



RESEARCH ARTICLE

FAST TRUCK VARIETY DEVELOPMENT AND PARTICIPATORY VARIETY SELECTION APPROACH FOR CLIMATE SMART AGRICULTURE IN SHEBEL BERENTA DISTRICT, EASTERN GOJAM, ETHIOPIA

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ABSTRACT

Durum wheat is produced time immemorial long ago and its diversity is high in Ethiopia. But due to low quality and amount of wheat production, the importation of hard wheat for pasta making industries is more than 40,000 tons per year. In the past three years (2014-2016) support to agricultural research development for strategic crops (SARD-SC) project new strategy with the objective of increasing production and productivity of durum wheat in Ethiopia has brought a significant change in many durum wheat growing districts and one of the focus areas of the project was Shebel Berenta district, Eastern Gojam. The new innovation platform of SARD SC brings the involvement of all stakeholders together from seed to pasta in durum wheat production system. Training as a component was given for all stakeholders and farmers (both husband and wife together) which was not seen in the past by other projects. One of the other strategies of the project was fast truck variety development where varieties are released in short period by testing in many locations in a year to address the problem of ever increasing climate change. Eighteen durum wheat varieties were tested at Debrezeit and other locations in 2014 cropping season. Varieties showed significant difference ($P < 0.01$) in maturity, plant height, thousand seed weight and grain yield. Utuba was both the highest yielding and early maturing variety (3923 kg/ha) and (107.33 days) respectively. The other strategy of the project was undertaking participatory variety selection (PVS) that fits to the changing environment. Twelve improved durum wheat varieties were demonstrated in different kebeles of Shebel Berenta district in 2015 cropping season. The farmer group members of each site involved in identifying their selection criteria such as: early maturity, tillering capacity, spike density and length, grain quality, height, economic yield and disease resistance. Out of these, by using pair-wise comparison the excessive criteria list was reduced to the major eight characters differently according to village farmers' environment, traits of interest and preference. Utuba variety which is early maturing and high yielding with high industrial quality standard was farmer's preference during PVS. As a result of these strategies, the demand of improved durum wheat seed in the district is increased that in turn encourages the seed enterprise to be engaged in the seed production of durum wheat which had no involvement before. Now the agro-industries would have good opportunities to get enough raw materials for their pasta making industries that lead to import substitution. This system in general has got good prospects for the sustainability of durum wheat production in the country and income generations to the poor resource farmers, and to make all stakeholders to be benefited as a whole.

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INTRODUCTION

Wheat is one of the major cereal crops in Ethiopia, which is being cultivated between 6 and 16°N and 35 and 42°E, and from 1500 to 3000 m.a.s.l. Ethiopia is the largest producer of wheat in the sub-Saharan Africa. The current total area devoted to wheat production in the country is estimated to be over 1.6 million ha, with an average grain yield of 2.45 tons per hectare (Central Statistical Authority (CSA), 2012). The two wheat species dominantly grown in the country are durum wheat (*Triticum durum* Desf.) and bread wheat (*T. aestivum* L.); the former being indigenous to Ethiopia while the latter is an introduction. Wheat constitutes a large portion of the daily diet of the Ethiopian population and contributes significantly to the

calorie and protein intake. Nutritionally, wheat provides an optimum amount of energy (339 kcal), protein (10.3 g), calcium (49 mg) and iron (1.5 mg) per 100 g of whole grain. The grain of durum wheat is used for the manufacturing of pasta products (Macaroni, Spaghetti and Noodles) and for the preparation of traditional recipes including "Injera", Bread, "Dabokolo", Porage, "Kinche", Boiled grain and other food recipes and beverages. The straw is mainly used as source of animal feed. Durum wheat is traditionally grown on heavy black clay (vertisols) and light soils by small-scale farmers under rain fed conditions. Ethiopia is among very few countries endowed with highly suitable environmental conditions to produce durum wheat. However, durum wheat is imported to meet the demands of local pasta and macaroni factories. Hence, there is a pressing need to enhance import substitution through developing good market linkage between durum wheat producers and agro-industries and improved

