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RESEARCH ARTICLE

IDENTIFICATION OF QUALITY PROTEIN MAIZE VARIETIES THROUGH PARTICIPATORY VARIETY SELECTION IN WESTERN AND MID-WESTERN HILLS OF NEPAL

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ABSTRACT

High yielding, nutritionally superior maize varieties, generally referred to as quality protein maize (QPM), compared to its normal counterpart helps not only to increase food security but also to enhance feed, fodder and nutritional security. Five QPM varieties including farmers' popular variety were evaluated at five and eight sites in Arghakhanchi, Dailekh, Dang and Surkhet districts using various schemes of participatory variety selection (PVS) like mother-baby trials, minikits and large plot variety cum production demonstrations during summer season of 2013-14 and 2014-15. Two sets of mother trials, one with recommended dose of fertilizers and second with farmers' practice of fertilizer application were planted at each site in both the years. Combined results of mother trials showed increased grain yield of the tested genotypes under recommended dose of fertilizer than in farmers' practices. Babies and minikits were managed by farmers, and mother trials and demonstrations by researchers. Highly significant differences for grain yield were recorded for location and fertilizer, significant for genotype, and genotype × location; and non-significant for location × fertilizer, fertilizer × genotype and location × fertilizer × genotype. Variety wise yield increment ranged from 10.16 (S03TLYQ- AB-01) to 27.21% (farmers' popular variety) when combined over locations. District wise yield increment was in between 4.38 (Arghakhanchi) and 51.67% (Chitwan). Feedback from babies and minikits was collected through household level questionnaire (HLQ) and focus group discussion (FGD). Most of the improved varieties were preferred by farmers compared to their popular variety because of higher grain yield, stay green character, better taste and tolerance to lodging, and better diseases and insect-pests tolerance. Based on experimental results and feedback from farmers and other stakeholders S99TLYQ-B was released as Poshilo Makai-2 in 2017 for commercial cultivation in Terai and inner Terai (up to 800 meter) during winter and mid-hills (800-1800 meter) during summer season. Thus, participatory variety selection can be used as complementory approach to conventional plant breeding.

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INTRODUCTION

Productivity and competitiveness of the agricultural sector are low although the majority of Nepali population is engaged in agriculture because of low adoption of improved technologies. Most of the cultivated area is under cereals, however there is a growing food trade deficit and malnutrition is still high (ADS, 2014). Thirty-five out of 75 districts are food insecure with respect to edible production (MoAD, 2017). Protein from livestock sources in Nepali diet is low (13%) compared to recommendation of 30% (NPC, 2011).

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Protein and protein-energy deficient malnutrition, nutritional anaemia, free radical damage, growth retardation, diminished resistance etc. are the common identified problems especially in vulnerable groups. Maize is the second most important crop that occupies 891583 ha of land with average productivity of 2503 kg ha^{-1} in Nepal (MoAD, 2017). Maize kernels contain about 9-12% protein. Roughly, half of the protein in a kernel of normal maize is composed of protein types where in lysine or tryptophan are the limiting amino acids. A nutritionally superior maize cultivar named quality protein maize (QPM) represents nearly one-half century of research dedicated to malnutrition eradication (Prasanna *et al*., 2001). It produces 70% to 100% more lysine and tryptophan than ordinary modern and traditional varieties of tropical maize (Bjornson

and Vasal, 1992). Increased content of potassium, zinc and oil in QPM over the normal maize are reported (Kies *et al*., 1965; Vasal, 2001). Newly developed QPM varieties are similar or better to normal maize in most of the quantitative traits (taste, yield, and disease and pests resistance) containing the amount of lysine and tryptophan nearly double when compared to normal maize (CIMMYT, 1999; 2000; Urrea, 2004). QPM is nutritionally risk-free. Enhanced lysine and tryptophan content, and protein utilization of QPM are comparable to milk or egg protein (Vasal, 2001). By consuming 175 grams of QPM, children can meet 90% protein requirement (Viteri *et al*., 1972; CIMMYT, 1999; 2000). A remarkable increase in anthropometric measurements of children fed with QPM as compared to children fed with normal maize was found on pre-school children for six months (DMR, India, 2001). Opaque-2 maize offers better quality protein in the diet of adults as well (Clark, 1966; Clark *et al*., 1977). Tortillas prepared from QPM had higher lysine content than from normal maize (Ortega *et al*., 1986; Sprouble *et al*., 1988). The biological value of normal maize protein is about 40% of the biological value of milk protein, whereas the biological value of QPM protein is about 90% of milk protein (Bressani, 1990). The nutritive value of QPM protein approaches that of protein of skim milk (CIMMYT, 1999; 2000). Only 37 percent of the common maize protein intake is utilized compared to 74 percent from QPM. Therefore, the available amount of protein from the same amount of QPM is said to be doubled compared to normal maize. In mid and high hills of Nepal, more than two thirds of the maize produced is utilized for human consumption. For nutritional security enhancement, QPM might be the option. However, the lack of high yielding OPVs is the main constraint in this region (Paudyal *et al*., 2001). Maize production, therefore, should be enhanced through increased productivity in maize-based systems using QPM to improve protein supply scenario.

The conventional plant breeding system has helped to develop high yielding varieties mainly for high potential agricultural environments. However, resource-poor and disadvantaged farmers in marginal environments have not benifited as anticipated from these varieties (Witcombe, 1996; Fano and Tadeos, 2017). It is reported that participatory research increases benefits and more effective at reaching women and poor, improving research efficiency and resulting more farmers' preferred varieties according to their interests thereby accelerating adoption (Ashby and Lilja, 2004; Singh *et al*., 2014). Several studies show the relevance of participatory plant breeding (PPB) and participatory variety selection (PVS) in the release and faster adoption of varieties, better understanding of farmers' variety selection criteria, acceleration of dissemination, increased cost-effectiveness, facilitated farmer learning, and empowerment of farmers with new technology (Sperling *et al*., 2001; Gunasekare, 2006; Tadesse *et al*., 2014; Liliane *et al*., 2017). Participatory selection approaches are needed because a low percentage of varieties developed by breeders are eventually adopted and utilized by farmers. This is partly because of non-participation of farmers in the selection process of varieties. The study conducted through PVS by Tadesse and his colleagues (2014) in four villages of Chilga district of Northwest Ethiopia, for selection of a QPM variety BHQPY-545, indicated not only preference because of its high quality protein but also their willingness to adopt this selected variety ahead of four already-released varieties evaluated. In Nepal, women, small-scale, marginal, resource-poor and socially disadvantaged (Dalits) farmers are mainly engaged in agricultural activities and are not getting anticipated benefits from the new technologies. About 96% females are engaged in agricultural occupation (MoAC, 2002; Lohani and Gyawali, 2003). The female-headed households were reported to be about 15% of the total households in Nepal (Lohani and Gyawali, 2003). Females also play a crucial role in choosing variety for their use. Ashby and Lilja (2004) also showed that the participatory researches are more beneficial and have high effectiveness in helping women and farmers who are financially challenged. Asif and his colleagues (2017) highlighted the importance of MBTs to bring in increased confidence of farmers and local people in innovation than traditional top-down extension approaches. Hence, this study was undertaken through participatory approaches in the breeding process, which could draw farmers' attention to the existence, availability, nutritional benefits, and production requirement of the improved QPM genotypes.

