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Comparative Evaluation and Demonstration of Field Pea Production Practices in Intermediate Altitudes of Northeastern Amhara, Ethiopia

Ademe Mihiretu[1,a,*], Netsanet Assefa[1,b]

[1]*Socioeconomics and Agricultural Extension Research Directorate, Sekota Dry-land Agricultural Research Center, Po. Box 62, Sekota, Ethiopia*
[*]*Corresponding author*

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On-farm evaluation and demonstration of different field pea production packages (IFPP, LFPP and LFTP) was carried out for two cropping seasons across districts on seventeen sites in Northeastern Amhara region. The objectives of the experiment were to evaluate the performance of different field pea technologies and to demonstrate the package to the farmers and the extension personnel then to collect feedback from participants. The experiment was conducted by comparing improved variety with its full package along with the local variety under full package practice and farmers' traditional practice. The agronomic, economic and farmers' preference analysis clearly indicated that the improved technology is superior to the local variety under full package and farmers' practice. The average mean grain yields of the improved practices (IFPP and LFPP) were 1901.7 and 1428.3 kgha^{-1}in Dehana, while 1933.3 and 1520 kg ha^{-1} in Sekota district, respectively. Therefore, the improved field pea technology had a yield advantage of 33.2% and 91.8% respectively from the local cultivar under improved and farmers practice in Dehana. However, the improved technology had 27.2% and 94.6% yield advantage over the local with improved and farmers practice in Sekota, respectively. The marginal rate of return for improved technology in Dehana and Sekota districts was 857.2 and 1344.7%, respectively. Farmers perceived the higher yield potential of the improved technology as a result many of them showed great demand for improved field pea technology. So that pre-scaling up of the improved variety with its production package is recommended to similar agro ecologies.

[a] ademe_78@yahoo.com.sg https://orcid.org/0000-0002-2861-5694 | [b] netsanetassefa5@gmail.com https://orcid.org/0000-0001-6611-6004

Introduction

Field pea (*Pisum sativum L.*) is one of the most important annual cool season pulse crop or grain legume. It has hypogeal emergence in which the cotyledons remain below the soil surface and produce white to reddish purple flowers, which are mostly self-pollinated (Adane, 2016; Yirga et al., 2019). Each flower will produce a pod containing four to nine seeds. Pea varieties have indeterminate or determinate flowering growth habit (Kandel et al., 2016). Field pea is grown in many countries and currently ranks fourth among the pulses in the world with cultivated area of 6.33 M and In Ethiopia, the crop is widely grown from mid to high altitude and ranks fourth in area coverage reaching 212,890 ha with an annual production of 2,632,663.9 ton (FAO, 2012). According to CSA (2016), on average 25147.7 ha of land has been allocated to field pea; with a total average production of 21406. 4 ton, an average yield of 8.6 qt/ha that putts Ethiopia in the list of major field pea producing countries in the world.

It is widely produced in the North, South, West and central part of Ethiopia and it is the most important cool-season food legume, Next to faba bean, in terms of total area coverage and next to faba bean and chickpea in terms of total annual production (Cherinet and Tazebachew, 2015). Field pea grain is a cheap source of protein supplement for the majority of Ethiopian, the annual consumption of pea seed per person is estimated to be 6-7 kg. It is also marketed as dry, shelled products and use as a source of foreign earning. Pea grain contains high levels of amino acids (23-25%), lysine, tryptophan, carbohydrates and proteins (21-25%) which are relatively low in cereal grains (MOARD, 2015, Cherinet and Tazebachew, 2015). Small holder farmers use the post-harvest by-products such as straw, pod walls and other residues in threshing for animal feed, especially during the dry season (Asfaw et al., 1994).

Field pea has important ecological and economic advantages in the highlands of Ethiopia by playing a significant role in soil fertility restoration and crop rotation farming system to minimize the negative impact of cereal based mono-cropping (Yirga et al., 2019). The crop is among the most highly efficient nitrogen-fixing crops and has the inherent ability to obtain much of its nitrogen requirement from the atmosphere by forming a symbiotic relationship with Rhizobium bacteria in the soil. It obtains as much as 80% of its total nitrogen requirement from fixation under good growing conditions (Cherinet and Tazebachew, 2015).

