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Farmer Preferred and Financially Feasible Onion Varieties for Scaling: Evidence from the Central Rift Valley in Ethiopia

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Abstract

Onion is a warm-season vegetable crop grown in Ethiopia. The productivity, however, is low on farmers field as compared to its recorded potential yield on research station. So, participatory on-farm demonstration and evaluation of improved onion varieties with their associated production practices was conducted in Adama, Lume and Adamitulu-Jidokombolcha (AJ) districts in the Central Rift Valley area. Nafis and Nasik Red were compared with Bombay Red, the check. Thirty-seven onion grower farmers were purposely selected and hosted the demonstrations on 9.25 hectares. Nafis and Nasik Red performed higher than the check yielding 29,757 kg/ha and 27,676 kg/ha on average respectively. The farmer-based practices yield gap found to be 9,238 kg/ha and 6,931 kg/ha for Nafis and Nasik Red respectively. Given, equal investments per unit area to produce the onion varieties, Nafis gave higher profit. Similarly, Nafis was the

most preferred onion variety compared to Nasik Red and Bombay Red because of its higher yield, deep red color, medium bulb size, tolerance to disease, pungency, market preference and longer shelf life. Nafis and Nasik Red produced higher financial returns and preferred by farmers. Hence, the varieties need wider scaling though concerted effrorts of agricultural development partmets in the study area and in similar agro-ecologies to enhance onion production and productivity in Ethiopia.

Keywords: Demonstration, farmers preference, onion varieties, yield gap

Introduction

Onion (*Allium cepa L.*) is one of the most important warm-season vegetable crops cultivated in Ethiopia. It is grown largely by smallholder farmers and few commercial growers mainly under irrigation and lower share using rain. Onion provides business options from seed, dry bulb, and seedling production. It has a low risk of over-production than most other vegetables because it can withstand the rough handling from field harvesting to final delivery to consumers. Moreover, onion dry bulb can be stored for 2–3 months when properly cured (Selamawit et al., 2013).

In Ethiopia, onion planted to 36.4 million hectares with a total production of 273,859 tons. The total production and the total cultivated area for onion grew by 18.7% and 59.7% respectively between 2015 and 2020. The productivity of onion, however, declined by 25.7 percent over the same production period (CSA, 2020).

The Ethiopian Institute of Agricultural Research (EIAR) released improved onion varieties to growers. For instance, Adama Red and Bombay Red are popular onion varieties. Whereas, Nasik Red and Nafis are more recent varieties that have a higher yield than Bombay Red and Adama Red. The Central Statistical Agency's (CSA) survey data from 2015 to 2020 revealed a low yield from farmers' practices as compared to the potential yield (40,000 kg per hectare) on research stations (CSA, 2020). The low productivity was found to be attributed to old variety, limited availability of quality seeds, disease (such as purple blotch) and low adoption of recommended production package (Bedru et al., 2009). Hence, an on-farm demonstration was carried out to evaluate the performance of recently released Nafis and Nasik Red onion varieties with their associated improved management practices. The objective of this paper was to highlight the performance of improved onion varieties, assess its financial return and identify farmer preference criteria in onion variety selection.

Materials and methods

Description of the study area

The study sites—Lume, Adama and Adamitulu Jidokombolcha (AJ) districts—are located in the East Shewa zone of Oromia National Regional State in the Central Rift Valley (CRV) in Ethiopia. The CRV is located between longitudes 38° 12'–39° 60' E and latitudes 6° 58'–8° 47' N, predominantly characterized by arid and sub-humid climate with mean maximum and minimum temperatures of 28.5°C and 12.6°C respectively. The area also characterized by a bi-modal rainfall pattern ranging between 175 and 358 mm rainfall during March to April and 420–680 mm during June to September, main season (Gizachew and Andualem, 2014). The predominant farming system is mixed rain-fed production system consisting of grain crops and livestock. The major grain crops are teff, maize, wheat, common beans, barley, chickpeas, lentils, and field peas. However, vegetable production is the most intensively practiced activity in the agricultural production system of the area. The most important vegetables grown under irrigation in the region include onion, tomato, , green pepper and cabbage (Wolter, 2007).

