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Characterization of soil nutrient management and post-harvest handling practices for onion production in the central rift valley region of Ethiopia

Negasi Tekeste A.[1, *], Nigussie Dechassa R.[2], Kebede Woldetsadik[2], Lemma Dessalegne[3], Abuhay Takele[3]

[1]Aksum University, College of Agriculture, P O Box 314, Shire, Ethiopia
[2]Department of Plant Sciences, Haramaya University, P O Box 138, Dire-Dawa, Ethiopia
[3]Melkassa Agricultural Research Centre, P O Box 2500, Adama, Ethiopia

Email address:
negasite@gmail.com(N. Tekeste A.), nigussiedachassa@gmail.com(N. Dechassa R.), Tsadike@haramaya.edu.et(K. Woldetsadik), lemmades@yahoo.com(L. Dessalegn), kidumet94@gmail.com(A. Takele)

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Abstract: Onion is an important cash crop for smallholder farmers in the Central Rift Valley Region of Ethiopia. A survey was conducted during the off-season of 2011 to document nutrient management and post-harvest handling practices in onion production in four districts (Adama, Merti, Dugda Bora and Adamitulu-Jiddokombolcha) in the region. Data were collected from 128 farmers using a standard questionnaire and focus group discussions. The results revealed that all of the sampled smallholder onion growing farmers used Diammonium phosphate (DAP) and urea whilst only 10.9% and 5.5% used farmyard manure (FYM) and compost, respectively. The growers on average used 298.8 kg ha^{-1} Urea and 299.21 kg DAP ha^{-1}. Only small amounts of farmyard manure (1.71 t ha^{-1}) and compost (1.56 t ha^{-1}) were applied by the onion growers. The data also showed that farmers did not practise curing and storing of onion bulbs, and sold the produce on the field during harvest at farm-gate prices. In conclusion, the results of the study revealed that farmers in the region produce onions with application of higher rates of inorganic mineral NP fertilizers than the rates commonly recommended by the research system. The results also showed that the farmers did not subject harvested onion bulbs to any post-harvest management practices for enhancing shelf-life and marketability of the crop.

Keywords: Inorganic Fertilizers, Farmyard Manure, Organic Fertilizer, Soil Fertility Management

1. Introduction

Onion (*Allium cepa* L. var. cepa) is an important vegetable crop worldwide, and is ranked second among all vegetables in economic importance [1]. In Ethiopia, the crop is one of the most important vegetables produced by smallholder farmers mainly as a source of cash income and for flavouring the local stew 'wot' [2,3]. In Ethiopia, the crop is believed to be more intensively consumed than any other vegetable crop. A lion's share of 95% of the vegetables and fruits produced in the country comes from the smallholder sector [4].

The Ethiopian Central Rift Valley region is an area of great economic importance to the national food security and foreign exchange earnings of the country through production of export crops [4]. However, the region is highly affected by land degradation mainly due to the rapidly growing population and lack of proper soil fertility management practices [5]. The bulk of onion produced in the county comes from this region where cultivation is mainly carried out using irrigation [6, 7]. However, the average productivity of onion is low and, at present, the national average yield is as low as 10.75 t ha^{-1} [8] as compared to the world's average yield of 17.30 t ha^{-1} [9]. Many reports indicate that, in Ethiopia, and in the rift valley areas, the low productivity of vegetables including onions, among others, is attributed to low or depleting soil fertility, poor agronomic practices such as imbalanced fertilization and lack of proper postharvest handling [2,3]. Moreover, postharvest losses in the country account for about 10.7% and 30% for onions and other vegetables, respectively [10, 3]. In fact, horticultural crop producers in developing countries are mostly resource-poor smallholder farmers who lack resources, and they are rarely organized into formal cooperatives or associations to tackle production and postharvest related problems [11, 12].

Appropriate use of pre-harvest practices can reduce losses of horticultural crops and enhance farming sustainability [13]. Proper soil fertility management practices may alleviate the declining soil fertility and improve crop yield and quality [14]. In onion production, timing, rate, and type of fertilizer application have been reported to have effects on yield, quality, as well as postharvest shelf-life of the crop [15, 16]. The reports further indicated that with proper nutrient management, there is a possibility of extending onion shelf-life for a considerable period of time under ambient conditions. This may create lucrative marketing opportunities for farmers if they get the option of storing their produces when there is an oversupply of onion bulbs in the market and prices fall.

