Suitable varieties and cropping systems

in underutilized crops for north west hills

R P Dua[1], B S Phogat[2] and H L Raiger[3]

NBPGR, Pusa, New Delhi 110 012

Hill states of Himachal Pradesh, Jammu and Kashmir and Uttarakhand in north-western Himalayan region have so far remained traditional in agriculture despite the adequate research and infrastructure development. Nearly 82% of the farmers are either small or marginal and are women with land holdings of less than 2 hectares which are widely scattered in remote villages. The agricultural conditions here are very different from the plains and as a result the Green Revolution has bypassed them. In remote and tribal areas which are not linked with transport facilities, only the traditional crops useful to their life support systems and endowed with better nutrition and medicinal properties, find place in agriculture. Since these crops have not been commercially exploited to the advantage of the farmers, these crops have been termed as underutilized crops. The work for the improvement and utilization of these crops has been carried out in All India Coordinated Improvement Project on Underutilized Crops. A brief account of the important underutilized crops in respect of the varieties developed and suitable cropping systems identified to raise the level of income in hill agriculture is discussed.

Hill states of Himachal Pradesh, Jammu and Kashmir and Uttarakhand in north-western Himalayan region have so far remained traditional in agriculture despite the adequate research and infrastructure development. Nearly 82 per cent of the farmers are either small or marginal and are women with land holdings of less than 2 hectares which are widely scattered in remote villages. The agricultural conditions here are very different from the plains and as a result the Green Revolution has bypassed them. In remote and tribal areas which are not linked with transport facilities, only the traditional crops useful to their life support systems and endowed with better nutrition and medicinal properties, find place in agriculture. Since these crops have not been commercially exploited to the advantage of the farmers, these crops have been termed as under utilized crops. The work for the improvement and utilization of these crops has been carried out in All India Coordinated Improvement Project on Underutilized Crops. The important underutilized crops in respect of the varieties developed and suitable cropping systems identified to raise the level of income in hill agriculture has been briefly accounted here.

Besides minor and small millets, the important underutilized crops in north west hills are amaranth, buckwheat, chenopods, rice bean, faba bean and perilla. Among these amaranth and buckwheat are grown even as pure crop on large areas whereas others are grown either in small pockets or as mixed crop or just in house premises. All these crops are nutritionally better than other food crops (Table 1) and are resilient in respect to biotic and abiotic stresses. Therefore, these crops assume significance in respect of their commercialization so that the income level of farmers can be raised.

Grain amaranth

Grain amaranth is cultivated as a leafy vegetable and is an important subsidiary food grain crop. This crop is cultivated in *kharif* season as a rainfed crop. Its grains are rich source of protein having highest percentage of lysine (6%). It is a versatile crop, grown in a wide range of agro-climatic conditions (temperature 20-40°C, elevation 500-2500 m amsl and rainfall 800-1500 mm). The C4 plant species is considered to be extremely energy efficient because of its superior photosynthetic pathway and thus can be a suitable crop for diversifying.

[1]ADG (FFC), ICAR, Krishi Bhawan, New Delhi 110 001; [2]Senior Scientist, Germplasm Evaluation Division; [3]Senior Scientist, AICRP on Underutilized Crops

Table 1. Nutritional status of minor food crops per 100 g (Joshi and Paroda 1991)

Food grain	Protein (g)	Carbo-hydrates (g)	Lipid (g)	Crude fibre (g)	Mineral matter (g)	Ca (mg)	P (mg)	Fe (mg)
Amaranth	16.0	62.0	8.0	2.43	3.0	490	600	17.5
Buckwheat	13.0	72.9	7.4	10.5	2.1	120	280	15.5
Chenopodium	14.0	65.0	7.0		3.0			
Job's tear	11.4	73.5	3.5		0.8			
Foxtail millet	12.3	60.9	4.3	8.0	3.3	31	290	5.0
Maize	11.0	66.0	3.5		1.1			
Barley	11.0	69.0	1.3		1.9			
Wheat	12.0	69.0	1.7	1.2	2.7	41	306	5.3
Rice	6.7	78.0	0.3	0.2	0.3	45	160	3.5