A brief description of the host districts goes as follows. Lume district is located 25 km to the west of Adama East Shewa zone capital. Geographically the district is located between $8^0$24' 30" N to 8^0 49' 30" N and 39^0 01' 00" E to $39^0$17' 00" E with a total area of 67,514.73 hectares. The major soil type is vertisol and the annual rainfall ranges between 500 and 1200 mm and temperature ranges from 18 to 28°C (Tesfaye and Fisha, 2018). Adama district is bordering in the South with Arsi zone, in the Southwest with Bora district, in the West with Lume district, in the North with the Amhara National Regional State, and in the East with Boset district. It is located 100 km southeast of the capital city of the country, Addis Ababa (Finfine). The topography is characterized by plain, undulating land, gentle slope, and rugged terrains. Its mean annual temperature and rainfall vary between 15°C and 20°C and 700–800 mm respectively. Geographically, it is located between 8° 33' 35" to 8° 38′ 46" latitudes and 39^0 10′ 57′ to 39^0 30' 15" longitudes (Hurgesa et al., 2019). The third district, Adamitulu Jidokombolcha (AJ), shares a border with Dugda district in the North and Negelle Arsi district in the South, Zuway Dugda district in the East and Southern Nations, Nationalities and People (SNNP) Regional state is in the West. The capital of the district Batu is located 168 km in the South of Addis Ababa (Finfine). The area receives a mean annual rainfall of 690 mm and it has an altitude between 1500 and 2300 meters above sea level (Tesfaye, 2008).

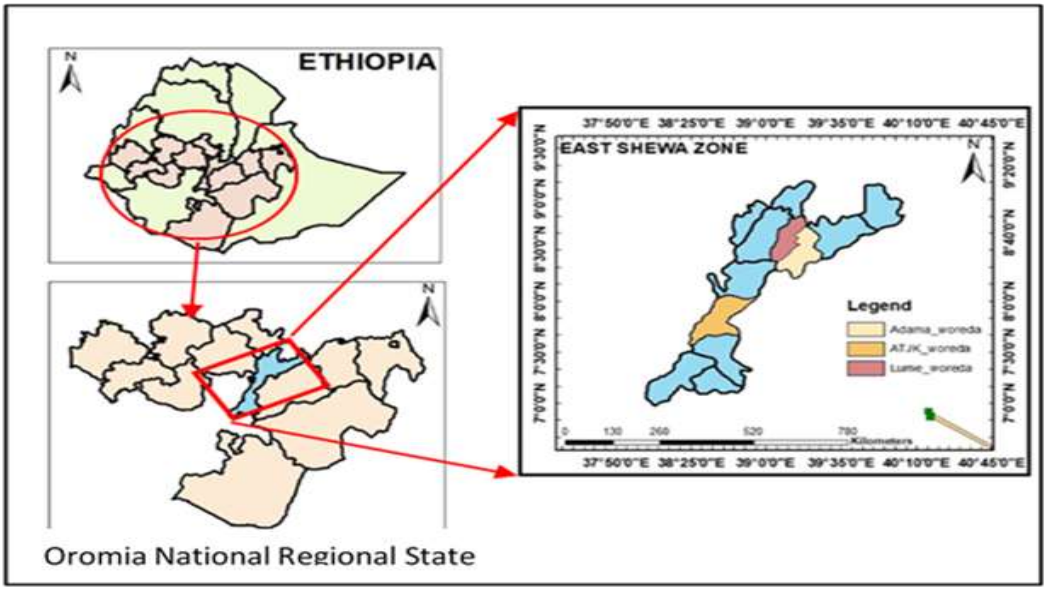

Figure 1. Map of the Study area

Site and farmers selection

Adama, Lume, and AJ districts were purposely selected based on their onion production volume in the East Shewa zone. The selection was done, in consultation with the respective districts and East Shewa zone Agricultural and Natural Resource Offices. The host selection criteria among others include: farmers who have an interest in the technology, have access to irrigation water, have experience in onion farming, who are willing to manage and allocate land for the demonstration. Before the establishment of the experiment, orientation and practical training were provided on the improved onion management practices and joint field planning was organized. In total, 37 host farmers' fields (twenty-two in 2018 and fifteen in 2019) were established on 9.25 hectares where each farmer allocated 0.125 ha on average for three varieties each. Farmers who established the demonstrations were considered as a replication. The demonstration was done for two years to increase the reliability of the data and produce stronger conclusions.

