, demands great care with respect to animal hygiene and personal hygiene about which majority of farmers are not conscious. Proper cleaning and management of udder is very important. For this purpose, a screening program on evaluation of udder health was introduced by application of California Mastitis Test (CMT) and for prevention of mastitis teat dips or sprays were used. Needs and assessments about the activities were determined according to educational / adaptability competence of the majority farmers and arrangements about necessary material procurements were made: The year 2007 remained major focus for such assignments.

Material and methods

Use of CMT (California Mastitis Test) Kits: The test was used to identify udders and quarters of lactating animals for subclinical mastitis (SCM). The village community-head / facilitator was specifically trained in the application of this test and interpretation of results. In 2008, about a dozen farmers participated in this activity. However, in 2009 the activity was expanded to majority by including farmers even having one animal (Table 135). This way the collective herd size, which was about 55-60 in 2008, turned about 85-90 animals in 2009 that remained under observation through CMT test and / or teat dips or sprays (see next paragraph please for further information). About 60 to 70% animals, especially buffaloes, were found + ve for one or two quarters (mild to moderate). Incidence of SCM was less in cows (40 to 50 %) when compared with buffaloes. Moreover, generally there was more morbidity and teat deformity in buffalos than cows.

Results and Discussion

Use of Antiseptic (Teat Dips/Spray):

In order to improve milk and udder hygiene 140-150 lactating animals (count varies because sale / purchase were routine) remained under antiseptic / teat-dip program: about 60 to 65 were buffalos, 80 to 85 were cows. In the early phase of this activity, a famous market brand of antiseptic dip (DIPAL) was provided to the farmers that was relatively costly. Before expanding this intervention further to other households, and to make it economically viable and technically sustainable lab-scale experimentation on cheap alternate was worked out. For this purpose, the main ingredients of the teat dip / spray i.e., polyvinyl iodine (as antiseptic) was mixed with glycerol (as emollient). After successful field trials of this cheap and alternate dip that created a positive perception in farming community, the activity was expanded to almost entire village covering about 75 percent village household (about 20 to 25 % households have no animals) with this alternate dip. In 2008 'teat cups' were introduced but it was observed that due to contamination, the efficiency of dip deteriorated very soon. Cup, being open and simple contrivance of convenience, was found more vulnerable to contamination. Spray bottles, being enclosed contrivance, were introduced that proved very successful alternate. Moreover cups were very costly. By the mid of 2009 majority community was using spray bottles for antiseptic application satisfactorily. At the terminal stage of the project in December 2009, it was keenly noted that the whole village lactating herd was under this intervention.

The above-referred formulation (detail of formulation can be viewed n annxture-1) was used to be prepared by the facilitator and disbursed to the participatory community members of the village substituting the costly supplies; even the low income families were ready to pay for it, as it was almost one fifth of cost of branded dip. With excellent mastitis control, the confidence of farmers about this formulation was built firmly. Due to positive effects and perception of dips in the project area, the technique was even on demand outside the village community and farmers of about a dozen animals were also provided antiseptic / dips in the adjoining satellite village, Nata. None of animals among the "treatment group" was reported clinically mastitis whereas among the control group five animals were reported clinically positive (30 to 40 in numbers): one quarter of three animals was reported permanently lost and two each with two and three quarters lost. This group was also subclinically 1 to 4 plus positive as shown by test kit.

Milk Quality

Personal hygiene of milkmen / milk maidens was also emphatically explained to the participants as a contributory factor in clean milk production. Farmers were briefed about the hygienic milking procedure, they were provided with textile udder towels and were demonstrated with hands-on training about their use, and its impact on the milk quality was explained. Microbial quality of milk was evaluated by aerobic plate count. Fifty samples from individual animals of selected farmers were tested and the average aerobic plate count was 2.33 ± 0.47 million ml^{-1} for control group and it was 0.492 ± 0.11 million ml^{-1} in treatment group. Fifty-five milk samples of individual animals of selected farmers were tested for their compositional analysis. Average total solids for buffalo milk were 16.5 and the fat contents 6.5 %. The respective figures for cow milk were 14.5 and 4.7 %.