MATERIALS AND METHODS

Genetic Materials and Experimental Sites

Five QPM varieties namely, S99TLYQ-B, S99TLYQ-AB, S03TLYQ-AB-01, S03TLYQ-AB-02 and Poshilo Makai-1, sourced from International Maize and Wheat Improvement Center, Mexico (CIMMYT) and farmers' popular variety were experimented under mother-baby scheme at five and eight sites in Arghakhanchi, Dailekh, Dang and Surkhet districts during summer season of 2013-14 and 2014-15, respectively. Maize is the staple food and major source of household income in these selected districts. Poshilo Makai-1 is a white kernel QPM variety released in 2008 in Nepal. All these varieties were used in minikits, too. Poshilo Makai-1 and S99TLYQ-B were used for variety cum production demonstration purposes.

Mobilization Training on QPM

A one-day farmers' mobilization training on mother-baby trials (MBTs), minikits, large plot production demonstrations on QPM was organized before planting at each site.

Baby Trials

Seed of varieties (0.5-1.0 kg/variety) was given to 25 farmers (5 farmers per site) to compare it with his/her popular variety under his/her own management in baby trials (BTs). BTs were farmers' led whereas mother trials (MTs) were led by researchers. Varieties were allocated to farmers randomly. The improved variety and their popular variety were planted in the same field in adjacent plots in the same day in case of BTs. Total of 500 and 800 farmers were involved in evaluation of babies in 2013-14 and 2014-15, respectively and compared the performances of both varieties from planting to post-harvest management.

Mother Trials

All the varieties tested in BTs including their popular variety as a check were grown together in a centrally located field of that site in mother trials (MTs). Ten and sixteen sets of MTs in each district managed by researchers were planted in 2013-14 and 2014-15, respectively. Among two sets of MTs at each site, one set was experimented using improved management practices and other set applying farmers' practice of fertilizer application with all other management practices remaining

same. Total 52 farmers were involved in evaluating MTs in a two-year period. First set was planted with fertilizers at the rate of 120:60:40 NPK kg ha^{-1} and 10 to15 ton ha^{-1} farm yard manure. In second set, fertilizer was applied as per farmers' practice prevailing at that site. MTs were managed in randomized complete block design (RCBD) with 3m long 6 rows plot size/variety having row-to-row and plant-to-plant spacing of 75 cm and 25 cm, respectively. Grain yield was calculated to 80% shelling recovery and 15% moisture content. Four central rows were used to take observations.

Layout plan of a mother-baby trial of five improved varieties and one farmers'popular variety in five farms at a site as an example has been presented below.

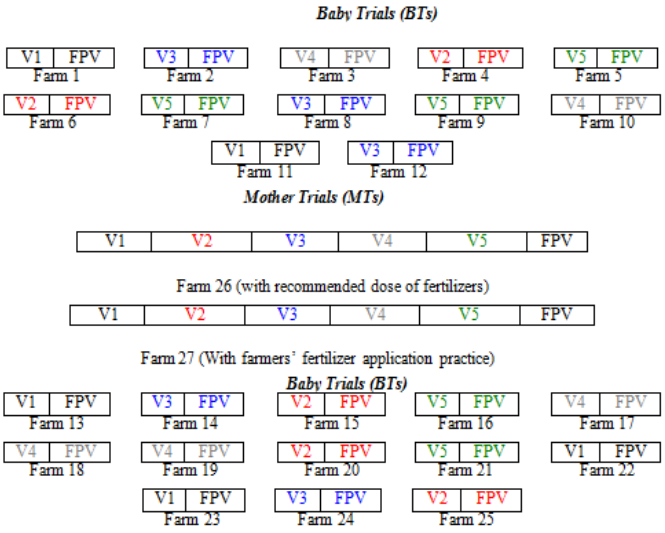

Fig. 1. Layout plan of a mother-baby trial of five QPM varieties and one farmers' popular variety in five farms, V1-V5 = New QPM varieties, FPV= Farmers' popular variety compared with V1-V5

Farmers' Field Day and Participatory Evaluation of Experimental Plots by Stakeholders

A farmers' field day was organized at each site of respective district during physiological maturity of the crop when pre-harvest evaluation of the varieties could be carried out. A total of 1352 stakeholders participated in the program. Stakeholders included farmers, staff of Department of Agriculture, researchers, local seed and grain traders, NGOs and others. Special attention was paid to women farmers and socially disadvantaged (Janajati and Dalit) farmers in the project. Participatory farm tours promoted discussions among stakeholders regarding positive and negative aspects of the experimented technology/variety.

These tours helped stakeholders to evaluate the varieties over the wide range of soil types, date of sowing and different management practices presented at the site along with the performance of varieties under improved management practices. Observations started from BTs and completed in MTs, at each tour. The stakeholders jointly evaluated plots, discussed on issues raised by farmers and finally select farmers' preferred variety/ies. After field visit, pre-harvest feedback was collected from individual farmer using household level questionnaire (HLQ) and ranking of varieties by the groups using focus group discussions (FGDs).

Minikits Distribution

For identification, promotion and wider dissemination of QPM varieties packets containing 1 kg seed (minikit) was distributed to the farmers. About 105, 108, 95, 70 and 150 sets of S99TLYQ-B, S99TLYQ-AB, S03TLYQ-AB-01, S03TLYQ-AB-02 and Poshilo Makai-1, respectively, for each district, and a total of 528 minikits per district were distributed in 2013-14. A total 2112 households evaluated these minikits during summer season of 2013-14. Number of variety wise minikits varied in different districts in 2014-15. 8, 28, 13, 24, 113; 7, 21, 10, 20, 81; 8, 24, 13, 26, 99; and 8, 22, 13, 29, 124 minikts of S99TLYQ-B, S99TLYQ-AB, S03TLYQ-AB-01, S03TLYQ-AB-02 and Poshilo Makai-1 were distributed, respectively in Arghakhanchi, Dailekh, Dang and Surkhet districts. The method of minikit evaluation was same as BTs but MTs were excluded. Thus, total 691 minikits were evaluated by farmers in 2014-15. As 500 and 800 households evaluated babies in 2013-14 and 2014-15, respectively, within a two-year period a total of 4103 households evaluated various QPM varieties in these districts. Feedback from babies and minikits was separately collected through HLQ and tabulated in each year.

