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Household Fertilizers Use and Soil Fertility Management Practices in Vegetable Crops Production: The Case of Central Rift Valley of Ethiopia

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Abstract

Large areas of farms are covered by variety of vegetable crops in the Central Rift Valley of Ethiopia. With a view to improve current vegetable production fertilizer use efficiency, survey has been conducted through collections of baseline information to describe household fertilizer uses and soil fertility management in vegetable production system using descriptive statistics. Multistage samplings were made to select representative growers in the six districts of East Showa zone. Based on field observations and group discussions, vegetable growers grouped their farm land into four local categories. The survey revealed that tomato growers apply variable rates of urea and DAP fertilizers for tomato cultivation. Survey results indicated that highest 43.61% of onion growers apply 200 kg of DAP fertilizer on their onion field, while 30.85% of growers apply 300 kg DAP per ha, another 39.35% apply, 400 kg and above DAP fertilizer, still 8.5% of onion growers apply 600 kg DAP fertilizer on their onion farm. This survey indicated that fertilizers were not wisely used in the vegetable crops production systems and the applications are in excess rate, which could leads to pollution of the environment from over dose application and from runoff in to the water bodies and leaching in to the ground water with economic loss. Most of the tomato and onion growers use three splits application of UREA and DAP mainly at transplanting, at first and second cultivation for both crops as top-dressing. The survey results indicated that 54.44% of onion growers apply an average of 230.35 kg ha^{-1} DAP at transplanting, while 46.53% apply an average of 188.29 kg ha^{-1} DAP at second split application, and finally 17.82% apply an average of 119.44 kg ha^{-1} DAP at last third split applications. This is the first document come across that vegetable growers in the CRV area apply DAP fertilizer as much as three splits. This indicates that there are no systems of updating of frontline development workers; poor extension services with shallow development workers knowledge made the growers totally depend on their own innovations for vegetable production.

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INTRODUCTION

Most agricultural lands in Ethiopia and in globe are suffering from major constraints to agricultural production. All vegetable and other crops are cultivated under moisture stress in the Central Rift Valley areas of the country during the main rainy season and using irrigations during following dry seasons (Edossa *et al.*, 2013a). The major constraints in the low precipitation areas include soil salinity, low CEC, high P precipitation property are few to mention (FAO, 2006). A total of 82 % of total agricultural land in Sub-Saharan Africa, and 76 % at global level are suffering from the above constraints (FAO, 2006). These area covers an estimation of more than 65% of Ethiopia and characterized by potential evapotranspiration is much higher the annual rainfall. Similarly, low agricultural productivity in these areas in particularly, the Central Rift Valley is reported by many investigators due to various reasons (Paulos *et al.*, 2002).

The dominant soils of the CRV area are calcareous soils that are rich in calcium carbonate due to nature of arid and semiarid areas (Edossa *et al.*, 2013b). They are characterized by the presence of calcium carbonate in the parent material and by a calcic horizon, a layer of secondary accumulation of carbonates (usually Ca or Mg), that contains excess concentrations of calcium carbonate (*Ibid*.). Soil pH can vary from 7 to 8.3 when only

$CaCO_3$ is present and from 8.5 to 10 when $NaCO_3$ is a major soil component (*Ibid*.). Similarly, large sodium content exist in the lower part of the Central Rift Valley where soil pH present from 8.5 to 10.0 (OWRDB, 2009). Although salinity and sodicity are common phenomena for arid and semiarid regions of the world, salt-affected soils have been recorded in all climatic regions and in a wide range of altitudes in the country (Tena, 2002; and Paulos *et al*., 2002; Heluf, 1985).