Survey on Price Structure of Milk and Yoghurt Markets

At the time of start of the project (July/August 2007), milk price per liter was Rs. 20 to 22 was being paid to the farmer by the bulk milk-buyers, called DODHI which was enhanced to Rs. 23 to 24 $liter^{-1}$ in winter 2007-08. Price for the yoghurt, called DAHI, was between 30 and 35 per kg in the nearby town market, 'Daultala'. By March /April 2008, there was further 10 to 15 % increase in the price paid to the farmers for their raw milk. In summer 2008, the payment was further enhanced in the favor of project area farmers because of hygienic quality of their milk. The price of yoghurt sold by national or multinational companies was Rs. 68 to 80 kg^{-1}. By August / September 2008, the price of raw milk being paid to the farmers, was again raised to Rs 28 to 30 $liter^{-1}$. In December 2008, the price increased from Rs. 30 to 34 $lit.^{-1}$ and remained steady until mid 2009. By the time of end of the project (Dec 2009), the prices being paid to the producers were Rs. 34 to 36 $lit.^{-1}$, which were on average Rs. 2 higher than that of the surrounding villages because of the fame of the hygienic quality of the milk of this village. Almost within a time-span of 2 ½ years the prices shoot two-fold. The impact of the project activity was evident from the fact that the bulk milk buyer prefer to procure milk from this village because the community was hygienic milking practitioner.

Table 135. Farmers and their animals under CMT / teat dip or spray program during the year 2008 and 2009*

S #	Farmers	Cow	Buffalo	Total
Year 2008				
1.	Ajmal Nawaz	-	1	1
2.	Amar Sajjad	4	7	11
3.	Amjad	-	1	1
4.	Arshad	1	-	1
5.	Babar	1	-	1
6.	Javed	3	2	5
7.	Liaqat	3	3	6
8.	Muhammaad Hanif	-	2	2
9.	Nazakat	1	1	2
10.	Omer	2	-	2
11.	Shahid Mahmood	-	1	1
Total		**15**	**18**	**33**
Year 2009				
1.	Abdul Hasnain	1	1	2
2.	Adil	-	1	1
3.	Ajmal Nawaz	-	2	2
4.	Ali Jan	-	1	1
5.	Amjad	-	1	1
6.	Ashiq	-	1	1
7.	Awais	1	1	2
8.	Babar	-	1	1
9.	Gous	1	1	2
10.	Haji Mahmood	-	2	2
11.	Hussain	1	1	2
12.	Imtiaz	-	1	1
13.	Irfan	-	1	1
14.	Javed	2	2	4
15.	Khuram	1	4	5
16.	Liaqat	5	4	9
17.	Mahmood	-	1	1
18.	Nazakat	2	2	4
19.	Omer	2	1	3
20.	Qaiser	2	-	2
21.	Qamar	1	1	2
22.	Raheel	2	-	2
23.	Riasat	1	1	2
24.	Sadiq	3	-	3
25.	Shahzad	-	1	1
26.	Wasim Razzaq	-	1	1
Total		**25**	**33**	**58**
Grand Total		**40**	**51**	**91**

*Some farmers stopped the program / activity due to culling or selling of animals, hence the number of animals varies as in description. For teat dips / spray this list is not complete, please see *Use of Antiseptic (Teat dips / sprays).*

Progress Expected.

At the end of the project, major focus was on master trainer program so that sustainability of interventions can be ensured: a group of 5 female trainers each for dairy product preparation and clean milk production was trained; 2 males on value added dairy product preparation and 5 males for clean milk production were imparted training. A group of three male farmers was given training on simplified milk analysis (Gerber test and lactometer), thereby helping to enhance their bargaining power to sell good quality milk at premium price.

The intervention seems to be reasonably viable and sustainable because it has been developed and inducted on the basic principle of simple methodology and ready availability of material required to carry on the activities. Consumable reagent of the CMT Kit was prepared by using detergent with addition of pH indicator. Its performance was compared with standard supply and was found equally good. This reagent along with other necessary gadgets of local / indigenous origin was assembled in the form of complete kit, which will substitute the standard imported kit at hardly one-tenth price. In this regard, the detailed information was provided to the master trainers. Similarly, complete formulation of the antiseptic spray/ teat dips was explained and demonstrated, both in practice and in writing, shown here as Appendix below. The material required for this is PVP iodine and glycerol, which are readily available in the nearby village market; it cost hardly one rupee per day per animal for mastitis prevention program. Keeping in view the benefits and cost, we are completely certain that at least mastitis control program and hygienic milking will prove viable and sustainable. The quality dairy product preparation for household consumption has had already proven so.

