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Evaluation of French Bean Germplasm Based on Farmer Specified Attributes through Participatory Varietal Selection (PVS) In Kashmir Valley

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ABSTRACT

French bean (Phaseolus vulgaris L.) is the most important vegetable-cum-pulse crop of the world covering about half of the global pulse acreage. The yields are disappointingly low in India as compared to about very high yield levels in some other countries like china. French bean being an important vegetable crop of valley was used as a target crop for identification of farmer preferred genotypes. Participatory rural appraisal was done in the sixteen locations using a structured questionnaire based on socio-economic attributes, farming systems, production constraints and varietal preferences. The results indicated that there was significant difference among various traits. A grandmother trial comprising of 50 genotypes was laid at main campus Shalimar while as mother trial comprising 30 genotypes was laid at four locations namely Rangar and Daetmuribagh (Budgam), Yarmuqam and Arhama (Ganderbal). Participatory varietal selection was done at farmer's field and through farm walk when the pods were at edible stage. During farm walk voting for each genotype was done and preferential score was calculated for each genotype. Genotypes which were selected by farmers almost at every location were; WB-195, WB-1186, WB-940, WB-648, WB-160, WB-1538 etc.

Key words: *French bean, PRA, PVS, grandmother trial*

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) is the most important vegetable-cum-pulse crop of the world covering about half of the global pulse acreage. In India, it is cultivated in Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Uttar Pradesh and North-easternStates as an important warm season vegetable-cum-pulse crop. Green bean is globally cultivated over an area of 1.5 million ha with a production and productivity of 19.83 million tons and 13.26 tha^{-1}, respectively. China has the largest acreage under green beans accounting for about 40 per cent of area (0.57 million ha) and is also the leading producer with a production of about 15.21 million tons (about 75%) followed by India, Thailand and Indonesia.

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In India, Green beans are grown over an area of about 2.1 lakh ha with production and productivity of 5.88 lakh tons and 2.80 kgha^{-1}, respectively[3]. The yields are disappointingly low in India as compared to about very high yield levels in some countries such as 25.95 t ha^{-1} (China), 23.50 t ha^{-1} (Tajikistan) and 21.66 t ha^{-1} (Poland)[4]. In J&K, French bean is cultivated over an area of about 2000 hectares with production of about 1600 tonnes and yield of about 0.8 t ha^{-1}[5]. However actual figures of French bean are not known. Beans are unique crops in having an inbuilt capacity for fixing atmospheric nitrogen, and therefore crops meet their own nitrogen requirement to a great extent and also leave nitrogen in the soil available to the succeeding crop. They are also important constituents in the diets of a very large number of people, especially in the developing countries and are good sources of protein(>20%), when taken in pulse form and help to supplement cereal diets, improving their nutritive value. whereas their by products provide nutritious fodder for livestock. Despite being called as "Grain of Hope" and "Poor Man's Meat", this crop has not received the just attention from breeders, farmers and policy makers alike due to inherent low yield of pulses, relegation to harsh environments; lack of major technological breakthrough and the lack of encouraging market and price support from the government[10].

Plant breeding, across crops and breeding programmes, has been instrumental in creating a broad spectrum of varieties that have served to enhance the productivity and profitability, resilience to biotic and abiotic stresses as well as quality of produce for industrial use. A critical appraisal of the various national and international breeding programmes reveals that even though the time period for product development has remained more or less same, the product life has declined significantly due to rapid changes in consumer preferences, climatic regimes, pattern of distribution of stresses. Even more disgusting feature of recent plant breeding programmes has been that by the time a variety is developed and ready for release, it has lost its relevance resulting in little or absolutely no adoption.

Participatory rural appraisal is an exercise aimed at identification of farmers constraints pertaining to production, consumption and marketing of crops and is thus a kind of market research, to identify farmers needs to allow cultivars, that are likely to meet their requirements, to be tested and avoid the cultivars that will be obviously acceptable[17]. Collinson and Feldstein[12] made an early attempt to get an insight into farmers assessment of varietal attributes in beans. They reported that farmers judge bean varieties on the basis of yield, performance under intercropping, performance under adverse conditions, early maturity and grain colour. Chirwa and Phiri[11] conducted PRA in bean producing areas in Malawi to identify farmer specifications for selection of varieties and found that farmers choice of varieties is largely governed by grain colour, cooking time, taste, grain size as well as grain brightness.