Vegetable growers in the CRV areas are trying to amend the soil fertility of irrigated lands through applying fertilizers, crop residues and animal wastes, and use crop rotations. They use variable rate of fertilizers for onion, tomato, cabbage and other vegetable crops productions. Based on the soil fertility survey made by Mengistu, (2008) some irrigation schemes in Adami Tulu and Jido Kombolicha districts use on average of 100-200 kg ha^{-1} DAP and 100 kg ha^{-1} Urea for irrigated vegetable crops production. Similarly based on the study conducted by Taha, (2007), in Dugdaa Boorraa District of East Showa, the average rate of fertilizer applied by sample households' onion grower during the 2005/06 year was 414.78 kg ha^{-1} where the majorities (60.6%) have applied 400 kg ha^{-1}; with the maximum amount of fertilizer used was 800 kg ha^{-1} while the minimum was 200 kg ha^{-1}. The early recommendation had contributed to blanket applications, for example, the 200 kg Urea + 200 kg of DAP ha^{-1} recommended for tomato and 200 kg Urea + 150 kg DAP ha^{-1} for onion in the CRV parts of Ethiopia (East Showa Zone Agricultural Development Office Annual Report for the Period 2003/2004 EC). On the other hand Edossa *et al.,* (2013b) proposed nearly 75 kg N ha^{-1} and 48 kg P ha^{-1} for verification for tomato production around Melkassa and similar soil types.

This probably indicates that research based recommended fertilizer application rate and schedule for each major vegetable crop does not exist in the area. Thus since soil fertility management in diverse vegetable crops is a dynamic over space and time, it is important to quantify what growers are currently applying and suggest approaches used to sustain soil fertility. Thus this diagnostic study was conducted with the objectives of to assess N and P fertilizer use and fertility management practices in vegetable fields and identifying factors associated with fertility related problems at household farm-levels in vegetable crops production.

MATERIALS AND METHODS

Description of the Study Area, Sample Size and Method of Sampling

The survey areas includes smallholder vegetable growers in the Awash River Basin; and from closed Rift Valley catchments were chosen as study area because they have long experiences and good potential for vegetable production using irrigation. The households living along Awash River and near the lakes have a long time experience in vegetable production. However there is similarity among sample districts in terms of climate, geology, vegetation, but there is difference on water sources, status of irrigation water use, more advanced towards Meki-Ziway area. Multi-stage purposive sampling procedure was employed to select PAs and sample respondents. At first stage, 6 districts (Boosat, Adaama, Lumee, Dugidaa, Boorra and A/T/G/Kombolichaa) were selected based on the availability of irrigation water sources' schemes. In the second stage, 2 vegetable growing PAs found in each district were selected; the growers from each PA were grouped in to 3-12 individuals for open dialogue with the questionnaires.

Data Sources, Methods of Collection and Analysis

The assessment of on-farm fertilizer use and soil fertility management practices in vegetable crop fields' deals with structured survey questionnaires related to fertility management practices in irrigated vegetable fields. The assessment include assessments of fertilizer and other nutrient sources management practices in vegetable production and need of extent of improvement in nutrient management practices.

In examining the existing soil fertility management practices in vegetable production in the study districts detailed and well-executed household survey was made through field observations, interviews with extension agents and farmers. Thus, this study employed group discussion, both primary and secondary data sources. Focus group discussions were a major tool to collect qualitative information and are also practical to discuss opinions, ideas, and constraints with the vegetable producers. These group discussions were held with farmers groups (one to two groups from each PA). Survey was conducted during mid of December 2011 since it is the main season of cultivation of irrigated vegetable crops production in the area. Key informant interviews were carried-out with the household vegetable growers and primary data were collected. The overall vegetable crops production, agronomic, irrigation and other field related data required for this study were collected. Growers were categorized in to high, medium and low incomes based on their views and interest. The data were analyzed using SPSS to derive descriptive statistics. These descriptive statistical tools were used to identify existing on-farm agronomic and irrigation management problems and analyze the current vegetable production situation.

RESULTS AND DISCUSSION

General understanding of the communities' vegetable crops production base and farming systems and understanding of differences within the community in terms of factors that may have implications for soil and plant nutrition were investigated. Results of assessments of on-farm fertilizer use and fertility management practices were included under the following topics and sub-topics.

Growers Farm Soil Categorization Scenario and Irrigable Land Fertility Status

Farmers through a long term farming experience have developed a local system soil classification with corresponding field management practices, thus growers grouped their farm land soils into about four local groups namely: *Gomboree, Boole, Koticha (Chafee) soil* and *Shakite* (sand dominated) soil types. *Chafee*- is wet land (farm covered by water during rainy season, but dry during dry season). Among samples interviewed, 41.83% across all incomes of growers replied that *Chafee/ Koticha* type is dominant soil type of their farmland, while 18.36% is assume their farmland to be *Shakitee* soil type. Additionally 13.26% of the growers described that their farm land soil type is *Gomboree* soil and finally 9.18% replied that their farmland is *Boole* soil type (Table 1).