Large Plot Variety cum Production Demonstrations

Most of the farmers preferred Poshilo Makai-1 and S99TLYQ-B in 2013-14. Therefore, large plot (500 m^2) production demonstrations of Poshilo Makai-1 and S99TLYQ-B were carried out at eight and four sites, respectively in each district during summer 2014-15. Row to row and plant to plant spacing was 75 cm and 25 cm, respectively. Fertilizer application was at the rate of 120:60:40 NPK kg ha^{-1}. Rest of the agronomic management was carried out as per recommendation. Observations were recorded from 9 m^2 plot.

Data Recording and Measurements

Individual farmer reported his/her own opinions, in BTs and minikits, through a HLQ using matrix ranking. Data in HLQ was recorded as scores where the new variety was compared to their popular variety as better (1), same (2) or worse (3). HLQs were filled twice, once before crop harvest around physiological maturity to collect feedback on pre-harvest traits viz. germination, plant height, insect-pests problems, lodging, nutritient requirement, drought tolerance and crop duration. The second set of observations, after 2-3 months of crop harvest, was taken to capture the feedback on post-harvest traits viz. maturity period, ear size, grain production, grain size, rotting in the store, insect pests problem in the store, his/her plan to plant this variety in the coming season and whether he/she has saved seed for next year planting. Similarly, with an objective of identifying farmers' preferred variety for each site, a focus group discussion (FGD) was conducted after receiving feedback from HLQ. At each site, a group consisting of 5-6 farmers was formed. As there were 26 farmers at a site, 4-5 groups were formed. Male and female groups were formed separately to avoid dominance of male farmers. The points included in HLQ were discussed in FGD. FGD was also conducted twice as HLQ. In FGD, based on the overall performance of varieties on various pre and post-harvest traits, the group ranked the varieties. Variety with many positive traits rankd first and with many negative traits ranked last.

In MTs and variety cum large plot production demonstrations, days to 50% tasseling and silking, plant and ear heights, and grain yield were also recorded using methodology adopted by Koirala *et al*. (2017).

Statistical Analysis

Mother trials were analysed using MSTATC version 1.2 (Freed, 1990) at 5% level of significance.

RESULTS AND DISCUSSION

Mobilization Training on QPM

Mobilization training helped them to understand the reasons for conducting MBTs, minikits, large plot production demonstrations and importance of QPM for food and nutritional security. Farmers were aquainted with purpose, activities and outputs of the project and the hidden benefit of QPM (almost double the amount of lysine and tryptophan compared to normal maize and high yield potential compared to their popular variety) was clarified to convince and motivate them towards low cost and low risk intervention QPM technology that automatically enhances their livelihoods (Fig. 4).

Baby Trials (2013-14)

A total 2600 households evaluated QPM varieties but received feedback only from 1882 (72.38%) households. Germination of improved varieties was found better than farmers' varieties as reported by farmers and ranged from 58 (S03TLYQ-AB-02) to 83% (Poshilo Makai-1). Reduced plant height, thicker stalk and resistant to lodging of improved varieties were recorded by majority of respondents. Early maturity of QPM varieties was reported by 67-86% households. Insects-pests problems both in field and store, and rotting problems in store was less in QPM varieties compared to farmers' variety. Higher grain yields by QPM verities were reported by majority of farmers which ranged from 64 (S99TLYQ-AB-01) to 74% (S99TLYQ-B). About 75, 77 and 78% of the respondents had indicated their preference to plant Poshilo Makai-1, S99TLYQ-B and S03TLYQ-AB-0, respectively. Similarly, 82% farmers decided to use S99TLYQ-AB and S03TLYQ-AB-02 varieties in the next years (Table 1).

Fig. 2. Experimental materials

Fig. 3. One of the experimental sites in Dang

Baby Trials (2014-15)

A total of 1491 households evaluated QPM varieties and feedback from 1233 (82.70%) households were received. Majority of respondents reported better germination of improved varieties. Thick stalk of the improved varieties as compared to farmers' variety was reported by 54 (S99TLYQ-AB) to 71% (Poshilo Makai-1) of the respondents. Most of the farmers also reported reduced plant height and less lodging problem of newly introduced varieties. Most farmers reported that these improved genotypes required similar amount of nutrient as their popular variety (Table 2).

Fig. 4. Farmers' training, Dang

Fig. 5. Seed distribution after training, Arghakhanchi

Table 1. Farmers' combined feedback towards QPM varieties in baby trials and minikits at various locations in western and mid-western hills, summer 2013-14

Parameter	S03TLYQ-AB-02			S99TLYQ-AB-01			S99TLYQ-B			S99TLYQ-AB			Poshilo Makai-1		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Germination	58*	36	6	80	9	11	75	16	9	74	15	10	83	12	5
Plant height (shortest the best)	61	30	9	82	13	5	80	14	6	79	13	8	84	13	3
Stalk thickness	56	36	8	77	12	11	76	18	6	80	14	7	68	21	12
Insect pests problem	71	12	16	85	10	4	85	9	5	77	14	8	97	3	0
Lodging problem	54	23	23	74	17	9	73	18	9	71	21	8	75	22	3
Maturity period (earliest the best)	67	21	13	71	14	14	71	15	14	73	20	8	86	11	3
Grain production	71	18	12	64	13	23	74	17	10	73	17	9	69	17	14
Grain size	73	15	11	77	12	12	77	13	10	80	8	12	84	12	4
Rotting in store	56	27	18	82	10	8	73	19	8	75	17	8	76	9	15
Storage insect pests	78	10	12	90	3	7	84	9	7	88	7	5	92	8	0
Plan for next year planting	82	12	7	78	11	10	77	15	8	82	11	7	75	15	10
Total distributed (no.)	405			505			420			545			725		
Feedback received (no.)	322			334			403			391			432		
Feedback received (%)	79.51			66.14			95.95			71.74			59.59		

*1: Better than local, 2: Similar to local, 3: Worse than local, *: Percent respondents supporting the point*

As per farmers, bigger ear size and grain size were additional positive aspects of QPM varieties. Majority of the respondents claimed increased grain production of these varieties from 50 (S03TLYQ-AB-01) to 57% (Poshilo Makai-1) when compared to their variety. Similarly, 53 to 66% of the participating farmers saved seeds from centre part of the field to be used for next year, and have plan to plant these varieties in coming years. The regions' combined results have been presented (Table 2).