Materials and the management

New onion varieties, Nafis and Nasik Red were planted side-by-side to compare and evaluate their performance with locally popular old variety, Bombay Red–check. Seeds were sown in a nursery on a well-prepared seedbed in the mid of September. The seedlings transplanted to experimental fields at 3 or 4 leaves stages. Planting was done on ridges of the furrow spacing 40 cm with 20 cm row on the ridge and 5 cm between plants. In addition, 200 kg/ha of NPS and 100kg/ha of Urea were applied, where 150 kg of NPS was applied during transplanting and

25 kg of NPS applied after 15 days of transplanting with 50 kg of Urea (first cultivation). During second cultivation (45 days after transplanting) the remaining half of the Urea (50 kg) and 25 kg of NPS were applied. The experimental plots were irrigated depending on the moisture condition of the soil (in 4–7 days). The crop was harvested when 90 percent of the leaves turned yellow and the top started falling as per the recommendations (MoANR, 2018). The data on yield were collected and analyzed based on the farmer-based gap and experiment-based gap.

Table 1. Description of improved onion varieties used for the demonstration

Variety	Maturity (days)	Research station yield (kg/ha)	Types
Nafis	90–100	40,000	OPV
Nasik Red	90–115	30,000	OPV
Bombay Red (check)	90–100	30,000	OPV

Note: OPV-open pollinated variety.
Source: MoANR, 2018.

Preference ranking

Focus group discussions were conducted with a group of onion producers to find out their perceptions of the onion varieties under evaluation. For the evaluation, experienced onion growing farmers were selected purposely to evaluate the varieties' performance twice (vegetative performance about two months and at harvest). At first, the farmers were requested to set their criteria for the evaluation of onion varieties and they did so. Based on the set criteria the demonstrated varieties were ranked. The ranking was done on a rating sheet indicating the criteria.

Yield gap analysis

Qualitative and quantitative data were recorded by researchers during scheduled farm visits. Data were collected using a data sheet. The yield gap in onion in the study area was analyzed using the definition and concepts provided by Lobell et al. (2009) as follows. The yield gaps were divided into two. First, the gap between the research station yield (potential) and demonstration field yield. Second, the gap between demonstration yield and farmers' yield (actual). Potential yield is the maximum possible yield obtained when the crop is grown applying research recommended management practices (FAO and DWFI, 2015).

For this study, the crop potential yield data was taken from the crop Variety Registry Book (MoANR, 2016). The crop Variety Registry Book which records potential yield of the crop under research management and that was considered as potential yield with all other environmental factors considered to be optimal. The crop yield performance from on-farm demonstrations plots was used as the demonstration yield. The farmer-based yield was recorded from the on-farm demonstration performance of Bombay Red (check). The demonstration trials

were conducted for two consecutive years across locations and a mean yield result for the districts was calculated.