Based on survey made by various researchers in different parts of Oromia, local soil and land types characterized by local farmers have similar physical properties such as water holding capacity, workability, fertility, etc…(Worku, 2006) and chemical properties such as soil quality characteristics (Tekelu, 2005) in different parts of Oromia and. Thus, the existence of different soil types in the area imply that fertilizer requirement and further field management study should be made for each category of soil fertility named by farmers. There should be crop type and soil type specific fertilizer application guidelines in the future.

Table 1: Farm soil category and naming by sample household vegetable grower

Farmers farm soil naming	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Gomboree type	2	10.52	4	8.88	7	20.58	13	13.26
Boole type	1	5.26	4	8.88	4	11.76	9	9.18
Shakitee type	4	21.05	9	20	5	14.70	18	18.36
Chafee/ Koticha type	12	63.15	17	37.77	12	35.29	41	41.83
Mixtures of all	0	0	5	11.11	0	0	5	5.10
1 and 4	0	0	4	8.88	6	17.64	10	10.20
2, 3 and 4	0	0	2	4.44	0	0	2	2.04
Total	**19**	**100**	**45**	**100**	**34**	**100**	**98**	**100**

All growers realized that the response of vegetable crops to fertilizers applications depends on how the soil responds to crop production and their practices over time. Thus, interms of fertility, the growers categorize their farm land based on the assumption of soil fertility status: *Chafee* soil type is assumed to be very productive, where as *Boolee* soil type with intermediate productive and *Gombore* soil type farm plot with very low productivity, finally *Shakitee* soil with very low water holding characteristics. Tekelu, (2005) found that farmers around Gimibichu, uses *Gombore* soil for forest/tree plantation and animal grazing indicating that *Gombore* soil have lower suitability for the crops production, while *Kooticha* soil type is preferred for crop production function. Farmers suggested that besides variations in soil type, within-farm soil fertility gradients affect response of vegetables to fertilizer application. All farmers complained *Gomboree* soil beside its marginality, it is a problematic soil. It is assumed to be not fertile and has very poor water holding capacity, fast crusting, and sealing and hard pan formation.

Farmers responded that *Chafee* land is the most fertile land with highest water holding capacity associated long irrigation frequency, this is probably due siltation of top soils with runoff in to water body during rainy season, due to much of cut, cleared and chopped water hyacinth along rivers and lake shores and dam after rainy season in the study areas, that would result accumulation of OM in to the soil. These would necessitates an estimation of corresponding DAP and Urea application rate for a given soil types and vegetable crops. Growers suggested that *Chaffee* soils are very responsive to nutrient applications; on the contrary *Gombore* had very low responsive to nutrient application. Additionally fertilizer management practices should consider different soil types like phosphorus under *Shakitee* soil conditions should be managed as a mobile nutrient and seasonal recommendation of P applications not to exceed crop uptake to prevent leaching losses (Hochmuth and Cordasco, 2008).

Vegetable growers generally categorize over all their irrigable soil fertility status in to one of the three subjective categories, among 51.48% replied that their farm land intermediate fertility status, while 35.64% have replied that their farm have fertile soil status (Table 2).

Table 2: Growers perceptions on whether household irrigable land fertility status.

Field fertility status	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Fertile (1)	9	47.36	18	38.29	9	25.71	36	35.64
Intermediate (2)	10	52.63	23	48.93	19	54.28	52	51.48
Not fertile (3)	0	0	5	10.63	4	11.42	9	8.91
1 and 2	0	0	1	2.12	1	2.85	2	1.98
2 and 3	0	0	0	0	1	2.85	1	0.99
1, 2 and 3	0	0	0	0	1	2.85	1	0.99
Total	**19**	**100**	**47**	**100**	**35**	**100**	**101**	**100**

These imply that vegetable growers probably apply variable rate of fertilizers that corresponds to the exact nutrient requirement of the crop and their soil types. It is crucial that soil test and vegetable crops response based fertilizer (Urea and DAP) recommendations should be developed in the Central Rift Valley of Ethiopia.

