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Research Article

Assessment of Production and Utilization Practices of Orange-Fleshed Sweet Potatoes (*Ipomoea Batatas* L.) in Sidama Region, Ethiopia

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Sweet potato (*Ipomoea batatas* L.) is an important crop which ensures food security in developing countries. It can be harvested at any stage as needed, thereby providing a flexible source of food and income for rural families that are most vulnerable to crop failures and cash income fluctuations. The production and consumption of orange-fleshed sweet potatoes (OFSP) by smallholder farmers in the Sidama region of Southern Ethiopia were explored in this study to identify key problems and opportunities in OFSP production. A preliminary investigation and rudimentary data collection were used to gather data. The data were analyzed using descriptive statistics, multiple linear regression, and index grading. Based on the descriptive analysis, smallholder farmers have small landholdings of 0.51 ha per family. Farmers conserve their planting materials by leaving them in the field. This causes the materials to be extensively infested with diseases, insects, and other vertebrate pests. Farmers (54.4%) do not apply inorganic fertilizersassuming that it stimulates more vegetative growth and results in tasteless storage roots. The continuous cultivation of OFSP without fertilizer application results in nutrient depletion and reduced yield. Further, the production and utilization of OFSP in the Sidama region is constrained by factors such as diseases, lack of storage facilities, lack of planting materials, drought, insect pests, low market price, and shortage of money to purchase inputs. According to the index ranking, drought, shortage of planting material, diseases, and insect pests were the most important. Combinations of social, ecological, and economic factors limit the production of sweet potatoes and therefore, a stronger extension system on agronomic practices and credit system should be made accessible to the farmers.

1. Introduction

Sweet potato (*Ipomoea batatas* L.) is a crucial food security crop for millions of people in Sub-Saharan Africa and Asia. The crop is among the world's most important crops, ranking fifth and seventh in production in Africa and the World, respectively [1–3]. It is mainly grown for human food and animal feed. It produces carbohydrate-rich storage roots with a substantial amount of vitamins A, B complex, C, and E, as well as minerals including calcium, potassium, and iron. According to Zhang et al. [4] and Gichuki et al. [5], Central America is considered the primary center of diversity of sweet potatoes based on molecular markers study and most likely the center of origin since the highest diversity was found in this region. However, in Sub-Saharan Africa, the majority of sweet potatoes are white-fleshed which are poor yielding (6 $t{\cdot}ha^{-1}$) and deficient in beta-carotene [6]. Sweet potato has a wide range of use and benefits, among them, chipped and milled into flour for making snakes and baby foods and boiled and eaten as food for families [7]. Orange-flesh sweet potato (OFSP) is rich in pro-vitamin A, which contributes to normal eyesight, healthy skin and mucous membranes, healthy cell growth, reproduction, and immunity to diseases such as malaria, measles, and respiratory diseases [8].

Sweet potatoes can be harvested in piecemeal as needed as a food security crop, thus providing a variable source of food and income to rural people who are prone to crop failure. There are some cultivars with a short maturing period of 3 to 5 months. The crop is drought tolerant and has a wider ecological adaption [9]. In 2017, the total production of sweet potatoes was 112.8 million tons in around 115 countries, with China being the leading producer, followed by Nigeria and Tanzania [10]. Most of the world's sweet potato production comes from developing countries [11].

Sweet potato is commonly produced in Ethiopia by smallholder farmers with limited land, manpower, and capital in the south, southwestern, and eastern regions. Ethiopia is among the world's largest producers of sweet potatoes. Sweet potatoes occupied roughly 53,499 hectares of land, with an annual production of 1.85 million tons during the main production season only [12]. Sweet potato is chiefly produced in Southern Nations, Nationalities, and Peoples', Sidama and Oromia regions of Ethiopia [13] with a trend of expansion in other regions. However, the average yield is very low at about 8 $t{\cdot}ha^{-1}$ compared to the potential yield of 30–73 $t{\cdot}ha^{-1}$ [14, 15].