Feedback from Female and Ethnic Groups

In 2014-15, among the 1882 feedback received, 638 (51.74%) and 595 (48.26%) were from female and male participants, respectively. Similarly, if we consider the participation as per ethnicity 371 (30.09%), 421 (34.14%) and 441 (35.77%) were from Janajati, Dalit (disadvantaged groups) and others, respectively. District and variety wise and combined across districts data on sex and ethnic groups have been summarized in Table 3 to 4.

Mother Trials

To identify productivity of QPM varieties and to demonstrate the effect of recommended dose of fertilizers on grain yield and other quantitative traits, two sets of mother trials applying recommended dose and farmers' practice were tested at eight sites in each district. During 2013-14, statistically significant differences were recorded for genotypes and practices, for all the traits under observation (Table 5).

Fig. 6: Mother trial, Dang

The pooled analysis of trials under Dailekh and Surkhet districts showed that under farmers practices, the highest ear height was recorded in Poshilo Makai-1 (134 cm) followed by farmer's popular variety (130 cm) and S99TLYQ-B (127 cm). Under improved practices, farmer's popular variety recorded the highest ear height (145 cm) followed by S99TLYQ-B (142 cm) and Poshilo Makai-1(136 cm). Plant and ear heights were found to be increased under recommended dose of fertilizer application than in farmers' practices. The yield increment in maize varieties due to improved practices over farmers' practices was 1790 (63.7%), 1542 (58.4 %), 1518 (53.1 %) and 1254 kg ha^{-1} (40%) in SO3TLYQ-AB-01, SO3TLYQ-AB-02, S99TLYQ-AB, and S99TLYQ-B, respectively. About 26.4% yield increment was recorded in farmers' popular variety under improved management compared to farmers' own practice of fertilizer application (Table 5).

Fig. 7. Data recording from mother trial

During 2014-15, statistically significant differences were recorded for grain yield among the tested genotypes providing varietal selection options to the farmers. Similarly, highly significant variations among the tested entries were observed at various environments and practices of fertilizer application. Genotypes by environment (G × E) interactions were evident for grain yield indicating location specific nature of the tested QPM varieties (Table 6). Other interaction items as environment × fertilizer (E × F), fertilizer × genotype (F × G) and environment × fertilizer × genotype (E × F × G) were statistically non-significant (data not shown in the Table 6). Variety wise combined grain yield across the environments showed that S99TLYQ-B produced the highest grain yield (4667 kg ha^{-1}) followed by Poshilo Makai-1 (4575 kg ha^{-1}),

Table 2. Farmers' combined feedback towards QPM varieties in baby trials and minikits at various locations in western and mid-western hills, summer 2014-15

Parameter	S99TLYQ-B			S99TLYQ-AB			S03TLYQ-AB-01			S03TLYQ-AB-02			Poshilo Makai-1		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Germination	91** (59)*	46 (30)	17 (11)	112 (60)	53 (28)	22 (12)	91 (54)	57 (34)	21 (12)	125 (62)	40 (20)	36 (18)	320 (70)	95 (21)	41 (9)
Plant height (shortest the best)	97 (68)	24 (17)	21 (15)	127 (70)	29 (16)	25 (14)	101 (66)	28 (18)	23 (15)	123 (66)	37 (20)	26 (14)	314 (71)	55 (12)	72 (16)
Insect pests problem	61 (44)	75 (54)	2 (1)	84 (45)	98 (52)	5 (3)	70 (47)	76 (51)	3 (2)	84 (47)	92 (51)	4 (2)	219 (51)	194 (45)	17 (4)
Lodging problem	80 (57)	51 (36)	10 (7)	103 (59)	57 (33)	14 (8)	89 (57)	56 (36)	10 (6)	122 (60)	71 (35)	9 (4)	290 (68)	109 (26)	28 (7)
Nutritient requirement	15 (11)	100 (71)	26 (18)	25 (13)	126 (67)	38 (20)	19 (12)	116 (75)	19 (12)	22 (12)	128 (71)	31 (17)	90 (20)	291 (66)	59 (13)
Drought tolerance	21 (15)	108 (78)	10 (7)	24 (13)	142 (78)	15 (8)	16 (11)	125 (82)	11 (7)	36 (19)	142 (75)	12 (6)	79 (19)	313 (76)	22 (5)
Maturity period (earliest the best)	57 (40)	31 (22)	53 (38)	68 (38)	42 (23)	71 (39)	65 (42)	32 (21)	56 (37)	66 (40)	43 (26)	58 (35)	144 (35)	112 (27)	158 (38)
Ear size	78 (56)	38 (27)	23 (17)	97 (52)	46 (25)	42 (23)	86 (54)	49 (31)	23 (15)	98 (55)	43 (24)	36 (20)	271 (62)	119 (27)	46 (11)
Grain production	78 (55)	49 (35)	14 (10)	90 (51)	61 (35)	25 (14)	74 (50)	63 (43)	11 (7)	95 (56)	59 (35)	16 (9)	238 (57)	156 (37)	25 (6)
Grain size	75 (54)	38 (28)	25 (18)	88 (50)	44 (25)	45 (25)	86 (58)	37 (25)	25 (17)	77 (46)	56 (34)	33 (20)	248 (60)	109 (26)	59 (14)
Rotting in the store	48 (40)	70 (58)	3 (2)	54 (35)	91 (59)	8 (5)	60 (45)	63 (48)	9 (7)	59 (42)	74 (53)	7 (5)	170 (48)	172 (48)	14 (4)
Insect pests problem in the store	44 (36)	75 (61)	4 (3)	55 (36)	87 (57)	10 (7)	53 (41)	63 (49)	12 (9)	55 (42)	71 (55)	4 (3)	148 (42)	189 (54)	16 (5)
Plan for next year planting	99 (67)	48 (33)	0 (0)	139 (76)	43 (23)	1 (1)	112 (70)	48 (30)	0 (0)	134 (76)	43 (24)	0 (0)	350 (82)	77 (18)	1 (0)
Save seed for next year planting	75 (53)	66 (47)	0 (0)	111 (62)	65 (37)	2 (1)	87 (57)	65 (43)	0 (0)	96 (56)	73 (43)	1 (1)	276 (66)	142 (34)	1 (0)
Total distributed (no.)		191			255			209			259			577	
Feedback received (no.)		166			210			178			203			476	
Female		90 (54)			118 (56)			85 (48)			116 (57)			229 (48)	
Male		76 (46)			92 (44)			93 (52)			87 (43)			247 (52)	
Janjati		56 (34)			74 (35)			45 (25)			65 (32)			131 (28)	
Dalit		43 (26)			66 (32)			68 (38)			61 (30)			183 (38)	
Others		67 (40)			70 (33)			65 (37)			77 (38)			162 (34)	
Feedback received (%)		87			82			85			78			83	