Household Vegetable Cultivation Practices after Transplanting

Most growers' in the study area exercises common cultivation practices for onion and tomato fields after transplanting each has its own objectives, such as ridging or bed preparation for tomato and onion, besides weeding and used to apply pesticides.

Household Urea and DAP Fertilizers Application in Vegetable Crops

As far as fertilizers use are concerned, vegetable growers in the study area are not only aware of the need for using different fertilizers DAP and Urea in all types of vegetable crops production but also all farm lands do not give reasonable yield without proper fertilizer amendments. Since farmers use common classification category of their farm land soil fertility status, they responded that the rates depends on soil types and the crop type they cultivate. The most common application rates (quantity) of available fertilizers DAP and UREA by growers for each vegetables crop is presented as follows:

UREA

Tomato: Results from the survey revealed that 32.46% of tomato growers in the study districts apply 200 kg Urea per ha for their tomato field, while 28.57% apply 400 kg Urea per ha, again among the growers, 37.65% apply 400 kg Urea per ha and above, and finally 9.08% apply 600 kg and above per ha for tomato cultivation (Table 3). While 200 kg ha Urea was recommended for tomato from Zonal Agricultural Office since long time.

Table 3: Frequency distribution of farmer's estimated Urea application rates (kg ha^{-1}) used by sample growers for tomato production in the 2010/2011 production year.

Rate kg per ha	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
None	3	15.78	5	15.15	4	15.38	12	15.58
100	2	10.52	4	12.12	4	15.38	10	12.98
200	6	31.57	8	24.24	11	42.30	25	32.46
300	1	5.26	1	3.03	0	0	2	2.59
400	4	21.05	14	42.42	4	15.38	22	**28.57**
600	3	15.78	1	3.03	2	7.69	6	7.79
800	0	0	0	0	1	3.84	1	1.29
Total	**19**	**100**	**33**	**100**	**26**	**100**	**77**	**100**

Onion: Of all sample growers, 36.17% apply around 300 kg Urea per ha for their onion field, followed by 32.97% who apply 400 kg per ha Urea. Generally, 48.92% of growers apply greater than 300 kg per ha urea, 45.73% apply 400 kg and above Urea per ha; while 13.82% apply 600 kg per ha (Table 4). The East Showa Zonal Agricultural Office recommendation is 150 kg of Urea for onion as split applications.

Table 4: Frequency distribution of farmers estimated Urea application rates (kg ha-1) used by sample growers for onion bulb production per crop cycle in the 2010/2011.

Rate kg per ha	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
None	1	5.55	3	6.97	3	9.09	7	7.44
50	0	0	3	6.97	2	6.06	5	5.31
100	0	0	1	2.32	0	0	1	1.06
200	7	38.88	13	30.23	14	42.42	34	**36.17**
300	0	0	1	2.32	2	6.06	3	3.19
400	7	38.88	13	30.23	11	33.33	31	**32.97**
600	3	16.66	8	18.60	1	3.03	12	12.76
800	0	0	1	2.23	0	0	1	1.06
Total	**18**	**100**	**43**	**100**	**33**	**100**	**94**	**100**

DAP

Phosphorus is used by plants to form nucleic acids and other vital chemicals. P promotes root formation, early growth and development (Brady and Weil, 2008; Jones, 2003). Dammonium phosphate (DAP) fertilizer has characteristics of phosphorus availability to plants when placed with seed (Jones, 2003). Besides because P is relatively immobile in the soil, Jones (2003) suggested that banding of P from 5 to 8 cm to the side and 3 to 5 cm below the seed is preferable to broadcast application. Thus it well known that vegetable growers in the study area know tomato and onion responds to P application:

Tomato: Survey results showed that tomato growers in the study area were applying on the average 286.65 kg rate of DAP per hectare, among sample growers, 33.76% apply 200 kg DAP per ha, while 29.87% growers apply 400 kg per ha, 33.76% apply 400 kg and above, 3.89% apply 600 kg and above DAP fertilizer (Table 5). These shows that when farmers cultivate their irrigable farm land twice in a year, they would have applied large quantity as much as twice of DAP in a year on same farm plot. Growers also assume that the rate should be increased season after season approximately around 30-40 kg, accordingly one could predict that the same farm plot would receive large quantity of artificial fertilizer doses per ha for next five years. Thus lack of proper fertilization input utilization is one the problems in irrigation water management reported by different scholars in the country (Mekuria, 2003).