Sweet potato is grown and primarily eaten fresh in Ethiopia.Because of their high-carotene (provitamin A) content, the need to promote OFSP cultivars is critically important[13, 16]. Although sweet potatoes have many potential uses and benefits, its yield in many areas of Ethiopia is below the potential yield of 30–73 $t{\cdot}ha^{-1}$ due to abiotic, biotic, and socioeconomic constraints before and after harvest. The biotic stresses include diseases, insect pests, and weeds, whereas the abiotic factors are drought, heat, and low soil fertility [17, 18]. Constraints related to socioeconomic and quality attributes include unavailability of improved varieties, poor planting material, the low β-carotene content in the white-fleshed sweet potatoes, and a low dry matter content (DMC) in the OFSP varieties that are currently available [14, 16, 17, 19]. Poor postharvest handling techniques are among the key factors that reduce the quality and value of the crop. Site-specific information is lacking on the production management of OFSP in the study area. Consequently, evaluating OFSP production and its utilization is critically important to identify the main challenges and opportunities for sustainable OFSP production. Therefore, it is imperative to assess production and utilization practices of OFSP under smallholder farmers in Sidama region to elucidate and document major constraints of production of the OFSP.

2. Materials and Methods

2.1. Site Descriptions. During the 2019/2020 growing season, the study was carried out in Hawassa Zuria and Boricha districts of the Sidama region. According to the 2014 SNNPRS-BOFED [20], the Sidama region has a population of 3, 677, 370 people. The region is in the country's central-eastern corner, bordered on the north, east, and southeast by Oromia, the south by Gedeo Zone, and the west by Wolayita Zone. The region is located between 5′ 45″ and 6′ 45″ north latitude and 38′ and 39′ east longitude. The region's overall area is 6981.9 km^2 [21]. Maize, coffee, enset, sweet potatoes, chat, and fruits are among the major crops produced in the study sites. The region is located between 1500 and 2500 meters above sea level, with an average annual rainfall of between 1200 and 1599 mm and average annual temperatures ranging from 15 to 19.9 degrees Celsius.

2.2. Techniques for Sampling and Sample Size. The study was carried out in four kebeles from two rural districts where sweet potato is substantially produced. Samples for the investigation were taken from the population of family heads, both men and women. Two kebeles in Hawassa Zuria rural district, namely Jarra dadoo and Doyo otolcho, and two kebeles in Boricha rural district, namely Aldaad deda and Hanja cafaa, were chosen using a purposive sampling approach (Figure 1). The number of farmers (n) in each kebele was used to compute the sample size using [22]

$$n = \frac{N}{1 + N(e)^2}, \quad (1)$$

where n is the sample size, N is the population size, and e is the precision level (0.05).

HouseholdHeads were chosen using a systematic selection procedure that divided N by n ($N/n = i$) and every i^{th} head of the home was chosen from a list at the kebele level, commencing with the first name of the head household. The sampling procedure is illustrated in Figure 1. The first household was selected using a lottery approach from the i ranges. The percent of the sampled population (C) was calculated [23].

$$C = \frac{n}{N} \times 100, \quad (2)$$

where n is the number of farmers chosen and N denotes the total number of farmers in a district.

2.3. Data Management and Statistical Analysis. A predesigned questionnaire was used to obtain primary data in two stages. First, a prelude assessment was required to obtain general knowledge about the kebeles, as well as to adjust and forward the study objectives to the kebele organization. A list of relevant criteria and questions was utilized to lead the talks with the center groups and key informants throughout the prelude assessment. Ten to fifteen members from each kebele were interviewed to ensure reliability. Pretesting was designed to identify any inadequacies and assist in making changes to a few questions before the actual data gathering. Thereafter, basic data on household demographics, production familiarity, production effectiveness, and proper production use were collected (better variety sources and assortments, option intervals, manipulation of soil fertility, pest management methods, postharvest management actions, and supervision OFSP production and consumption