Participatory plant breeding has evolved as viable alternative to the conventional plant breeding that lays more emphasis on the involvement of different stakeholders right from deciding the varietal specifications, selection of parents through to the selection across segregating generations as well of testing and release of the product. The greater involvement of farmers and other stakeholders ensures that their perceptions are taken care of in order to speed up the rate of adoption. The level of participation may vary depending upon the stage of PPB programme but participation has to be effective at all the stages. Appropriate client orientation mechanism in the form of participatory rural appraisal (PRA) has to be done in order to generate basic data for varietal specifications and decide the stages and levels of participation of farmers. Therefore, the present study "Farmer Participatory Varietal Selection (PVS) in French Bean (*Phaseolus vulgaris* L.)" aimed in the area of participatory plant breeding was under taken.

MATERIALS AND METHODS

Selection of area

In the present study two districts namely Budgam and Ganderbal were selected. In each district two locations were selected for undertaking the study namely Rangar (E_1) and Daetmuribagh (E_2) in District Budgam and Yarmuqam (E_3) and Arhama(E_4) in District Ganderbal. Both the districts were selected on the basis of their strategic importance.

Participatory rural appraisal

In order to get an insight into the production constraints and livelihood opportunities of French bean in district Budgam and Ganderbal, participatory rural appraisal was done in . A questionnaire was drafted in light of available literature and consultation with Prof. John Witcombe of CAZS, Banger, University that aimed at creating a baseline information about the socio-economic status, production systems, management systems, varietal preferences , constraints and opportunities of French bean growing farmers of the areas of study.

Household surveys and group discussion were held and fifty respondents in each location were contacted and information gathered for questions in the questionnaire. The probing technique was used to derive as much information as possible in order to arrive at a much clear understanding of farmers perspectives, constraints and their willingness to participate in the process of varietal evaluation and genetic resource conservation through large scale use. Flexible approach was used in PRA to derive any other information provided by farmers that was as such not covered within the contents of PRA questionnaire.

Laying of grand-mother trials

Fifty lines of French bean selected out of the germplasm screening on the basis of yield, maturity and disease reaction. The material represented different market classes of French bean in order to provide for choice of farmers in light of their preferences and local market value. The material was grown in a replicated trait with replications using four local varieties provided by farmers as check. Each genotype was represented by 2 x 3 metre length with spacing of 15 x 30 cm.

Laying of mother trials

Thirty breeding lines out of the germplasm collection in gene bank that represented diverse market class and performed consistently better in station trials were evaluated at four locations namely Rangar, Daetmuribagh, Yarmuqam, and Arhama. The experiment was laid in a replicated design with two replications for each genotype of 2 x 3m dimensions spaced by 50 cm between plots to allow for farm walk. The farmers own variety was used as check.

Farm walk and preference score index

At the time of full pod development, farm walk was organised at all locations in which farmers were provided with different colours of paper slips to assess the varieties as preferred (positive) or not-preferred (negative). The preference score index was calculated at the farm walk and the varieties designated as preferred or non-preferred were discussed with farmers regarding the traits they liked/disliked in those varieties. Preference score index (PI) was calculated as given by De-Boef and Thijssen[13]; Ceuarelli[10]:

$$PI = \frac{\text{No. of positive votes} - \text{No. of negative votes}}{\text{Total No. of votes}}$$

The mean preference score was calculated across four locations to arrive at cumulative preference of varieties on the basis of traits specified by them.

Data collection

The data of ten competitive plants from each replication for various morphological, agronomical, yield and yield attributing traits to study their correlation with farmer's preferential scoring over four random

environments was recorded. Each selected plant were taken at random from each experimental plot in a replication and tagged for recording bio-metrical observations. Mean value of all characters and median were worked out. Observations were recorded at the appropriate developmental stages of the plant growth as per the descriptors for French bean.

Statistical analysis of data

The qualitative data generated through participatory rural appraisal (PRA) was analyzed by using χ^2-test. The data generated from replicated grandmother trial and the data from replicated individual locations was handled as replicates and analyzed through ANOVA. However, wherever, required data transformation was done before such analysis.