Profitable onion production requires appropriate soil fertility and post-harvest management as well as addressing other production constraints. However, little research has been done in Ethiopia to appraise soil nutrient management and postharvest handling practices in onion production. Results of such studies could be an impetus to design and formulate optimal fertilizer requirements for higher productivity and enhanced shelf-life of the crop. Therefore, there is a need to test the hypothesis that smallholder farmers in the Rift Valley Region of Ethiopia practise appropriate soil fertility and postharvest management in onion production.

It is, thus, vital to characterize nutrient and postharvest management practices of smallholder farmers producing onions in the region. Documenting the available information will enable stakeholders to be aware of the prevailing conditions and constraints of production for appropriate interventions to improve productivity and profitability of the crop. This paper presents the results of a study conducted to characterize soil nutrient and post-harvest handling practices in onion production in the Central Rift Valley Region of Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The study was undertaken in the Central Rift Valley Region of Ethiopia, which is located between longitude 38°00'-39°30' E and latitude 7°00'-8°30' N latitude and at altitude ranging between 1200 - 1640 metres above sea level. The area has an arid to semi-arid climate with mean maximum and minimum temperatures of 28.5 ^{0}C and 12.6 °C, respectively. The area is characterized by a bi-modal rainfall pattern ranging from 500-850 mm, with the long rainy season extending from June to September [5].

The soils of the rift valley region are largely volcanic in origin [17], with pH ranging from slightly acidic to very alkaline [18]. The major field crops grown in the region are teff, barley, maize, lentils, faba bean, chickpea, and field pea. However, vegetable production is the most intensively practised activity in the agricultural production system of the area due to proximity to lucrative local markets in the capital Addis Ababa and Adama town. This marketing opportunity and high demand for the crop motivates farmers to produce vegetables in three cycles within the same year, but a two-cycle production is the most common one. The most important vegetables grown under irrigation in the region include snap beans, tomato, onion, cabbage, and broccoli [19].

2.2. Sampling and Data Collection

The primary data collection covered four districts in the Central Rift Valley Region of Ethiopia in eastern Shewa and Arsi Zones of the Oromia Regional State. Three districts are from eastern Shewa (Adama, Dugda Bora, and Adamitulu-Jiddokombolcha) whereas one district, namely, Merti, is from Arsi zone of the Regional State.

A two-stage sampling was employed to select onion producing districts, peasant associations (PAs) and households targeted by the study. A peasant association is the smallest unit of administration in rural Ethiopia, comprising hundreds of farm households. The districts, each of which comprises a number of peasant associations, were purposefully selected based on onion production potential. Similarly, eight peasant associations (PAs) were purposively selected from the whole study districts using a probability proportionate to the size of onion producing PAs in the district. Selection of the PAs in the districts was based on availability of year-round irrigation water potential. Similarly, from a whole list, names of household heads in each peasant association were selected through a systematic random sampling technique based on a probability proportionate to the size of onion producing peasant association. Hence, two PAs from Dugda Bora district (24 households), three PAs from Adamitulu-Jiddokombolcha district (66 households), two PAs from Adama district (29 households) and one PA from Merti district (9 households) were selected. Thus, a total of 128 households were used for the primary data collection in the study area based on the degree of heterogeneity of the population, time and resource availability. Moreover, for the purpose of having the right output from the survey work, collection of qualitative information was managed through focus-group discussions. The focus-group discussions were comprised three groups, each having six participants per district. Finally, primary data were supplemented with secondary data to ensure adequacy and reliability of the information gathered.

Both structured and semi-structured questionnaires were used as an instrument for the data collection. The questionnaires were reviewed and pre-tested, which helped further adjustment to solicit for desired responses. Data were collected using a formal survey technique through conducting interviews with household members, primarily shouldering the responsibility for production and management of onion. The data collection was carried out in 2011. Agricultural development agents within the districts and professionals from Ethiopian Institute of Agricultural Research, namely, Melkassa Agricultural Research Centre participated in the administration and collection of the questionnaires.

2.3. Statistical Analysis

Descriptive statistics, namely, mean, frequency distribution, and percentages were employed to analyse the data. The chi-square and t-test were employed using SPSS software version 18. Preliminary analysis of the data showed that there is no significant difference between the four districts. Thus, most of the statistical analysis was based on combined values of each variable from the four districts. Index ranking was calculated based on the formula: Index = sum of (6x No. of respondents ranked 1st + 5 x No. of respondents ranked 2nd+ 4 x No. of respondents ranked 3rd+ 3 x No. of respondents ranked 4th+2 x No. of respondents ranked 5th + 1 x No. of respondents ranked 6th) for each constraint divided by sum of (6 x total No. of respondent ranked 1st+5x total No. of respondent ranked 2nd+4 x total No. of respondent ranked 3rd+3 x total No. of respondent ranked 4th+ 2x total No. of respondents ranked 5th + 1x total No. of respondents ranked 6th) for all constraints mentioned [20].