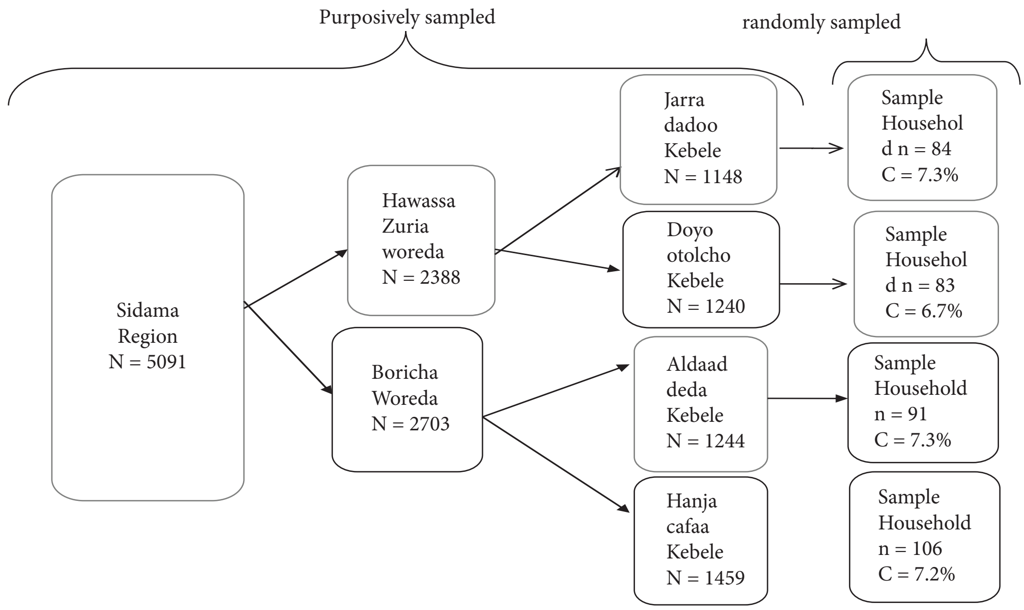

Figure 1: Total number of kebele households (N), number of sampled households (n), and the proportion of sampled households (C).

by gender). During data collection, the observation method was also applied. This involved recording observed facts on what happened in the field, OFSP storage, the site's general appearance, and reference during data analysis.

The Statistical Package for the Social Sciences was used to analyze the data (SPSS, version 20). To summarize and organize the research data, descriptive statistics such as percentage, frequency, and mean were used. The effect of each variable on the productivity of OFSP under smallholder farmers at the study site was investigated using multiple linear regression analysis with average yield (t ha^{-1}) as a dependent trait (Y) and other studied variables as independent variables (X). In addition, the main factors affecting sweet potato production were ranked using an index ranking system based on the formula: Index = sum of (8X number of household heads ranked first + 7X number of household heads ranked second + 6X number of household heads ranked third + 5X number of household heads ranked fourth + 4X number of household heads ranked fifth + 3X number of household heads ranked sixth + 2X number of household heads ranked seventh + 1X number of household heads ranked eighth for each constraint divided by the sum of (8X Total number of household heads rated first + 7X Total number of household heads rated second + 6X Total number of household heads rated third + 5X Total number of household heads rated fourth + 4X Total number of household heads rated fifth + 3X Total number of household heads rated sixth + 2X Total number of household heads rated seventh + 1X Total number of household heads rated eighth) for all constraints mentioned.

3. Results and Discussion

3.1. Household Demographic Information. The majority of the family leaders interviewed (80.5%) were men, while the rest (19.5%) were female family heads (widowed or divorced) (Table 1). Males are typically the family resource leaders, which is similar to other African countries. Our results agree with those reported by Ahmad et al. [24] in Nigeria where 71% of the respondents were men.

Approximately 68.4% of family respondents were in the active farming age group (15 to 65 years old), while 31.6% were elderly (>65 years old) (Table 1). This indicates that this community has efficient and autonomous workers who are recognized to have the physical strength required for OFSP production. This result is consistent with the findings of Negasi et al. [25], who reported the active age group (15–65 years old) to be primarily involved in onion production in Ethiopia's rift valley regions. Similarly, Ahmad et al. [24] stated that most of the farmers are young people who are still strong and full of energy to make a meaningful impact on agricultural production. In Nigeria, Okoruwa and Ogundele [26] depicted that the average age of sweet potato farmers to be 42 years. The average household size of Hawassa-Zuria districts was ≈5, whereas that of Boricha was about 6 (Table 1). This result suggests that there is a sufficient supply of family labor in the study area. Similar to this study, Simonyan and Obiakor [27] reported that the majority of rural dwellers had families with more than five members. Several authors have attributed the growth of family size to easily finishing family agricultural tasks in time due to the division of responsibilities among family members [24, 28]. According to Okoye et al. [29] and Udensi et al. [30], relatively high family size is more likely to supply more labor for farm operations such as weed management and fertilizer application. However, Simonyan and Obiakor [27] reported that a large household size does not ensure higher labor efficiency since it is comprised of mostly children who go to school during working hours. Results from this study revealed that most of the farmers (56%) had completed primary school (Table 1), which was higher than the national average adult literacy rate (46.7%) [31]. This indicates that

Table 1: Socioeconomic characteristics of the respondents.