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durum wheat varieties with acceptable quality standards. Furthermore, owing to its diverse and suitable agro-climatic conditions, the country has high production potential of quality durum wheat for foreign markets. Since quality and yield of durum wheat are often affected by different biotic, a biotic and socio-economic factors, enhancing and sustaining its production and quality demands is a concerted effort on prioritized research and development areas. Apart from other non-governmental organization common approach for development work, SARD SC project comes in to picture with a new approach in 2014 in Shebel Berenta district, Eastern Gojam with the objective of enhancing sustainable productivity and income of durum wheat along the value chains. Large portion of the district is moisture stressed area that needs a special attention and mechanism that would adapt to climate change. The strategies of the project to meet the above-mentioned objectives were: fast truck variety development and undertakes participatory variety selection that fits to the changing environment with the innovation plat form approach.

MATERIALS AND METHODS

Ten selected entries from preliminary variety trial (pvt) which were promoted to national variety trial stage including Utubavariety which was released in the fast truck variety development program were laid down in RCBD design with three replications in multilocations. The plot size was six rows of 2.5 m length. Fertilizer rate and other agronomic practices have been applied as per the recommendations for each location. Besides, the most promising lines in the NVT (National Variety Trial) were exposed to the prevailing rust races in the field and laboratory and chemical quality parameters were taken before their advancement to variety verification trial.

Data collected

Phenology, disease, agronomic, physical and chemical seed quality data were taken. Analysis of Variance (ANOVA) was analyzed using Statistical Analysis System (SAS) statistical software version 9.0 (Statistical Analysis System (SAS), 2002), for all the traits evaluated as per (Gomez and Gomez, 1984).

Description of the project area

SARD SC project new approach (innovation plat form) with participatory variety selection (PVS) was started during the main cropping season of 2013 at Shebel Berenta districts in EasternGojam Zone, North West Ethiopia.During main cropping season, Shebel Berentaon average receive anannual rainfall of 700 mm, but the distribution was not uniform and it was highly affected by the recurrent drought, with maximum and minimum temperature of 24.6 and 20.7 °c, respectively. The type of soil of the district is 45.54% vertisol and the rest is other type of soils (Shebel Berenta district agricultural bureau, 2014).

Experimental Materials

Based on participatory variety selection result, three durum wheat varieties such as Utuba, Ude and Yerer were used for the innovation plat form program of the project. Each variety seed were obtained from Debrezeit agricultural research center.Utuba variety was developed by fast truck variety

development mechanism where varieties are being tested in many locations in one year in the yield trial to shorten the year of variety releaseprocedure. Descriptions of the varieties indicated here below in (Table 1).

Table 1. Description of the varieties

No.	Variety name	Maintainer and year of Release	Origin	Seed color	Maturity group
1	Ude	DZARC/EIAR,2002	CIMMYT	Umber	Medium
2	Yerer	DZARC/EIAR,2002	CIMMYT	Umber	Medium
3	Utuba	DZARC/EIAR, 2014	ICARDA	Umber	Early

DEZARC- DebrezeitAgricultural Research Center; EIAR-Ethiopian Institute of Agricultural Research

Participatory variety selection

Participatory variety selection activities were done in the first year on 12 durum wheat varieties in each kebele to make an access for the farmers to select their best preferred varieties that fits to their agro ecology.Scores were given to each variety based on the selection criteria (1= very good, 2= good, 3= average, 4= poor and 5= very poor) and ranked each of them. To select the best varieties fitted to farmers' interest, multiply weights given to each criterion by the rank of the varieties. According to de Boef and Thijssen (deBoef and Thijssen, 2006), scoring and ranking were done on consensus of participants where differences were solved by discussion. Durum wheat varieties used for PVS were: Utuba, Megenagna, Yerer, Mosobo, Metaya, Mangudo, Selam, Mukuye, Asasa, Denbi, Kilinto and Hitosa. To bridge the Market gap between producers and agro- industries, Ethio- Italian development project best practice in bale zone was adopted where memorandum of understanding agreement is signed among major stake holders prior to planting of the crop. All agronomic practices were done according to the recommendation of the area and training was also given how to apply the packages properly.In each kebelefarmers' field days were organized at different growth stage of the cropto share their experience to other farmers who do not participate in the innovation plat form approach program.