Table 2. Weighted mean grain yield of amaranth varieties tested for four years in north-western hills

Variety	2005	2006	2007	2008	Weighted mean	
					Mean	Rank
'VL 44'	17.69(5)	23.15(5)	13.77(4)		18.52(14)	
'Annapurna'	17.47(5)	22.84(5)	19.83(3)	20.57(4)	20.20(17)	II
'IC 35407' ('Durga')	19.10(5)	28.35(5)	17.47(4)	24.30(4)	22.46(18)	I
'PRA 2'	17.12(5)	21.39(5)	15.91(4)	17.47(4)	18.12(18)	
'PRA 3'	18.19(5)	21.24(5)	16.86(4)	18.15(4)	18.73(18)	III

Values in parenthesis are the number of locations tested

Table 3. Weighted mean maturity days of amaranth varieties tested for four years in north-western hills

Variety	2005	2006	2007	2008	Weighted mean	
					Mean	Rank
'VL 44'	118.00(5)	109.57(5)	124.21(4)		116.76(14)	I
'Annapurna'	130.13(5)	131.80(5)	141.78(3)	143.67(4)	135.86(17)	
'IC 35407'	117.80(5)	109.97(5)	124.00(4)	118.08(4)	117.07(18)	II
'PRA 2'	127.13(5)	130.70(5)	139.50(4)	141.67(4)	134.10(18)	III
'PRA 3'	129.67(5)	130.60(5)	140.92(4)	142.92(4)	135.38(18)	

Values in parenthesis are the number of locations tested

Table 4. Yield (kg/ha) and monetary returns from different intercrops with grain amaranth in hills under drought conditions

Treatments	Grain yield (kg/ha)		Grain amaranth equivalent (Kg/ha)	Gross returns (Rs/ha)
	Grain amaranth	Intercrop		
Grain amaranth + rice bean (1: 2)	444.44	50.00	527.77	**7916.15**
Grain amaranth + cow pea (1: 2)	277.80	50.00	377.80	5667.00
Grain amaranth + french bean (1: 2)	333.33	272.20	968.46	**14526.90**
Grain amaranth + finger millet (1: 2)	211.10	116.70	250.00	3750.00
Grain amaranth + barnyard millet (1: 2)	416.70	88.90	452.26	6783.90

Through All-India Coordinated Research Project, five varieties namely 'Annapurna', 'PRA-1', 'PRA-2', 'PRA-3', 'VL Chua 44' and 'Durga' have been released during 1983-84, 1996-97, 1999-2000, 2002-03, 2005-06 and 2005-06 respectively. Trials conducted during the last four years on the performance of these varieties (Table 2) under recommended package of practices for its cultivation with fertilizer doze of N : P: K @ 60 : 40 : 20 kg/ha and inter row spacing of 45 cm have revealed that the oldest variety 'Annapurna' is still a ruling variety, holds promise and gives on an average 20 q /ha. This variety is drought tolerant and widely adapted. The new variety 'Durga' gives about 22 q/ha grain yield and matures earlier by 10-15 days than other high yielding varieties taking about 117 days for maturity (Table 3). It is recommended for rainfed and low to medium input conditions in mid to high hill regions of India. The crop is grown mainly as a sole crop. However, the crop can be suitably grown as a mixed crop with either maize, small millets, french bean or other beans. The best economic yields can be obtained when amaranth and french bean are grown in 1:2 row ratio (Table 4). It is also found that the fertilizer doze recommended for pulses (N : P @ 20 : 40 kg/ha) is sufficient to give higher economic yields in inter-cropping systems and there is no need to apply extra doze of fertilizer to amaranth (Table 5).