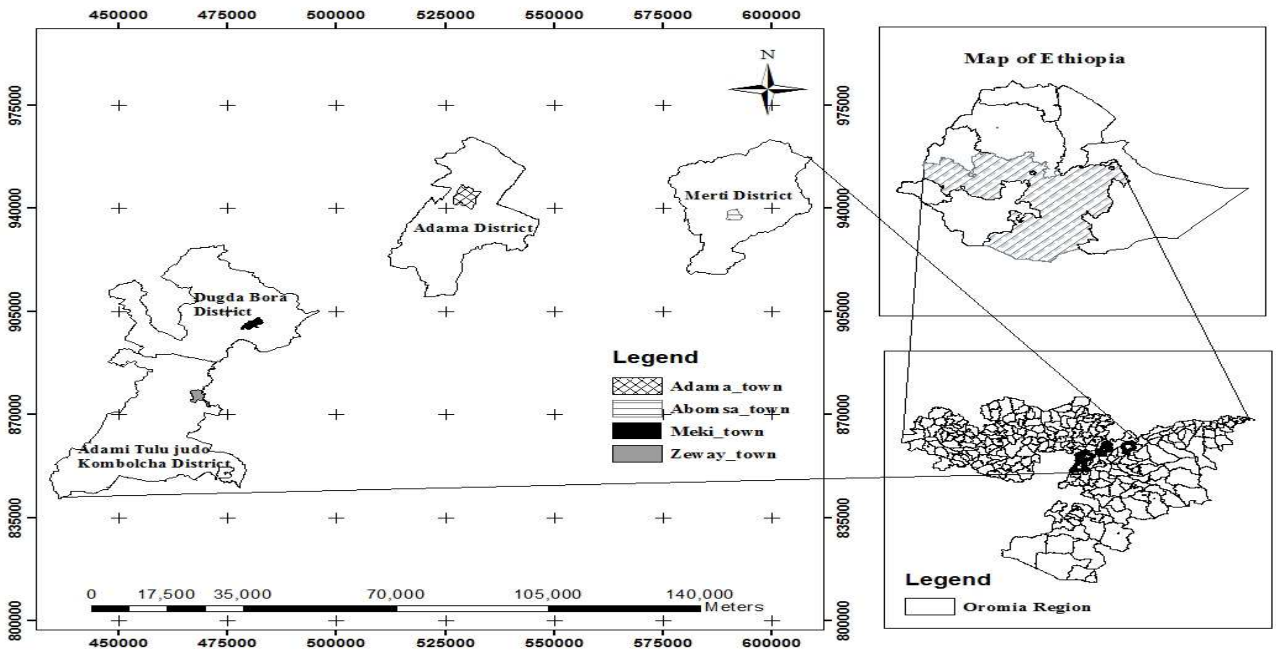

Figure. 1. Location Map of the study area

3. Results and Discussion

3.1. Demographic Characteristics and Fertilizer Management

Age group, sex, household size, and educational status of household heads are shown in Table 1. The majority of the household heads directly involved in onion production were male (89.1%). Similar findings on vegetable production were reported from previous studies in Ethiopia [21] and Cameroon [22]. This could be due to the labour demanding nature of the crop for different activities during production and the relatively limited freedom of women in Ethiopian culture to mobilize resources and participate in different farming activities in their villages as heads. It is, therefore, important to encourage involvement of women in vegetable farming with men to synergistically attain the goals of widespread efforts that are underway in the country to attain household and national food security.

The average age of the respondents was 36 years with most households (97.7%) in the age category of 15-64 years. The study result indicated that onion production in the study area is mainly carried out by the active age group of the society. This might be due to government's positive policy in creating job opportunities for the youth and labour demanding nature of the crop. This is in line with the findings of [22] and [23], who reported that most vegetable farmers were in the active age group.

Diverse households educational status was observed, with the majority (71.9%) being either illiterate or without any formal education. This result in is in contrast to the reports of [24] and [23], who, in peri-urban vegetable farms of Botswana, and Ghana, respectively, found that most vegetable farmers were literate. This lower literacy level of vegetable farmers in the study area, coupled with the poor extension services, in the region may have a negative impact on the overall soil fertility and postharvest management practices in onion production.