Characteristics	Frequency		Percentage		
Gender of household head					
Male	293		80.5		
Female	71		19.5		
Age of the household head					
15–65 years old	249		68.4		
>65 years old	115		31.6		
Education level of household head					
No education	125		34.3		
Primary education	204		56.0		
Secondary education	27		7.4		
Postsecondary education	8		2.2		
Respondent's family size	*Frequency*	*Percent*	*Mean standard deviation*	*Minimum*	*Maximum*
Hawassa Zuria	189	51.9	4.6 ± 1.7	2.00	10.00
Boricha	175	48.1	5.7 ± 1.7	2.00	11.00
Total	364	100.0	5.1 ± 1.8	2.00	11.00

SD: standard deviation; HH: household.

the majority of the farmers had a reasonably high degree of education and were familiar with fundamental farming practices. This is further supported by Doss [31], who stated that one of the factors that influence farmers' acceptance of agricultural technologies is their high literacy level. Farmers can make better sweet potato production operations as a result of high literacy levels using published materials such as booklets, leaflets, posters, and other items [32].

3.2. Production Experience. The mean number of years of farming experience of the farmers in the two districts was 21.5 (Table 2). About 51.9% of the respondents have been planting sweet potatoes for the past more than 20 years. This result is similar to that of Gebru et al. [28] who found that the average farm experience of households in their study was more than 20 years. This result shows that the farmers are highly experienced in the cultivation of OFSP. The average farm size grown by each household was about 0.51 ha, with OFSP cultivation accounting for roughly 0.094 ha (19%). The higher number of years of farmers growing sweet potato implies a wealth of production knowledge which can be further improved and taught to other farmers to increase OFSP production in their farms.

3.3. Sweet Potato Varieties Grown by Farmers. The varieties currently grown most by smallholder farmers in the area include: Kulfo (65.7%) and Tulla (32.4%) (Table 3). Studies have shown that Kulfo is the best variety in terms of marketable yield and other agronomic attributes [33]. This could be the main reason for its dominance in production in the study areas.

3.3.1. Method for Preserving Sweet Potato Planting Material. The majority of farmers (82.4%) kept planting materials in situ in the field, while the rest utilized different methods (Table 3). These methods result in materials being extensively infected with viruses and other diseases, as well as insect and vertebrate pests. This could explain the significant drop in productivity, quality roots, and biomass compared to the preceding crop. Of the 318 sweet potato samples of different varieties that were collected and tested for virus, 62.8% were affected by sweet potato feathery mottle virus infection [34]. The virus incidences were highest (86%) and lowest (32%), respectively, in samples collected from Humbo and Sodo Zuria District of the Wolaita zone [34]. These findings are consistent with those of Namandaa et al. [35], who found that sweet potato planting materials obtained from waterlogged agricultural plots were infected with virus, and that acquiring it from volunteer plants after rains caused planting delays. Planting materials for sweet potatoes were mostly recycled from previous crops since just a tiny percentage of farmers utilized certified planting materials. This indicates that either the majority of farmers are unaware of the need of utilizing clean, certified planting materials or that they do not have access to improved planting materials. This could explain why sweet potato yields are still poor. In a review of sweet potato production constriantsassesments conducted across numerous nations, Fuglie [36] reported the lack of clean and sufficient planting materials was a prominent barrier in most African countries.

The majority of farmers (78.3%) adopted appropriate spacing for OFSP production (Table 3), demonstrating that they chose intensive farming to maximize the yield of their limited area. According to Adubasim et al. [37], the highest root yield was achieved at a plant spacing of 60 cm × 30 cm. The yield values under these plant spacing exceed the African average root yield of sweet potatoes, which is estimated at 7.0 $t\,ha^{-1}$ FAOSTAT [38]. This implies that farmers who plant in rows at such specific dense spacing could have higher yields than the African average yield and those who use arbitrary plant spacing. Similar to our observation, Sen et al. [39] reported higher sweet potato tuber yields of 20 $t{\cdot}ha^{-1}$ where the vine cuttings were closely planted.

In this survey, nearly 30% of smallholder farmers (29.7%) preferred to utilize manure over artificial fertilizers

Table 2: Farming experience and land size of households.