*1: Better than local, 2: Similar to local, 3: Worse than local, * & **: Number and percent respondents supporting the point, respectively*

Table 3. Sex and ethnic group wise received feedback in various districts, summer 2014-15

Parameter	Arghakhanchi					Dailekh					Dang				
	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
Female	19	27	23	38	63	25	39	20	23	49	16	25	14	24	47
Male	24	27	26	19	78	17	18	24	26	62	22	28	31	23	58
Janjati	12	19	9	12	34	26	29	23	31	38	13	23	12	20	53
Dalit	10	5	20	12	54	12	20	11	10	41	3	16	14	13	27
Others	21	30	20	33	53	4	8	10	8	32	22	14	19	14	25
Distributed (no.)	48	68	53	64	153	47	61	50	60	121	48	64	53	66	139
FB received (no.)	43	54	49	57	141	42	57	44	49	111	38	53	45	47	105
FB received (%)	90	79	92	89	92	89	93	88	82	92	79	83	85	71	76

**Variety: 1. S99TLYQ-B, 2. S99TLYQ-AB, 3. S03TLYQ-AB-01, 4. S03TLYQ-AB-02, 5. Poshilo Makai-1*

Table 3: Sex and ethnic group wise received feedback in various districts, summer 2014-15 (contd...)

Parameter	Surkhet					Combined				
	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
Female	30	27	28	31	70	90	118	85	116	229
Male	13	19	12	19	49	76	92	93	87	247
Janjati	5	3	1	2	6	56	74	45	65	131
Dalit	18	25	23	26	61	43	66	68	61	183
Others	20	18	16	22	52	67	70	65	77	162
Distributed (no.)	48	62	53	69	164	191	255	209	259	577
FB received (no.)	43	46	40	50	119	166	210	178	203	476
FB received (%)	90	74	75	72	73	87	32	85	78	83

**Variety: 1. S99TLYQ-B, 2. S99TLYQ-AB, 3. S03TLYQ-AB-01, 4. S03TLYQ-AB-02, 5. Poshilo Makai-1*

Table 4. Sex and ethnic group wise received feedback in various districts, summer 2014-15

Parameter	Arghakhanchi	Dailekh	Dang	Surkhet	Total
Female	170	156	126	186	638
Male	174	147	162	112	595
Janjati	86	147	121	17	371
Dalit	101	94	73	153	421
Others	157	62	94	128	441
Distributed (no.)	386	339	370	396	1491
FB received (no.)	344	303	288	298	1233
FB received (%)	89.12	89.38	77.84	75.25	82.7

Table 5: Overall performance of QPM genotypes under farmers' practices and improved practices in mother trials, combined over locations (Dailekh and Surkhet districts), summer 2013-14

SN	Genotype	Ear height, cm		Increment over FP (%)	Plant height, cm		Increment over FP (%)	Grain yield, kg ha^{-1}		Increment over FP (%)
		FP	IP		FP	IP		FP	IP	
1	S03TLYQ-AB-02	116	127	11 (9.5)	215	242	27 (12.6)	2639	4181	1542 (58.4)
2	S03TLYQ-AB-01	113	132	19 (16.8)	207	247	40 (19.3)	2810	4600	1790 (63.7)
3	S99TLYQ-B	127	142	15 (11.8)	220	255	35 (15.9)	3138	4392	1254 (40)
4	S99TLYQ-HG-AB	122	130	8 (6.6)	218	243	25 (11.5)	2860	4378	1518 (53.1)
5	Poshilo Makai-1	134	136	2 (1.5)	236	244	8 (3.4)	3535	4432	897 (25.4)
6	Farmers' Popular Variety	130	145	15 (11.5)	249	263	14 (5.6)	3350	4235	885 (26.4)
Mean		124	135	11 (8.9)	224	249	25 (11.2)	3055	4370	1315 (43)
F-test (Genotype)		*			*			*		
LSD (0.05)		14.25			18.98			588		
F-test (Practice)		*			*			*		
LSD 0.05 (Practice)		19.12			24.61			861.6		
F-test (G × P)		ns			ns			ns		
CV (%)		10.8			7.9			15.5		

FP-Farmers' practice, IP-Improved practice

S03THYQ-AB-01 (4557 kg ha^{-1}) and S99TLYQ-AB (4420 kg ha^{-1}). Farmers variety produced the lowest grain yield both under improved and farmers' management. Grain yield increment of the tested genotypes under improved management practices ranged from 10.17 (S03TLYQ-AB-01) to 27.21% (farmers' popular variety). Results when combined over locations, varieties S03TLYQ-AB-01, S99TLYQ-B, S99TLYQ-B, S03TLYQ-AB-02, Poshilo Makai-1 and farmers' variety produced higher grain yield under improved management practices compared to farmers' practices of fertilizer application by 10.17, 12.16, 12.83, 13.71, 15.85 and 27.21%, respectively. Performance of improved varieties under recommended practices were found better in Arghakhanchi followed by Dailekh and Surkhet. Environment wise yield increment was in between 4.38 (Arghakhanchi) and 51.67% (Rampur). Most of the QPM varieties including farmers' popular variety produced higher yield under improved management compared to farmers' method of fertilizer application.

Focus Group Discussions

First of all, varieties were ranked site wise in each district. Then sites' combined results have been presented as a district rank to identify farmers' preferred varieties for the district (Table 7).

Fig. 8. Feedback collection, Surkhet

Fig. 9: Feedback compilation, NMRP Rampur

Preferences towards variety differed from location to location even with in a district. Based on overall performances, farmers preferred Poshilo Makai-1 followed by S99TLYQ-B and S99TLYQ-AB, respectively in Arghakhanchi district.

