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Research article

Pre-extension demonstration of improved carrot varieties at Gemechis and Chiro districts, Oromia regional state, Ethiopia

Samson Moges*

Department of Agriculture Extension, Ethiopia Institute of Agricultural Research, Addis Ababa, Ethiopia.

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Carrots (*Daucus carota L.*) are root vegetables that belong to the Apiaceae family. They are widely cultivated and well-liked. A demonstration was conducted in the Chiro and Gemechi districts of the west Hararghea zone, eastern Ethiopia, for two consecutive years (2022 and 2023). The objective was to showcase potential carrot varieties and assess farmers' satisfaction levels. The demonstration was conducted on the fields of 12 hosts and 24 follower farmers. Carrot varieties Haramaya-I and Nantes were used for demonstration. During the harvesting stage of the carrots, a field day was conducted with participants and neighboring farmers to create demand and measure farmers' satisfaction. Farmers identified marketability and high-yielding carrot varieties, disease and pest resistance, uniformity and thickness of the roots, taste, and color as potential selection criteria. Farmers' satisfaction data was collected from 36 households using structured questionnaires. Yield data was also collected from the demonstration trial. Based on pre-set selection criteria, a ranking system was used to determine satisfaction levels. Out of seven parameters, the Nantes variety scored higher than the Haramaya-I variety in five, while Haramaya-I scored higher than Nantes in two. Generally, Nantes scored 1016 points, and Haramaya-I scored 789 points in the field. This result revealed that the breeder should consider marketability, color, taste, and other critical factors in addition to yield. The Haramaya-I and Nantes varieties were compared for yield, and the results indicate that there is no significant mean difference in yield potential between the varieties (t-value=0.7492).The full package trial plot a statistically significant mean difference compared to the usual farmer practices in both Haramaya I (t-value=3.9722) and Nantes (t-value=3.4789). Based on the mean score of harvesting differences, the plot with the full package showed a higher yield than the plot with usual farmer practices. These results suggest that adopting the full package of appropriate agronomic practices and improved varieties can have a positive impact on yield.

Key words: Demonstration, Descriptive statistics, Improved carrot varieties, Satisfaction level

INTRODUCTION

The carrot (*Daucus carota L.*) is a widely grown root vegetable of the Apiaceae family. The first recorded use of carrot roots as a vegetable was in the 10th century in what is today known as Afghanistan. In the early 20th century, the genetic variety of orange carrots that originated in Europe in the 16th century quickly expanded over the rest of the world (Wassu et al., 2015). Although the exact time of the introduction of carrots to Ethiopia is not known, the crop has been known since the early 1960s in the research system.

Carrot roots are high in carotenoids, which are precursors to vitamin A (Tabor et al., 2012), hydrophilic (phenolic chemicals), and pro-healthy antioxidants (Baranski et al., 2012). It is a crop-rich source of nutrients necessary for excellent health because it also contains carotenoids, flavonoids, vitamins, and minerals (Zeleke et al., 2014). The carrot roots are consumed regularly in Ethiopia as vegetables in salads, soups, and stews (Tabor et al., 2012)

Farmers' satisfaction is seen as a significant sign of sustainability (Sarandón, et al., 2004), which has emerged as a primary focus of scientific study and policy objectives (López et al., 2002). Client satisfaction surveys can address the dependability and responsiveness of services, as well as providers' willingness to meet clients' demands WHO, 2000.

The literature states that agricultural demonstrations are one of the most common features of agricultural extension. Poor extension services were ranked as the top reason for non-adoption. Moreover, (Elias et al., 2013) observed that the

*Corresponding author. Samson Moges, E-mail: maresam2@gmail.com.

effect of extension program participation on farm productivity is marginal. Demo is a major weapon for introducing the findings of modern research into agricultural practices to increase agricultural production in particular and uplift the rural masses. Just as a picture speaks a thousand words, demos can communicate a rich spectrum of messages to farmers. Extension workers use these methods as tools to bring about positive changes in the behavior of rural communities. They aim to create optimal learning situations and facilitate effective communication and interaction between extension workers and farmers. Moreover, extension methods stimulate adult youth, both male and female, for action. Well-presented demos can play a critical role in enabling adoption. When farmers can see for themselves that technology works, they are more likely to try it. Conversely, poorly presented demos can negatively affect the learning process and discourage farmers from adopting a new technology.

A "quiet revolution" in the production of carrots is taking place as a result of rising urbanization, population expansion, income development, policy reform, and substantially improved infrastructure. The same is true in West Hararghea, where urbanization and population growth have increased. As a result, consumption of vegetables rises year after year. But in comparison to demand, production is still quite low.

According to the West Hararghea Office of Agriculture and Rural Development annual 2022 report, there is a shortage in vegetable supply. This shortage is not only due to population growth but also to low productivity. The productivity problem comes from unused, improved varieties and a lack of awareness of the production package. Carrot production is a lucrative business in West Harerghe, especially for women and youth.

Therefore, this activity aims to improve local agronomic practices and increase the productivity of carrot-producing farmers in two districts of West Hararegheh, namely Gamachise and Chiro. The on-farm trial focused on introducing new varieties and a new production system. The farmers' satisfaction level and the difference in yield were evaluated accordingly based on the results of the on-farm trial.