Having all these multiple benefits in the economic lives of the farming communities, however the productivity of the crop in Ethiopia is unstable and low (855 kg ha^{-1} on average) as compared to the research findings, 829.1–4579.5 kg ha^{-1} (Tamene et al., 2013). The finding by Smykal et al. (2012) indicates, the average productivity of the crop is 1240 kg ha^{-1} in Ethiopia which is far below the potential 4000-5000 kg ha^{-1} traditionally achieved in Europe (Netherlands, France and Belgium) as well as the world average yield of 1700 kg ha^{-1}. Use of low yielding local cultivars that are susceptible to different biotic and abiotic stresses and poor practice practices can be cited as a major reason for low productivity (Cherinet and Tazebachew, 2015). By far, genotype by environment interactions is the most difficult factor to increase field pea yield in Ethiopia due to diverse agro climatic zones, frequent drought and high sensitivity to various environmental factors (Mulusew et al., 2010, Tamene et al., 2013). In spite of its importance, the yield obtained under farmers' practice is low due to production related problems. Hence, there was a need to supply varieties which are adaptable, productive and suitable to moisture stressed areas through assessing and identifying best performing stable field pea genotypes in grain yield and other desirable traits for northeast drylands of the Amhara region. Consequently, the improved field pea variety was released by Sekota Dry land Agricultural Research Center in 2017 by the name '*Yewagnesh',* achieving most breeding and agronomic traits (mainly higher yield) for north eastern Amhara region (Yirga et al., 2019).

However, this variety is not demonstrated and promoted to clients since stakeholders in the extension system (viz., researchers, extension workers and farmers) have inconsistencies on field pea production packages and practices in the study area. In one hand, researchers argue and recommended that using improved field pea variety with its full production package is unescapable solution for production enhancement in the study area (Yirga et al., 2019). On the other hand, farmers stacked to the inherent local field pea cultivars and the existing agronomic practices. This is because farmers trust that no yield difference among the advocated and prevailing varieties as well as production practices since legume crops are obviously fertilizer fixer so that irrelevant to incur cost for insignificant variation. Likewise, agricultural extension workers believe that, improved field pea varieties are good but spending for package components like fertilizer is wasteful since field pea is blessed crop with intrinsic capacity of earning its nitrogen from the atmosphere. In order to resolve these paradoxes in the extension system, this on-farm experiment launched comprising the improved field pea variety with its full package in one side and the local cultivar with and without full package in the other side. The study is generally intended to relieve inconsistencies on different field pea production practices in intermediate altitudes of north-eastern Amhara under the strict participation and supervision of researchers, experts and farmers. The specific objective was thus to compare, evaluate and demonstrate the variations achieved through variety difference, keeping the production package components constant and vice versa.

Materials and Methods

Description of The Study Area

The study was conducted in Dehana and Sekota districts of Wag-khimra zone in the Northeastern Amhara region. Dehana is located at 12°55'559''N latitude and 38°42'293''E longitude whereas Sekota located at 12.68ºN' latitude and 39.015ºE' longitude. Dehana is located at 2541 m above sea level having black (Mihiretu et al., 2019) (vertisol) soil type with a mean annual rainfall of 895.2 mm. Whereas, Sekota district is situated at 2100 m above sea level with black sandy soil, having a mean annual rainfall of 774.3 mm. The mean temperature of Dahana and Sekota districts was 26.2°C and 28.5°C respectively (WoA, 2013).

Sampling, Experimental Design and Farmers' Participation

On-farm comparative evaluation and demonstration of different field pea production practices was conducted in 2017/18 and 2018/19 production years in participatory approach. Two districts (Dehana and Sekota) were purposively selected to illustrate the mid altitude recommendation domain for field pea production in the northeast Amhara region. Farmers' research and extension group **(**FREG) was organized in each site consisting twenty members to enhance participatory evaluation. The group members were selected in consultation with key informants that are conversant to the areas in order to represent different social segments of the community (having diverse spectrum of age, sex and wealth status). The groups had chairman and secretary to facilitate the FREG tasks as well as they had an action plan and meeting schedule to evaluate the experiment following the physiological growth stages. Six arbitrary farmers from each group on top of five farmers' training center (FTCs) were selected to host the trial. Trial plots were for free while other experimental costs were covered by the research center. Before the commencing the trials all FREG members provided training on the basic agronomic practices and technology package components embracing theoretical and practical sections.

