An Approach in Disseminating Dual Purpose Wheat Technology : A Case from Uttarakhand, India

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ABSTRACT

To demonstrate green fodder harvest through wheat, trials at farmers' fields were conducted during winter of 2011 to 2012 to compare the impact of green fodder harvest on the grain and straw yield on two varieties - local wheat variety, and improved variety- VL 829 with and without egyptian clover with the four treatments and four replications using randomised block design in two districts of Uttarakhand. The treatments were: (1) no fodder cut; no fertiliser (2) fodder cut at 79 to 85 days after sowing; no fertiliser (3) fodder cut at 79 to 85 days after sowing with 100 kg urea (46 kg N) /ha after the cut (4) fodder cut at 79 to 85 days after sowing with 6 MT FYM /ha after the cut with four replications. Further chemical composition and nutritive evaluation was carried using proximate principles in both the varieties. In district Tehri Garhwal , harvesting fodder at 79 days after sowing of the improved variety VL 829 produced significant quantity of additional green fodder (about 3.20 MT /ha) in the lean season without any significant reduction in the grain and straw yields. In district Pithoragarh, improved VL 829 wheat variety resulted about 1.70 MT green fodder at 85 days after sowing with no significant reduction of grain yield but produced more straw (about 1.50 MT additional /ha). Thus, the fodder harvest innovation from local wheat and improved wheat was demonstrated to the farmer to get quality fodder without impacting the grain yield during the lean season for uptake.

***Key words**: Demonstration; Innovation; Dual purpose technology; Wheat; Egyptian clover; Feed scarcity;*

Most meat and milk in the developing world comes from so-called 'mixed' crop-and-livestock systems [which] . . . are central to global food security, as they also produce close to 50 per cent of the global cereal output (*Herrero et al., 2009* and *2010*).Wheat a leading cash and grain crop in many parts of the world (*Ali et al., 2007*), is of immense importance for the food security in Asia. Since 1997, India is the second largest producer of wheat in the world next only to China, contributing about 35 per cent of the total cereals produced in the county and contributes 13 per cent of the global wheat sown area and about 12.5 per cent of the global production (*FAOSTAT, 2012*).In some countries like Australia, Turkey, USA, etc. wheat is commonly grown for the dual-purpose of producing forage and grain from the same crop. Dual purpose wheat provides high quality forage for stocker cattle during the season, when other forage sources are low in quantity and quality (*Krenzer, 2000*). In some cases such as flooding or frost, only-grain wheat can be used as forage wheat and be cut for hay or silage (*Lee et al., 2007*). In the USA, forage wheat varieties have an average forage dry matter (DM) yield of about 3t/ha but some cultivars may be much more productive (7-11 t DM/ha in Montana) (*Cash et al., 2009*).

However in India, use of wheat for dual production of grain and livestock forage is limited, so is the case in Uttarakhand, a north Indian hill state where mixed crop-livestock system predominates. Small farmers are unable to put required area under green fodder due to scarce land resources as only 10 per cent of the area is irrigated where vegetables and cereal crops get preference over fodder crops and generally farmers feed livestock with dry fodder, straw which reduce productivity. In addition to it, small dairy farmers face many feed constraints such as inadequate feed quality and quantity (*Lukyu et al 2011*) along with peculiar geographical conditions and agro-ecological nature of this region, food as well as fodder/feed security at local level is of utmost importance, particularly during winter months.

Dual-purpose wheat which can provide both fodder as well as grain is a suitable option under such situation as indicated in studies reported by various scientists (*Sharma et al, 1985; 87; Singh, 1987; Singhal, Tripathy, Singh and Harika, 2008; DARE/ICAR Annual Report, 2009- 2010*) revealed that cereal crops, if used as dual purpose crops (grains as food for humans and green fodder as feed for livestock), fodder shortage in the lean seasons can be reduced to a great extent.