Selected Utuba variety through the innovation plat form in the target district

Threehundred sixty male and 52 female farmerswere selected based on their clustered farm from four kebeles (the least administration unit) namely: Worego, Gebisit, Gedaeyesus and Mozhen. The total amount of hectare was 104 ha, out of this 95.5 ha was made in broad bed drainage system. Before planting, all participating farmers (husband and wife together) in the innovation plat form with development agents (DAs) were trained on wheat technology packages while other stakeholders (credit agencies, service providers, unions, input suppliers, etc.) were given training about the objectives of the project including the policy makers. During selection, member farmers of the innovation plat form who have clustered farm field have been considered to make use of the advantage of clustering.

All the system to be effective, there was the active involvement of DAs at the grass root level with the farmers, focal persons in the agricultural bureau at district level, innovation plat form facilitators drawn fromdifferent research centres (Debrezeit, Holeta and Adet researchers).

RESULTS AND DISCUSSION

Fast truck variety development

Varieties with the normal procedures are released after taking seven to eight years. In fast truck variety development mechanism, it takes five to six years where varieties are being tested in many locations in one year in the yield trial to shorten the year of variety release procedure to adapt the ever-increasing climate change. When Utuba variety was released in the fast truck variety development procedure, it was tested for one year instead of two years in the national variety trial stage by broadening the testing locations.

Crop Phenology

The 12 durum wheat varieties tasted in the fast truck variety development program had shown highly significant ($P < 0.01$) differences in days to heading, days to physiological maturity, height, thousand seed weight and grain yield at Debrezeit research center (Table 2). Days to heading ranged from 56.58 to 69.04. The shortest days to heading was recorded for IDON-MD-2009_off/53/2009, later on named by the name Utuba after released; while the longest days recorded for DSP2009_off.F4.3H.639_meh.1H.240. Values for days to physiological maturity ranged from 107.33 to 115.03. The earliest maturity period was recorded for Utuba variety (107.33), while the latest was recorded for DSP2009_off.F4.3H.639_meh.1H.240 (115.03). Differences among varieties and across locations for phenological traits could be due to genetic and effects of the environments. The highest days to physiological maturity variety is more suitable to areas where there is optimum rain fall while the shortest days to maturity fits to moisture stress area. Utuba variety which had the shortest days to maturity could fit for moisture stress areas like Shebel Berenta area.

Table 2. Mean number of days to heading and maturity, plant height, thousand grain weight (gm) and grain yield (Kg) of 18 durum wheat varieties tested in 12 locations during 2014 cropping season

Treatments	DTH	DTM	TGW(gm)	PLH(cm)	YLD (kg/ha)
IDON-MD-2009_off/12/2009	62.21	111.25	36.95	79.21	3130.76
IDON-MD-2009_off/34/2009	59.50	110.54	42.30	82.99	3503.96
IDON-MD-2009_off/53/2009	56.58	107.33	43.74	83.44	3922.86
DSP2009_off.F3.2H.22_meh.1H.26	59.29	109.88	39.66	76.33	3073.58
DSP2009_off.F4.1H.783_meh.4H.259	59.00	109.46	38.75	74.72	3197.42
DSP2009_off.F4.1H.785_meh.2H.262	58.50	108.17	41.17	75.55	3151.77
DSP2009_F6off/1508/2009	61.83	111.13	37.23	80.91	3183.49
IDON-MD-2009_off/25/2009	60.54	111.33	43.63	96.68	3072.22
DSP2009_off.F4.1H.378_meh.4H.187	61.46	110.08	42.83	70.59	3073.67
DSP2009_off.F4.3H.639_meh.1H.240	69.04	115.03	38.96	79.85	3291.24
DSP2009_off.F4.2H.712_meh.1H.248	61.92	112.25	40.45	99.77	3838.28
DSP2009_off.F4.2H.735_meh.2H.251	59.29	108.88	38.70	70.78	3008.35
DSP2009_off.F4.3H.976_meh.2H.292	62.54	110.63	36.02	73.13	3144.70
Hitosa	61.29	110.63	32.22	80.69	3404.40
Mangudo	59.21	110.25	43.15	82.04	3135.32
Ude	61.58	109.88	39.84	81.38	3204.13
Yerer	66.63	113.79	40.62	76.80	3053.73
Local	57.97	104.64	37.57	75.83	3077.22
Grand mean	62.21	111.25	36.95	79.21	3130.76
CV%	5.3	1.7	11	8	17
5%LSD	3.38	8.00	5.10	4.37	467.46