The improved variety was compared with the local cultivar under full package utilization to display differences achieved through improved variety, keeping package components constant. While the local cultivar was managed in full package and farmers' prevailing practice in order to show changes attained due to full package utilization, keeping the variety constant. The experiment was laid on three side by side plots having an area of $100m^2$. The treatment arrangement was designed as un-replicated simple block considering farmers as replications. The treatments were laid in the following order: improved variety with full package practice (IFPP), local cultivar with full package practice (LFPP) and local cultivar with farmers' traditional practice (LFTP).

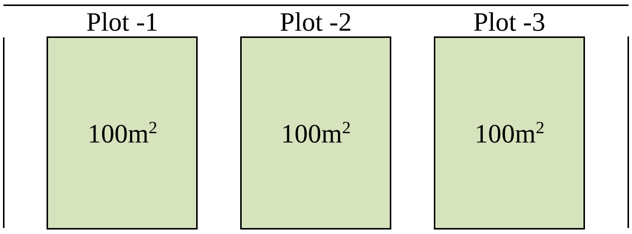

Figure 1. Experiment design
(Note: 0.5m distance between plots and border in all sides)

The full package practice in this study comprises components (viz., suggested seed and fertilizer rates, inter and intra row spacing, land preparation and weeding rate at optimum level).

Therefore, full package practices were planted in row at 150 and 100 kg ha^{-1} seed and fertilizer rates respectively. Di ammonium phosphate (DAP) fertilizer was applied by hand drilling, keeping intra and inters row spacing of 0.1m and 0.3m, respectively. Land preparation and weeding were done as per the recommendation (3x-plowing and 2x-weeding). The farmers' traditional practice was sown in broadcast devoid of fertilizer at 180 kg ha^{-1} seed rate with 2x-plowing and zero weeding.

Data Collection

Both quantitative and qualitative data types were collected from trial plots and farmers using checklist and focus group discussions (FGDs). Secondary data was also collected from different published and unpublished (working reports from district office of agriculture) sources to triangulate and support results from the experiment.

The quantitative data (days to maturity, grain and biomass yield) were collected on plot basis. The data generated was utilized for calculating the technology index, technology and extension gaps (EG) using toning formulas. Economic data (production costs and benefits) were collected to compare the cost-effectiveness of treatments. Yield was adjusted by 10% and the selling prices of grain and biomass yields at the farm gate were taken. The average labor cost for row planting and weeding was expressed in person day, where one person day was assumed to be eight hours of work.

Qualitative data such as farmers' reaction and preference to each treatment was probed in FGDs through assigning literate farmers in each group to lead the evaluation since most of participant farmers were unable to read and write. Farmers therefore brainstormed to identify their main evaluation criteria to be considered in selecting the field pea production practices under local context. Crop yield, biomass yield, vegetative performance, early maturity, seed size, seed color, disease and pest tolerance were given due attention by farmers.

Data Analysis

The quantitative data (days to maturity, grain and biomass yields) were analysed in descriptive statistics like mean, frequency and percentages. Besides, technology gap (TG), variety gap (VG) and technology index (TI) were calculated by the following formulas (Yadav et al., 2004).

TG = Improved yield – Farmers yield (1)
EG = Potential yield – Improved yield (2)
TI = (Technology gap/ Potential yield) × 100 (3)

The three treatments (IFPP, LFPP and LFTP) were subjected twice to analysis of variance (ANOVA) followed by Tukey's post hoc test (SPSS, 2007). The first of which was depending on agronomic records as explanatory variables and the second was depending on the indicative scores as explanatory variables. The coefficient of determination (R^2) and the Tukey's test (HSD) has been applied to significant variables in both analyses. The data of the indicative scores of sites for the three agronomic records were standardized and the sample variance (S^2) has been calculated from the following formula (4):

$$S^2=\sum (xi - x)^2/n-1, \quad (4)$$

Where;
S^2 = Sample variance
Σ = Sum
x_i = The term in data set (indicative scores of sampling sites),
x = Sample mean, and n is sample size (Alaa and Mahgoub, 2019).

The results of ANOVA (R^2, F, P) and the sample variance (S^2) have been taken to express for the impact of the agronomic records and their order of importance, on the different treatments of the trial area.