Dual purpose wheat technology refers to growing of wheat for green fodder until 55-60 day after sowing and then for grain and dry straws (Bhusa). In order to have increased biomass, dual purpose wheat can be planted with Egyptian clover (berseem) in late October. In hill region in wheat this stage is reached between 70-90 days after sowing; the crop is harvested at 2-3 inches above ground or above second node to facilitate regeneration of the wheat crop. Berseem crop can be knocked out using hand weeding 3-4 days after harvesting of green fodder. The practice is very useful in peri-urban interface where there is demand for green fodder by dairy farmers. To address the feed quality and quantity constraints dual purpose wheat (*Triticum spp.*) along with Egyptian clover (*Trifolium alexandrium*) could be a good option. Results revealed in Indian multi-location farmer participatory trials dual purpose wheat sole or in mixed stand with Egyptian clover, can yield an additional 12 to 15 t/ha green fodder for livestock feeding and increased the farm gate return by more than Rs.10620 per ha. (*Kamboj, 2012*).Often farmers and researchers have apprehensions that cutting wheat for green fodder will not regenerate or the practice may result in heavy yield penalty in grain production. Results from the field trials have indicated that wheat crop regenerates very fast when cut above second node as reflected by dynamic NDVI measurements taken with Green Seeker optical sensors for 55-60 days old crop (*Kamboj, 2012*).

Against this background, with an objective to create awareness of the tested innovative technology for adoption, among the less progressive farmers, demonstration method was used for informing farmers on benefits of cutting wheat as fodder. This paper presents the findings from the farmers' fields on comparative analysis of dual purpose wheat varieties local and improved with and without berseem, with and without top dressing of manure/fertiliser after green harvest along with nutritive evaluation.

METHODOLOGY

The experiment was conducted at farmers' fields in village Kothera and Thaeli of a northern state Uttarakhand of India.

Table 1. Detail of study site in Uttarakhand, India

Details	Tehri Garhwal	Pithoragarh
Latitude	30.3‘ and 30.53‘N	29.4° to 30.3° N
Longitude	77.56‘ and 79.04‘ E	80° to 81° E
Village	Thaeli	Kothera
Altitude	975m	1500m
Population density (per kilo meter^2)	169	68
Av. temperature	1.80 to 32^{0}C	5.5 to 45^{0}C
Av. annual rainfall	1228mm	1051.4 mm

Treatment and Experimental design: The trial was carried out with two varieties - local wheat variety (the name not known by the farmers) and improved variety-named VL 829 in completely randomised block design with plot size of 2m^2. Trial followed four treatments with four replication with berseem and without berseem:

(1) No fodder cut; no fertiliser
(2) Fodder cut at 79 to 85 days after sowing; no fertiliser
(3) Fodder cut at 79 to 85 days after sowing with 100 kg urea (46 kg N) /ha after the cut
(4) Fodder cut at 79 to 85 days after sowing with 6 MT FYM /ha after the cut.

The trial variety was same in all the replications. Sowing time in all the plots was same. The wheat crop was sown (seed rate 100 kg/ha) along with Egyptian clover/berseem (seed rate 25 kg/ha) in the first location (Tehri Garhwal) on November 7, 2011 using seed drill. As per treatments, harvesting of crop for fodder was done at 79 days after sowing, followed by critical irrigation and final harvest was done at 180 days after sowing. In the second location, Pithoragarh the seeds were sown (broadcasting) on November 30, which was late by 45 days compared to the normal sowing season (mid October) and fodder was harvested at 85 days after sowing. Here also, irrigation was given at 87th days after sowing and final harvest was done at 171 days after sowing 100 kg urea (46 kg N) /ha was applied within 10 days of sowing and after the defoliation in the selected