Table 136. An overview of the activities undertaken at village, Lodhay (2007-09).

July to December '07												
Activities						**J**	**A**	**S**	**O**	**N**	**D**	
Milk testing							x			x		
Farmers enlistment for clean milk production							x			x		
Farmers interest and awareness sessions						x	x			x		
Market survey for price structure							x			x	x	
Meeting and linkages with value chain personnel										x	x	
Market survey for procurement of material										x	x	
Kit validation for detection of sub-clinical mastitis											x	
January to December '08												
Activities	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Milk testing for compositional quality	x	x	x		x						x	x
Milk testing for bacteriological quality	x	x	x	X	x							
Market linkage, product survey, price structure etc	x	x	x	X	x		x	x				
Enlistment updating for clean milk production	x	x			x	x	x	x	x	x	x	x
Interest group awareness sessions	x			X		x	x	x			x	x
Community perception on the activities		x		X				x	x			x
Hands-on training sessions	x	x		X	x	x	x	x				
Procurement of material / supplies	x	x	x	X	x	x	x	x		x	x	x
Induction and use of teat dips	x	x	x	x	x	x	x	x	x		x	x
Induction of udder towels	x				x	x	x	x			x	
Monitoring subclinical mastitis	x	x	x	x	x	x	x	x	x	x	x	x
Field trips / tours	x	x	x	x	x	x	x	x	x		x	x
Review and work planning										x		x
January to December '09												

Activities	J	F	M	A	M	J	J	A	S	O	N	D
Milk testing for compositional quality	x				x						x	x
Product survey, price structure etc		x		x	x		x	x				x
Enlistment updating for clean milk production	x	x			x		x					x
Interest group awareness sessions	x		x	x	x	x		x			x	x
Formulation of CMT Kit and antiseptic dips						x					x	
Training on milk testing at farm level by farmers			x		x							
Hands-on training, dairy products, milk hygiene etc	x		x	x	x	x	x	x			x	x
Induction and use of teat spray / dips	x		x	x		x	x	x			x	x
Monitoring subclinical mastitis	x	x	x	x	x	x	x	x				
Field trips / tours/ review and wrap up visit etc	x	x	x	x	x	x	x	x			x	x

3.4.2 Irrigated Site: Adding value through improved milking hygiene and dairy processing

In 2007 farmers' milk production, processing and marketing practices were documented. Small scale dairy farmers were encouraged to form interest groups. The selected community was trained in improved milk harvesting processing technologies.

Hygienic milk harvesting practices were introduced which will include major intervention such as teat dips and pocket free milk containers / utensil. This will directly add to milk quality by reducing bacterial load of raw milk. This will also reduce incidence of sub-clinical mastitis in animals thereby improving productivity and economic return to the community. As a result of healthy udder the sale value of animals will also be enhanced.

The female community members were trained in raw milk preservation technology so that both morning and evening milk can be pooled and picked once a day thereby fetching premium price and reducing transportation cost.

The women were also trained in improved processing technologies. Traditional versus improved methods of processing milk to cheese, butter and yoghurt/Dahi etc. were demonstrated. Twenty-five women at Chak No. 105/SB and twenty-two female members at Chak No. 74/SB attended the training course. The training sessions were carried out twice in 2008 i.e. during the month of February-March and August-September 2008. Thirteen training session were organized for female training members in each village.

The following processing methods were introduced in both project villages:

- Clean milking and clean milk processing
- Concept of cleaning and know how about bacteria and fungi and cleaning of pots.
- Clean milk handling
- Value addition/ dairy technology
- Milk chilling
- Flavored milk (chocolate) making
- Condensed milk making
- Cottage cheese making (3 training)
- Whey healthier making
- Peanut butter making
- Yoghurt (2 training)

In the village Chak No. 105/ SB thirty-four women and in Chak No. 74/ SB thirty-one women started producing the improved products. Ingredients and preparation methods for the dairy products are listed below.

Flavored milk (chocolate)
Ingredients: Milk (Fresh or Fat reduced), Chocolate (Powder or syrup), Cocoa Powder, Sugar (whole or crushed)
Preservative: Sorbitol
Method: Add all ingredients in pasteurized milk and mix well and put it for chilling. After chilling store at low temperature
Storage: Plastic bottles at refrigeration temperature
Storage time: 15-30 days

Condensed Milk (Khoya)
Ingredient: Milk, Sugar and Preservative
Storage: At refrigerator temperature 15-30 days
Method: Boil the milk and dehydrate it up to a moisture content of 20%, adding sugar is optional.