Partial budget was employed to determine economic feasibility of each treatment. It was calculated taking into account the additional input costs (variable costs) and the returns obtained after harvesting (gross benefits). The net benefit was the resultant of deduction between gross return and total variable cost. Marginal cost was calculated by deducting the total variable cost of improved practices with respect the cost of previous practice while the marginal net benefit was calculated by deducting the net benefit of improved practices with respect to the net benefit of forgoing practices. The marginal rate of return (MRR) of one treatment to the other was calculated as (5):

$$MRR=\frac{\Delta NB}{\Delta TVC} \times 100 \quad (5)$$

Where;
MRR = Marginal rate of return
ΔNB = Change in net benefits and
ΔTVC = Change in total variable input costs

The minimum return which farmers expect to earn from a technology called acceptable minimum rate of return (AMRR) is set to between 50 and 100% because the technology packages are new to the farmers so that required for them to introduce some new skills; hence 50% AMRR was taken as a reasonable estimate. All costs and benefits were valued in monetary terms calculated at the farm gate prices. Sensitivity analysis is worthwhile through computing the worst, most likely and best-case scenario on the cost and return sides (changes in inputs and outputs) by adjusting the items that most likely to fluctuate (CIMMYT, 1998). This is because farmers are dealing with uncertainties every day; from not knowing, what the weather will be to wondering if market prices will increase or decrease by tomorrow, thus farmers are forced to make decisions based on the imperfect information. Hence, the combination of partial budget and sensitivity analysis is robust enough to handle questions that farmers deal with technology packages.

After ranking and weighting the identified parameters pair-wisely, weighted ranking matrix table was constructed. Farmers in each group were asked to compare and contrast treatment each other and then to give values based on identified parameters. Counting the values provided for each treatment, finally to put scores. The scores given by farmers to each treatment under each criteria summed (least sum was ranked 1st), then the obtained rank was multiplied by the respective weight for treatments. Finally, the products were aggregated for each variety for final selection (least sum was ranked 1st) (Russell, 1997). To end with, Spearman's rank correlation was used to see the degree of coincidence between farmers' preference rank with actual value of measured attributes (Ferdous et al., 2016). The correlation coefficient is defined as(6):

$$r_s=1-\frac{6\sum d^2}{n\,(n^2-1)} \qquad (6)$$

Where;
d = Difference in the ranks assigned to the same phenomenon
n = Number of phenomena ranked

Finally, extension activities like field days and diagnostic visits were undertaken to create awareness about the technology package in general and the variety in particular to diffuse and benefit the farmers in the long run (Abate et al., 2017).

Results and Discussions

Grain and Biomass Yield Performances of The Different Practices

The study revealed that treatment (IFPP) provided highest mean yield in both districts. It had a yield advantage of 33.2 and 91.8%, respectively from LFPP and LFTP in Dehana district. Likewise, in Sekota, IFPP had 27.2 and 94.6% yield advantage in that order (Table 1). This result confirmed with the result obtained by Aemiro et al. (2018) during verity development stage. The IFPP had highest mean biomass yield than LFPP and LFTP in both districts. Overall, the grain and biomass yields of IFPP in all sites exceeded that of the LFTP. This was mainly attributed to the use of package components like improved variety, adequate seed rate, proper practice practices and judicious use of fertilizers. However, the significant yield variation between similar treatments across districts was observed may be due to the slight agro ecological variations of the two locations.

The technological gap between the IFPP and LFTP in Dehana and Sekota districts was 910 and 940 kg ha^{-1}, respectively. This finding revealed that the productivity problem in field pea variety could be overwhelmed by adopting the improved varieties as well as the efficient package practices. The statistical figures revealed that the extension gap between the potential yield and the IFPP was not considerable (388.3 and 357.3 kg ha^{-1} in Dehana and Sekota, respectively), designating that it was possible to replicate the potential yield in real farm context.

The technological index of 41.1% and 39.7% in Dehana and Sekota districts respectively, offered evidence that there was a scope for further improvement in the productivity of field pea. However, to further bridge up the gap between technology developed and technology transferred, there is a need to strengthen the extension network besides emphasis on specific local recommendations. The technology index indicates the feasibility of evolved technology at the farmer's field, hence the lower values of technology index is depicts the more feasibility of the technology demonstrated (Yadav et al., 2004).

