



Socio- Economic Upliftment of Tribal Farmers through Grain and Hybrid Seed Production of Quality Protein Maize under Hilly Condition of J&K

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Authors' contributions

This study was carried out in collaboration among all authors. Author VS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author DK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Maize is the principal food crop of rain-fed hilly areas of Jammu and Kashmir grown during *Kharif* season. It is staple food of the tribal population as well as fodder for their animals residing in hilly region of the state. Quality Protein Maize cultivars are nutritionally enriched maize with high protein content (more than 9%) and high level of two essential amino acids lysine (4.07% of protein) and tryptophan (1.05% of protein) content with better balanced amino acid composition in grains. In the FLDs, the average grain yield of Vivek QPM - 9 was observed as 27.40 q/ha where as in case of HQPM - 4 the average yield was 26.10 q/ha in comparison to the check cultivar i.e., Bio Seed 9621 (26.30 q/ha) under rainfed conditions of Rajouri district of J&K. The single cross hybrid seed production of QPM showed that the farmer's income enhancement was about 2.78 times than the grain crop. The B: C ratio of grain yield was 1.72 whereas it was observed 2.78 in case of seed yield.

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1. INTRODUCTION

In rain-fed hilly areas of Jammu and Kashmir Maize is the major crop grown during *Kharif* season. It is staple food of the tribal population residing in hilly areas of the state. Many newly introduced hybrids cultivars are in practice and occupy many areas of the state. The farmers still prefer to grow old maize landraces / desi / traditional varieties due to non availability of quality seeds. The productivity level of Jammu and Kashmir state (1837 kg/ha) is far below the national level (2509 kg/ha). This may be due to poor adaptability of new cultivars in this agro-climatic environment [1]. Most of the hybrids / varieties of maize grown in the area are non quality protein maize which is nutritionally poor in comparison to Quality Protein Maize.

In Rajouri district, about 33.11 per cent population belongs to scheduled tribes i.e., Gujjars and Bakerwal community [1]. The farmers of this community mainly grow rain-fed maize and rice under irrigated condition during *kharif* season. Due to the rain-fed conditions, small land holdings and poor socio-economic status, their average farm income is far below than the farmers of the plain areas. They still follow age old and traditional crop cultivation practices due to lack of education, awareness of scientific management, local inputs and technical skills [2]. Their average income can be enhanced in generating alternative employment potential and improving or upgrading their farming skills through scientific interventions. The seed production of any crop gives higher returns in comparison to the normal crop production. The majority of maize hybrids grown in rainfed areas of this Rajouri district are non-QPM cultivars. The majority of farmers are unable to purchase the hybrid seeds due to high price. Therefore, availability of quality seed of hybrids especially QPM hybrids is a major constraint in increasing maize productivity in this area.

The normal maize grain under Indian conditions on an average, contains 14.9 % moisture, 11.1 % protein, 3.6 % fat, 2.7 % fiber, 66.2 % other carbohydrates and 1.5% minerals (Martinez *et.al.*, 2017). Maize kernel protein is made up of five different fractions. The percentage of different fractions to total nitrogen in maize kernel is albumin 7 %, globulin 5 %, non-protein

nitrogen 6 %, prolamine 52 % and glutelin 25 % and the left over 5 % is residual nitrogen [3]. The mature maize kernel consists of a germ, pericarp and endosperm. An endosperm consists of 90% starch which is a source of concentrated energy and 10% protein which include albumins, globulins, zein and glutelin out of which zein consists 50–70% of total proportion [4]. Zeins are the important storage proteins; these forms as deposit on rough endoplasmic reticulum-delimited protein bodies (PBs) [5]. Protein is the main structural and functional component of every living organism. The poor quality of protein in normal is attributed due poor presence of largest concentration of an alcohol soluble protein 'prolamine' also known as 'Zein' in the endosperm. Among those zein proteins, α -zeins and δ -zeins are deposited in the central region, and γ -zeins and β -zeins were deposited in the outer region of protein bodies [6]. They increase as the grain matures. Zein is very low in lysine and tryptophan content and in Maize the presence of high content of zein results into the poor quality of protein in normal maize. The zein fractions are rich in cysteine and methionine amino acids, and it also consists of glutamine, leucine and proline and is completely devoid of two important essential amino acids lysine and tryptophan, whereas other proteins consist of these amino acids in large quantities [7]. Suppression of zein fraction without drastically altering the contribution of other fractions could be, thus, seen as a feasible approach to bring about improvements in the amino acid balance in maize grain [8]. The high quality of protein in other fractions in other parts of maize kernel becomes recessive due to the dominance of zein in normal maize. The poor quality of protein in normal maize affects its 'Biological value' i.e. the availability of protein in the body. For this purpose, a new corn type known as 'Quality Protein Maize' (QPM) was developed by lowering the concentration of zein by 30 %. As a result, the concentration of two essential amino acids viz., lysine and tryptophan in grain was increased in QPM. The balanced proportion of all these essential amino acid in Quality Protein Maize (QPM) enhanced the biological value of protein. The True Protein Digestibility of normal maize and Quality Protein Maize is almost same, but the biological value of normal maize is just half as compared to that of QPM varieties (Martinez *et.al.*, 2017) Quality Protein Maize cultivars are nutritionally enriched maize with