RESULTS

The results of genotypes evaluated in a Randomized Complete Block Design (RCBD) with two replications across four random environments (Farmers perception, Preference score.

Farmers perception

The chi-square (χ^2-test) analysis (Table-1) of different traits of French bean revealed that the farmers preference was highly significant for most of the traits. Household Level Questionnaire (HLQ) conducted revealed that most of the people across all locations grow beans for vegetable purpose. While, regarding the source of seed, significant number of the selected farmers were using own seed for production of French bean. In context to cropping system, it is being widely practiced as sole cropping, however at location, Badampora, (41.86%) were practicing mixed cropping. Data of farming practice across sixteen locations revealed that crop is grown mostly rain-fed, however 40.48 per cent of farmers of Daetmuribagh grow under assured irrigation. Data on the use of fertilizers revealed, significant number of the selected farmers use manures for their French bean fields, the highest use of fertilizer (28.57%) were used by farmers of Daetmuribagh District budgam where assured irrigation is available for most of the fields. On comparison between low yielding varieties or diseases as major constraints, data revealed that the low yielding varieties was significant factor limiting crop production than diseases. Further, χ^2 value of diseases revealed that BCMV is the number one challenge to French bean production.

Adamo[1] used farmers social networks as entry points for rural appraisal in Ethiopia for identification of constraints of bean production and observed that major production constraints prioritised by farmers were moisture stress, poor soil fertility, weeds, soil erosion, pests and diseases and shortage of cultivable land. Collinson and Feldstein[12] reported that farmers judge bean varieties on the basis of yield, performance under intercropping, performance under adverse conditions, early maturity and grain colour. Similar results were reported by Chirwa and Phiri[11], Katimgi *et al*[18]., Birachi *et al*[8]., Gichangi *et al*[15]. Also, Rubyogo *et al*[21]., and Asfan *et al*[6]., conducted extensive rural surveys. They could identify six important attributes out of 32 traits offered for appraisal. The traits included earliness, pod load, pod length, seeds pod^{-1}, culinary quality and marketability.

Moreover, white color of seed (Table 1a) significantly remained at par from other four colours. Regarding seed type, farmers favoured kidney shaped beans genotypes as it is socially and ecologically fit under their production system followed by oval, Cubiodal and cylindrical type. Also, 87.00 per cent of farmers favoured kidney shaped beans followed by oval shaped beans and highly significant aspiration for plain pods was noted against cylindrical pods. Green color of pods and stringless varieties were significantly preferred by majority of farmers in comparison to green with purple streaks and green with red streaks. Almost across all locations more than 78 per cent of people preferred string-less genotypes. From Table-1b chi-square value showed significant difference between earliness and uniform maturity. The perceptions of farmers regarding the nature of culinary traits revealed that significant number of farmers preferred French bean variety that

tastes well. Similar PRA was conducted to get feedback from end users (farmers) regarding the preferences and perceptions about bean crop by Frio *et al*[14]., Witcomb *et al*[24]., and Gichangi *et al*[15].

Preferential scoring

Evaluation of Mother Trials through farmer's preferential ranking was carried out at four locations Table-2. Rank summation preferential data for different test entries showed lowest cumulative rank for WB-1186 (the most preferred variety) with mean preference rank of 1.25, and WB-160 as second best (1.75) followed by WB-195 (2.6), WB-648 (4.25), WB-249 (4.5), WB-1538 (4.75) and WB-940 (6.75). Table-2.4 clearly shows that WB-195, WB-1186, WB-160, WB-1538, WB-940, WB-648, WB-249 and WB-569 were statistically at par in term of rank summation index and mean preference ranking. The reasons for the preference were related to many traits including pod texture, early maturity, high fresh pod yield, taste and free from diseases as per the interviews.

The use of participatory approaches is not new in agricultural development and over the last few decades it has found its way into formal crop improvement[9]. This has been in response to the need to improve the impact of research on the livelihoods of farmers. The reasoning has been that if farmers priorities, needs and capacities are valued and better understood by researchers, extension agents and other professionals, they will be better equipped to make appropriate and sustainable recommendations which, in turn, will positively influence farmers access to new technologies.