plots was applied. While in plots with FYM treatment 6 MT FYM /ha after the cut was applied. Wheat crop was cut before node formation in the wheat plant at $2^{1/2}$ - 3 inches above the ground in both the sites. Observations were recorded using a quadrate of 0.25/ meter^2 at three places from a plot. Non destructive observations like- number of wheat, berseem plant /meter^2, plant height and number of tillers/meter^2 was recorded. Destructive observations like- green fodder yield, average number of grain /spike, average gram 1000 grain weight, total biomass was recorded. Berseem was uprooted with the roots at 79 days after sowing in Tehri Garhwal and 85th day in district Pithoragarh. Feed samples were collected, pooled and chemically analysed for proximate principles as per Association of Official Analytical Chemists (*AOAC, 1995)* for nutritive evaluation. The data were statistically analysed using mean and standard error as per standard procedure (*Snecdecor and Cochran,1994*) and Statistical analysis carried out by General Linear Models (GLM) procedures using SAS (9.2) to draw meaningful conclusion.

RESULTS AND DISCUSSION

Non-destructive and destructive observations at the two trial sites after sowing: It was observed in Tehri Garhwal district at 79 days after sowing that average number of plants/m^2 (52 to 131 *vs* local variety 25 to 70), the number of tillers/m^2 (248 to 336 *vs* local 139 to 234), average number of berseem plants /m^2 (335 to 486 *vs* local 236 to 421), average height of wheat plant (26.65 to 33.97cm *vs*. local (22.1 to 25.2 cm), mean green fodder yield (2.75t/ha vs local 1.73 t/ha) was more in improved variety VL 829 than the local wheat. Average plant height of berseem in local as well as improved wheat VL 829 was in the range from 11.6 to 14.4 cm. In case of Pithoragarh, at 85 days after sowing it was observed that the average number of plants/m^2 ranged between (359 to 666) in local wheat was less than the improved wheat (481 to 821). In improved wheat the number of tillers/m^2 ranged between (592 to 838) while (522 to 860) in local. Average number of berseem plants /m^2 was more in improved wheat (270 to 391) than in the local wheat (185 to 321). Average plant height in improved wheat VL829 was (22.10 to 24.94 cm) less than local wheat (22.9 to 28.1 cm). Average plant height of berseem in local as well as improved wheat VL829 was in range between 5.88 to 7.1 cm. The mean average green fodder yield from local variety (2.16 t/ha) was more than that of improved wheat (1.92 t/ha). These variations could be because of different soil and agro-climatic conditions. In Pithoragarh before the green fodder harvest the number of plants and tillers were more in the improved variety than the local one. When fodder was cut at 85 DAS, the plants and tillers of local variety increased in number in the berseem and non-berseem plots. In the case of improved variety though the number of plants increased after cutting, the number of tillers got reduced in berseem and non-berseem plots. In district Tehri Garhwal, as far as the green fodder yield is concerned (Table 2) in the case of local varieties, it increased with urea application (in plots with and without berseem) and FYM application (in berseem plots). In the case of improved varieties, the yield was less in the rest of the treatments.When fodder was cut at 79 days after sowing, the plants and tillers increased in number and the increase was more when urea was applied. When berseem was sown along with wheat it did not show much change in these parameters after fodder cut. While in case of

Table 2. Destructive observation of local and improved variety VL 829 at two sites

Treatments	Green fodder yield (ton/ha) in 79 DAS* at Tehri Garhwal		Green fodder yield (t/ha) in 85 DAS* at Pithoragarh	
	Local	VL829	Local	VL829
No berseem; Cut; No Urea/FYM	1.56	2.88	2.12	1.59
No berseem; Cut + Urea @ 100 kg /ha	1.88	2.72	2.36	2.36
No berseem; Cut + FYM @ 6 MT /ha	1.36	2.24	2.06	1.70
With berseem; Cut; No Urea/FYM	3.20	1.90	1.86	2.18
With berseem; Cut + Urea @ 100 kg /ha	2.22	1.72	2.28	1.69
With berseem; Cut + FYM @ 6 MT /ha	2.94	1.96	2.30	1.93
Mean (across 6 treatments, 24 replications)	1.73	2.75	2.16	1.92

*DAS=days after sowing

Pithoragarh the local variety produced more than the improved one. The yield of the both varieties increased slightly across all treatments.