Table 1: *Demographic characteristics of the sample households*

Variable	N=128
Sex	
Male(%)	89.1
Female(%)	10.9
Age of household head	
Average	35.95
Minimum	18.00
Maximum	67.00
SD	11.54
Age category	
15-64 years (%)	97.7
>64 years	2.3
Educational level	
Illiterate (%)	21.1
Able to read and write (%)	50.8
6^{th}grade and less (%)	23.4
7^{th} -12^{th}grade (%)	3.9
Above 12^{th}grade (%)	0.8
Family size	
Average	5.88
SD	3.32

Note: SD = Standard deviation

3.2. Methods of Maintaining Soil Fertility in Onion Production

Methods used for management of soil fertility in onion production in the study area include application of inorganic fertilizers such as urea and DAP (Diammonium phosphate), farmyard manure, and compost as well as crop rotation. The study revealed that all households use inorganic fertilizers and crop rotation to maintain soil fertility (Table 2). Similar findings have been reported by [25] in central Ethiopia, where application of inorganic fertilizer, compost, and farmyard manure is commonly practised in soil fertility management. The authors further indicated that the percentage of onion growers using farmyard manure, compost, and residue together in the study area is as low as 20.3%. In contrast, the use of fallowing for soil fertility management was limited with only 4.8% (Table 2). Contrary to this report, however, [26] reported that about two-thirds of farmers in Ethiopia use fallowing for maize production. According to the interview of individual famers and focus group discussions, the limited use of fallowing was mainly due to small landholdings, which is directly related to high population growth that leads to land fragmentation and uninterrupted cultivation of the land that causes soil nutrient depletion and mining.

Table 2: *Methods used for maintaining soil fertility in onion production*

Ways of maintaining soil fertility	N	Per cent of household (%)
Chemical fertilizer[(Diammonium phosphate(DAP) & urea)]	128	100
Application of Farmyard manure(FYM)	14	10.9
Application of compost	7	5.5
Crop rotation	128	100
Fallowing	4	4.8
Residue management	5	3.9
Total number of sampled households	128	

Note: N = 83 for fallowing practice

3.2.1. Use of DAP and Urea

All sampled households used DAP and urea for onion production (Tables 2 and 3). The use of inorganic fertilizers by all sample households shows the importance of applying nutrients to production of the crop in the study area. In line with this finding, [27] reported that market-oriented vegetable production in Uganda cannot be realised without application of mineral fertilizers. In accord with the findings of this study, in the mid-altitude of western Ethiopia, more than 80% of the farmers use inorganic fertilizers for crop production [26, 25]. Accordingly, [28] indicated that DAP and urea were the sole nutrient sources used by farmers in Ethiopia as the soils of the country are severely deficient in plant-available nitrogen and phosphorus.

Households on average applied 298.8 kg ha^{-1} urea and 299.21 kg ha^{-1} DAP, respectively, in one growing season for vegetable production (Table 3). The amount ranged from 100-700 kg ha^{-1} urea and 50-600kg ha^{-1} DAP. In general, the findings of this study revealed that onion growers in the study area applied higher doses of DAP and urea than the blanket recommended amount in the region, which is 200 kg ha^{-1} DAP and 150 kg ha^{-1} urea. Besides, the analysis of variance showed a non-significant difference ($P \leq 0.05$) in the amount of urea and DAP used among the study districts. In line with the findings of this study, excessively high fertilizer application in vegetable production was reported by [29]. Similarly, application of fertilizers in amounts that exceeded crop requirements of five-fold was reported for the Beijing area in China [30]. Moreover, [31] reported application of higher rates of mineral fertilizers for vegetable production in eastern Ethiopia. The absence of significant differences in the amounts of DAP and urea used by farmers in the study districts might be attributed to the similarity of the onion-growing farmers in educational status and other socio-economic conditions.

The high consumption rate of mineral fertilizers in the region could possibly be due to favourable government policies in increasing access of farmers to agricultural inputs to increase productivity, farmers' expectations of benefiting from increased use of mineral fertilizers as well as the use of flood irrigation system which often leads to inefficient use of nutrients owing to loss through leaching and run-off of the applied fertilizers. Besides, during the focus group discussions, farmers noted that their farm lands are relatively poor in fertility and therefore need to be fertilised with ample amounts of fertilizers.