Table 5: Amount of DAP fertilizer rate per ha applied by household tomato growers.

Rate kg per ha	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
None	3	15.78	5	15.62	4	15.38	12	15.84
100	1	5.26	4	12.5	2	7.69	7	0.09
200	6	31.57	8	25	12	46.15	26	33.76
300	2	10.52	4	12.5	0	0	6	7.79
400	6	31.57	10	31.25	7	26.92	23	29.87
600	1	5.26	1	3.12	0	0	2	2.59
800	0	0	0	0	1	3.84	1	1.29
Total	**19**	**100**	**32**	**100**	**26**	**100**	**77**	**100**

Onion: Survey results indicated that highest 43.61% of onion growers apply 200 kg of DAP fertilizer on their onion field, while 30.85% of growers apply 300 kg DAP per ha, another 39.35% apply, 400 kg and above DAP fertilizer, still 8.5% of onion growers apply 600 kg DAP fertilizer on their onion farm (Table 6).

Table 6: Household onion growers DAP fertilizer application rates per ha in the 2010/2011 production year.

Rate kg ha^{-1}	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
None	1	5.55	3	6.97	4	12.12	8	8.51
50	0	0.0	1	2.32	0	0.0	1	1.06
100	0	0.0	2	4.65	3	9.09	5	5.51
200	9	50	18	41.86	14	42.42	41	**43.61**
300	0	0.0	1	2.32	1	3.03	2	2.12
400	7	38.88	14	32.55	8	24.24	29	30.85
600	1	5.55	4	9.30	2	6.06	7	7.44
800	0	0.0	0	0.0	1	3.03	1	1.06
Total	**18**	**100**	**43**	**100**	**33**	**100**	**94**	**100**

Other vegetables such as cabbage, pepper (green), sweet and water melon, carrots, cauliflower, lettuce, egg plant, cucumber, pumpkin, squash, zucchini are less important vegetable crops in the area. References on these crops fertility requirement study conducted in the country were not obtained. Growers use variable rates of Urea and DAP as blanket applications for minor vegetable crops.

This survey indicated that fertilizers were not wisely used in the vegetable crops production systems in the study area and the applications are in excess rate, which could leads to pollution of the environment from over dose application and from runoff in to the water bodies and leaching in to the ground water with economic loss. Many scholars such as Hochmuth and Hanlon, (2010), indicated that application of unneeded nutrients contributes not only to farming inefficiency, but also, potentially, to groundwater pollution. Loss of nutrients is possible when nutrient levels in excess of what the crop can use are applied. These extra nutrients are subject to movement out of the root zone, off the field, and into ground or surface water bodies. This indicates that water bodies in vegetable farming areas should be frequently monitored in the country. Similarly application of P inorganic fertilizers might not give response under long term residual effects in the irrigated farm in these areas.

Although this part of the country is well-suited for vegetable production due to the ideal soil and climatic conditions for production of high yields of good quality of vegetables, farmers in the area apply varying blanket fertilizers rate, which in most cases is in excesses of the crop requirement rate. Thus, this would change both physical and chemical properties of the irrigated farm soil in a very short period of time due to residual effect. Excess fertilizers, besides increasing salt contamination of the soil and groundwater, reduce yield, lower crop quality and shorten storage time after harvest, resulting in short-term as well as long-term economic losses (Villora *et al.*, 2004). Hengsdijk and Jansen, (2006) indicated that farmers may overuse fertilizers in vegetables to compensate for these losses, as a consequences the presence of water hyacinths in shoreline of lakes is as an indicator of eutrophication which suggests nutrient enrichment of Lakes. Besides growers replied many problems associated with fertilizer inputs such as adulteration, rebaged sack and late delivery or absence of fertilizer to the household vegetable growers is very common. Similar analyses were reported by Belay, (2004) fertilizer input situations in Ethiopia. Additionally all growers complained that government yearly fertilizers import scheduling is made for June planting only; there are no fertilizers available for use in vegetable crops production after September so that they buy and use adulterated fertilizers from merchants. Getachew and Mohammed, (2012) also reported that in some places of CRV where irrigation common, the supply of fertilizer for irrigable areas seems overlooked that farmers are buying from traders that have high probability for adulteration.