high protein content (more than 9%) and high level of two essential amino acids lysine (4.07% of protein) and tryptophan (1.05% of protein) content with better balanced amino acid composition in grains [9].

The increased protein quality in QPM is expected to help in reducing protein malnutrition among the rural masses. It also provides nutritionally rich feed and fodders to the poultry birds, livestock. It may be helpful in poverty alleviation programme by developing maize-based rural entrepreneurship like laddu and other value added products like infant food, health food / mixes, corn flakes, convenience food, specialty foods and emergency ration. If Quality Protein Maize is utilized in diversified ways by converting them into a variety of products for use, it is possible to make a significant impact on health status of the malnutrition problem. The nutritious products developed from QPM can replace fancied and highly priced industrial foods. In the background of above details, the study was undertaken with the objectives to enhance the availability of quality seeds of Quality Protein Maize hybrids in rural areas of hill region and bring about socio-economic up-liftment of farmers with special emphasis on scheduled tribe through scientific hybrid seed production techniques as a rural entrepreneurship programme.

2. METHODOLOGY

The training programmes were conducted in the rural areas of the Rajouri district to cover two aspects. First aspect was to reduce the protein malnutrition among the rural masses and second aspect was to train the rural youth of Rajouri District about the single cross hybrid seed production of two QPM varieties Vivek QPM - 9 and HQPM - 4 from their respective parents to enhance their income. The parents for the production of Vivek QPM - 9 were VQL - 1 and VQL - 2 and HKI - 161 and HKI - 163 as the parent of HQPM - 4.

2.1 Popularization of QPM among Tribal Farmers through Trainings and FLDs

In the year 2014-15, five training programmes were conducted in five villages of four different blocks of district Rajouri. Twenty (20) farmers from all five villages i.e., Chawa, Pulllian, Deharian, Khablan and Dhanwakot were selected through semi-structured interview schedule having land holding from 0.75 to 1.25 ha and were trained the importance, scientific management of Quality Protein Maize. After

completion of the training programme the FLD was distributed to get acquainted with the cultivation and to compare the yield potential with the prevailing cultivars.

Six training programmes were conducted at Mehari, Panjgrain, Rajpur Bhata, Garan, Khah and Gurdhan villages of five blocks (Rajouri, Manjakote, Nowshera, Kalakote and Budhal) of district Rajouri were trained in the year 2015-16.

In the year 2014-15, forty front line demonstrations (FLDs) of two Quality protein Maize cultivars i.e., Vivek QPM-9 and HQPM- 4 have been conducted at farmer's field in ten villages i.e., Chawa, Pulllian, Gurdan, Agrati, Dhanwan, Deharian, Lamberi, Mehra, Kotdhara and Chowkiyan of five different blocks of Rajouri district. And forty one front line demonstrations (FLDs) of two Quality protein Maize cultivars i.e., Vivek QPM - 9 and HQPM - 4 have been conducted at farmer's field in twelve villages i.e., Panjgrain, Gurdan, Pulllian, Palma, Gambhir, Thandikasi, Ningandar, Mubarakpura, Deharian, Lamberi, Kotdhara and Chowikia of seven different blocks in the year 2015-16.