Table 3: *Reported amount of fertilizer applied in the study area*

Amount of urea(kg ha^{-1})							
District	N	%	Mean ± SD	Minimum	Maximum	F-test	p-value
Adama	29	22.6	282.75±125.5	100	600		
Adamitulu-Jiddokombolcha	66	51.6	320.9±124.5	150	700		
Dugda Bora	24	18.8	281.25±117.7	100	500		
Merti	9	7	233.3±70.7	200	400		
Total	128	100	298.8±131.8	100	700	1.671NS	0.177
	Amount of DAP(kg ha^{-1})						
Adama	29	22.6	282.75±145.9	100	600		
Adamitulu-Jiddokombolcha	66	51.6	294.69±121.5	100	600		
Dugda Bora	24	18.8	302.08±117.4	50	450		
Merti	9	7	377.77±100.3	150	450		
Total	128	100	299.21±126.1	50	600	1.373NS	0.254
	Amount of FYM and Compost						
FYM(t ha^{-1})	14	10.9	1.71±1.36				
Compost(t ha^{-1})	7	5.5	1.56±1.61				

Note: N=number of respondents, SD=Standard deviation, NS=Non significant

Table 4*: Method and timing of applying inorganic fertilizer*

Timing for urea application	**N**	**Per cent**
Top dressing (split)	114	89.1
Basal dressing (once before planting)	5	3.9
Basal dressing (once at planting)	9	7.0
Total	128	100
Timing for DAP application		
Basal dressing (once before planting)	4	3.1
Basal dressing (once at planting)	97	75.8
Top dressing (split application)	27	21.1
Total	128	100.
Method of application (DAP + Urea)		
Broadcast	4	3.1
Band	124	96.9
Other	0	0.0
Total	128	100

Note**:** N=Number of respondents

3.2.1.1. Timing and Methods of Applying DAP and Urea

Banding was the most common (96.9%) method of applying urea and DAP fertilizers whilst broadcasting was less commonly used (3.1%) (Table 4). Split application of urea was practised by most (89.1%) of the growers during planting and weeding. DAP was applied only once at planting by the majority (75.8%) of the households (Table 4). Band placement of fertilizer minimizes soil contact, reduces nutrient tie-up, and often results in increased fertilizer use efficiency [32]. Accordingly, [33] in Nigeria reported that band application of P fertilizer was found to be the most effective method in onion production.

3.2.2. Use and Management Practices for Farmyard Manure and Compost

In contrast to the use of the inorganic fertilizers, the use of farmyard manure and compost was very low, accounting only for 10.9% and 5.5%, respectively (Table 2). Moreover, the average amounts of the organic materials used were very small with 1.7 t ha^{-1} for farmyard manure and 1.56 t ha^{-1} for compost (Table 3).

Supporting to these findings, [34] indicated that the use of manure is extremely low for soil fertility maintenance in

Ethiopia. Participants in the focus group discussions alsoindicated that the bulky nature of organic manures for transport and application, limited availability of livestock manure and composting material, as well as poor knowledge and extension services were among the main causes for the use of small amounts of farmyard manure and compost in the area. In conformity, [26] reported a low supply and fewer users of organic fertilizer in Ethiopian lowlands. This was clearly observed in the findings of this study that all farmyard manure and compost users were the ones cultivating onions on their own landholdings rather than on rented land (Table 5). No land renters applied organic fertilizers. This is attributed to the fact application of manure is a long-term investment in soil fertility management for crop production and renters may have no guarantees whatsoever for the use of the rented land in the coming seasons. In line with this finding, insecure and crumbling tenure arrangements also contributed to declining soil fertility in Niger, where secure land, accounts for 90 percent of manured fields [35].

***Table 5:** Relationship between Farmyard manure (FYM) and compost use with type of land cultivated*

	FYM use								
	Yes		**No**		**Total**		**X^2**	**p-value**	**Cramer's V**
Type of land	N	%	N	%	N	%			
Own land	14	100	70	61.4	84	64.8			
rented	0	0	44	38.6	44	35.2			
Total	14	100	114	100	128	100	5.411**	0.020	0.206
	Compost use								
	Yes		No		Total				
Type of land	N	%	N	%	N	%			
Own land	7	100	77	62.8	84	64.8			
rented	0	0	44	37.2	44	35.2			
Total	7	100	121	100	128	100	4.015**	0.045	0.177

Note:** = significant at 0.01 significance level

All farmyard manure and compost users for onion production in the study area were found to be the ones owning their own land and cattle (Tables 5 and 6). A chi-square statistic ($\chi2$=5.411, p=0.020), revealed the presence of significant differences at 1% significance level in the use of farmyard manure between those cultivating their own land and those cultivating rented land. Similarly, significant differences ($\chi2$= 4.015, p=0.045) at 1% level of significance were obtained between those cultivating their own land and those cultivating rented land for onion production in the use of compost (Table 5). In Ethiopia, the pace of adopting application of organic manures and water harvesting technology was often determined by the feelings and attitudes farmers have on the ownership of the land they cultivate [36]. Similarly, [38] indicated that land tenure insecurity is one of the root causes for physical and biological soil degradation in Africa.