Values	Frequency	Percentage	Mean ± standard deviation	Minimum	Maximum
Household head's farm experience (year)					
Hawassa Zuria woreda	189	51.9	21.1 ± 7.6	8.00	43
Boricha woreda	175	48.1	21.9 ± 11.10	8.00	46
Total	364	100.0	21.5 ± 9.4	8.00	46
Total land size of household (ha)					
Hawassa Zuria woreda	189	51.9	1.0 ± 0.6	0.45	3.38
Boricha woreda	175	48.1	0.8 ± 0.4	0.25	3.00
Total	364	100.0	0.9 ± 0.5	0.25	3.38

HH: household; SD: standard deviation.

Table 3: Sweet potato production management in the study site.

Characteristics	Frequency	Percentage
Orange-fleshed sweet potato cultivars were used		
Kulfo	239	65.7
Tulla	118	32.4
Alamura	7	1.9
Sweet potato planting material conservation method		
Plant on soil embankment	25	6.9
Plant after harvest	13	3.6
Left on-farm	300	82.4
Do not conserve	26	7.1
Use of recommended spacing		
Yes	285	78.3
No	79	21.7
Types of fertilizer they use		
Organic	108	29.7
Inorganic	47	12.9
They did not use any fertilizer	198	54.4
The integration of both	11	3.0
Types of beds they use		
Ridges	246	67.6
Flats	118	32.4
Land-use type		
Pure stand	302	83.0
Intercropping	62	17.0
Important orange-fleshed sweet potato pests in the area		
Disease	113	31.0
Insect	211	58.0
Weed	40	11.0
Disease control strategies they used		
Cultural	18	4.9
Chemical	312	85.7
Both	31	8.5
None	3	0.8

like DAP and urea, whereas a considerable number of farmers (54.4%) did not use fertilizer. According to the farmers, inorganic fertilizers support extensive vegetative growth resulting in tasteless storage roots. Some farmers claimed that sweet potato does not require applied soil nutrients and can thrive on poor soils. This result agrees with those of Stephan et al. [40], who report farmers do not utilize fertilizers in the production of sweet potatoes. The authors suggested that although the reasons for not using fertilizer may be far from reality, more studies are needed in order to design a fertilization approach that could increase sweet potato yields while maintaining root quality. The higher cost of inorganic fertilizer is one of the major reasons for the none or low use not only in sweet potato cultivation but also in other crops.

The sweet potato was grown on ridges by 68% of the farmers interviewed, similarly, Githunguri et al. [41] found that most farmers employed ridges to grow sweet potatoes, presumably because this planting method produces higher yields than other methods. The study revealed that 83% of farmers grew sweet potatoes under monocropping and 17% under intercropping with other crops (Table 3). According to Benjamin et al. [42], the most preferred strategy was mixed cropping with other food crops, which means farmers prefer growing crops in a mixture to reduce the risk of harvest failure in the event of drought or other unanticipated constraints. However, in the research area, a high number of farmers planted sweet potatoes as a monoculture, indicating that those farmers' perceptions of the crop's worth are improving. Insects were regarded as a major pest by the majority of farmers (58%) in this study, followed by disease (31%), while weeds were identified as a major limitation by 11% of farmers. Adane [43] observed viral incidences of up to 80% and 100% in samples taken from farmers' fields and germplasm collection locations, respectively. One or more viruses were found in those samples according to Benjamin et al. [42]. Similarly, Tesfaye et al. [44] recorded viral occurrences of 75% in farmer's fields and 100% in experimental stations in their study. In the same study, the authors recommended that cultural practice was the cheapest control strategy for resource-poor farmers. However, data obtained in this study showed that a number of farmers were unaware of sweet potato pests and diseases. This indicates that farmers must be educated about sweet potato diseases, pests, and other cultural practices. Degu et al. [45] suggested the necessity to increase farmers' ability to adopt and maintain innovative varieties and technology.

The unavailability of disease- and pest-free sweet potato planting materials and lack of resistant types appear to be the key pest and disease control difficulties. To boost sweet potato production, it is critical to find resistant varieties and promote the production of clean seeds. Sweet potato virus disease has also been identified as a key barrier to sweet potato production in Ethiopia as reported by Adane [43]. Some farmers suggested utilizing clean planting materials as a coping strategy to boost output. This indicates that farmers are open to adopting research innovations aimed at increasing sweet potato yields.