DTH= days to heading, DTM= days to maturity, TGW= thousand grain weight, PLH= plant height, YLD//HA= yield/ hectare

Grain yield and thousand seed weight

Mean values of grain yield (kg/ha) and thousand seed weight (gm) are presented in (Table 2). Analysis of variance showed highly significant differences among varieties for grain yield (YLD) and thousand seed weight (TSW) at Debrezeit. Grain

yield ranged from 3008 kg/ha (DSP2009_off.F4.2H.735_meh.2H.251) to 3923 kg/ha (Utuba). Varieties produced high yield (kg/ha) of 3922.86, 3838.28 and 3503.96 were Utuba, DSP2009_off.F4.2H.712_meh.1H.248 and IDON-MD-2009_off/34/2009, respectively, and low yield obtained from DSP2009_off.F4.2H.735_meh.2H.251 (3008 kg/ha) as shown in (Table 2). Varieties Utuba and DSP2009_off.F4.2H.712_meh.1H.248 gave the highest grain yield and had yield advantage of 18.89 and 16.39% over standard check (Mangudo) and 45.29 and 42.23% over local check (3077.22 kg/ha), respectively. Getting a variety which has early maturity period with high yielding character like Utuba variety is more advantageous to mitigate climate change problems for low moisture stress areas.

Participatory Variety Selection

Participatory variety selection (PVS) is useful practical and cost effective method to revealed preferred plant

Table 3. Varieties demonstrated in 2014 cropping season for participatory variety selection activity in two districts

No	Variety	Woregokebele		Mozhenkebele	
		Yield t/ha	Rank	Yield t/ha	Rank
1	Ude	8.0	1	5.83	1
2	Megenagna	5.0	3	2.08	9
3	Yerer	5.33	2	4.17	2
4	Mosobo	4.47	5	2.23	8
5	Metaya	5.0	3	2.67	6
6	Mangudo	2.0	7	3.67	4
7	Selam	3.33	6	2.83	5
8	Mukuye	2.0	7	2.37	7
9	Assasa	1.83	8	3.75	3
10	Denbi	1.7	9	2.0	10
11	Kilinto	3.8	4	2.0	10
12	Hitosa	1.8	8	2.37	7
Mean yield		4.14		3.60	

characteristics and varieties among predetermined varieties for targeted environments by obtaining farmer input. During PVS Researchers and/or agricultural experts only explained to the farmers about the objective of the trial and their participation, and provided information to farmers' queries.

Table 4. The two kebeles farmers' preference on the 12 durum wheat varieties overall ranking result

No.	Varieties	Woregokebele	Mozhenkebele	Overall ranking
1	Ude	1	1	1
2	Megenagna	3	9	6
3	Yerer	2	2	2
4	Mosobo	5	8	7
5	Metaya	3	6	4
6	Mangudo	7	4	5
7	Selam	6	5	5
8	Mukuye	7	7	7
9	Assasa	8	3	5
10	Denbi	9	10	9
11	Kilinto	4	10	7
12	Hitosa	8	7	7