Estimating available soil nitrogen and crop fertilizer requirement would be very important to improve N NUE of vegetable crops. Thus, fertilizer application based on N budgets that credits soil NO_3-N before planting; N mineralization from soil organic matter and other potential N sources improve nitrogen use efficiencies approach as a key mitigation alternative to reduce fertilizer cost, increase vegetable yield, and nitrate leaching in CRV region. Finally vegetable growers critically complained that national fertilizer input provision is scheduled for only for rainfed crops, while vegetable growers could not get and apply proper fertilizers out of *Kiremt* season, at the time of this survey period, if they get it was expired (not in a granular form) and not in an original bags and rebaged (adulterated) fertilizer bags.

Household Urea and DAP Fertilizers Application Scheduling (Timing)

Urea Fertilizer Application Scheduling

Vegetable crops need different quantities of plant nutrients at different growth stages (Jones, 2008). Giving a plant the right nutrient at the right time will not only increase the yield, it will also help improve quality and profit, and prevent damage from diseases and pests (Brady and Weill, 2008). Many scholars indicated that split application of nitrogen throughout the cropping period increase the N fertilizer use efficiency (Chandrasekaran *et al*., 2010).

Nitrogen in a DAP is utilized as initial N requirement, where as Urea would be applied two to three split applications for the latter growth and development. From this point of view, most of the tomato and onion growers use three splits application of UREA mainly at transplanting, at first and second cultivation for both crops as top-dressing. The investigation indicated that 27.72% of tomato growers apply an estimated average 130.35 kg Urea ha^{-1} at transplanting, while 59.50% apply an average of 155.41 kg Urea ha^{-1} at second split application, and finally 40.59% of tomato growers apply an average of 156.70 kg Urea ha^{-1} at third split application. Similarly onion growers in the study area 40.59% apply an average of 163.41 kg Urea ha^{-1} at first split transplanting, while 73.26% apply an estimated rate of 181.01 kg Urea ha^{-1} at second split application and finally 46.53% of onion growers apply an average rate of 159.68 kg Urea ha^{-1} at third split application. The blanket recommendation for onion is application of 75-100 kg ha^{-1} as first Urea application after 15 days after transplanting, and finally 75-100 kg ha^{-1} as second Urea application after 35 days after transplanting; Similarly the blanket recommendation for tomato in the study area is 200 kg DAP ha^{-1} at transplanting, followed by 75-100 kg ha^{-1} first Urea application after 20 days after transplanting and finally 75-100 kg ha^{-1} second Urea application after 45 days after transplanting (East Showa Zone Agricultural Development Office Annual Report For the Period 2003/2004 EC, Irrigation Department). It seems that three or more split applications of N fertilizer are essential for vegetable crops cultivated under heavy furrow irrigation that causes leaching. Strange *et al*., (2000), recommended that besides normal N application for elongated harvest season tomato, maintenance applications up to 11 kg of N per ha per week is necessary in California.

Green pepper, cabbage and water melon: Although there is similar blanket fertilizer recommendation for these crops green pepper and cabbage growers apply variable rate and timing of Urea and DAP. Finally household vegetable growers apply P to most vegetable crops each season (twice a year) irrespective of soil tests, thus there may be P has built up in many irrigated soils and short and long-term P residues must be investigated.

DAP Fertilizer Application Scheduling

Vegetable growers in the study area apply variable rate of DAP quantity not only at transplanting but also as much as three splits applications for both tomato and onion crops. The survey result indicated that 48.51% of tomato growers apply an estimated rate of 199.38 kg ha^{-1} DAP at transplanting, while 38.81% apply an average of 174.48 kg ha^{-1} DAP at the second split application, and still 10.89 % apply an average of 147.72 kg ha^{-1} DAP at third split application for tomato crop.

Similarly the survey results indicated that 54.44% of onion growers apply an average of 230.35 kg ha^{-1} DAP at transplanting, while 46.53% apply an average of 188.29 kg ha^{-1} DAP at second split application, and finally 17.82 % apply an average of 119.44 kg ha^{-1} DAP at last third split applications. This report is the first document come across that vegetable growers in the CRV area apply DAP fertilizer as much as three splits. These phosphorus fertilization practices were based on vegetable growers experience not augmented with empirical data from experiment station field tests.