Fig. 10. Farmers' preferred variety Poshilo Makai-2

Fig. 11. Farmers' preferred variety Poshilo Makai-1

However, farmers' ranking did not coincide with grain yield rank of the mother trials (Table 6). In Arghakhanchi, in the trials under improved management practices S99TLYQ-B produced the highest yield (6490 kg ha^{-1}) followed by S99TLYQ-AB (6132 kg ha^{-1}) and Poshilo Makai-1 (6025 kg ha^{-1}), while the variety (Poshilo Makai-1) in third position for grain yield in MTs, was farmers' choice (Table 7). In Dang district, Poshilo Makai-1 was the top yielder (4673 kg ha^{-1}) followed by S99TLYQ-B (4352 kg ha^{-1}) and S03TLYQ-AB-02 (4162 kg ha^{-1}) under improved management practices. Likewise, under farmers' management highest grain yield was recorded in Poshilo Makai-1 (4294 kg ha^{-1}) followed by S99TLYQ-B (4007 kg ha^{-1}) and S03TLYQ-AB-01 (3999 kg ha^{-1}). However, farmers ranked promising varieties S03TLYQ-AB-02 the first, S99TLYQ-AB the second and S99TLYQ-B the third. The recommended QPM Variety Poshilo Makai-1 occupied the 4th position (Table 8).In Dailekh, grain yield under improved management condition ranged from 5074 kg ha^{-1} (S99TLYQ-B) to 5578 kg ha^{-1} (Poshilo Makai-1) whereas it ranged from 4262 kg ha^{-1} (S03TLYQ-AB-02) to 4833 kg ha^{-1}(S99TLYQ-B) under farmers' management. Finally, most of the participating farmers preferred Poshilo Makai-1 and ranked first. Farmers ranked three varieties viz., S99TLYQ-AB, S03TLYQ-AB-01 and S03TLYQ-AB-02 as second and S99TLYQ-B the third (Table 9). In Surkhet district, under improved management practices grain yield ranged from 4435 kg ha^{-1} (S99TLYQ-B) to 5239 kg ha^{-1} (S03TLYQ-AB-01). Under farmers' management condition the highest grain yield was produced by S03TLYQ-AB-01 (5132 kg ha^{-1}) followed by

Table 6. Mean grain yield (kg ha^{-1}) of tested genotypes in different districts under recommended dose of fertilizer and farmers' management, 2014-15

Environment	Fertilizer	S99TLY Q-B	S99TLY Q-AB	S03TLYQ-AB-01	S03TLYQ-AB-02	Poshilo Makai-1	Farmers' Popular Variety	Mean	Increment over FP (%)
Arghakhanchi	1	6490	6132	5819	5752	6025	4520	5789	4.38
	2	6640	5637	5658	5441	5427	4473	5546	
Dailekh	1	5074	5082	5339	5095	5578	4729	5149	13.09
	2	4843	4430	4466	4262	4758	4559	4553	
Dang	1	4352	3135	3910	4162	4673	5055	4214	17.48
	2	3578	3334	3999	3331	4294	2984	3587	
Surkhet	1	4435	4912	5239	5178	4909	4454	4855	7.55
	2	4037	4592	5132	4765	4621	3940	4514	
Rampur	1	4319	4170	3581	3203	3371	4269	3819	51.67
	2	2899	2773	2431	2769	2097	2142	2518	
Mean	1	4934	4686	4778	4678	4911	4605	4765	14.99
	2	4399	4153	4337	4114	4239	3620	4144	
Overall mean		4667	4420	4557	4396	4575	4113	4454	
Increment over FP		12.16	12.83	10.17	13.71	15.85	27.21	14.99	
Environment						**			
LSD (0.05)						327.2			
Fertilizer						**			
LSD (0.05)						235.6			
Genotype						*			
LSD (0.05)						408.1			
Genotype × Environment						*			
LSD (0.05)						750			
CV (%)						22.55			

1-With fertilizer, 2-Farmers' practice applying fertilizer

Table 7. Ranking of QPM varieties by focus groups in Arghakhanchi district, summer 2014-15

Site	Parameter	S99TLYQ-B	S99TLYQ-AB	S03TLYQ-AB-1	S03TLYQ-AB-2	Poshilo Makai-1
Thulopokhara-4	Pre-harvest	3	2	4	5	1
	Post- harvest	2	3	3	3	1
Thulopokhara-7	Pre-harvest	2	2	2	2	1
	Post- harvest	2	3	3	4	1
Thulopokhara-1,3-7,9	Pre-harvest	3	3	4	2	1
	Post- harvest	3	4	2	4	1
Divarna-4 (Jimurthung), 5	Pre-harvest	2	2	2	2	1
(Kallabot)	Post- harvest	1	3	3	3	2
Wangla 1-3,5-6,8	Pre-harvest	1	3	4	4	2
	Post- harvest	2	3	3	3	1
District rank	Pre-harvest	2	2	4	3	1
	Post- harvest	2	4	3	5	1
	Overall combined	2	3	4	5	1

1=the best

Table 8. Ranking of QPM varieties by focus groups in Dang district, summer 2014-15

Site	Parameter	S99TLY Q-B	S99TLYQ -AB	S03TLYQ-AB-1	S03TLYQ-AB-2	Poshilo Makai-1
Laxmipur-5 (Goddhara)	Pre-harvest	2	3	5	1	4
	Post- harvest	2	3	4	4	1
Laxmipur-5 (Sawarikot and Chhekbar)	Pre-harvest	2	3	5	1	4
	Post- harvest	3	5	4	2	1
Rampur-5, Harnok-3	Pre-harvest	5	1	2	3	4
	Post- harvest	5	3	1	4	2
Syuja-9 (Darma)	Pre-harvest	1	2	1	3	4
	Post- harvest	3	3	2	1	4
Syuja-4 (Kalimati, Tangtang Khola), 5 (Chhap,	Pre-harvest	3	1	2	2	3
Rangbang), 6 (Mirpani), 7 (Khada), 8 (Kuja)	Post- harvest	4	4	2	3	1
Syuja-4 (Bhojpokhara, Tangtang Khola, Kalimati),	Pre-harvest	4	3	4	1	2
5 (Chhap and Rangbang), 6 (Jaruwa), 7 (Khada and Harjapata)	Post- harvest	1	2	5	3	4
Syuja 7 (Khada and Harjapata), 8 (Khairdhara)	Pre-harvest	2	1	4	3	3
	Post- harvest	1	3	2	2	2
Syuja-1 (Pakharpani, Takura), 4 (Kalimati), 5	Pre-harvest	2	1	3	3	3
(Chhap, Rangbang), 6 (Syujadanda)	Post- harvest	4	1	4	2	3
District rank	Pre-harvest	3	1	4	2	5
	Post- harvest	3	3	3	2	1
	Overall combined	3	2	5	1	4

1=the best

Table 9. Ranking of QPM varieties by focus groups in Dailekh district, summer 2014-15