The common ANOVA table is constructed to illustrate the effects of treatments and other factors like experimental errors on the parameter values under consideration (Table 2). Besides, the post hoc analysis (Tukey-HSD) carried out to compare the means of every pair of treatments in the study districts (i.e., identifying which variety has significantly larger mean as compared to the other varieties). As depicted in table 2 below, the ANOVA test revealed that there is statistically significant difference in grain yield and days to maturity between treatments in both districts (P<5%). However, significant difference in mean biomass yield across treatments was observed only in Sekota district (P=1%). The Tukey-HSD test also indicated that among treatments, IFPP was best performing practice in grain yield and days to maturity across districts at less than 5% significant level (Table 3).

Table 1 Yield performance, technology gaps and index in the field pea demonstration

T	Mean yield (kg ha^{-1})		Range yield index (kg ha^{-1})		VG (kg ha^{-1})	TG (kg ha^{-1})	EG (kg ha^{-1})	TI (%)
	Grain	Biomass	Grain	Biomass				
Dehana								
IFPP	1901.7	4773.3	1620-2340	4360-5450	472.4	910	388.3	39.7
LFPP	1428.3	4723.4	1180-1750	4020-5020				
LFTP	991.7	3490	790-1300	3150-4250				
Sekota								
IFPP	1933.3	4531.7	1690-2240	4160-5100	413.3	940	357.3	41.1
LFPP	1520	4373.4	1380-1690	4120-4720				
LFTP	993.3	3336.7	720-1230	2980-3740				

T: Treatments, VG: Variety gap, TG: Technology gap, EG: Extension gap and TI: Technology index, Potential yield (PY) of field pea = 2290 kg ha^{-1}, where: VG = IFPP - LFPP, TG = IFPP - LFTP and EG = PY - IFPP; TI = TG/PY×100

Table 2 ANOVA test on differences in grain yield, biomass yield and maturity days across districts

P	SV	Dehana					Sekota				
		SSQ	df	MS	F	Sig.	SSQ	df	MS	F	Sig.
GY	Treatments	2485.6	2	124.3			2663.6	2	133.2		
	Errors	756.9	15	50.5	24.63	0.000	411. 7	15	27.4	48.53	0.000
	Total	3242.5	17				3075.3	17			
BY	Treatments	6341.1	2	3170. 6			21116.1	2	1055.8		
	Errors	2605. 7	15	173.7	18.25	0.001	12691.5	15	8460.9	1.25	0.315
	Total	8946. 8	17				14803.1	17			
DM	Treatments	2.83	2	1.42			3.00	2	1.50		
	Errors	0.4	15	0.25	57.37	0.000	0.43	15	0. 29	52.20	0.000
	Total	3.20	17				3.44	17			

P: Parameters, GY: Grain yield (kg ha^{-1}); BY: Biomass yield (kg ha^{-1}); DM: Days of maturity, SV: Source of variation, SSQ: Sum of Squares, MS: Mean Square; *, ** and *** imply the significance levels at 10, 5 and 1% respectively

Table 3 Tukey-HSD test to identify best performing technology in grain yield, biomass yield and days to maturity across districts

P	PV	Dehana			Sekota		
		MD	SDE	THSD	MD	SDE	THSD
GY	IFPP–LFTP	4.733***	1.297	0.006	4.133***	9.565	0.002
	IFPP–LFTP	9.100***	1.297	0.000	9.400***	9.565	0.000
	LFTP–LFTP	4.367***	1.297	0.011	5.267***	9.565	0.000
BY	IFPP–LFTP	0.500	2.406	0.977	66.917	53.107	0.438
	IFPP–LFTP	12.83***	2.406	0.000	77.283	53.107	0.339
DM	LFTP–LFTP	12.33***	2.406	0.000	10.367	53.107	0.979
	IFPP–LFTP	-0.095***	0.091	0.000	-0.100***	0.979	0.000
	IFPP–LFTP	-0.650***	0.091	0.000	-0.047***	0.979	0.001
	LFTP–LFTP	0.030***	0.091	0.012	0.053***	0.979	0.000

P: Parameters, GY: Grain yield (kg ha^{-1}); BY: Biomass yield (kg ha^{-1}); DM: Days of maturity, PV: Pair of varieties, MD: Mean Difference, SDE: Std. Error, THSD: Tukey-HSD Sig.; *, ** and *** imply significance levels at 10, 5 and 1% respectively

Partial Budget Comparison

Expenditures which were similar across treatments were not taken and analyzed, hence given the prevailing farm gate prices, the benefit-cost ratio was computed for grain and biomass yield on hectare basis. The farmers were hence able to generate an average gross income of ETB 30,788.2 and 36,442.2 from the IFPP in Dehana and Sekota districts, respectively (Table 4). The MRR result shows that for every ETB 1.00 invested in improved technology (changing from LFTP to IFPP), farmers can expect to recover the ETB 1.00 and obtain an additional ETB 8.57 and 13.47 in Dehana and Sekota district respectively. On the other hand, the result indicated that farmers' will be profitable even by transforming from existing practice to package application with the local cultivars in both districts.