Non-destructive and destructive observations at the trial sites at the time of harvest: In district Tehri Garhwal at 180 days after sowing, average plant height in local variety ranged from (90.1 to 97.15 cm) which was more than the improved wheat variety VL 829 (85.05 to 94.97 cm). The spike length ranged from 10.8 to 11.8 cm in local and 9.7 cm to 11.8 cm in improved variety. Number of tillers/m^2 (302 to 355) in improved variety was more than local variety ranged which from (201 to 271) In case of Pithoragarh, 171 days after sowing, average plant height in local variety ranged from (59.20 to 65.90 cm) which was less than the improved wheat variety VL 829 (66.70 to 76 cm). The spike length ranged from 5.62 to 6.32cm in local was less than improved variety (6.22 to 7.20 cm). Number of tillers/m^2 (594 to 859) in improved variety was more than local variety (509 to 719). In Tehri Garhwal it is found that average number of grains per spike ranged between 45.7 to 58.5 while in case of improved variety it was between 45.9 to 55.5. The range 41.54 to 50.09 was average gram 1000 grain weight in local variety in comparison to 38.35 to 50.33 in improved variety. It was observed that fodder harvest had not significant difference on the plant height, spike length and number of tillers in both local and improved varieties with and without berseem. In the local and improved varieties without berseem the number of grains per spike and 1000 grain weight had not significant difference when fodder was cut with and without fertilizer /manure application. But with berseem there was reduction in both these characteristics in both the varieties. Regarding the total biomass yield, it got reduced by about 30 per cent in both local and improved varieties when fodder was cut at 79 days after sowing from plots with and without berseem (this is explained by removal of green fodder at the rate of1.73 MT and 2.75 MT /ha from local and improved varieties respectively). In case of Pithoragarh, it is found that average number of grains per spike ranged between 44 to 50 in local and between 42 to 48 in improved variety VL-829. The range 28.03 to 30.90 was average gram 1000 grain weight in local variety in comparison to 36.40 to 39.57 in improved variety. It is found that fodder harvest did not influence much on the plant height, spike length and number of tillers in both local and improved varieties with and without berseem. In the local and improved varieties the number of grains per spike and 1000 grain weight did not change much across treatments when fodder was cut with and without fertilizer /manure application while the total biomass yield got reduced lightly in both local (7.63 t/ha to 10.93 t/ha) and improved varieties (9.72 t/ha-11.70 t/ha) when fodder was cut at 85 days after sowing from plots with and without berseem.

Impact of fodder harvest on grain and straw yield in experimental sites: Statistical analysis carried out by General Linear Models (GLM) procedures using SAS (9.2) software revealed that in Tehri Garhwal between varieties (across all treatments) there is significant difference ($p<0.05$) for green fodder yield (improved variety better) but the difference is not significant for grain and straw yields though they appear to be more in the case of improved variety (Table 3). It means harvest of green fodder can be recommended in both the varieties but it is strongly recommended in the case of improved variety as the quantity of fodder produced by the improved variety is higher and significant. In district Pithoragarh between varieties (across all treatments) there is significant difference ($p<0.05$) in straw yield (improved variety better) but the difference is not significant for grain and fodder yields (Table 3). Therefore, cutting green fodder can be recommended in the case of improved variety as the quantity of straw produced by it is higher and significant (in the local variety also farmers can be advised to cut fodder as cutting has no significant impact on grain and straw yields).