Cottage Cheese
Ingredients: Milk, Citric acid and Salt
Preservative: Sorbitol
Storage: Packaging in polythene bags at refrigeration temperature
Storage time: 15-30 days
Processing method: Take the milk pasteurized at 65^{o}Ċ.Cool the milk to 50^{o}Ċ and add preservative and citric acid. Curd is made. Cook the curd for few seconds. Drain the whey. Pressing gently to remove all the whey. Dry salting. Pack the cheese in polythene bags. Keep at refrigeration temperature.

Whey Healthier (by product of cottage cheese)
Whey which is a byproduct of cottage cheese can be used by adding some valuable ingredients like fruits such as banana, apple, strawberry etc. In this way, the by-product is used and its nutritive value is increased. Use of these products is beneficial for human health.
Ingredients: Whey, banana pulp, sugar, apple green food color
Preservative: Citric acid
Storage: Packaging in plastic bottles and Storage at refrigeration temperature

Peanut Butter
Peanut and Cocoa powder is added to pure butter (animal fat) while at the markets vegetable oil is used for peanut butter preparation.
Ingredients:Butter, Peanuts, Chocolate syrup, Cocoa powder, Salt
Preservative: Citric acid

Fruit Yoghurt
Fruit yogurt provides more nutrients than simple yoghurt.
Ingredients: Milk, Mixed Culture, Sugar, Preservative for Yoghurt; either fruit purees from apple, banana, or mango or fresh fruits like banana, apple and mangoes.

Annex 1: Background on agricultural system in Pakistan

Agriculture is the backbone of Pakistan economy. About 75-80 % of the population depends on agriculture which contributes 30% to the GDP. It is the second largest sector, accounting for over 21 percent of GDP, and remains by far the largest employer, absorbing 45 percent of the country's total labour force. Nearly 67 percent of the country's population resides in rural areas, and is directly or indirectly linked with agriculture for their livelihood. The agriculture sector is a primary supplier of raw materials to downstream industry, contributing substantially to Pakistan's exports, on the other; it is a large market for industrial products such as fertilizer, pesticides, tractors and agricultural implements. Despite its critical importance to growth, exports, incomes, and food security, growth in the sector, particularly in the crop subsector, has been falling for the past three decades and their contribution in only 7.1 percent to GDP.

Without major new investments in agriculture, it may not be possible for Pakistan to tackle emerging challenges such as declining water availability, climate change and scarcity of food and feed. Investments in the field of seeds, farming technology and techniques, and the water infrastructure are need of the time. Overall, there has been a decline in crop production from the last three decades in the crop sector which is contributing to prices hiking of essential food items. Integrated farming systems (crop + livestock) are practiced in the country and shortage of feed is a major limiting factor in livestock production (GOP, 2009).

Livestock in rainfed area of Pothwar-Pakistan (project area) is often remained undernourished (see photos below) because of the non availability of green fodder and thus sustained on cereal residues (wheat straw / sorghum stalk etc) which are nutritionally not rich source of feed for animals. Therefore, the health of the animals and their productive potential is very low compared to the same animal breed raised in irrigated area with adequate fodder/ forages availability. Livestock nutrition is being one of the most important limiting factors of livestock production in the area and thus hampering the animal productivity in the form of milk and meat. This area needs special and immediate attention by the researchers and the government officials. In traditional livestock farming animals are fed through chopped fodder and wheat straw. Kitchen wastes and some concentrates usually cottonseed cakes are offered to milking animals. Commercial livestock owners in urban and peri urban areas purchase fodder and concentrate from the markets and then sale their milk at a rate which can compensate all the feeding expenses including their labor costs, etc. The concentrate generally contains wheat bran, cottonseed cake and rice polishing or crushed wheat. All feed ingredients are purchased from the open market. Cattle feed prepared at some places can also ensure the availability of nutrients to the animals.

Animals are getting their nutrition in a variety of ways depending upon the available feed resources and existing circumstances. Breeding bulls and milking animals are usually stall-fed with wheat straw, green fodder and concentrate, (mostly cottonseed cake) while dry animals and young stock are grazed in newly harvested fields, on canal banks, roadsides and wastelands. A small livestock holder only purchase concentrate from market, all other necessary feed ingredients are produced on his own or hired lands. Apart from this a fair number of animals is in support from wide ranges and pastures which if exist in good condition and properly managed, farm animals will perform quite satisfactorily even without supplementing their diet with the concentrate, except flushing rations given at breeding times.