The blanket recommendation for onion is application of 150 kg DAP ha^{-1} at transplanting and similarly the blanket recommendation for tomato in the study area is 200 kg DAP ha^{-1} at transplanting, followed by split application of Urea application after different days first and second cultivation after transplanting (East Showa Zone Agri. Dev. Offices Annual Report for the Period 2003/2004).

Overwhelming evidence indicates that for annual crops, timing of phosphorus fertilizers should largely be applied pre-plant (Sanchez, 2007). Hochmuth *et al*., (2009) stated that supplemental or side dress applications of P are usually not needed during the vegetable growing season when careful attention is given to the P fertilizer needs of the crop at planting (it is pre plant application); and rarely will P be needed in a nutrient solution being injected into a drip irrigation system. Thus these three split side dressing applications would lead to either excess accumulation of P or might increase P in the runoff (rainy season) and sedimentation of P in furrow irrigated field. These probably indicate that there might be high residual P in the irrigated vegetable field that needs less application of P for following years. Currently use of DAP split application for onion crop indicates that vegetable growers were not getting well scientific extension services from both research and agricultural development offices. This indicates that there are no systems of updating of frontline development workers. Poor extension services with shallow or unupdated frontline development workers knowledge made the growers totally depend on their own intuition in the whole vegetable production systems. Zonal experts have very old production manuals, district experts might not have and frontline development workers have nothing.

The survey results suggested that a balanced N, P and nutrient fertilization program is needed in vegetable crops nutrition to optimize yields and economic returns and reduce the potential for nitrate-N contamination of ground water. On the other hand this study suggested that the long term dynamics of heavy dose applications of inorganic nitrogen and phosphorous nutrients should be investigated thoroughly.

Trends of Household Fertilizer Application Rates in Vegetable Crops Production

All respondents suggested that use of fertilizer rate is in increasing trends in quantity per season per unit area. 92.2% of growers replied that they increase fertilizer rate every season at increasing rate (Table 7). Many growers worried that there is soil fertility decline due to removal of valuable organic matter from the ecosystem and other unknown reasons. They underlined that they don't apply same quantity of both Urea and DAP per unit area every season. Even if they either rent in or share in the plots; they collect information of previous Urea and DAP application rates made from land owner in conditions.

Table 7: Trend of increasing rates of fertilizers used per unit area as practiced by household vegetable growers.

Trends in fertilizer rate	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Increasing	17	89.47	42	91.30	33	97.05	92	92.92
Decreasing	0	0	1	2.17	0	0	1	1.01
Same	2	10.52	3	6.52	1	2.94	6	6.05
Total	**19**	**100**	**46**	**100**	**34**	**100**	**99**	**100**

These indicate that fields used for cultivating two crops per year, in five to ten years time, the amount of fertilizers damped into the farm land would be excessively high and would become toxic to the environments and water body in the CRV area. Although applying various rates of fertilizers for vegetable crops, soil types would improve crop yield, the additional amount per unit area for each crop and soil types should be based on exactly crop requirement.

Household Crop Residues and Animal Waste Management Practices

Use of household crop residues and animal waste management is an old vegetable field management practices not only supply plant nutrients but also improve soil physical and chemical conditions.

Use of crop residues: Use of crop residues is a common practice among some vegetable growers; however 70.40% replied that they do not use crop residues for their farm land fertility management practices, while 29.59% use crop residues as organic matter after harvest for soil fertility management (Table 8).

Crop residues management: Among the respondents, 29.59% across all income replied that they use crops residues for soil fertility maintenances on their vegetable farms. They responded that they incorporated the crop residues into the soil; while 70.4% of growers replied that they do not use crop residues at all. Among the crop residue users, some of them use for compost preparation (Table 9).

Severe land pressure had led to limited fallowing practices on densely populated areas where land is increasingly cropped on a continuous basis. All crop residues are used for both feeding animal stock and fuel energy. As a result there has not been any significant incorporation of organic matter to improve topsoil structure and nutrient status. There also substantial topsoil losses through wind and water erosion. Low levels of organic matter in the top soil has in turn led to reduced levels of plant nutrients, lower nutrient and water holding capacity, poor top soil structure (resulting in reduced resistance to erosion), poor rainfall infiltration and inadequate moisture retention characteristics.