Table 3. Impact of varieties on green fodder, grain & straw yield

Varieties	Tehri Garhwal			Pithoragarh		
	F	G	S	F	G	S
Local variety	1.73	3.95	3.11	2.16	4.31	4.51
Improved variety	2.75	4.47	3.83	1.92	4.26	6.44
Overall mean*	2.24	4.21	3.47	2.04	4.29	5.48
Probability (P)	0.0031	0.21	0.88	0.30	0.91	<0.0001
LSD	0.65					0.84

If $P< 0.05$, significant at 5% level of significance; $P>0.05$, NS; *across treatments; F=Fodder, G=Grain, S=Straw,

In districts Tehri Garhwal and Pithoragarh in case of treatments are concerned (Table 4) both in the case of local and improved varieties, there is no significant impact on fodder, grain and straw yields among various treatments. However, in Tehri Garhwal though not significant, if farmers chose improved variety for dual purpose, the best treatment is found to be sowing wheat

Table 4. Impact of treatments on green fodder, grain & straw yield in

Treatments	Tehri Garhwal						Pithoragarh					
	Local Variety			VL-829			Local Variety			VL-829		
	Fodder	Grain	Straw	Fodder	Grain	Straw	Fodder	Grain	Straw	Fodder	Grain	Straw
No Berseem; Cut; Urea	1.88	4.60	3.18	2.72	3.60	3.20	2.36	5.00	4.04	2.36	4.24	5.86
No Berseem; Cut; FYM	1.36	4.22	2.82	2.24	3.98	3.56	2.06	3.84	3.79	1.70	4.78	5.92
No Berseem; Cut; No Urea/FYM	1.56	4.12	2.70	2.88	3.80	3.36	2.12	3.98	4.16	1.69	3.82	5.77
With Berseem; Cut; Urea	1.72	3.40	2.82	2.22	4.68	3.12	2.28	4.22	5.28	1.69	4.44	7.10
With Berseem; Cut; FYM	1.96	2.70	2.36	3.22	3.52	3.04	2.30	3.53	4.41	1.93	3.96	7.00
With Berseem; Cut; No Urea/FYM	1.90	3.38	3.02	3.20	5.32	3.70	1.86	3.48	4.50	2.18	3.62	7.30
Overall mean (across treatments excluding no cut)	1.73	3.73	2.81	2.75	4.15	3.33	2.16	4.01	4.36	1.92	4.14	6.49
Probability (P)	0.97	0.35	0.86	0.58	0.52	0.98	0.96	0.18	0.89	0.65	0.96	0.41

If P< 0.05, significant at 5% level of significance; P>0.05, NS

Table 5. Selection of variety and treatment – the decision matrix

In Tehri Garhwal			
Presently, local variety yields	→	No Fodder	→ 5.46 MT grain* and 4.78 MT straw*
Local variety when cut at 79 DAS	→	1.88 MT Fodder	→ Application of urea after fodder harvest (best treatment) will produce 4.60 MT grain and 3.18 MT straw
Improved variety when cut at 79 DAS	→	3.20 MT Fodder (significant)	→ Sowing wheat with berseem (best treatment) will produce 5.32 MT grain and 3.70 MT straw
In Pithoragarh			
Presently, local variety yields	→	No Fodder	→ 5.20 MT grain* and 4.40 MT grain*
Local variety when cut at 85 DAS	→	2.36 MT Fodder	→ Application of urea after fodder harvest (best treatment) will produce 5 MT grain and 4.04 MT straw
Improved variety when cut at 85 DAS	→	1.70 MT Fodder	→ Application of FYM after fodder cut (best treatment) will produce 4.78 MT grain and 5.92 MT straw (straw significant)

** Average of four replications of the treatment "no berseem, no cut, no urea /FYM"*

with berseem as it is found to yield more quantity of grains (5.32MT) in comparison to other treatments. Whereas if they choose local variety for dual purpose, then they can go for urea application after fodder cut as it produces comparatively more quantity of grains (4.60 MT).

In case of Pithoragarh, if farmers chose improved variety for dual purpose as it has significant straw yield), the best treatment is found to be application of FYM after fodder cut as it is found to yield more quantity of grains (4.78 MT) in comparison to other treatments. Whereas if they choose local variety for dual purpose, then they can go for urea application after fodder cut as it produces comparatively more quantity of grains (5 MT) among other treatments.