Site	Parameter	S99TLYQ-B	S99TLYQ-AB	S03TLYQ-AB-01	S03TLYQ-AB-02	PoshiloMakai-1
Narayan Municipality-2 (Kusada)	Pre-harvest	2	2	2	2	1
	Post- harvest	2	2	2	2	1
Narayan Municipality-2 (Kusada)	Pre-harvest	2	2	2	2	1
	Post- harvest	2	2	2	2	1
Narayan Municipality-6 (Chautara),	Pre-harvest	2	2	2	2	1
7 (Bijaura)	Post- harvest	2	2	2	2	1
Narayan Municipality-7 (Bijaura)	Pre-harvest	2	2	2	2	1
	Post- harvest	2	2	2	2	1
Narayan Municipality-9 (Sadhu)	Pre-harvest	2	2	2	2	1
	Post- harvest	2	2	2	2	1
Narayan Municipality-9 (Sadhu)	Pre-harvest	2	2	2	2	1
	Post- harvest	3	2	2	2	2
District rank	Pre-harvest	2	2	2	2	1
	Post- harvest	3	2	2	2	1
	Overall cobmined	3	2	2	2	1

1=the best

Table 10. Ranking of QPM varieties by focus groups in Surkhet district, summer 2014-15

Site	Parameter	S99TLYQ-B	S99TLYQ-AB	S03TLYQ-AB-1	S03TLYQ-AB-2	Poshilo Makai-1
Ramghat-3 (Galatitole,	Pre-harvest	5	2	3	4	1
Himaltole, Naukot)	Post- harvest	4	1	2	1	3
Ramghat-2 (Sunar, Bargaon,	Pre-harvest	3	4	2	1	5
Danda, Ghaneltole)	Post- harvest	4	2	1	1	3
Ramghat-2, 3(Gothen,	Pre-harvest	3	3	2	1	3
Bargaon, Danda, Ghanel)	Post- harvest	4	3	2	1	5
Ramghat-2 Jajarkottole)	Pre-harvest	2	3	1	4	5
	Post- harvest	2	3	1	4	5
Ramghat-1 (Bhimpur)	Pre-harvest	3	3	4	2	1
	Post- harvest	4	5	3	2	1
Maintada-9 (Khatritole)	Pre-harvest	5	4	3	1	2
	Post- harvest	5	4	3	2	1
Ramghat-1 (Jharankot)	Pre-harvest	5	4	3	2	1
	Post- harvest	5	4	2	3	1
Sahare-8 (Botechaur)	Pre-harvest	3	5	1	4	2
	Post- harvest	3	5	2	4	1
District rank	Pre-harvest	4	3	1	1	2
	Post- harvest	5	4	1	2	3
	Overall combined	5	4	1	2	3

1=the best

Table 11. Performance of QPM varieties in large plot production demonstration at various locations, Arghakhanchi, summer 2014-15

Location	Variety	Days to 50% flowering		Height, cm		Grain yield, kg ha^{-1}
		Tasseling	Silking	Plant	Ear	
Thulopokhara-5	Poshilo Makai-1	68	71	255	110	7026
Thulopokhara-4	Poshilo Makai-1	69	72	290	130	6383
Divarna-5	Poshilo Makai-1	70	73	295	115	6287
Thulopokhara-9	Poshilo Makai-1	69	72	280	110	5837
Thulopokhara-7	Poshilo Makai-1	70	73	255	150	5539
Sandhikharka-4	Poshilo Makai-1	68	71	230	105	4786
Mean		69	72	268	120	5976
Divarna-5	S99TLYQ-B	66	69	255	120	6565
Sandhikharka-4	S99TLYQ-B	68	72	215	105	6199
Thulopokhara-4	S99TLYQ-B	66	69	200	110	5861
Mean		67	70	223	112	6209

Table 12. Performance of QPM varieties in large plot production demonstration at various locations, Dang, summer 2014-15

Location	Variety	Days to 50% flowering		Height, cm		Grain yield, kg ha^{-1}
		Tasseling	Silking	Plant	Ear	
Khada	Poshilo Makai-1	64	67	235	105	5740
Tusarpani	Poshilo Makai-1	64	67	260	140	4160
Khada	Poshilo Makai-1	65	68	205	100	4136
Sawarikot	Poshilo Makai-1	66	69	215	120	3804
Syujadanda	Poshilo Makai-1	67	70	220	120	3642
Mean		65	68	227	117	4296
Khada	S99TLYQ-B	64	67	210	110	9080
Goddhara	S99TLYQ-B	62	64	220	110	7680
Mean		63	66	215	110	8380

Table 13. Performance of QPM varieties in large plot production demonstration at various locations, Surkhet, summer 2014-15

Location	Variety	Days to 50% flowering		Height, cm		Grain yield, kg ha^{-1}
		Tasseling	Silking	Plant	Ear	
Ramghat-3	Poshilo Makai-1	62	67	215	104	8780
Maintada-2	Poshilo Makai-1	60	64	230	115	7850
Ramghat-2	Poshilo Makai-1	63	67	230	115	7690
Ramghat-1	Poshilo Makai-1	59	63	220	106	7580
Ramghat-2	Poshilo Makai-1	65	68	198	95	6850
Ramghat-2	Poshilo Makai-1	63	67	215	104	6600
Ramghat-2	Poshilo Makai-1	64	67	210	90	6300
Maintada-9	Poshilo Makai-1	64	67	232	115	6220
Mean		63	66	219	106	7234
Ramghat-1	S99TLYQ-B	58	62	225	115	8695
Ramghat-3	S99TLYQ-B	63	66	243	146	8650
Maintada-9	S99TLYQ-B	63	66	230	112	8120
Ramghat-1	S99TLYQ-B	63	66	235	117	7230
Mean		62	65	233	123	8174

Table 14. Combined performance of QPM varieties in large plot production demonstration in various project districts, summer 2014-15

District	Variety	Days to 50% flowering		Height, cm		Grain yield, kg ha^{-1}
		Tasseling	Silking	Plant	Ear	
Surkhet	Poshilo Makai-1	63	66	219	106	7234
Arghakhanchi	Poshilo Makai-1	69	72	268	120	5976
Dang	Poshilo Makai-1	65	68	227	117	4296
Mean		66	69	238	114	5835
Dang	S99TLYQ-B	63	66	215	110	8380
Surkhet	S99TLYQ-B	62	65	233	123	8174
Arghakhanchi	S99TLYQ-B	67	70	223	112	6209
Mean		64	67	224	115	7588

S03TLYQ-AB-02 (4765 kg ha^{-1}) and Poshilo Makai-1 (4621 kg ha^{-1}). Here, varieties ranked by the focus groups and ranked in the mother trials were the same. Farmers' preference in Surkhet district was S03TLYQ-AB-01, S03TLYQ-AB-02 and Poshilo Makai-1 (Table 10). Farmers do not always select only high yielding varieties for their use. In addition to yield, they select the varieties based on earliness, grain colour, non-lodging, stay green, good husk cover, larger ear and grain size, drought tolerance, insect-pests resistance in the field and in the store as well. Hence, there was difference in farmers' preference vis a vis mother trials conducted by researchers. Similar type of result was reported by Tadesse *et al*., in 2014. PVS also helped to increase the adoption rate of released variety Poshilo Makai-1 and similar case was reported in India by Ghosh and his colleaugues (2014) in a study on chickpea carried out at rainfed rice fallow lands of Chhattisgarh and Madhya Pradesh.