There are several primary reasons for the scarcity of green fodder in the dry areas.

The first primary reason is the meager land holdings of the farming community in the area which are too small to depend on wholly for agricultural need of the family, due to division of land among the family members generation after generation and thus can't prefer fodder / forages crops over staple main winter crop i.e. wheat which is necessary for the sustenance of farming families.

Secondly, the rainfall pattern is uncertain with its amount, occurrence and distribution. Usually, two third rainfalls occurs in summer months (mostly in July-August) and only one third during rest of the year. Therefore, the crop production under such situation is considered as a risky business and thus farming / livestock raising community often remain reluctant to take risk to implement and apply the improved production technologies which are too some extent are expensive (seed, fertilizer etc) at initial stages than the traditional ones.

Thirdly, the traditional practice of fodder growing in the region is that, brassica crop is grown in wheat as mixture or as an intercrop in wheat as one row of brassica after every 10 rows of wheat. When the crop reaches at knee height stage, farmers start to pull out the brassica for fodder purposes and kept the wheat crop for grain harvest (see photo below). It is also observed that farmers use wheat (small amount) as green fodder and mixing it with previous year's wheat straw to feed their animals especially dairy animals. Those who have land and irrigation facilities (< 10 % of the total rainfed community) also grow traditional berseem and oats in mixtures. The majority rainfed farmers and livestock rearing farmer's community in the area, have no option to feed their animals with green and balanced nutritional fodder.

Poor health and productivity of the animals

Brassica in wheat crop

Traditional practices of fodder production

There are two main crop seasons in Pakistan, namely the winter season (rabi) which begins in October-December and ends in April-May and the summer season, where sowing takes place in April-June and harvesting in October-December. In rainfed areas the summer season normally begins with the onset of monsoon rains which usually occur in end of June or 1st week of July. The livestock population in rural as well as commercial sector is increasing rapidly every year as

compared to the available feed resources. The livestock population in Pakistan is supported by feed resources derived mainly from crops, fodder, rangelands and other grazing areas, and from agro-industrial by-products. It is estimated that existing feed resources are deficient by 29 and 33 % for total digestible nutrients (TDN) and crude protein (DP) respectively (Malik, 1988). On most of the dairy farms the milk yield varies from 5-10 kg milk per animal per day. It is believed that if animals given sufficient balanced feed, the productive potential of animals may reach to 10 to 15 kg of milk daily in early six month of lactation but due to poor feeding, the productive potential of the animals could be harvested. The present feed resources available to animals in the area can only achieve 50% of the inherited productive potential of the animals. As the land holdings get smaller and smaller, the diffusion of new technologies have become expensive and difficult. Therefore, it is necessary to give, more emphasis to increase the livestock productivity under small land holdings. There is no alternative for better management and feeding.