Objectives

1. To showcase the top-performing carrot varieties.
2. To assess farmers satisfaction level.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Gemechis and Chiro Districts, which fall under the West Hararghe Zone of Oromia National Regional State in Ethiopia. The West Hararghe zone is made up of 15 districts, including Gemechis and Chiro. Gemechis is located at an elevation ranging from 1300 to 3017 meters above sea level, while Chiro is situated at an altitude of 1830 to 3200 meters above sea level. These two districts are located approximately 305 and 333 kilometers away from Addis Ababa, respectively. Chiro is located between longitudes 40.8667 9° 4′ 60″ North and 40° 52′ 0″ East, whereas Gemechis is located between latitudes 8° 10′ N and 40° 45′ E. The minimum and maximum temperatures experienced in Gemechis and Chiro are 20°C and 22°C, respectively, with annual precipitation totals of 850-1000 mm and 700-1100 mm. Both districts experience a bimodal rainfall distribution pattern. The first short rainy season, known as "belge", starts in the first week of March and ends in May. The second main rainy season, locally named "gena", begins in the first week of June and ends late in September. The farming systems in both districts are categorized as crop-livestock farming systems. Major crops produced using irrigation include onions, carrots, tomatoes, potatoes, cabbage, sugarcane, sweet potatoes, hot peppers, and chats, according to the District Office of Agriculture in 2022.

Site and farmers selection

This research activity was focused on introducing new carrot varieties and a new production system and was carried out in six villages located in the Chiro and Gumechis districts of the Oromia Region. The selection of these villages was purposeful due to the abundance of carrot-producing farms in these areas. 12 host farmers were purposefully selected based on their willingness to host the demonstration trial. The selection of districts and villages was done in collaboration with zonal and district experts to ensure the sustainability of extension service delivery.

Implementation procedure

Carrot seeds of two different varieties, Haramaya-I (acquired from Haramaya University) and Nantes (purchased at the local market in Chiro), were sown on well-prepared soils with 20 cm rows between them. Once the seedlings reached a height of 10 cm, they were thinned to one plant per stand with a spacing of 5 cm. All necessary agronomic management procedures, such as weeding, hoeing, and fertilizer application (NPS and Urea), were applied evenly to all demonstration plots. Farmers managed one plot to demonstrate crop management's effect on yield. Root yield data were carefully collected from all plots.

In the demonstration, farmers used carrots from the Haramaya and Nantes varieties. A minimum plot size of 10 m x 3 m per farmer was used for the PED. Host farmers and their development agents received training and orientation on appropriate technology packages. Field events, such as field days, were organized at the village level. Yield data, feedback, and opinions from farmers were recorded. The demonstration was responsibly managed by the respective village DAs and hosting farmers. These activities engaged 30% of female and young farmers.Client satisfaction surveys can address the dependability and responsiveness of services, as well as providers' willingness to meet clients' demands WHO, 2000.

Data collection and analysis

Using descriptive and cross-sectional research methods, the levels of satisfaction of host and follower farmers with the demonstrated carrot technology in the Chiro and Gemechis districts were investigated .The satisfaction levels of farmers in the surveyed wards were measured using an ordinal scale ranging from 1 (extremely satisfied) to 5 (not dissatisfied). Farmers determined the selection criteria based on the important characteristics of carrot technology, yielding seven significant criteria. Satisfaction levels were recorded during the field day demonstration based on the criteria of yield quantity, root thickness, marketability, disease and insect resistance, color, taste, and root uniformity of carrot types.

Field days were organized at the peak of maturity, and assessments were conducted at all trial sites. Yield data were taken by measuring representative values from each plot. Descriptive statistics were utilized (ttest, Std.Dev, min, Max, sum and rank) and Stata 13 and Google Sheets were employed for data analysis.

RESULTS AND DISCUSSION

The effects of agronomic practices on output

Figure 1 shows that using the full package production system results in a higher median yield than using farmers' usual production system. It's clear to see that using the full package production shifts the yield upward.

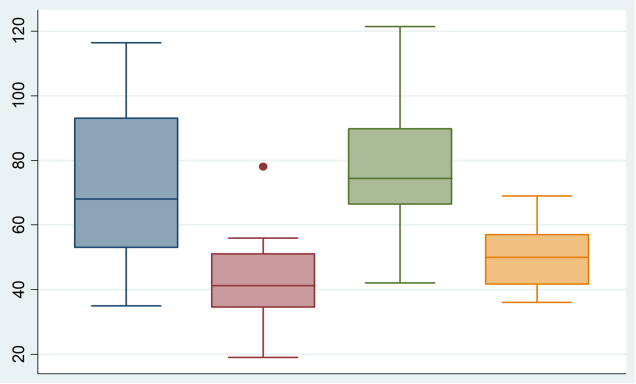

Figure 1. Yield performance.
Note: (▬) Yield Nantes with full package, (▬) Yield Nantes with farm practice, (▬) Yield Haramay a with full package, (▬) Yield Haramay a with farm practice.