The average livestock holding per household was 2.82 Tropical Livestock Unit (TLU) (Table 6). The major livestock reared by households in the study area were cattle, sheep, goats, horses, donkeys, mules, and poultry. An independent sample t-test revealed a significant mean difference (t =11.13) at less than 1% significance level between livestock ownership and the use of farmyard manure, where farmyard manure users were found to possess more Tropical Livestock Unit (TLU) than non-users (Table 6). Moreover, the bivariate correlation (r = 0.701***) indicated the presence of a positive and strong relationship between livestock ownership and the use of farmyard manure (Table 6). In line with the findings of this study, many authors [38, 26] reported a strong association between livestock owners and the use of organic fertilizers in Ethiopia and semi-arid areas of Africa. Reports indicated that application of farmyard manure combined with inorganic fertilizers led to higher onion bulb yields and economic benefits in Ethiopia [39] and in vegetable production in Kenya [40], compared to the lone application of each fertiliser.

***Table 6:** Relationship between livestock holding in (Tropical livestock unit) and use of farmyard manure and compost*

TLU	**FYM use**	**N**	**Mean**	**SD**	**t-value**	**p-value**	**r**
	Yes	14	4.2	2.5			
	No	114	1.6	1.42			
	Total	128	2.82	2.21	11.127***	0.000	0.701***
	Compost use						
	Yes	7	3.2	2.8			
	No	121	2.46	2.22			
	Total	128	2.82	2.21	0.759Ns	0.449	-0.062

Note: SD=standard deviation; where N=Number of respondents

***Table 7:** Distribution of households with storage, timing and method of farmyard manure and compost application*

Variable	N	Per cent
Time(manure & compost)		
once (at time of land preparation)	14(7)	100
once at planting	0	0.0
other	0	0.0
total	14(7)	100
Method (manure and compost)		
broad casting	14(7)	100
other	0(0)	0.0
total	14(7)	100
Manure storage		
open field	13	93.0
protected	1	7.0
total	14	100
Compost storage		
compost pit	7	100
other	0	0.0
total	7	100

Note: Number in parenthesis= number of compost users; where, N= number of respondents

3.2.2.1 Storage, Timing, and Method of Application

Most households applied farmyard manure and compost once before planting (basal) at the time of land preparation using the broadcast method. Open field storage was the most common method of storing farmyard manures which accounted for 93% of the households applying farmyard manure (Table 7). In conformity with these findings, [41] reported that over 60% of farmers stored farmyard manure in the open, leading to significant losses in nutrients. This indicates the presence of a huge loss of nutrients from farmyard manures due to volatilization and leaching of nutrients, which may lead to poor quality organic material to be used as a fertilizer source. Similarly, [41] indicated a significant loss of nutrients especially nitrogen from organic manures stored in the open due to leaching during the rains or even denitrification when the sheds become soggy and anaerobic conditions prevail.

3.3. Onion Bulb Yield and Postharvest Handling Practices

The yield of onion in the study area is shown in Table 8.The average yield ranged from 10-35 t ha^{-1} within the districts having an overall average of 23.02 t ha^{-1}. This average productivity obtained in the current study is much higher than the national average productivity of 10.75 t ha^{-1}[8]. The increased productivity of onion might be due to the greater focus and encouragement given by Ethiopian government in vegetable production in particular and agricultural production in general, which may have contributed to the increased marketing and input supply. Availability of improved seed, nursery management, and other agronomic management practices may be some of the factors that are promoting increased productivity of the crop. However, more has to be done to further improve the yield of onion on farmers' fields since the productivity is still much lower than the productivity from research fields, which averages 30-35 t ha^{-1}[2]. Therefore, technical training and extension services on improved crop husbandry have to be further strengthened to enhance productivity.