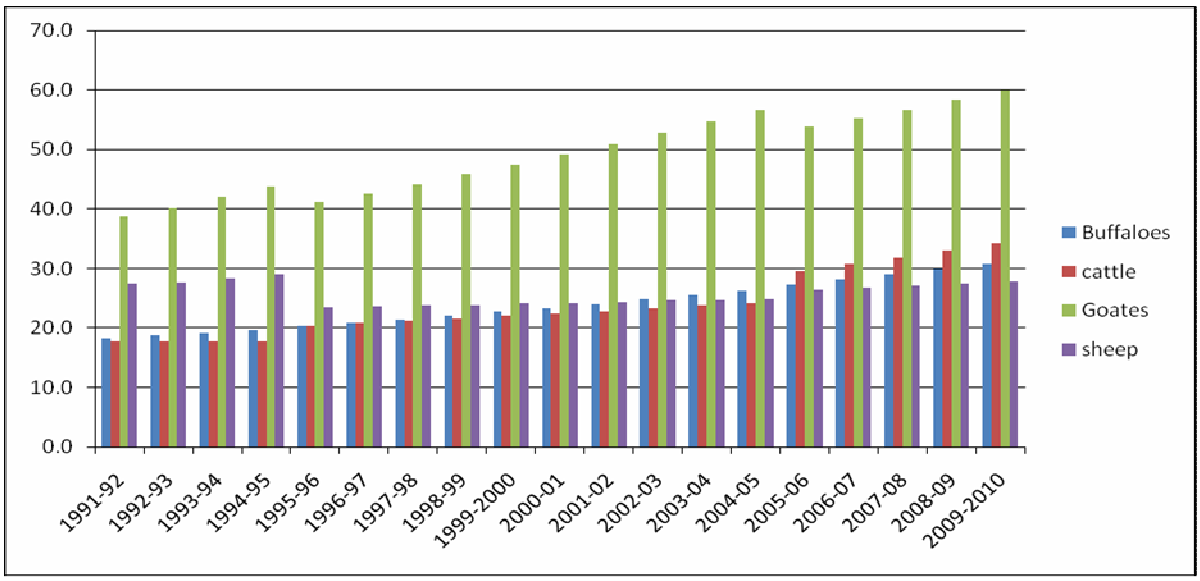
Livestock sector too plays an important role in the national economy. It contributed approximately 53.2 percent of the agriculture value added and 11.4 percent to national GDP during 2009-10 and thus grew by 4.1 percent in 2009-10 as against 3.5 percent last year. Gross value addition of livestock at current factor cost has increased from Rs. 1304.6 billion (2008-09) to Rs. 1537.5 billion (2009-10) showing an increase of 17.8 percent as compared to previous year (Govt., 2010). The population growth, increase in per capita income and export revenue is fueling the demand of livestock and livestock products. In order to speed up the pace of development in livestock sector, Government has created a separate Ministry of Livestock & Dairy Development as a part of Reform Agenda and political commitment of present Government to improve service delivery, reduce poverty, achieve sustainable economic growth and expand opportunities to address the needs of livestock rural farmers and to protect the livelihood concerns of rural community.

There are about 30 million buffaloes and 35 million cattle in the country respectively as is indicated in the Table-1. Two famous breeds of buffaloes exist in the country, as Neli-Ravi and a Kundi found in Punjab. Both of these breeds are well reputed and are comparatively better yielder at average farms than cattle. Most rural families rear 2 to 4 buffaloes and cattle for milk production and try to meet their domestic demand. Some people sell their extra produce to the neighboring families. Due to the improvement of infrastructure and market roads, about 70 % of smallholders are now producing milk for sale in the market. Usually male and female calves suckle the mothers and are retained during the lactation. The best males calves are kept for breeding and the remaining males are usually sold for slaughter whilst the females are kept for future replacements.

There are about 85 million small ruminants' heads in the country. The goats have dominant share by having 60 millions heads possibly due to the reason that they can be easy to rear in dry and mountainous. With the passage of time the number of the animals increased, the goat population has increased one third from year 1991-1992 to year 2009-10. The small ruminants are easy to rear and graze than the large ruminants with higher requirement of fodder forages. Goats are kept for milk and meat production and they can be classified into dairy and meat categories. In Punjab, Beetal, Dera Din Panah, Nachi and Teddy are most commonly found. The Beetal, Dera Din Panah (DDP) and Kamori are called poor man's cow because of their good milk production. Barbari, Chapper and Teddy are famous for meat while Pak Angora, Bikaneri, Kaghani and Khurrasani are kept for mohair and hair. Goats usually breed more than once a year and twinning is very common especially in Teddy breed that often gives two kids per kidding. Three to four kids per parturition have also been common.

There are mainly two types of sheep in Pakistan viz; thin-tailed and fat-tailed sheep. Thin tail sheep are generally found in irrigated areas and fat tail breeds in arid rangelands and mountainous areas of