Therefore, adopting the improved practice merely (changing from LFTP to LFPP), farmers can make a profit of ETB 4.97 and 8.15 in Dehana and Sekota district respectively, after covering the cost (ETB 1.00). The sensitivity analysis also shows that if the price of output becomes constant and the price of inputs increased by 10%, the field pea technology (IFPP) has a positive return in net benefit by 464.9% and 554.9% in Dehana and Sekota districts respectively. Likewise, if the prices of output remain constant and the price of inputs increased by up to 511.4% and 610.4% in Dehana and Sekota districts respectively, field pea production (IFPP) would have a positive return.

Farmers' Preference to Different Field Pea Production Package Practices

In both districts, farmers identified five preference parameters in common to select their best field pea production practice due to the homogeneous sociocultural entities that farmers share in common. The parameters picked were valued and weighted to their importance for comparison. The result from weighted ranking matrix shows that the practice which has greater percentage from the total weight was picked as first choice. Therefore, in Dehana and Sekota districts, farmers preferred IFPP being the best in all parameters (Table 5). Farmers in both districts had similar primary choice to early maturity; this is due to the fact that the study locations are dry land and even characterized by rain shortage as a result the farmers interested in early maturing varieties. However, farmers in Dehana used tolerance to disease before grain yield as a parameter since the area has a long history of chocolate spot incidence so that they need a variety tolerant to such diseases. Biomass yield also had higher credit as parameter in both districts, because as agro pastoral the farmers require greater biomass yield in order to solve livestock feed shortage.

Spearman's rank correlation coefficient was calculated to see the degree of coincidence between farmers' preference rank and actual value of measured attributes. Therefore, the degree of coincidence between farmers' preference rank and actual values rank for grain yield, biomass yield and earliness attributes were 100, 50 and 100 respectively in percentage points (Table 6).

Table 4 Partial budget and sensitivity analysis

Cost/Benefit items	Dehana			Sekota		
	IFPP	LFPP	LFTP	IFPP	LFPP	LFTP
Adjusted average grain yield (kg ha^{-1})	1711.5	1285.5	892.5	1740	1368	894
Adjusted biomass yield (kg ha^{-1})	4296	4251.1	3141	4079	3936	3003
Gross benefits (ETB/ha)	36808	25689	17950	42412	31877	21176
Costs of seed (ETB/ha)	4050	3375	4050	4050	3750	4500
Cost of fertilizer (ETB/ha)	1250	1250	0.00	1220	1220	0.00
Labor cost for the package (ETB/ha)	720	720	0.00	700	700	0.00
Total costs that vary (ETB/ha)	6020	5345	4050	5970	5670	4500
Net benefits (ETB/ha)	30788	20344	13900	36442	26207	16676
MRR	857.2	497.6		1344.7	814.6	
Sensitivity analysis (%)	511.4			610.4		
Average price of fertilizer (NPS) in ETB/kg	= 12.5	12.2				
Cost of improved [local] seed in ETB/kg	= 27 [22.5]	27 [25]		1 USD = 27.94 ETB		
Price of improved [local] grain in ETB/kg	= 20 [18]	22.5 [21]		ETB, Ethiopian birr		
Average local Labor day's pay in man/day	= 60	70				
Average local price of biomass in ETB/kg	= 0.6	0.8				

Table 5 Summary of farmers' evaluation criteria and preference ranking across districts