Large Plot Variety cum Production Demonstrations

With a view to promote, disseminate, convince and popularize farmers' preferred QPM varieties, large plot demonstrations were conducted in all four project districts in 2014-15. Two QPM varieties preferred by farmers, in 2013-14, Poshilo Makai-1 (white kernel) and S99TLYQ-B (yellow kernel) were demonstrated using improved package of practices at eight and four sites, respectively in each project district. Thus, total 48 demonstrations were conducted. In Arghakhanchi district, grain yield of Poshilo Makai-1 ranged from 4786 (Sandhikharka-4) to 7026 kg ha^{-1} (Thulopokhara-5) with average value of 5976 kg ha^{-1}. For S99TLYQ-B, it ranged from 5861 (Thulopokhara-4) to 6565 kg ha^{-1} (Divarna-5) having mean value of 6209 kg ha^{-1}. Both the varieties performed well in Arghakhanchi district providing varietal selection option for white and yellow kernel types. Maturity period of these varieties coincided with their popular variety, thus fit into their existing cropping pattern. Ear placement of both the varieties is at the center position of the plant, hence are resistant to lodging. Both the varieties were preferred by farmers (Table 11). In Dang district, as presented in Table 12, grain yield of Poshilo Makai-1 ranged from 3642 (Syujadada) to 5740 kg ha^{-1} (Khada) with average value of 4296 kg ha^{-1}. For S99TLYQ-B, it was in between 7680 (Goddhara) and 9080 kg ha^{-1} (Khada) having mean value of 8380 kg ha^{-1}. S99TLYQ-B performed well in Dang district than Poshilo Makai-1 in case of grain yield. S99TLYQ-B found to mature earlier compared to PoshiloMakai-1. In Surkhet district, grain yield of Poshilo Makai-1 ranged from 6220 (Maintada-9) to 8780 kg ha^{-1} (Ramghat-3) with an average value of 7234 kg ha^{-1}. For S99TLYQ-B, it was ranging from 7230 (Ramghat-1) to 8695 kg ha^{-1} (Ramghat-1) having mean value of 8174 kg ha^{-1}. Both the varieties performed well in Surkhet district providing varietal selection option for white and yellow kernels (Table 13).

Data when combined over locations within the district, the grain yield of Poshilo Makai-1 was the highest in Surkhet (7234 kg ha^{-1}) followed by Arghakhanchi (5976 kg ha^{-1}) and Dang (4296) districts. Likewise, S99TLYQ-B produced the highest grain yield in Dang district (8380 kg ha^{-1}) followed by Surkhet (8174 kg ha^{-1}) and Arghakhanchi (6209 kg ha^{-1}). Overall in the project district, S99TLYQ-B produced higher grain yield (7588 kg ha^{-1}) compared to Poshilo Makai-1 (5835 kg ha^{-1}) (Table 14). Koirala *et al*., (2009) conducted organoleptic test of QPM varieties to identify their usefulness for various culinary purposes. The highest grit recovery (71.8%) was found in S99TLYQ-B followed by Poshilo Makai-1 (69.7%) and farmers' local (68.2%). For roasting purpose S99TLYQ-B and Poshilo Makai-1, for boiling purpose Poshilo Makai-1, for "*Bhat"* from grits S99TLYQ-B, for breads Poshilo Makai-1 were preferred by stakeholders. Thus, for most of prevailing culinary dishes that farmers prepare, QPM varieties were found to be better than local ones as per

stakeholders' preferences. Poshilo Makai-1 with white kernels was released in 2008, based on farmers' preference both from grain yield and other agronomic characters, and grain quality preferences. However, the farmers were also wanted yellow kernel type QPM variety. Based on farmers' feedback from this study and experiments conducted in other parts of the country, S99TLYQ-B has been released as Poshilo Makai-2 in 2017. We believe that PVS can be used as a complementary breeding approach to conventional plant breeding to effectively address the needs of the farmers. Its application is useful not only in selecting and popularing varieties in remote and marginal areas but also in identifying consumers' preferred varieties with in a possible shortest period of time for high potential pockets.

Fig. 12: Monitoring of on-farm QPM seed production

Fig. 13. Stakeholders' workshop (I year)

Participatory variety selection (PVS) approach was identified an effective tool in identifying and promoting new technologies within a possible shortest period of time in different countries for various crops viz. rice in Bhutan, India, Phillipines, Myanmar and Cameroon (Tshewang and Ghimiray, 2010; Singh *et al*., 2014; Menchie R del Rosario, 2014; Rahman *et al*., 2015; Malaa *et al*., 2016), wheat in Ethiopia (Fano, Dargo and Tadeos Shiferaw, 2017), barley in Ethiopia (Aynewa, 2013; Yalemtesfa, 2017), sorghum in Malawi and Burkina Faso (Nkongolo *et al*., 2008; Brocke *et al*., 2010), chickpea in India and Ethiopia (Ghosh *et al*., 2014; Goa *et al*., 2017), potato in Ethiopia (Kolech *et al*., 2017), rapeseed-mustard in India (Asif M Iqbal *et al*., 2017), eggplant and roselle in Mali (Diouf *et al*., 2017), faba bean in Ethiopia (Gereziher *et al*., 2017), cowpea in Namibia (Horn *et al*., 2017), soybean in Ethiopia (Getahum *et al*., 2016) and tef in Ethiopia (Belay *et al*., 2006), and specifically on maize in Nepal (Koirala, 2009, 2012; Koirala and Ghimire, 2007; Koirala *et al*., 2008, 2012) and in Ethiopia (Tadesse *et al*., 2014).

Conclusion

Participatory variety selection using mother-baby trials, minikits and large plot variety cum production demonstration schemes was found one of the best options to identify farmers' preferred location specific high yielding varieties within a possible shortest period of time. Most of the tested QPM varieties yielded better than farmers' popular variety under both the improved management and farmers' management conditions. Overall ranking of the varieties was done based on their performance in pre and post-harvest traits. S99TLYQ-B produced higher grain yield of 7588 kg ha^{-1} compared to Poshilo Makai-1 (5835 kg ha^{-1}) in the project districts in large plot production demonstration. Poshilo Makai-1, a white kernel QPM variety was released in 2008, based on the preferences of farmers in hilly regions. Based on overall performance, as reported in this study, the yellow kernel QPM variety S99TLYQ-B has been released for commercial cultivation in 2017 as Poshilo Makai-2.

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