3.4. Production and Postharvest Management of Sweet Potato in the Study Site

3.4.1. Orange-Fleshed Sweet Potato Yields. The majority of respondents (48.1%) obtained on-farm yields of sweet potato ranging from 6.0 to 7.5 t·ha^{-1}, which is lower than the average yield of 10 t·ha^{-1} at the farmer level in Ethiopia (Table 4). According to Zhang et al. [4], the average yield of sweet potato in Ethiopia is about 8 t·ha^{-1} compared to 18 t ha^{-1} in Asian countries. This suggests that production constraints must be addressed in order to increase sweet potato yield in Ethiopia. In Ethiopia, sweet potato has a potential yield of 50 to 60 t·ha^{-1}, however, farmers obtain about 6 to 8 t·ha^{-1} [45]. A number of variables contribute to the yield gap, including a lack of high-yielding, virus-free planting materials, lack of effective insect pest management, and absence of the utilization of enhanced crop management alternatives. Data concerning postharvest management show that 69.5% of the respondents have an understanding of the importance of sweet potato storage (Table 4). After physiological maturity, most (89.8%) of smallholder farmers store OFSP roots by leaving them in the soil of the farm (in situ) to store and use them when the need arises, which exposes the roots to various diseases and pest attacks. According to Gurmu et al. [46], most of the respondents (98.4%) stored the storage roots in situ in the soil, harvesting them when they were needed for food. The major constraints that affect the storage of sweet potato roots in situ leaving them in the soil were described by the respondents as heat (31.6%), insect pests (mainly weevil) (25.6%), diseases (21.8%), and rodents (20.9%) [47]. A similar trend was reported in Uganda where farmers practiced harvesting sweet potatoes in a piecemeal manner by storing them in pits [48].

The respondent farmers believed that some rain was favorable for prolonging the lives of the storage roots in the soil, which was an unexpected observation [46]. As a result, postharvest limitations have remained a major constraint in Ethiopia for agricultural products in general and horticulture production. In the study site, 52.5% of respondents grow both white-fleshed sweet potatoes (WFSP) and orange-fleshed sweet potatoes (OFSP), whereas 29.4% grow WFSP and 18.1 grow OFSP types (Table 4). This preference could have arisen as a result of the cultivar's genetic dissimilarity. Similarly, Gurmu et al. [46] reported that 78.3%, 83.1%, and 67.7% of the respondents were familiar with OFSPs in Sidama, Wolayta, and Gamo Gofa, respectively. These authors indicated that, given a chance to choose and grow among the WFSP and OFSP, 54.7% responded to grow both WFSP and OFSP, while 27.6% indicated WFSP and 17.8% preferred OFSP only. Among the respondents who were aware of OFSPs, 77.7% disliked the varieties due to the inherent wateriness on cooking (low root dry matter content) and associated poor taste [46].

Table 4: Yield and postharvest management of orange-fleshed sweet potatoes.

Characteristics	Frequency	Percent
Yield (t·ha^{-1})		
<6	138	37.9
6–7.5	175	48.1
7.5–10	34	9.3
>10	17	4.7
Awareness on sweet potato storage		
Yes	253	69.5
No	111	30.5
Place of storage		
In the soil	11	3.0
In the bright room	10	2.7
Leaving in the field	327	89.8
In modified diffused light storage (DLS)	1	0.3
Not stored	15	4.1
Preference to grow		
WFSP	107	29.4
OFSP	66	18.1
Both	191	52.5

WFSP, white fleshed sweet potato; OFSP, orange fleshed sweet potato.

3.5. Major Causes and Constraints That Influence Production Management of Orange-Fleshed Sweet Potatoes. The farmers' ability to produce and consume OFSP in the assessment site was limited due to a variety of factors. According to the index ranking, drought, lack of planting material, diseases, and insect pests were the most significant (first to the fourth rank) constraints affecting the production of OFSP in the study site (Table 5). This result is consistent with those of Emana and Gebremedhin [49] who reported pests, drought, a scarcity of desirable seed varieties, and the cost of gasoline for driving water for irrigation and fertilizer restrictions, as the main horticulture production restraints in Ethiopia. Similar to this study, Negasi et al. [25] also reported the unavailability of storage facilities as a major problem affecting onion production. Gurmu et al. [46] reported heat and drought at 21.6%, shortage of planting materials (20.1%), shortage of land (15.7%), diseases (10.0%), insect pests (9.4%), a lack of draft power (oxen, donkeys, horses, and mules) (8.1%), shortage of money to cover input costs (7.9%), a lack of labor (5.1%), and weeds (2.0%) as the major sweet potato production constraints in Ethiopia. Abigail et al. [50] reported the shortage of labor as the most prominent limitation affecting sweet potato production in Nigeria. The authors attribute the inefficacies in labor to be due to the reliance on hoe and cutlass in Nigeria. However, a large number of able-bodied people in most parts of the country have abandoned farming in favor of a motorbike transport industry, which pays a somewhat consistent daily wage, causing a labor shortage. According to the farmers, the second major productivity constraint on sweet potato farms is the lack of access to updated technologies. For example, most farmers relied on basic equipment such as a cutlass and a hoe with a poor adoption rate of the improved vine for planting. Similar to this study, Abigail et al. [50] reported poor yield to be linked to the usage of rudimentary equipment and the sort of locally grown vines [50]. Okonya et al. [51] found insect infestations as the fourth ranked