Weighted parameters		Dehana			Sekota		
		IFPP	LFPP	LFTP	IFPP	LFPP	LFTP
Seed size (boldness)	Score	1.00	2.00	3.00			
	Weight	6.00	6.00	6.00			
	Score *weight	6.00	12.0	18.0			
Early maturity	Score	1.00	3.00	2.00	1.00	3.00	2.00
	Weight	1.00	1.00	1.00	1.00	1.00	1.00
	Score *weight	1.00	3.00	2.00	1.00	3.00	2.00
Grain yield	Score	1.00	2.00	3.00	1.00	2.00	3.00
	Weight	3.00	3.00	3.00	2.00	2.00	2.00
	Score *weight	3.00	6.00	9.00	2.00	4.00	6.00
Tolerance to diseases	Score	1.00	1.00	1.00	1.00	1.00	1.00
	Weight	2.00	2.00	2.00	4.00	4.00	4.00
	Score *weight	2.00	2.00	2.00	4.00	4.00	4.00
Seed color	Score	1.00	2.00	2.00	1.00	2.00	2.00
	Weight	4.00	4.00	4.00	6.00	6.00	6.00
	Score*weight	4.00	8.00	8.00	6.00	12.0	12.0
Biomass yield	Score	1.00	1.00	2.00	1.00	1.00	2.00
	Weight	5.00	5.00	5.00	3.00	3.00	3.00
	Score*weight	5.00	5.00	10.0	3.00	3.00	6.00
Tolerance to pest	Score				1.00	2.00	2.00
	Weight				5.00	5.00	5.00
	Score*weight				5.00	10.0	10.0
∑(score×weight)		21.0	36.0	49.0	21.0	33.0	40.0
Rank		1.00	2.00	3.00	1.00	2.00	3.00

Ranks: 1= Best; 2= fair; 3= worst. The score multiplied by the weight to provide overall preference for each variety considering varied parameters.

Table 6 Correlation between farmers' preference rank and the actual measured traits rank

Treatments	Grain yield rank			Biomass yield rank			Earliness rank		
	Actual	Farmers	d^2	Actual	Farmers	d^2	Actual	Farmers	d^2
IFPP	1	1	$(1-1)^2$	1	1	$(1-1)^2$	1	1	$(1-1)^2$
LFPP	2	2	$(2-2)^2$	2	1	$(2-1)^2$	3	3	$(3-3)^2$
LFTP	3	3	$(3-3)^2$	3	2	$(3-2)^2$	2	2	$(2-2)^2$
	r_s = 1 (100%)			r_s = 0.5 (50%)			r_s = 1 (100%)		

Field Days and Promotion

At the end of the trial, mini field day was organized involving different stakeholders (farmers, and experts from zonal to district levels). Thus, 39 (11 female) farmers as well as 13 (2 female) experts attended in Dehana district. Likewise, 29 (7 female) farmers and 6 (1 female) experts in Sekota visited the trials. The participant farmers and experts as a group were valuing the practices by their overall performance. The farmers finally preferred the improved technology (IFPP) for its earliness, seed color and vegetative performance-having direct effect to the biomass yield. Nonetheless, all treatments criticized for their poor performance in pest tolerance since all treatments were vulnerable and attacked by aphid incidence in both districts.

Conclusion

Experiments conducted under the close supervision of scientists, experts and farmers are important mechanisms to create demand driven agricultural technology promotion and diffusion. Therefore, improved field pea variety with its full package components was compared with the local cultivar with and without full package components at representative districts in north eastern Amhara region. The result revealed that the improved technology provided highest yield in both districts, with a yield advantage of 91.8 and 94.6% from farmers practice in Dehana and Sekota respectively. The farmers were able to generate a net income of ETB 30788.2 and 36442.2 from improved technology in Dehana and Sekota districts, respectively. The MRR result shows that for every ETB 1.00 invested in improved technology, farmers can expect to recover the cost and obtain an additional ETB 8.57 and 13.47 in Dehana and Sekota district. The technological gap between the improved technology and farmers practice in Dehana and Sekota districts was 910 and 940 kg ha^{-1} respectively, revealed that field pea productivity problem could be overwhelmed by adopting the improved technology. The technological index of 41.1% and 39.7% in Dehana and Sekota districts offered evidence that there is a scope for further improvement in field pea production. The improved technology in both locations was selected primarily in most farmers' preference parameters. From the experiment thus, it can be concluded that there are wider possibilities to support the government efforts towards enhancing food security via producing enough using improved technologies. Therefore, it's safe to recommend the improved field pea technology for further dissemination in the respective districts through identifying viable technology sources. Moreover, to bridge the gap between technology developed and technology transferred, there is a need to strengthen the extension networks besides the emphasis on specific local recommendations.

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