Buckwheat

Its tender shoots are used as leafy vegetable. The grain, as a food, is used in several culinary preparations during fast and religious festivals in India. The plant also has a medicinal value due to presence of a glucoside called 'rutin' which strengthens blood vessels and is used in the treatment of several other diseases as well. Buckwheat is an excellent source of lysine and is the only food grain, not deficient in nutritional quality. Buckwheat grain contains comparatively lesser protein than that of wheat, barley, rye or oats but slightly more than that of maize. The biological value of protein is superior to other food plants and is nearly equal to that of eggs.

Four important varieties have been released for north west hills. These are 'Himpriya' (*F. tataricum*), 'VL Ugal 7' (*F. esculentum*), 'PRB 1' (*F.*

Table 5. Economics of different fertilized dozes in amaranth based intercropping systems in hills under normal rainfall

Treatment	Fertilizer dose	1st crop yield (q/ha)	Grain amaranth yield (q/ha)	Grain amaranth equivalent yield (q/ha)	Straw yield (q/ha)	B : C ratio	Net profit (Rs)
Rice bean + grain amaranth (2 : 1)	F_1	6.06	6.56	16.66	28.61	1.47	8056.00
	F_2	9.87	7.39	23.84	31.64	2.00	17877.00
	F_3	7.56	7.34	19.94	28.26	1.75	12883.00
French bean + grain amaranth (2 : 1)	F_1	9.99	6.11	29.42	32.65	2.49	26384.00
	F_2	14.22	9.08	42.26	36.48	3.57	45646.50
	F_3	10.86	8.74	34.08	35.19	2.75	32535.50
CD (5%)		3.60	NS	4.90	4.34		
CV (%)		24.91	26.30	11.75	8.97		

F_1 : N_{27} P_{33} (kg/ha) : Average of RDF for pulse crop & amaranth
F_2 : N_{20} P_{40} (kg/ha) : RDF for pulse crop
F_3 : N_{60} P_{60} (kg/ha) : RDF for amaranth

Table 6. Effect of seeding time of tartary buckwheat as intercrop in kalazira

Treatment	Buckwheat		Kalazira yield (kg/ha)	Kalazira equivalent yield (kg/ha)	Net returns	B : C ratio
	Seed yield (kg/ha)	Straw yield (Kg/ha)				
Sowing date						
June 30	1719	2708	223.1	278.1	100,496	3.11
July 7	1573	2500	225.2	275.5	98,761	3.05
July 14	1511	2761	222.6	271.0	97,447	3.01
Kalazira sole			222.6	222.6	71,337	2.48
Seed rate (kg/ha)						
40	1736	2917	226.3	295.8	110,841	3.41
60	2049	3680	224.0	306.0	117,712	3.58
80	1563	2292	223.2	285.7	103,312	3.11
100	1056	1736	222.0	264.2	91,303	2.71

Table 7. Gross return (Rs./ha) and cost benefit ratio of different crop rotations in hills.

Treatment	1st season crop (rice bean)	2nd season crop	Pooled income	Total cost of cultivation	B : C ratio
Rice bean –wheat	12,850.00	15,240.00	28,090.00	19,206.50	1.46
Rice bean –mustard	11,097.50	19,005.00	30,102.50	17,846.00	1.68
Rice bean –pea	10,406.50	31,969.00	42,375.50	19,346.00	2.19

esculentum) and 'Himgiri' *(F. tataricum)* released in 1991, 1991, 1998 and 2006 respectively. The testing of these varieties continuously for four years indicated that tataricum types are higher yielding than the esculentum types as the former are more tolerant to low temperature being grown in higher hills up to 3500 m, are self fertile and escapes yield losses due to rains. Among esculentum types 'PRB 1' is better adapted than 'VL 7', the latter being a state released variety from Uttarakhand, whereas the former has been released for cultivation in hills of Uttarakhand (erstwhile Uttar Pradesh), Himachal Pradesh and north eastern states. Varieties 'VL 7' and 'Himgiri' (Table 7) are earlier in maturity (80 days) when planted during normal spring season and are suitable for cultivation in double cropping systems after taking pea / potato / beans. This crop can also be cultivated in orchards of apple and kalazira (*Bunium persicum*) plantings. The B: C ratio for late sowings of buckwheat in end of June as an inter crop in kalazira has been recorded to be higher (3.11) as compared to July sowings and it was highest (3.58) when 50% higher seed rate of buckwheat (60 kg /ha) was used (Table 6).