In Tehri Garhwal farmers can be strongly advised to go for the improved variety (VL 829) and harvest about 3.20 MT of green fodder at 79 DAS and following the best treatment (sowing wheat with berseem) to have maximum grain yield while in case of district Pithoragarh farmers can harvest about 1.70 /2.36 MT of green fodder per ha in both the varieties without any significant reduction in grain yield. But the improved variety, in addition to green fodder, can also produce significantly higher quantity of straw (about 1.50 MT additional, compared to the local).

Chemical composition and nutritional evaluation: The chemical composition of local and improved wheat VL 829 - green fodder, straw and seed is (% DM basis) is presented in Table 6.Whole-crop wheat forage has a highly variable composition, depending on maturity stage,

Table 6. Chemical composition of local wheat and improved wheat VL-829 from the trial sites

Wheat	Average range*				
	DM %	EE%	CP%	CF %	AIA %
Local Wheat – Green fodder	77.28-81.58	2.45-2.70	9.20-10.75	27.50-28.88	1.12-2.12
Local wheat – Straw	9.20-10.65	0.52-0.75	2.80-3.20	32.15-34.00	1.78-2.10
Local wheat – Seed	10.20-18.40	2.11-3.11	9.75-11.20	9.50-10.86	0.32-0.40
Improved wheat VL 829 Green fodder	75.90-80.00	2.50-2.80	8.10-10.22	27.20-28.85	1.34-2.08
Improved wheat VL829 Straw	7.60-11.30	0.70-0.85	2.90-3.18	32.90-34.50	1.65-2.15
Improved wheat VL-829 Seed	10.75-12.75	2.75-3.33	9.82-12.50	9.85-11.20	0.30-0.80

**DM=dry matter, EE=ether extract, CP=crude protein, CF=crude fibre, AIA=acid insoluble ash, Values are on DM basis except for dry matter*

climate and other parameters. The results shown below indicates that crude protein values in local wheat varied from 9.20-10.75 per cent as against 8.10 to 10.22 per cent on dry matter basis in improved wheat VL-829. This variation could be because of varietals difference, location and can be attributed because of factors like-season, soil, environment and stage of harvest.

CONCLUSION

It can be concluded that, based on the results of multi-location farmer participatory trials dual purpose wheat sole or along with berseem can address the quantity and quality constraints of green fodder during lean season when the land is limitation. This intervention is successful in plains of India where unlike hills the green fodder is sold to the landless dairy farmers. Also in the plains, the wheat crop is ready for first fodder cut between 50-60 days after sowing, while in case of hills of Uttarakhand two districts Tehri Garhwal and Pithoragarh, harvesting fodder stage comes between 79-85 days after sowing. Perhaps it can be said that in any part of the country wheat crop can be harvested for fodder before node formation, it can yield grain and fodder. Improved variety VL 829 produces significant quantity of additional green fodder (about 3.20 MT /ha) in the lean season without any significant reduction in the grain and straw yields. But as the land parcels in hills are small, so green fodder supply will last maximum for a month. The best treatment to be followed to achieve this is 'sowing of berseem along with wheat. In Pithoragarh , farmers can grow the improved VL 829 variety and cut about 1.70 MT green fodder at 85 DAS. It will have no significant reduction of grain yield but will produce more straw (about 1.50 MT additional /ha). This is resulted by the best treatment 'application of FYM after fodder cut'. The trial results at farmers' fields were demonstrations to show the farmers that wheat crop yield fodder when cut before node formation, during feed scarce winter season without negatively impacting the grain yield.

Acknowledgement: This research was part of the programme "Enhancing Livelihoods through Livestock Knowledge Systems", of ILRI which was funded by Sir Ratan Tata Trust and Navajbai Ratan Tata Trust.

Paper received on : February 24, 2014
Accepted on : April 17, 2014

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