Experience with a range of participatory extension and research models such as Farmer Field Schools, Local Agricultural Research Committees and Farmer-to- Farmer extension models demonstrate that these initiatives may be effective in empowering farmers and supporting them in their own identification of solutions to local problems[16]. The term "participatory plant breeding" has been used to refer to different forms of interaction between farmers and researchers at different stages of the crop research process. It emerged as a concept during the last two decades with efforts to extend the success of modern crop improvement to areas and groups that had benefited less, e.g. small-scale farmers in agro-ecologically and socio-economically marginal and variable environments[2,9,22,23]. The objective of participatory plant breeding is to facilitate quicker and more extensive uptake of new cropping technologies by shifting the locus of plant genetic research and improvement toward the local level through direct stakeholder involvement, e.g. scientists, farmers, extension agents, industry, consumers and others, at different stages of the breeding process.

Farmers used as many as 40 selection criteria which indicates the complexity of user constraints and needs, but majority of farmers considered yield, tolerance to biotic and abiotic stresses, earliness, marketability, cooking characteristics, seed colour and size and growth habit as important criteria reported by Assefa *et al*[7]., Humphries *et al*[16]., Asfan *et al*[6]. Similarly Mwale *et al*[20]., evaluated seven dwarf bean lines at five sites in Malawi farmers field and observed that the high yielding varieties exhibited stable performance across all locations and seasons. Mulualem *et al*[19]., used a modification of mother-baby trial system wherein a single season grand mother-mother baby trial system is used to evaluate improved lines on-station and on-farm.

The use of PVS proved to be a useful selection method. Farmer participation creates a feeling of ownership. Variety selection by farmers at the same low input farming conditions addresses also the needs of more marginalized farmers. It is a rapid and cost effective way to assess and select potential varieties. Joshi and Witcombe[17] reported that adoption rates of cultivars would be improved through increased farmers' participation. Poor farmers can adopt new varieties as rapidly as wealthier ones through participatory varietal selection.

Table-1: Participatory Rural Appraisal in French bean (*Phaseolus vulgaras* L.) for various traits