Rice bean

Rice bean is a promising multipurpose crop with a good potential to be used as food, fodder, green manure and cover crop. It is immune to Yellow Mosaic Virus (YMV), a prominent disease in greengram and blackgram and thus can easily replace greengram in plains if short duration varieties are developed. The crop can also be used as a donor for incorporating disease resistance in other *Vigna* species. The nutritional quality of rice bean has been reported to be the best among all the traditional pulses on account of its high protein and appreciable quantities of two limiting amino acids : methionine and tryptophan. It contains high quality of vitamins: thiamine, niacin and riboflavin. Calcium and iron contents are also appreciably high. Phytin-phosphorus which generally inhibits the phosphorus availability and lowers the protein digestibility in most of the Asian pulses is low in this bean.

Two varieties 'PRR 1' and 'PRR 2' for north west hills and a variety 'RBL 1' for plains have been released during 1995, 1997 and 1986 respectively. The testing of these varieties during last four years clearly indicated that the varieties 'PRR 1' and 'PRR 2' released for hills gave better yield and matured earlier than the variety 'RBL 1' released for plains. Among varieties released for hills, variety 'PRR 2' was

(Continued on page 18)

Suitable varieties and cropping...
(Continued from page 12)

better adapted and gave more seed yield than 'PRR 1' since the latter has been released only for Uttarakhand state. The variety 'PRR 2' gave average seed yield of 12. 46 q/ha against 11.91 q/ha of 'PRR 1'. Both the varieties matured in about 126 days.

Rice bean has been recorded to perform better than greengram and blackgram as a pulse crop and better than cowpea as a fodder crop at an elevation of 2000-2200 m amsl. Among different crop rotations, rice bean – pea rotation has been found to be most economical (Table 7).

Rice bean being a leguminous crop, is also better suited to be used as an intercrop with either maize or amaranth in hills. As indicated in Tables 4 and 5, it is an important intercrop for amaranth, next to french bean, when grown in row ratio of 2 : 1, giving a gross return of about Rs. 8,000 per hectare under stress conditions and net profit of about Rs. 18,000 per hectare under well fertilized and normal rainfall conditions.

SUMMARY

In hills, the underutilized crops play a significant role in agriculture for food, nutrition and house hold security for the people inhabiting in remote and inaccessible areas. These crops are nutritionally superior to the regular cereals and some of them have medicinal value also. These crops are resilient in nature and can withstand weather adversaries. The farmers have been cultivating these crops to sustain their livelihood and nutritional security. To raise the status of these poor farmers, it is important to develop superior varieties and standardize the cultivation practices and cropping systems in these crops for higher production and productivity. Several varieties have been released in crops like amaranth, buckwheat and rice bean. An analysis of the data gathered over four years revealed that the varieties 'Annapurna' and 'Durga' in amaranth; 'Himpriya' and 'Himgiri' (*F. tataricum*) and 'PRB 1' (*F. esculentum*) in buckwheat and 'PRR1' in rice bean are the best varieties in hills. Best economic yields can be obtained when amaranth and french bean are intercropped in row ratio of 1: 2 with fertilizer doze of pulses (20 N: 40 P kg/ha). In higher hills (1800-2000 m amsl) rice bean followed by pea as a vegetable crop is the most profitable crop rotation. In buckwheat early maturing varieties 'Himgiri' in tataricum type and 'VL 7' in esculentum type are best suited for double cropping system after taking either pea or potato. ■