Table 5: The area's major orange-fleshed sweet potato production constraints.

Constraint	Prioritization									
	1st	2nd	3rd	4th	5th	6th	7th	8th	Index	Rank
Shortage of planting materials	38	10	8	4	3	2	2	0	0.0149	2
Shortage of land	24	5	4	1	0	0	0	0	0.0294	5
Disease	30	10	3	2	2	1	1	0	0.0204	3
Drought	56	23	13	9	6	2	2	0	0.0090	1
Insect pest	14	10	6	3	2	1	1	1	0.0263	4
Storage problem	16	5	3	2	1	0	0	0	0.0370	6
Low market price	9	3	2	2	2	1	1	1	0.0476	7
Shortage of money to purchase inputs	7	4	3	1	1	1	0	0	0.0588	8
Total	194	70	42	24	17	8	7	2		

among the obstacles in the production process. The fifth major barrier in sweet potato production was the lack of finance. Most formal credit sources and certain informal credit sources made it difficult for farmers to meet the requirements for obtaining a loan [52]. Diseases are the sixth major barrier in sweet potato production and affect crop yield. Bad roads, poor output prices, lack of processing facilities, and expensive transportation costs were also noted as factors affecting production.

Results of the multiple linear regressions show that the independent variables utilized in the model clarify differences in OFSP production (Table 6). The coefficients were considerably different from zero, resulting in significant F-values (15.8) and R^2 principles of 15%, which demonstrate the model's goodness of fit. The predominance of market, storage, insect pest, and planting materials remained in the equation as significant variables. The market and storage factors positively significantly ($p = 0.001$) affected OFSP, whereas the insect pest and planting materials negatively significantly ($p = 0.001$) affected the OFSP yield (Table 6).

3.6. Major Consumption and Utilization Method of Orange-Fleshed Sweet Potatoes in the Area

3.6.1. Frequency of Eating OFSP. It was shown that the majority of the respondents (44.5%) commonly ate OFSP once in a week, while 32.7% and 15.7% of the respondents consumed it once a month and daily, respectively. Only 7.1% ate OFSP twice a day (Table 7).

According to Nungo [53], over 80% of the sweet potatoes produced in SSA is consumed fresh. When in season, it is a secondary staple in most other rural areas, eaten 2–4 times per week with breakfast frequently served with boiled or steamed roots. Sweet potato is not commonly used as a morning or snack dish in metropolitan diets. There is a common cultural perception in Africa that sweet potato is a "sweet" food that is best suited for women and children [54]. Adults prefer high-starch types of food while youngsters prefer softer, lower-starch roots, according to Low et al. [55].

3.7. Common Processing Method of OFSP Sweet Potato Products for Consumption in the Household. Most respondents (78.3%) consumed fresh OFSP after boiling or processed for other purposes, while 11.8% and 9.9% consumed roasted and steaming, respectively (Table 7). This result is consistent with those of Fawole [56] who reported boiling and roasted sweet potato processed forms are the most consumed products. However, alternative use methods such as manufacturing chips and combining sweet potato flour with wheat flour for goods like chapatti, Mandazi, or porridge have not yet been fully developed in African countries [57].