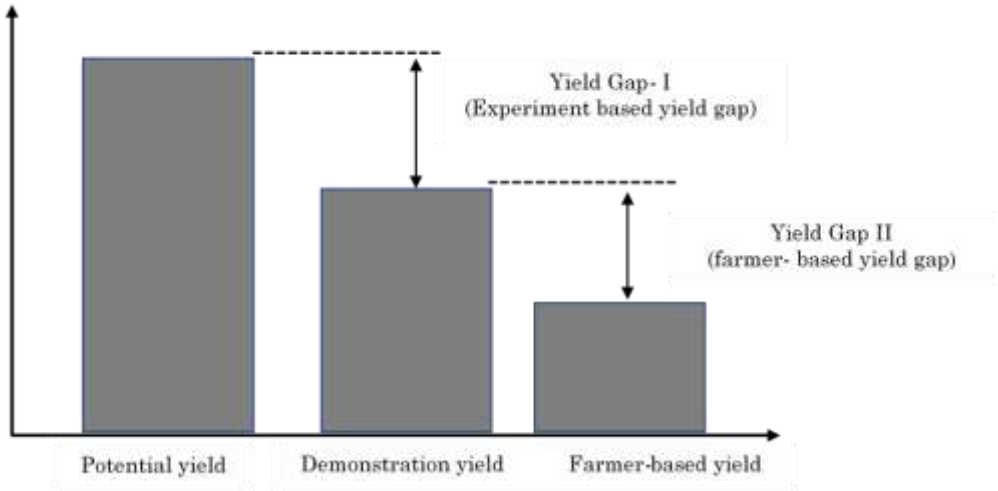

Figure 2. Yield gap as adopted from Loblle et al., 2009

Profitability analysis

To analyze the profitability of onion production, total return, gross margin, net return, and benefit-cost ratio were calculated. Land was taken as a fixed asset in the assessment of its opportunity cost. Costs of irrigation, pesticides, land preparation, seed, fertilizer, and hired labor were calculated based on the existing market price of inputs during the experimental period. The total cost was estimated by adding up variable costs and fixed cost.

Data collection and data analysis

Quantitative and qualitative data were collected. The yield directly measured on the field and farmers' variety and traits preference were recorded using a data collection sheet. The data were analyzed using descriptive statistics, preference ranking, yield gap, and profitability criteria. To estimate the cost of onion cultivation, benefit-to-cost (BCR) method was used according to Gines (2021).

Results and discussion

Yield Performance

From the yield recorded, Nafis and Nasik Red gave higher yield when compared with the yield of the check (Bombay Red) during the two years. The highest mean yield of 29757 kg/ha was recorded from Nafis with a 45 percent yield increment over the check. Comparing the yield difference across the districts the highest yield of 33208 kg/ha was recorded from the demonstration in Lume district. Summarizing the yield result of the varieties from the demonstration plots of the

respective districts over years, Nafis and Nasik Red gave higher yields than the check. A similar yield increment was also reported by Bedru et al. (2009) for Nasik Red as compared to Bombay Red. The increased yield in demonstration plots showed the feasibility and suitability of Nasik Red and Nafis.

Table 2. Summary of demonstration yield performance of onion varieties, 2018–2019 (N=37)

District	Variety	Productivity by year (kg/ha)		Combined Mean	SD	CV
		2018 (n=22)	2019 (n=15)			
Adama	Nafis	34600.1	19638.1	28845.5	8557.7	30%
	Nasik Red	27476.9	18581.1	24055.4	8469.3	35%
	Bombay Red (check)	23236.9	16497.4	20644.8	5316.6	26%
AJ	Nafis	23114.2	33108.3	27657.0	9440.2	34%
	Nasik Red	24123.0	32825.6	28078.7	6929.1	25%
	Bombay Red (check)	23303.1	28686.5	25750.1	7509.6	29%
Lume	Nafis	31127.1	33290.5	31959.2	6065.1	19%
	Nasik Red	29666.7	33729.9	31229.4	7087.0	23%
	Bombay Red (check)	10134.4	22583.2	14922.4	6573.4	44%
Total	Nafis	30204.7	28678.9	29586.1	8049.6	27%
	Nasik Red	27358.5	28378.8	27772.1	7957.5	29%
	Bombay Red (check)	18490.4	22589.0	20152.0	7683.1	38%

Note: SD= standard deivation; CV= Coefficient of variation
Source: On-farm demonstration fields.

A shown in Table 3, there is a significant mean yield difference among the varieties. The mean yield of Nafis was significantly higher than that of the check–Bombay Red. Nafis gave a significant yield advantage of 9434.13 kg per hectare. Similarly, Nasik Red gave a significantly higher yield than the check–Bombay Red (Table 3). This shows that the recently released improved onion varieties have a statistically significant yield advantage over the check.