Locations	N	R	Crop Grown for			Source of seed			Cropping system			Irrigation System		Fertilisers	
			Pulse	Vegetable	Both	Institution	Farmer own seed	Market	Sole crop	Intercrop	Mixed crop	Assured irrigation	Rainfed	Fertiliser	Manures
Rangar (Budgam)	50	43	7 (16.28)	23 (53.49)	9 (20.93)	6 (13.95)	34 (79.06)	3 (6.98)	23 (53.48)	5 (11.62)	15 (34.88)	13 (30.23)	30 (69.77)	10 (23.25)	33 (76.74)
Daetmuribagh (Budgam)	50	42	11 (26.19)	26 (61.90)	6 (14.28)	8 (19.04)	32 76.19)	2 (4.74)	23 (54.76)	2 (4.74)	17 (40.48)	17 (40.48)	25 (59.52)	12 (28.57)	30 (71.42)
Sogaam (Budgam)	50	37	7 (18.92)	25 (67.57)	5 (13.51)	7 (18.92)	28 (75.67)	2 (5.40)	25 (67.57)	6 (16.22)	6 (16.22)	8 (21.62)	29 (78.38)	7 (18.92)	30 (81.08)
Khansahab (Budgam)	50	38	8 (21.10)	23 (60.53)	7 (18.42)	6 (15.79)	31 (81.58)	1 (2.63)	24 (63.16)	4 (10.53)	10 (26.31)	7 (18.42)	31 (81.58)	4 (10.53)	34 (89.47)
Aarigam (Budgam)	50	40	6 (15.00)	24 (60.00)	10 (25)	3 (7.50)	35 (87.50)	2 (5.00)	27 (67.50)	7 (17.50)	6 (15.00)	11 (27.50)	29 (72.50)	9 (22.50)	31 (62.00)
Sholipora (Budgam)	50	44	8 (18.18)	28 (63.64)	8 (18.18)	3 (6.82)	39 (88.64)	2 (4.54)	22 50.00	8 (18.18)	14 (31.82)	11 (25.00)	32 (72.73)	10 (22.73)	34 (77.27)
Soibugh (Budgam)	50	43	7 (16.28)	23 (53.49)	13 (30.23)	2 (4.65)	41 (95.35)	0 (0.000)	24 (55.81)	4 (9.30)	15 (34.88)	13 (30.23)	30 (69.77)	8 (18.60)	35 (81.39)
Wadwan (Budgam)	50	36	3 (8.33)	27 (75.00)	6 (16.66)	3 (8.33)	33 (91.67)	0 (0.00)	28 (77.78)	2 (5.55)	6 (16.66)	10 (27.78)	26 (72.22)	6 (16.66)	30 (83.33)
Manigam (Ganderbal)	50	43	13 (30.23)	20 (46.51)	10 (23.26)	5 (11.63)	38 (88.73)	1 (2.32)	22 (51.16)	6 (13.95)	15 (34.88)	12 (27.91)	31 (72.09)	8 (18.60)	35 (81.39)
Yarmuqam (Ganderbal)	50	42	8 (19.05)	30 (71.43)	4 (9.52)	5 (11.90)	37 (88.09)	0 (0.00)	23 (54.76)	5 (11.90)	14 (33.33)	13 (30.95)	29 (69.04)	9 (21.43)	33 (78.57)
Arhama (Ganderbal)	50	40	10 (25.00)	19 (47.50)	11 (27.50)	5 (12.50)	35 (87.50)	0 (0.00)	23 (57.50)	4 (10.00)	13 (32.50)	12 (30)	28 (70.00)	8 (20.00)	32 (80.00)
Zazna (Ganderbal)	50	39	9 (23.08)	27 (69.23)	3 (7.69)	4 (10.26)	34 (87.18)	1 (2.56)	27 (69.23)	3 (7.69)	9 (23.08)	8 (20.51)	31 (79.49)	5 (12.82)	34 (87.18)
Badampora (Ganderbal)	50	43	12 (27.91)	25 (58.14)	6 (13.95)	4 (9.30)	39 (90.69)	0 (0.00)	19 (44.19)	6 (13.95)	18 (41.86)	11 (25.58)	28 (65.12)	12 (27.91)	31 (72.09)
Ahan (Ganderbal)	50	45	10 (22.22)	28 (62.22)	7 (15.56)	5 (11.11)	37 (82.22)	3 (6.67)	23 (51.11)	8 (17.78)	14 (31.11)	10 (22.22)	35 (77.780	11 (24.44)	34 (75.56)
Baroosa (Ganderbal)	50	44	10 (22.73)	24 (54.54)	10 (22.27)	5 (11.360	36 81.82)	3 (6.82)	25 (56.82)	3 (6.82)	16 (36.36)	10 (22.73)	34 (77.27)	9 (20.45)	35 (79.55)
Wakura (Ganderbal)	50	36	4 (11.11)	25 69.44)	7 (19.44)	4 (11.11)	31 (86.11)	1 (2.77)	22 (61.11)	5 (13.89)	9 (25.00)	4 (11.11)	32 (88.89)	7 (19.44)	29 (80.56)
Chi-square value			105.84			168.83			38.72			76.74		115.87	

Table-1a: Participatory Rural Appraisal in French bean (*Phaseolus vulgaras* L.) for various traits