***Table 8:** Reported bulb yield(t ha^{-1}), postharvest handling and marketing of onions in the study area*

District	N	%	Mean ± SD	Min	Max	F-test	p-value
Adama	29	22.7	22.3 ± 6.7	14	35		
Adamitulu-Jiddokombolcha	66	51.6	23.8 ± 4.8	14	31		
Dugda Bora	24	18.7	22.9 ± 5.8	10	32		
Merti	9	7	20 ± 3.9	16	26		
Total	128	100	23.02 ± 5.5			1.558NS	0.203
Store onions							
Yes	0	0.0					
No	128	100					
Total	128	100					
Apply post-harvest treatment							
Yes	0	0.0					
No	128	100					
Total	128	100					
Sell of produce (Marketing)							
Directly to wholesalers on farm through special dealers	121	94.5					
Directly to distributors on the market of nearby towns	2	1.6					
To nearby towns market and selling to consumers	5	3.9					
Total	128	100					

Note: N=number of respondents, SD=Standard deviation, Min=minimum, Max=Maximum, NS = non-significant

With respect to postharvest handling, all sampled households in the study area do not store and use any post-harvest treatment options to improve the marketability and postharvest shelf life of onions (Table 8). In line with this finding, [42] and [21] reported that farmers in Ethiopia and India do not cure/treat as well as store onions; hence, producers often sale their produces in the market immediately after harvesting to avoid postharvest losses and handling costs. This shows that farmers are not getting deserved prices and incomes as they are solely dependent on the prevailing market “pseudo-prices” at the time of harvest, which are mostly fixed by brokers.

3.4. Constraints in Soil Nutrient Management and Post-harvest Handling Practices for Onion Production

3.4.1. Constraints in the Use of DAP and Urea

Factors associated with the use of DAP and urea that constrain onion production were high cost, low accessibility, and poor knowledge on fertilizer management (Table 9). In Ethiopia, studies by [31] revealed that the practicability of using organic mineral fertilizers by smallholder farmers is constrained by high costs. Similarly, in India, high costs of inorganic fertilizers were identified as the major factors constraining onion production [43, 45]. Besides, absence of access to credit has been a great challenge in the use of the required amounts of inorganic fertilizers (Table 9). Corroborating this suggestion, previous reports revealed that fertilizer use in onion production in Ethiopia and India is

constrained by lack of access to credit facilities [44, 45].

The supply side of inorganic fertilizers to farmers has been encouraging but lack of accessibility was the major problem (Table 9). Several authors [26, 41, 24] indicated the limited accessibility of fertilizers in Africa greatly undermines vegetable production in particular and agricultural production in general.

Poor knowledge on the use of inorganic fertilizers especially on applying the right amounts at the appropriate time and lack of appropriate agricultural extension services were the other major problems pinpointed by farmers in the individual interviews and focus group discussions (Table 9). Several related findings have been reported in Ethiopia [26] and in different parts of Africa and Asia [42, 43, and 45] for onion and cereal crops production.

Table 9: *Constraints for the use of DAP and Urea*

	Ranking							
Constraints	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**Index**	**Rank**
High cost	57	22	23	3	0	0	0.20860	1
Availability	22	27	21	25	26	11	0.18445	5
Accessibility	16	29	25	33	37	14	0.19917	2
Absence of access to credit	20	25	18	30	34	16	0.18521	4
Poor knowledge & extension service	11	24	39	32	29	16	0.19313	3
Other(shortage of moisture & labour)	0	0	0	3	0	69	0.02942	6
Total	126	127	126	126	126	126		

3.4.2. Constraints in the Use of Farmyard Manure and Compost

Horticultural crops respond well to the use of organic manures [46]. Despite a mixed crop-livestock farming system in the study area, there is limited use of manures. Farmers in the area singled out that bulkiness to transport and apply the manures and limited availability of composting materials, coupled with absence of landownership (rented land for onion production) as the major bottlenecks hampering the use of organic manures (Tables 10 & 11). Labour shortage in preparing compost pits and related activities was raised as one of the major factor constraining the use of compost by farmers in the study area (Tables 10 & 11). Similarly, bulkiness and difficulty of transporting and limited availability of organic manure were reported to have constrained vegetable and crop production in Ghana and South Africa [23, 41].

Absence of effective extension services has been raised by individual farmers and focus group participants as another major factor hampering the use of or organic manures

in vegetable production the study area (Tables 10 & 11). As a result, substandard storage facilities and reckless handling of organic manures is the extra problems for the decline in the quality of manure. Consistent with the results of this study, it was reported that weak extension services on appropriate timing, placement, and dosing fertilizers by farmers severely affected vegetable production in Kenya and Ghana [47, 23].

Land ownership has been cited as a fourth ranking problem hindering the use of organic manure in onion production. Research findings suggest that farmers' decisions on adopting new technologies are dependent mainly on the fertility status of the land, access to irrigation, and profitability [48]. Similarly, insecure and crumbling land tenure arrangements were reported to have contributed to declining soil fertility in Niger, where secured land accounts for 90 per cent of the manured fields [35]. Similarly, [49] reported that, in Ghana, sharecroppers put enormous pressure on soil fertility to realise immediate high yields in order to pay land rents.