2.2 Upliftment of Economic Condition of Tribal Farmers through Trainings on Single Cross Hybrid Seed Production Technique of QPM

Twenty farmers of tribal community from different blocks of Rajouri District were selected to train about single cross hybrid seed production technique of QPM. Farmers were trained about different aspects of single cross hybrid seed production technique of QPM conducted at the Research Farm of RARS, Rajouri at different crop growth stages to train and make them familiar about the different scientific operations involved in production of single cross hybrids seeds of Quality Protein Maize. The selected farmers were trained in the below mentioned techniques under "Single Cross Hybrid Seed Production Technology of Quality Protein Maize".

2.3 Isolation Distance

If possible, the hybrid seed production should be taken either in the area where no other maize variety is planted nearby the seed production plot or at least 400-500 metre distance is required between two maize genotypes to maintain the genetic purity. This can also be achieved through "Time Isolation". If distance isolation is not possible under village condition the time isolation can be adopted by sowing the crop either early or late.

Table 1. Sowing details of crops

Parents	Female	Male
Vivek QPM 9	VQL 1	VQL 2
HQPM 4	HKL 163	HKL 161
Sowing time	First week of July in Kharif and Last week of August for post monsoon	
Seed rate	Female 15 kg/ ha	Male 10 kg/ ha
Female: Male row ratio	3 rows : 1 row	
Spacing	Row spacing (East- West direction) : 60 cm Plant spacing : 20 cm	

2.4 Removal of Off-type Plants and Thinning

- I. At early stage i.e. after 12-15 days of sowing, off-type plants and excess plants should be removed and proper plant to plant distance of 20-25 cm should be maintained to provide an equal opportunity to each plant to grow,
- II. At knee height stage and At flowering i.e. before anthesis
- III. Dissimilar plants should be removed from the male and female lines to maintain the genetic purity of seed. Dissimilar tassel bearing male plant should also be removed.

2.4.1 Detasseling

Detasseling in female should be done before anthesis. It should be practiced row-wise. One person should follow to monitor the each row to check that no part of the tassel is left inside. The process of detasseling should continue for 8-10 days. While detasseling, leaf should not be removed which will otherwise reduce the photosynthesis. It has been observed that the removal of 1 to 3 leaves along with tassel reduces 5-15 per cent yield. The removed tassel should not be thrown in the field but fed to the cattle as it is nutritive fodder.

2.4.2 Harvesting

Male parent should be harvested first than the female and should be kept separately. Optimum moisture content in grain at harvesting should be around 20 per cent. The harvested cobs should spread evenly instead of making heap.

2.5 Stages of Crop Inspection

- I. At the time of sowing: to monitor the land, isolation distance, planting ratio of male: female, proper sowing time, seed treatment
- II. During pre-flowering / vegetative stage: to verify the rouging and removal of off type plants

- III. During flowering stage: to check disease and pest infestation
- IV. During post-flowering and pre-harvest stage: to remove the late and diseased plants
- V. Harvesting time: to see the proper time of harvesting

2.6 Post Harvest Management

2.6.1 Drying and sorting of seed parent cobs

The drying of the cobs should not be done either on the kuccha or pucca flour, rather it should be dried on tarpoline sheets to avoid seed injury and during night the cobs should be kept covered. To maintain the purity, dissimilar, diseased and pest infested cobs should be removed before shelling. The female cobs should be dried upto 13-14 per cent moisture content before shelling.

2.6.2 Shelling

Shelling of female parent should be done earlier than male to avoid mechanical mixture. Shelling can be done manually or by power operated maize sheller.

2.6.3 Seed processing

All under size, broken, damaged etc seeds should be removed for maintaining the quality of seed.

2.6.4 Storage and marketing

Seed drying should be done till the moisture content of the seed is reduced to 8 per cent and it should be kept in aerated jute bags. Seed should be stored at cool and dry place preferably in cold storage. Poor storage conditions will lead to loss of vigour and poor germination. Marketing should be done with specifications and standards.

Village (s) / Urban Locality	:	Pullulian, Deharian, Khablan, Chawa, Dhanwankote, Palma, Mehari, Panjgrain, Chowikia, Kotedhra, Thandikasi, Rajpur Bhata, Garan, Khah and Gurdhan
Block / Taluka	:	Doongi, Rajouri, Manjakote, Lamberi, Kalakote, Thanamandi, Panjgrain, Qila Darhal and Budhal
District	:	Rajouri
State	:	Jammu and Kashmir

2.7 Quality Studies

2.7.1 Protein content (%)

Total N content was determined from the maize (grain) of each treatment by Kjeldahl's method [10]. The protein percentage from the corn was calculated by the following formula. Per cent protein = N % x 6.25 (Factor)

3. RESULTS AND DISCUSSION

3.1 Popularization of QPM among Tribal Farmers through Trainings and FLDs

All the farmers selected for the training were firstly conveyed through oral discussion about the role of QPM in their daily diet, need of protein for growing child and pregnant women, the yield comparison with the cultivars popularly grown in the area and availability of green fodder after

harvest due to stay green nature of Vivek QPM - 9.