Locations	N	R	Production constraints		Diseases				Varietal prefrences Colour of seed						Seed coat pattern	
			Low yield	Disease	Angular leaf spot	BCMV	Rust	Anthracnose	Small red	Kidney red	White navy	White kidney	Chocolate	Black	Plain	Mottled
Rangar (Budgam)	50	43	37 (86.05)	6 (13.95)	6 (13.95)	25 (58.13)	5 (11.63)	7 (16.28)	10 (23.56)	4 (9.30)	4 (9.30)	18 (41.86)	2 (4.65)	5 (11.63)	33 (76.74)	10 (23.56)
Daetmuribagh (Budgam)	50	42	40 (95.24)	2 (4.76)	3 (7.14)	22 (52.38)	8 (19.05)	9 (21.43)	9 (21.43)	5 (11.90)	8 (19.05)	22 (52.38)	0 (0.00)	1 (2.38)	35 (83.33)	7 (16.67)
Sogaam (Budgam)	50	37	34 (91.89)	3 (8.10)	3 (8.10)	28 (75.67)	2 (5.40)	4 (10.81)	10 (27.02)	3 (8.10)	3 (8.10)	18 (21.62)	0 (0.00)	3 (8.10)	32 (86.49)	5 (13.51)
Khansahab (Budgam)	50	38	35 (92.10)	3 (7.89)	4 (10.53)	26 (68.42)	4 (10.43)	4 (10.53)	12 (31.58)	4 (10.53)	2 (5.26)	16 (42.11)	1 (2.63)	7 (18.42)	37 (97.37)	1 (2.63)
Aarigam (Budgam)	50	40	35 (87.50)	5 (12.50)	5 (12.50)	23 (57.50)	5 (12.50)	7 (17.50)	8 (20.00)	6 (15.00)	4 (10.00)	20 (50.00)	0 (0.00)	2 (5.00)	35 (87.50)	5 (12.50)
Sholipora (Budgam)	50	44	36 (81.82)	8 (18.18)	5 (11.36)	27 (61.36)	6 (13.64)	6 (13.64)	10 (22.27)	4 (9.09)	7 (15.91)	21 (47.73)	1 (2.27)	1 (2.27)	37 (84.09)	7 (15.91)
Soibugh (Budgam)	50	43	36 (83.72)	7 (16.28)	5 (11.63)	25 (58.14)	5 (11.63)	8 (18.60)	10 (23.26)	5 (11.63)	6 (13.95)	19 (44.19)	0 (0.00)	3 (6.98)	35 (81.39)	8 (18.60)
Wadwan (Budgam)	50	36	32 (88.89)	4 (11.11)	2 (5.56)	23 (63.89)	7 (19.44)	4 (11.11)	5 (13.89)	2 (5.56)	6 (16.67)	18 (50.00)	2 (5.56)	3 (8.33)	33 (91.67)	3 (8.33)
Manigam (Ganderbal)	50	43	34 (79.07)	9 (20.33)	4 (9.52)	24 (57.14)	10 (23.81)	5 (11.63)	13 (6.98)	5 (11.63)	3 (6.98)	20 (46.51)	0 (0.00)	2 (4.65)	40 (93.02)	3 (6.98)
Yarmuqam (Ganderbal)	50	42	35 (83.33)	7 (16.67)	4 (9.52)	26 (61.90)	6 (14.28)	6 (14.28)	10 (23.81)	4 (9.52)	2 (4.76)	20 (47.62)	1 (2.38)	5 (11.90)	39 (92.86)	3 (7.14)
Arhama (Ganderbal)	50	40	32 (80.00)	8 (20.00)	5 (12.50)	23 (57.50)	6 (15.00)	6 (15.00)	8 (20.00)	2 (5.00)	3 (7.50)	25 (62.50)	1 (2.50)	1 (2.50)	36 (90.00)	4 (10.00)
Zazna (Ganderbal)	50	39	30 (76.92)	9 (23.08)	5 (12.82)	20 (51.28)	9 (23.08)	5 (12.82)	5 (12.82)	4 (10.26)	4 (10.26)	23 (58.97)	0 (0.00)	3 (7.69)	36 (92.31)	3 (7.69)
Badampora (Ganderbal)	50	43	37 (86.05)	6 (13.95)	10 (23.26)	20 (46.51)	5 (11.63)	8 (18.60)	9 (20.93)	2 (4.65)	5 (11.63)	25 (58.14)	0 (0.00)	2 (4.650	39 (90.70)	4 (9.30)
Ahan (Ganderbal)	50	45	38 (84.44)	7 (15.56)	10 (22.22)	30 (66.67)	2 (4.44)	3 (6.67)	12 (26.67)	3 (6.67)	4 (8.89)	19 (42.22)	1 (2.22)	6 (13.33)	39 (86.67)	6 (13.33)
Baroosa (Ganderbal)	50	44	37 (84.09)	7 (15.91)	10 (22.73)	28 (63.64)	4 (9.10)	2 (4.54)	10 (22.73)	4 (9.10)	4 (9.10)	23 (52.27)	0 (0.00)	3 (6.82)	40 (90.91)	4 (0.10)
Wakura (Ganderbal)	50	36	34 (94.44)	2 (5.56)	3 (8.33)	30 (83.33)	2 (5.56)	2 (5.56)	8 (22.22)	2 (5.56)	1 (2.78)	22 (61.11)	1 (2.78)	2 (5.56)	35 (97.22)	1 (2.78)
Chi-square value			171.40		25.80				27.60						200.08	