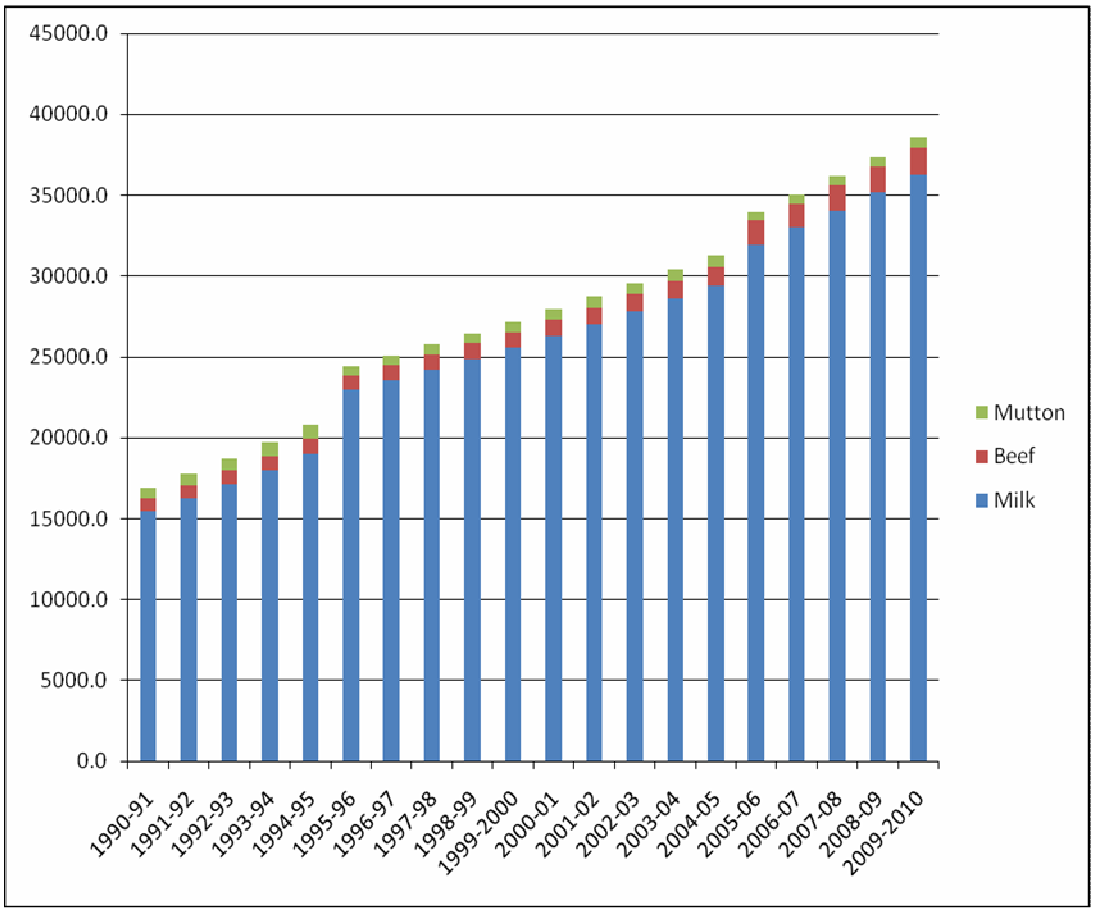
the country. Usually sheep are kept for wool and mutton production. The wool is of coarse quality and is mostly used in the local carpet industry. Local sheep breeds generally breed once a year and rarely produce twins. In Punjab, Buchi, Cholistani, Kajli, Lohi, Salt Range, Sipli and Thalli sheep are most commonly found.



Annex figure 1: Statistics for large and small ruminant population (in millions) for the period of 1991-2010.
*Source: Ministry of Livestock & Dairy Development***.**

The Government of Pakistan has started several below mentioned initiatives such as
1-Strengthening of Livestock Services Project (SLSP)
2-Livestock Production & Development of Meat Production.
3-Milk Collection Processing and Dairy Production & Development Program.
4-Prime Minister's Special Initiative for Livestock (PMSIL)
5-National Programme for the control and prevention of Avian Influenza.
6-Improving Reproductive Efficiency of Cattle and Buffaloes in smallholder's production system
7-Up gradation and Establishment of Animal Quarantine Stations in Pakistan

But all these efforts could not sustain and perished without harvesting the fruitful results. Of the many big reasons, the most significant was that the interventions were not developed according to the need of small landholders, tenants and landless livestock owners. Most of the technologies are beyond the affordable limit of the rural farmers and no effort will be acceptable to farmers until it is cost-effective, economical, efficient, practicable, adjustable, approachable, and solution oriented. The cheap technologies should also be coupled with economic incentives and services in the public and private sector. Livestock production is the second biggest economic activity after crop husbandry for rural people in the country. The activities of livestock sector needs to be concentrated with small farmers and landless livestock producers. Unless we take care of the rural livestock, the production potential of such a huge number of animals can't be enhanced. The people's land holdings gradually are getting smaller day by day creating a competitive atmosphere between crop and livestock sector