The farmer group members of each site involved in identifying their selection criteria such as: early maturity, tillering capacity, spike density and length, grain quality, height, economic yield and disease resistance. Out of these, in both locations using pair-wise comparison the excessive criteria list was reduced to the major eight characters differently according to village farmers' environment, traits of interest and preference. This is in agreement with findings of (Danial *et al.*, 2007; Mekonen *et al.*, 2012; Molla, 2012), said that farmers' criteria vary with environmental conditions, traits of interest, ease of cultural practice, processing, use and marketability of the product, ceremonial and religious values. The farmers' selection criteria of Woregokebele were early maturity, grain yield and disease resistance by considering marketability and home consumption of the variety; whereas Mozhenkebele farmers' selection criteria was biomass yield, grain yield, late maturity and spike length just considering their animals feed as well. The process of ranking at Woregokebele revealed that, there were differences among varieties. High scores were given to four of the varieties namely: Ude, Yerer, Megenagna and Metaya, respectively; whereas at Mozhenkebele three varieties Ude, Yerer and Assasa were selected with high priority as indicated in (Table 4). Ude and Yerer varieties were selected in both kebeles as their top priority, respectively based on their set criteria. The overall rank of the tested durum wheat varieties is indicated in (Table 4).

Tested durum wheat varieties suitable to both Kebeles have been identified based on their grain yield potential and farmers' preference. The overall variety evaluation rank is shown in (Table 4). Ude, Yerer, Metaya and Selam performance across both Kebeles was higher than other varieties and based on their grain yield score they are top yielding varieties, respectively, Figure 1 below shows the field performance of Ude variety during field visit. The result of grain yield performance of the twelve durum wheat varieties in both Kebeles (Table 2) revealed that Ude and Yerer produced higher grain yield than the highest mean yield of Worego (4.14 t/ha). In comparison within the tested durum wheat varieties, Mukye and Selam were shown consistency across the two Kebeles; Mukye produced below whereas Selam produced above the national average yield 2.45 t/ha (Central Statistical Authority (CSA), 2012). Varieties Ude, Yerer, Selam and Metaya had shown higher yield across both Kebeles above the national average yield.

Innovation platform approach with PVS impact on durum wheat production in the targeted district

Innovation platform approach which dealt with the involvement of all stake holders in the value chain had started

its activity with training that enables them to have a common understanding among stake holders on the objective of innovation platform of durum wheat in Shebel Berenta district, Eastern Gojam. All stake holders had their own part for the success of durum wheat value chain in Shebel Berenta district. Each stake holder, after taking the innovation platform approach system training, they had a good contribution for the major actors (farmers and agro industries) to discharge their active role in the production as well as in the market value chain of durum wheat. As a trend, training in the past in any crop value chain was given only for bureau of agriculture technical staff members and farmers, other stake holders were not considered as equally important in the enhancement of production, productivity and market linkage in the value chain.

**Fig. 1. Performance of Ude variety during field visit**

In SARD SC project innovation platform approach, training for all stake holders was an important tool in durum wheat value chain in Shebel Berenta district. The training had two categories: training for all stake holders on the objectives of the innovation platform approach on durum wheat value chain and technical training for agricultural bureau innovation platform facilitators and farmers. The other unique approach in SARD SC project was female farmers training participation. All coupled farmers have been trained equally. As a result of this approach each stake holder knows what is to be done in the value chain to take his own part and to make facilitation for others to support each other to achieve the major goals. Male farmers were witness how the application of recommended agricultural practices is improved after the involvement of their female partners in the training. In general, innovation platform approach enhances the active involvement of each stake holder in the value chain for on time supply of agricultural inputs,

improved seed supply, better crop management in the field and market linkage for sustainability of production and productivity of durum wheat. As a result of this, farmers who were involved in SARD SC project have got a yield range of 3.0- 5.0 tons/ha whereas others who were not involved got 1.8-2.8 tons/ha on average using the selected varieties during PVS activity.

Conclusion and recommendations

Fast track variety development could be one of the important methods to adapt climate change in the climate change smart agriculture. Training on the objectives of the targeted crop value chain for all stake holders and technical training for farmers (both husband and wife together), farmers' field day to share their experience, and participatory variety selection in the targeted district prior to implementation of the project have got a pivotal role for the success of value chain of a crop.

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