The study compared the yields of two carrot varieties, one with full packaging and the other with farmer-usual practices. The Nantes yield with farm practice was significantly lower than the Nantes yield with the complete package. The mean yield and standard deviation for Nantes' yield with the complete package were 42.95833 and 15.13944, respectively, with a t-value of 3.4789. On the other hand, the mean yield of Haramaya-I carrots with the full package showed a significant difference compared to farmer practice, with a t-value of 3.9722 at a 0.05 level. These results indicate that using full-package agronomic practices can significantly affect yield. Therefore, it is recommended that when entering the carrot production business,producers should use full agronomic practices to increase production per unit of land. Please refer to Table 1 for detailed information.

In Table 2 the mean yield difference between varieties and within varieties at different farming practices was compared in the field. The plot of the full package does not have a significant mean difference (mean=50.757, SD=10.87007, t-value=1.4157; mean=42.95833, SD=15.13944). Based on the mean score of harvesting differences, the plot with a full package was higher than the plot with usual farmer practices. In terms of yield, the full package plot and the plot of farmers' practices were also not significantly different (t-value=0.7492). The result was comparable to distinct from (Kassa Melese et al., 2018).

Farmer satisfaction on the demonstrated varieties

Mini farmers field days were organized at each demonstration site to involve key stakeholders and improve linkages among relevant actors. 74 female and 151 male farmers attended the event. Farmers used the platform to share their thoughts on the potential of the presentned carrot and its way of productio. Selection parameter was a key focus, as it was expected to provide significant insights into the topic. Therefore, the farmers, including both the host and the follower, were asked to indicate their satisfaction levels concerning the varieties of carrots that were delivered to them. The results showed that the Nantes carrot variety received the highest score of 1016, indicating that farmers were satisfied with it. In comparison, the Haramaya carrot variety received a score of 789, following Nantes. Respondents were asked to rate their satisfaction levels with various parameters, and the results are presented in Table 3.

Table 1. Two-sample t-test with equal variances.

Variable	Obs	Mean	Std.Dev	Min	Max	t value
Yield Haramaya-I with a full package	12	79.8583	23.1087	42	121.5	3.9722
Yield Haramaya-I with a farmer practice	12	50.757	10.87	36	69	
Yield Nantes with a full package	12	72.4667	25.1818	35	116.5	3.4789
Yield Nantes with farmer practice	12	42.9583	15.1394	19	78	

Table 2. Two-sample t-test with equal variances.

Variable	Obs	Mean	Std.Dev	Min	Max	t value
Yield Haramay-I with a full package	12	79.8583	23.1087	42	121.5	0.7492
Yield Nantes with a full package	12	72.4667	25.1819	35	116.5	
Yield Haramay-I with farmer practice	12	50.757	10.8701	36	69	1.4157
Yield Nantes with farmer practice	12	42.9583	15.1394	19	78	

Table 3. Haramaya-I Caarot variety of the Nantes carrot variety received the highest score of 1016, indicating that farmers were satisfied with it.

Attribute	**5**	**4**	**3**	**2**	**1**	**Score**	**Sum**	**Rank**
Yield	15	17	4	0	0	155		
Root thickness	0	0	23	13	0	95		
Disease and pest	11	24	1	0	0	154		
Marketability	0	0	21	15	0	93	789	2nd
Color	0	0	30	6	0	102		
Test	0	0	15	21	0	87		
Root uniformity	0	0	31	5	0	103		
Nantes Carrot variety								
Attribute	5	4	3	2	1	Score	Sum	Rank
Yield	10	16	10	0	0	144		
Root thickness	13	16	7	0	0	150		
Disease and pest	0	0	26	10	0	98		
Marketability	25	11	0	0	0	169	1016	1st
Color	10	16	10	0	0	144		
Test	8	28	0	0	0	152		
Root uniformity	17	17	2	0	0	159		

Source: Field Data, 2023.

Note: * Score for each preference: For the first preference, multiply the total frequency by 5, for the second, multiply by 4, for the third, multiply by 3, for the fourth, multiply by 2, and for the fifth, multiply by 1.

CONCLUSION AND RECOMMENDATION

This study used participatory demonstration to examine farmers' satisfaction with different carrot varieties as well as yield differences between traditional farming practices and full-package production systems. The results of the analysis indicate that the mean score of harvested yield differences in the plot with a full package production system was higher than in the plot with usual farmer system.

The study also revealed that farmers preferred Nantes over Haramaya-I in terms of five attributes, including root thickness, marketability, color, taste, and root uniformity. However, farmers were highly satisfied with Haramaya-I for pest, and disease characteristics as compared to Nantes. The study suggests that carrot breeders should focus on enhancing the color, root thickness, taste, and uniformity of the root to facilitate a higher level of satisfaction from farmers.

The result indicated that producing the Nantes variety is more preferred than Haramaya-I, as the commercial root did not differ significantly between the Haramaya-I and Nantes varieties. However, Nantes was also better in terms of color, taste, marketability, and root uniformity.

The study demonstrated that using a full-package production system has a positive effect on yield. Therefore, farmers should consider adopting available production technology to increase carrot production.

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