Table-1b: Participatory Rural Appraisal in French bean (*Phaseolus vulgaras* L.) for various traits

Locations	N	R	Seed shape				Pod shape		Pod color			Pod texture		Maturity		Culinary Traits		
			Kidney	Oval	Cuboidal	Cylindrical	Cylindrical	Flat	Green	Green with red streaks	Green with purple streaks	String	Stringless	Earliness	Uniform maturity	Cooking time	Taste	Flatulence
Rangar (Budgam)	50	43	33 (76.74)	6 (18.18)	1 (2.32)	3 (6.98)	12 (27.91)	31 (72.09)	36 (83.72)	3 (6.98)	4 (9.30)	1 (2.32)	42 (97.67)	37 (86.05)	6 (18.18)	5 (11.63)	37 (86.05)	1 (2.32)
Daetmuribagh (Budgam)	50	42	38 (90.48)	1 (2.38)	0 (0.00)	3 (7.14)	15 (35.71)	27 (64.28)	35 (83.33)	5 (11.90)	4 (9.52)	0 (0.00)	42 (100.00)	24 (57.14)	19 (45.24)	7 (16.67)	33 (78.57)	2 (4.76)
Sogaam (Budgam)	50	37	36 (97.30)	1 (2.700	0 (0.00)	0 (0.00)	10 (27.030	27 (72.97)	36 97.30	1 (2.70)	0 (0.00)	1 (2.70)	36 (97.30)	28 (75.68)	9 (24.32)	5 (13.51)	30 (81.08)	2 (5.40)
Khansahab (Budgam)	50	38	33 (86.84)	5 (13.16)	0 (0.00)	1 (2.63)	13 (34.21)	25 (65.79)	34 (89.47)	2 (5.26)	2 (5.26)	8 (21.05)	30 (78.95)	25 (65.79)	13 (34.21)	12 (31.58)	26 (68.42)	0 (0.00)
Aarigam (Budgam)	50	40	35 (87.50)	5 (12.50)	0 (0.00)	0 (0.00)	15 (37.50)	25 (62.50)	36 (90.00)	1 (2.50)	1 (2.50)	5 (12.50)	35 (87.50)	22 (55.00)	18 (45.00)	10 (25.00)	29 (72.5)	1 (2.50)
Sholipora (Budgam)	50	44	35 (79.54)	9 (20.450	1 (2.27)	2 (4.54)	15 (34.09)	29 (65.91)	30 (68.18)	8 (18.18)	5 (11.36)	3 (6.82)	41 (93.18)	25 (56.82)	19 (43.82)	12 (27.27)	29 (65.91)	3 (6.82)
Soibugh (Budgam)	50	43	37 (86.05)	6 (13.95)	0 (0.00)	0 (0.00)	15 (34.88)	27 (62.79)	34 (79.07)	4 (9.30)	2 (4.65)	10 (23.26)	33 (76.74)	24 (55.81)	19 (44.19)	13 (30.23)	25 (58.14)	0 (0.00)
Wadwan (Budgam)	50	36	28 (77.78)	6 (16.67)	1 (2.78)	1 (2.78)	10 (27.78)	26 (72.22)	35 (97.22)	5 (13.89)	2 (5.56)	2 (5.56)	34 (94.44)	23 (63.89)	13 (36.11)	15 (41.67)	20 (55.56)	1 (2.78)
Manigam (Ganderbal)	50	43	30 (69.77)	10 (23.26)	0 (0.00)	3 (6.98)	18 (41.86)	25 (58.14)	33 (76.74)	4 (9.30)	6 (18.18)	0 (0.00)	43 (100.00)	23 (53.49)	19 (44.19)	8 (18.60)	31 (72.09)	4 (9.30)
Yarmuqam (Ganderbal)	50	42	29 (69.05)	10 (23.81)	2 (4.76)	1 (2.38)	16 (38.09)	26 (61.90)	29 (69.05)	7 (16.67)	5 (11.90)	1 (2.38)	41 (97.62)	29 (69.05)	13 (30.95)	5 (11.90)	37 (88.09)	0 (0.00)
Arhama (Ganderbal)	50	40	22 (55.00)	8 (20.00)	5 (12.50)	5 (12.50)	14 (35.00)	26 (65.00)	23 (57.50)	6 (15.00)	9 (22.50)	3 (7.50)	37 (92.5)	27 (67.50)	13 (32.50)	15 (37.50)	24 (60.00)	1 (2.50)
Zazna (Ganderbal)	50	39	24 (61.54)	6 (15.38)	3 (7.69)	6 (15.38)	9 (23.08)	30 (76.92)	24 (61.54)	4 (10.26)	8 (20.51)	6 (15.38)	30 (76.920	28 (71.79)	11 (28.21)	14 (35.89)	22 (56.41)	3 (7.69)
Badampora (Ganderbal)	50	43	29 (67.44)	10 (23.26)	0 (0.00)	4 (93.02)	13 (30.23)	30 (69.77)	33 (76.74)	3 (6.98)	7 (16.28)	1 (2.33)	42 (97.67)	30 (69.770	13 (30.23	18 (41.86)	24 (55.81)	1 (2.33)
Ahan (Ganderbal)	50	45	30 (66.67)	8 (17.78)	1 (2.22)	6 (13.33)	12 (26.67)	33 (73.33)	30 (66.67)	6 (13.33)	4 (8.89)	3 (6.67)	42 (93.33)	25 (55.56)	20 (44.44)	16 (35.56)	25 (55.56)	4 (8.89)
Baroosa (Ganderbal)	50	44	26 (59.10)	12 (27.27)	1 (2.27)	5 (11.36)	12 (27.27)	32 (72.73)	35 (79.54)	4 (9.10)	3 (6.82)	3 (6.82)	41 (93.18)	38 (86.36)	6 (13.64)	7 (15.91)	36 (81.82)	2 (4.54)
Wakura (Ganderbal)	50	36	25 (69.44)	4 (11.11)	1 (2.78)	6 (16.67)	12 (33.33)	24 (66.67)	34 (94.44)	6 (16.67)	5 (13.89)	0 (0.00)	36 (100.00)	25 (69.44)	13 (36.11)	6 (16.67)	29 (80.56)	1 (2.78)
Chi-square value			98.66				44.17		127.78			241.17		47.96		68.54		