Table 10: *Constraints in the use of farmyard manure*

	Ranking							
Constraint	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**Index**	**Rank**
Bulkiness for transport	55	23	19	8	3	0	0.20816	1
Limited availability	26	29	22	33	15	0	0.19569	2
Poor knowledge & extension service	19	21	36	30	31	2	0.19531	3
Burns the crop and spread weeds	8	26	24	26	26	9	0.15602	5
Absence of own land/land ownership	16	29	25	24	19	22	0.17869	4
Other (messy & hard to handle, attract insects)	0	0	0	6	32	93	0.06611	6
Total	**124**	**128**	**126**	**127**	**126**	**126**		

Table 11: *Constraints for compost use*

	Ranking							
Constraints	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**Index**	**Rank**
Limited availability of composting materials	33	28	21	13	7	0	0.19974	1
Bulkiness for transport	23	18	20	15	14	17	0.16736	5
Poor knowledge & extension service	18	24	24	16	17	21	0.17956	3
Absence of own land/land ownership	23	23	18	17	16	6	0.17409	4
Shortage of labour	21	25	25	17	12	17	0.18629	2
Other (nutrient release, bad smell)	0	0	12	22	34	39	0.09293	6
Total	**118**	**118**	**120**	**100**	**100**	**100**		

3.4.3. Constraints in Post-harvest Handling Practices

Limited availability of storage facilities was the major factor that compelled producers to sell all their produce immediately after harvest, risking much lower prices than would be under normal market conditions (Table 12). In line with this finding, several researchers [50, 3, and 31] reported that absence of storage facilities were the major constraints to the production and marketing of horticultural crops in Ethiopia and India.

The households strongly raised that poor knowledge and extension on postharvest handling and storage as the major bottleneck for the profitability of onion production and marketing in the area (Table 12). Besides, in the focus group discussions, it was stressed that the lack of knowledge and extension services on pre-harvest management practices for enhanced post-harvest quality and storability hinders effective implementation of onion bulb storage. The farmers further suggested that training be given on pre-harvest management to improve productivity of onion in the region. A similar finding was reported for India by [43].

Lack of access to credit has a great impact on establishing storage structures and facilities as well as guaranteeing regular cash flows (Table 12). Results consistent with the findings of this study were reported for India by [12]. Moreover, poor storage potential of existing onion varieties was identified as a barrier to applying post-harvest handling practices by the individual interviews and focus group discussions (Table 12).

Table 12: *Constraints on the use of postharvest handling practices as prioritized by the sample households*

	Ranking							
Constraints	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**Index**	**Rank**
Unavailability of storage facilities	27	28	26	13	8	0	0.18043	2
Limited regular cash flow	29	30	23	17	7	3	0.18943	1
Poor knowledge and extension services	19	23	29	21	16	8	0.17534	3
Absence of good storing varieties	19	17	19	28	20	13	0.16125	5
Lack of access to credit service	32	22	19	15	5	4	0.17103	4
Other	1	7	11	26	44	62	0.12250	6
Total	127	127	127	120	100	90		

4. Conclusion and Recommendation

This study has revealed that onion producing smallholder farmers in the Rift Valley Region of Ethiopia apply higher amounts of inorganic N and P fertilizers than the amounts prescribed by the research system for producing the crop. However, the results also showed that the farmers apply low amounts of organic manures such as farmyard manure and compost to produce the crop. This may exacerbate deterioration of soil quality and make production of the crop unsustainable in the long term due to depleting of organic matter. In addition, farmers practice little post-harvest management and offer their produce for sale as soon as they harvest, risking lower prices. The major problems constraining proper soil nutrient management and postharvest handling practices in onion production in the study area include high cost of inorganic fertilizers with limited accessibility, bulkiness to transport and apply manures, limited availability of composting materials, poor knowledge and extension services, and absence of access to credit. Therefore, to enhance onion production and productivity in the area, it is vital to increase accessibility of smallholder farmers to inorganic fertilizers at affordable prices, and create awareness on integrated use of optimum rates of inorganic fertilizers and organic manures. Besides, introducing low-cost storage structures, making growers aware of the benefits accruing from post-harvest handling practices, and improving access to credit facilities through organizing growers in to formal onion producing cooperatives is recommended. Future research on the crop in the study area should focus on studies geared towards formulating appropriate rates of inorganic and organic fertilizers for optimum yield and quality of the crop. In addition, research will have to look into affordable post-harvest practices and storage methods that may prolong shelf-life of the crop to stabilize market prices and maximize incomes of farmers.

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