The result of the data (Table 2) reveals that the average grain yield of Vivek QPM - 9 was observed as 27.40 q/ha where as in case of HQPM - 4 the average yield was 26.10 q/ha in comparison to the check cultivar i.e., Bio Seed 9621 (26.30 q/ha). All the crops were grown under rainfed conditions.

The quality parameter analysis of both QPM hybrids (Table 3) reveals that the Nitrogen content in the grain was 1.44 per cent in case of Vivek QPM-9 where as 1.63 per cent in case of HQPM-4, but the Protein content in Vivek QPM-9 was 08.89 per cent and 10.18 per cent in case of HQPM-4. The grain yield was found at par with the popularly grown non QPM hybrid maize cultivar "Bio Seed 9621".

Table 2. Comparison of grain yield between QPM and popular cultivars

Cultivars	Farming Situation	No. of Demonstrations	Area under Demonstrations (ha)	Av. Grain Yield (q/ha)
Vivek QPM-9	Rain fed	55	11.55	27.40
HQPM-4	Rain fed	26	05.46	26.10
Bio Seed 9621 (Check)	Rain fed	81	17.00	26.30



Photo 1(A & B). Field preparation



Photo 2(A & B). Crop stand

Table 3. Quality Characters of QPM hybrids under FLD

Hybrid Name	Hybrid Type	Nitrogen content in grain (%)	Protein content in grain (%)
Vivek QPM-9	Single cross	1.44	08.98
HQPM-4	Single cross	1.63	10.18

Method Used: Protein analyzer and Kjeldahl's method



Photo 3(A & B). Detasseling or removal of male flower from female lines

The farmers liked both the QPM hybrids because of at par grain yield but among both cultivars Vivek QPM-9 was liked most due to its stay green nature. This stay green nature of the stalk was able to provide the green fodder for their cattle even after harvest.



Photo 4(A & B). Farmers training programme in different villages and on farm



Photo 5(A & B). Front line demonstration of QPM on farmers field

Table 4. Economic of single cross hybrid seed production over grain

Parameters	Hybrid seed	Grain
Yield	16.40 q	26.30 q
Rate (Rupees per kg)	75.00	15.50
Net return (Rs)	94,553.00	34,010.00
B : C ratio	1 : 2.78	1 : 1.72

3.2 Upliftment of Economic Condition of Tribal Farmers through Trainings on Single Cross Hybrid Seed Production Technique of QPM

The study was conducted from the data available from the farmers regarding the profitability of seed production over grain crop (Table 4) showed that the enhancement in the farmer's income was about 2.78 times than the grain crop with the net return of Rs. 34,010.00 from grain yield and Rs. 94,553.00 in case of seed yield of single cross hybrid QPM. The B: C ratio of grain yield was 1.72 whereas it was observed 2.78 in case of seed yield.

4. CONCLUSION

The farmers relished both the QPM hybrids because of at par grain yield but among two cultivars Vivek QPM-9 was liked most due to its stay green nature. This stay green nature of the stalk was able to provide the green fodder for their cattle's even after de-cobbing the mature cobs for grain yield.

The profitability of seed production over grain crop and showed that enhancement of farmer's income was more than double from the seed production of single cross hybrid of QPM over traditionally grown maize crop which leads to the development of their socio-economic capability. The enhancement in the farmer's income is about 2.78 times than the grain crop with a net

return of Rs. 94,553.00 from seed yield of single cross hybrid QPM and Rs.34,010.00 in case of grain yield. The B: C ratio of grain yield was 1.72 whereas; it was observed 2.78 in case of seed yield. The highest hybrid seed yield of single cross hybrid maize was recorded 16.40 q / ha. The cultivation and popularization of the QPM cultivars is an important intervention to fight with the protein malnutrition problem in the rural areas where maize is staple food stuff.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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