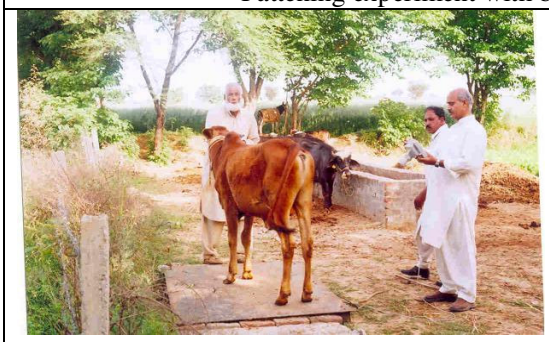


Annex figure 2. Statistics for milk, and meat (beef and mutton) production (million tons) for the period of 1991-2010.
Source: Ministry of Livestock and Dairy Development

Little efforts have been undertaken to fulfill the feeding requirements of the livestock which is basic and main hurdle to develop the livestock industry on sound basis in Pakistan especially in rainfed regions. Rural livestock production demands all kind of management of rural cattle, buffaloes, sheep, goat in a scientific and wise able way according to the modern husbandry techniques. The latest innovations demand that their management should be understood correctly and should be given due importance if the production from the animals is desired up to their genetic potentials. It requires balanced feeding and management requirements.

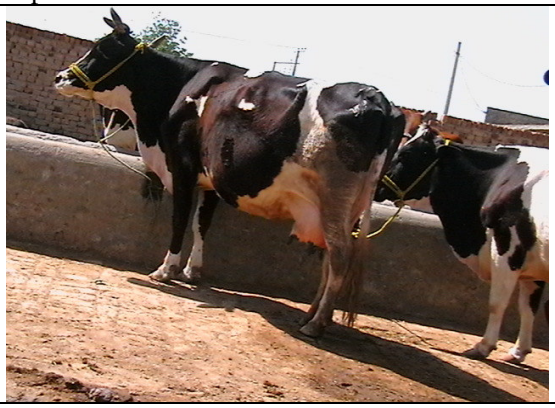
Annex 2: Selected photos from the field

Fattening experiment with buffalo and cattle calves at the rainfed site



Weighing of a cattle calf for the fattening experiment

Weighing of a buffalo calf in the fattening experiment



Feeding experiment for increasing milk production conducted with buffaloes and cows

Hygienic milk production: California Mastitis Tst	Teat dipping to prevent mastititis
Women Partcipants in one of the value addition training sessions	Women Partcipants of the value addition course with trainers
Value addition products	Value addition products

<table>
<tr><td> </td><td> </td></tr>
<tr><td colspan="2">Review mission seeing the bufflo bull provided at the irrigated sites in the project.</td></tr>
<tr><td> </td><td>
</td></tr>
<tr><td>Feed mill at rainfed site</td><td>Country representative visiting the mill along with the scientists.</td></tr>
</table>

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Annex 4: Preparation of antiseptic for teat dipping or spraying.

Iodine teat dip concentrate is very user friendly and can be prepared by the farmers themselves. It serves as an efficient disinfection and skin conditioner for better udder hygiene. This can also be used for treatment of minor injury / abrasions to animals by topical application.

Formulation:

- 10 % w/w 'PVP iodine' (equal to 1.0 % available iodine): 500 ml pack
- Glycerol as skin conditioning agent (emollient): 50 ml

Preparing concentrate: Add 50 ml glycerol to 500 ml iodine: usually 500 ml above referred pack has enough dead space that it can accommodate 50 ml of glycerol so then there is no need of second container. Concentrate is ready after mixing.

Prepare the usage solution: Mix 1 part of above "concentrate" with 4 to 5 parts of clean, preferably boiled (but first allow it to cool to ambient temperature) water.

Usage: Use as demonstrated by dipping the teats at least up to 2.5 inches depth or preferable spray by the spray bottles after each milking, morning and evening. And don't wipe it: let it dry itself. Discard any teat dip that becomes dirty or contaminated (indicated by change in color and appearance). Always use a clean dip cup or good working spray bottle.

Cautions / Precautions: Keep it in a cool (below 25^{o} C) and dark place away from light in the original container.
Keep out of reach of children. It is irritating to eye. Wash hands after application. Don't inhale the mist when spraying. Consult your doctor in case there is any excessive personal problem of irritation or allergy to iodine.
Consult your veterinarian if your animal teats are excessively sore or chapped and are not responding to this application.