Table 3. t-test of yield difference among the varieties

Variety	t	df	Sig(.2-tailed)	Mean difference
Nafis	7.129	36	.000	9434.13
Nasik Red	5.825	36	.000	7620.14
Control: Bombay Red (mean:20152 kg/ha)				

Analysis of yield gaps

We presented in Table 4 the difference in performance between the potential, demonstration, and actual farmer yield. The experiment-based yield gap (Yield Gap-I) was calculated and found to be10243 kg/ha and 2328 kg/ha for Nafis and Nasik Red respectively. On demonstration plots, the yield of onion with improved management for Nafis was 29757 kg/ha. Based on the result, the farmer-based yield gap was 9238 kg/ha and 6931 kg/ha for Nafis and Nasik Red respectively. This corroborates the realization of yields on farmers' fields. Similarly, the demonstration plots have higher yield increments.

Table 4. Mean yield of improved onion varieties, extension gaps, and technology gap (kg/ha)

Location	Variety	Number of farmers	Potential yield	Check yield	Demo. yield	Experiment-based gap	Farmer-based gap
Adama	Nafis	13	40,000	19867	27,119	12,881	7,252
	Nasik Red		30,000		23,029	6,971	667
Lume	Nafis	13	40,000	16358	33,208	6,792	1,685
	Nasik Red		30,000		31,698	-1,698	11,831
AJ	Nafis	11	40,000	25331	28,943	1,057	3,612
	Nasik Red		30,000		28,288	1,712	2,293
Mean/ total	Nafis	37	40,000	20519	29,757	10,243	9,238
	Nasik Red		30,000		27,670	2,328	6,931

Source: On-farm demonstration fields.

Farmers' varietal preference

The onion varieties were evaluated by farmers' set preference criteria. The criteria used for the evaluation by farmers were: yield, tolerance to disease and insect, bulb size, bulb color (deep red color is the most preferred), pungency, storability, and market preference. The individual weight of the selected traits resulted that higher yield had the highest weight score and bulb size and pungency obtained the lowest weight score. Market preference, relative tolerance to insects and disease were also found to be important traits of onion. The analysis of preference weight scores, as given in Table 5, for each characteristic of the onion varieties resulted that Nafis was preferred for most of the characteristics except average bulb size. Similarly, Nasik Red is ranked second. In reference to the average bulb size, Nasik is the most preferred one. This signifies the importance of the Nasik Red variety in markets where average bulb size is preferred by consumers.

During group discussion, it was remarked that seeds shortage of improved varieties, disease and insect, the high price of chemicals and market price fluctuation are the major challenges hindering onion production and productivity in the areas. The farmers identified, thrips and purple blotch as a major diseases affecting onion production. A similar result was also reported by Yetayh et al. (2019).

Table 5. Ranking of onion varieties based on farmers' preferred criteria (N=27)

Varietal Characteristics	Individual weight	Nafis	Nasik Red	Bombay Red
Market preference	0.141	3.807	2.397	1.692
Better yield	0.149	2.980	2.533	2.533
Good bulb color	0.115	2.990	2.070	1.265
Average bulb size	0.105	1.995	2.100	1.680
Relative tolerance to insect	0.129	3.483	2.064	1.677
Pungency	0.105	2.520	1.890	1.470
Tolerance to disease	0.129	3.354	2.193	1.419
Storability	0.127	3.175	2.032	2.032
Total		24.304	17.279	13.768
Rank		1st	2nd	3rd

Note: Ranking scores out of 3 points with 1= low; 2= moderate; and 3= high.
Source: Authors focus group discussion

Cost of onion production

Onion production involves a number of inputs and management practices. Land rent, land clearing, seedling management, transplanting, hoeing, harrowing weeding and chemical application, and harvesting are the major activities that incur costs in onion production (Table 6). Onion producers invested a mean of 186,290 ETB per hectare. From the total investment, the cost of fungicide and insecticide was the highest (22 percent) followed by that of land rent, fertilizer cost plus labor, and cost for harvesting which accounts for 59 percent of the total investment. Generally, in onion production, it is found that the cost of inputs was55 percent compared with the cost of labor (45 percent).