Table-2: Cumulative average ranks of preferential score of genotypes over four locations

Genotype	Individual ranks				Cumulative rank	Average of ranks	Pooled preference Score
	Rangar (Budgam)	Daetmuribagh (Budgam)	Yarmuqam (Ganderbal)	Arhama (Ganderbal)			
WB-195	03	03	03	02	11	2.75	2.375
WB-1186	01	01	01	02	5	1.25	3.625
WB-479	10	13	13	12	48	12.00	0.4375
WB-160	02	02	02	01	07	1.75	3.125
WB-252	10	08	08	13	39	9.75	0.750
WB-941	05	10	10	06	31	7.75	0.875
WB-335	13	10	10	18	51	12.75	0.125
WB -940	13	04	04	06	27	6.75	1.125
WB-492	27	24	25	25	101	25.25	-3.000
WB-429	21	17	17	20	75	18.75	-0.875
WB-1538	05	04	04	06	19	4.75	1.375
WB-416	13	17	17	13	60	15.00	-0.125
WB-223	17	20	20	18	75	18.75	-0.875
W B-322	17	22	22	16	77	19.25	-1.000
WB-1128	10	13	14	06	43	10.75	0.500
WB-147	17	10	10	04	41	10.25	0.500
WB-249	04	04	04	06	18	4.50	1.625
WB-1136	05	17	17	06	45	11.25	0.375
WB-360	05	08	08	16	37	9.25	0.750
WB-1139	16	13	14	22	65	16.25	-0.500
WB-30	17	20	20	13	70	17.50	-0.625
WB-345	24	24	25	23	96	24.00	-2.625
WB-648	05	04	04	04	17	4.25	1.500
WB-1181	21	13	14	20	68	17.00	-0.625
WB-46	23	22	22	23	90	22.50	-1.750
WB-569	10	04	04	12	30	7.50	1.125
WB-467	17	13	20	20	70	17.50	-0.750
WB-411	24	23	23	22	92	23.00	-2.250
WB-481	26	24	23	25	98	24.50	-2.750
WB-651	10	08	08	12	38	9.50	0.875
Standard deviation					28.828	7.20	1.626
Standard error					5.263	1.32	0.296
C.D.					8.948	2.237	0.505

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