Table 8: Use of crop residues in irrigated vegetable field among household growers.

Use of crop residues	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Yes	7	36.84	14	30.43	8	24.24	29	29.59
No	12	63.15	32	69.56	25	75.75	69	70.40
Total	**19**	**100**	**46**	**100**	**33**	**100**	**98**	**100**

Table 9: Household management practices of crop residues in irrigated field.

Crop residue management	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
None	6	75	12	41.37	9	47.36	27	48.21
Residues are left on the surface	0	0	7	24.13	2	10.52	9	16.07
Residues is incorporated into the soil	2	25	9	31.03	7	36.84	18	32.14
Residues are used for compost preparation	0	0	1	3.44	1	5.26	2	3.57
Total	**8**	**100**	**29**	**100**	**19**	**100**	**56**	**100**

On-farm animal waste management: Similarly 65.30% of the growers responded that they do not use on-farm animal waste and of other types of organic matter originating from animal sources, it is only 34.69% that do use any animal waste on their vegetable farms (Table 10).

Table 10: Use of animal waste as soil fertility management input in irrigated field.

Attribute	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Yes	6	31.57	18	40	10	29.41	34	34.69
No	13	68.42	27	60	24	70.58	64	65.30
Total	**19**	**100**	**45**	**100**	**34**	**100**	**98**	**100**

Among sample household vegetable growers, 61.53% do not use animal waste, while 23.07% of growers collect and incorporate animal waste into the soil, the remaining 11.53% use animal waste for compost preparation (Table 11). Some vegetable growers prepare compost from farm yard waste and other left over vegetative matters which are excellent source of nutrients. This would be one of components of integrated soil fertility management (ISFM) for CRV area.

Table 11: On-farm household animal waste management practices by household growers.

Animal waste management	High income		Medium income		Low income		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Not used	9	64.28	21	56.75	18	66.66	48	61.53
It is left on the surface (1)	1	7.14	0	0	0	0	1	1.28
It is collected and incorporated in to the soil (2)	3	21.42	9	24.32	6	22.22	18	23.07
Used for compost preparation (3)	1	7.14	5	13.51	3	11.11	9	11.53
1 and 2	0	0	1	2.70	0	0	1	1.28
2 and 3	0	0	1	2.70	0	0	1	1.28
Total	**14**	**100**	**37**	**100**	**27**	**100**	**78**	**100**

CONCLUSIONS

Diagnostic survey has been conducted through collections of baseline information to describe household fertilizer uses and soil fertility management in vegetable production system in the six districts of east Showa zone, the Central Rift Valley of Ethiopia. Based on field observations and group discussions, vegetable growers grouped their farm land into four local categories. *Gomboree, Boole, Koticha (Chafee) soil* and *Shakite* (sand dominated) soil types. *Chafee*- is wet land (farm covered by water during rainy season, but dry during dry season). The survey revealed that tomato growers apply variable rates of urea and DAP fertilizers for tomato cultivation. Survey results indicated that highest 43.61% of onion growers apply 200 kg of DAP fertilizer on their onion field, while 30.85% of growers apply 300 kg DAP per ha, another 39.35% apply, 400 kg and above DAP.

Vegetable growers manage their vegetable field soil fertility in a very traditional way; growers have lack of fertilizer application knowledge. They apply DAP fertilizer in two to three splits which not common applying DAP as splits for annual crops. Therefore it is essential to create the vegetable fertilizer task force at national and regional levels that review regularly nutrient management systems at household producer levels that would suggest further appropriate fertilizer recommendations for every season for each vegetable crop, each planting density and soil types in the CRV of the country. Research based seasonal fertilizer recommendation guideline, for applying and managing these fertilizers for major vegetable crops to result in acceptable crop production and to minimize negative environmental impacts should be developed. However the selected variables are not exhaustive, further detail and multidisciplinary approach should be regularly made to solve fertility management related problems in the area. Thus identification of the reasons behind existing gaps between known research recommendations and the situations in the farmer's fields due given attention.

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