Table 6. Cost of onion production (ETB/ha)

Activity/input	Lume		Adama		AJ		Total Mean	
	Mean cost	% of cost	Mean cost	% of cost	Mean cost	% of cost	Mean cost	% of cost
Input costs								
Land rent	24,500	15	25,875	14	26,350	13	25,575	14
Seed price	7,000	4	7,000	4	7,000	3	7,000	4
Fungicide and insecticide	23,200	14	45,200	24	55,000	27	41,133	22
Fertilizer and labor for application	15,470	9	22,500	12	26,988	13	21,653	12
Fuel cost	8,950	5	3,100	2	5,348	3	5,799	3
Sub-total	**79,120**	**47**	**103,675**	**56**	**120686**	**59**	**101,160**	**55**
Labor costs								
Land clearing	2,450	2	2,900	2	2,410	1	2,587	1
Ploughing	7,400	5	12,700	7	5,450	3	8,517	5
Hoeing and cultivation	8,300	5	3,200	2	12,650	6	8,050	4
Nursery bed, water, shade, management	6,050	4	2,700	2	4,600	2	4,450	2
Transplanting	15,870	10	12,900	7	13,350	6	14,040	8
Guarding	5,500	3	7,500	4	5,600	3	6,200	3
Hand weeding-three times	13,075	8	12,700	7	12,400	6	12,725	7
Labor for chemical spray	10,820	7	6,550	4	4,475	2	7,282	4
Harvesting	17,280	10	20,880	11	25,680	12	21,280	11
Sub-total	**86,745**	**54**	**82,030**	**46**	**86,615**	**41**	**85,131**	**45**
Total cost	**165,865**	**100**	**185,705**	**100**	**207,300**	**100**	**186,290**	**100**

Source: On-farm demonstration fields

Financial feasibility analysis

The total costs for the demonstrated onion varieties were alike within a particular district and vary across the districts The benefit of each variety was calculated by including the costs of fertilizer, seed, chemicals, and labor. The financial feasibility of the innovation was computed using the benefit-to-cost ratio (BCR) and net profit. Nafis had the highest benefit-to-cost ratio in all the study areas. For every one ETB invested in the production of onion, the farmers earned a higher net income from Nafis variety. In the financial feasibility analysis we considered land as a fixed cost; taking into account land rent. However, those farmers who own land earned additional income as shown in Table 7. Comparing the district

level return, the highest return was from Lume district by producing Nafis variety. The profitability relates directly to the productivity and lower cost of production compared with the other study areas. Thus, farmers will be at the high-profit level if they cultivate Nafis using associated production practices followed by Nasik Red.

Table 7. Financial feasibility of improved onion variety production

Item	Lume			Adama			AJ		
	Nafis	Nasik Red	Bombay Red	Nafis	Nasik Red	Bombay Red	Nafis	Nasik Red	Bombay Red
Overall mean yield in kg/ha	33,200	31,700	16,400	27,100	23,000	19,900	28,900	28,300	25,300
Price (ETB/kg)	14.25	14.25	14.25	12.75	12.75	12.75	12.87	12.87	12.87
Fixed Cost	24,500	24,500	24,500	25,875	25,875	25,875	26,350	26,350	26,350
Variable cost	141,365	141,365	141,365	159,830	159,830	159,830	180,950	180,950	180,950
Total Cost	165,865	165,865	165,865	185,705	185,705	185,705	207,300	207,300	207,300
Total Return	473,100	451,725	233,700	345,780	293,378	253,343	372,458	364,092	325,997
Net Return	307,235	285,860	67,835	160,075	107,673	67,638	165,158	156,792	118,697
BCR=TR/TC	2.85	2.72	1.41	1.86	1.58	1.36	1.80	1.76	1.57

Conclusion and Recommendation

Nafis and Nasik Red with improved management practices gave the highest yield per unit area on a farmers' field. The yield gaps result indicates that the farmers need to use, variety and the recommended practices, to increase their onion productivity and production. Similarly, the host farmers fetched the highest financial returns from the technology. The new varieties were also the most preferred because of their market preference, higher yield, preferred bulb color, average bulb size, relative tolerance to insects, pungency, relative tolerance to disease and storability.

Therefore, it is advisable to grow Nafis and Nasik Red by replacing Bombay Red on large-scale production to increase the production and productivity of onion then improve the livelihood of onion farmers in the study area and similar agro-ecologies in Central Rift Valley areas and beyond in Ethiopia.

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