3.8. OFSP Product Familiar at Household Level. The most prevalent sweet potato products at the household level were from WFSP (65.1%) and OFSP (34.9%). The low percentage of OFSP varieties in comparison to WFSP types could be attributable to their low dry matter content (DMC). This is consistent with the findings of Gurmu et al. [13], who found that farmers and consumers dislike OFSP cultivars due to their low storage root DMC. WFSP cultivars have high storage roots which are preferred by farmers. Currently, OFSP types are frequently promoted due to their high-carotene (provitamin A) content, similar to the findings of Tofu et al. [16] and Gurmu et al. [13]. The root DMC of the OFSP cultivars is low, which has a direct impact on taste and influences its adoption. According to the results of several authors, varieties with high storage root DMC are preferred by most African households since this trait is correlated with a good taste [16, 17, 19, 58]. Therefore, the WFSP varieties are more accepted by farmers than the OFSP varieties due to their high DMC. However, the problem of low root DMC can be reduced through the crossing and development of OFSP varieties with high root DMC of WFSP varieties in Ethiopia [59, 60].

The majority of farmers (86%) said they were aware that OFSP is high in vitamin A. Meanwhile, 14% stated that they were not aware that OFSP is high in vitamin A.Awared respondants preferred sweet potatoes over vitamin-fortified foods since it was readily available, relatively inexpensive, and simple to prepare [61]. In the present study, farmers who knew about the nutritional value of OFSP were nearly three times more likely to use it than those who did not. This is consistent with a prior expectations and knowledge of OFSP's nutritional value which is anticipated to encourage its use, particularly for home use. This indicates that any program that includes effective instruction on the nutritional advantages of OFSP is more likely to be adopted.

Table 6: Multiple regression outcomes for causes affecting the yield of OFSP.

Independent characters	Regression coefficients	SE	t-value	p value
Market	0.319	0.082	3.902***	0.000
Storage	0.282	0.068	4.134***	0.000
Insect pest	-0.223	0.062	−3.609***	0.000
Planting materials	-0.161	0.051	−3.122**	0.002
Constant	1.128	0.297	3.803***	0.000
Number observation	364			
R^2	0.150			
F-value	15.803***			

**Significant at 99% level of significance.

Table 7: Method of consumption and utilization of orange-fleshed sweet potato in the area.

Variables	Frequency	Percentage
How often do you eat sweet potato		
Twice a day	26	7.1
Daily	57	15.7
Once a week	162	44.5
Once a month	119	32.7
Common processing method of OFSP sweet potato products for consumption in your household		
Boiling	285	78.3
Steaming	36	9.9
Roasting	43	11.8
Which products are you familiar with		
White-fleshed sweet potato	237	65.1
Orange-fleshed sweet potato	137	34.9
Are you aware that OFSP has a high vitamin A content		
No	51	14.0
Yes	313	86.0
You promoted the consumption of OFSP by your youngsters and pregnant ladies		
No	44	12.1
Yes	320	87.9

3.9. Sensitivity of Children or Pregnant Women to Consuming OFSP. About 87.9% of the respondents encouraged their youngsters and pregnant ladies to consume OFSP and only 12.1% were not encouraged. This is attributed to the non-awareness of vitamin A content of OFSP. Vitamin A deficiency is a severe health problem in Sub-Saharan Africa affecting young children aged from 0 to 6 years and pregnant women. Meanwhile, the orange-flesh variety is high in beta-carotene, which the body uses to make vitamin A. Vitamin A is a wonderful source of energy and key nutritive components, and it can help rural inhabitants improve their nutritious status [62].

4. Conclusion

The combinations of social, ecological, and economic factors influence the OFSP production in the Sidama region in the southern part of Ethiopia. In this region, factors such as diseases, lack of storage facilities, lack of planting materials, drought, insect pests, low market price, and lack of currency to achieve inputs existed as the main constraints affecting OFSP production and productivity. To increase OFSP production and consumption under resource-poor farmers, improved cultural practices are the most important ways in developing a cost-effective disease management strategy that should focus on planting bed types (sweet potato planting on ridges), use of recommended spacing for good plant population, and farmer collaboration. Furthermore, the extension system should prioritize the OFSP as an essential and specialized commodity in order to increase productivity and consumption. Academics and nongovernmental organizations (NGOs) need to research the diversity of farmers' expertise to increase crop yields through site-specific and recommended fertilizer practice packages and applicable terrestrial-use structures. To enhance soil productivity, collaboration with nearby stakeholders such as higher education institutions and research centers is required. Planting materials that are free from diseases should be made readily available to increase the production and consumption of orange-fleshed sweet potatoes. Finally, the food and nutrition security policy will gradually achieve its goal, when similar food security packages are promoted.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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