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Farmers' Perceptions on Salinity Problems in Irrigated Fields in Kilosa District

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Abstract
Soil salinity contributes to one of the most serious ecological and environmental problems in most of the irrigation schemes in Tanzania. Understanding farmers' perceptions of soil salinity and its effects on crop productivity is important in promoting soil and water conservation practices. A study was conducted in Chanzuru and Ilonga villages in Kilosa District in 2016 to determine farmers' perceptions on soil salinity problems in the District. Therefore, a socio-economic survey was carried out on 60 respondents. Data were collected using the semi-structured questionnaires. The data were analyzed using SPSS descriptive statistics and chi-square test. The finding of the study showed that farmers perceived salinity more on the basis of location than they did on the basis of socio-demographics. The main causes of soil salinity as perceived by farmers were poor quality of irrigation water and poor drainage systems. Some socioeconomic and demographic characteristics that significantly influenced the farmers' perceptions were sex and household size. The perceptions of farmers in the study area varied significantly from village to village, with their socio-demographic determinants. Farmers adapted the strategy of crop diversification and increase in farm size as a response to the problem of salinity occurring in their fields. Farmer perception on salinity should therefore be used as entry point by stakeholders to develop intervention programs that help to solve the problems occurring in the farmers' fields.
Key words: Salinity, farmers' perception, problem confrontation index, crop diversification, irrigation water, scheme, sources of information, extension service

2.0 INTRODUCTION

Salinization of Soil is one of the serious environmental factors that limit crops productivity worldwide. Because of this adverse factor, most of the agricultural crop is now considered salt-sensitive due to the high concentration of salts in the soil (Munns and Tester, 2008). Salinity is a serious problem because, it affects about 800 million ha of arable lands worldwide and approximately 33 % of irrigated areas (about 74.25 million ha) are currently considered threatened by soil salinization by various degrees (Kumar and Shrivastava, 2015). It has been projected by (Jamil *et al.*, 2011) that by the year 2050, there will be more than 50 % of the farm land worldwide, which would become salt-affected.

Rice has shown to be the most sensitive cereal crop while barley the most tolerant cereal crop (Munns and Tester, 2008; and Karan *et al*., 2012). Salinity has serious effects on percentage of filled spikelets, grain weight, and can also hinder the uptake of essential nutrients in rice (Clermont-Dauphin *et al*., 2010).

Most irrigation schemes, which are especially within the arid and semiarid environments, are already experiencing increasing levels of salt-affected soil, solely due to the mismanagement of the soils, the use of poor quality irrigation water, poor drainage system, poorly designed and managed irrigation infrastructures, excessive use of irrigation water and climate change (Kashenge-Killenga, 2010).

Most irrigation water qualities have adverse effects on the physical properties of soil, because it is mostly connected with the buildup of sodium ion on the soil exchange complex. The quality of water can impact the volatility of the soil aggregates which eventually leads to the dispersion of the clay particles and the clogging of soil pores. When underground water is made to move to the soil surface by evapo-transpiration, the soluble salts condense on the soil particles on the surface and form a white crust (Plate 2.1). Irrigation practices affect the land by increasing the rates of leakage and groundwater recharge which results into the rise in water table. The water tables when it rises it brings salts into the plant root zone which affects both plant growth and soil structure; then the salt remains behind in the soil surface after the water has been taken up by plants or lost due to evaporation (Podmore, 2009).

Understanding the perception of farmers on the causes and effects of soil salinity makes room for policy makers to decide on the best measures that safe guide the farmers' production within a given location. Kruger (2006); and Wickham *et al.* (2006) reported that farmers' perceptions could be a good entry point for any intervention on the environmental conservation either by changing their perception through practical demonstrations or by building on what they already know.

Plate 2.1: **Saline soil in study area (Chanzuru, Kilosa)**

Farmers' perceptions on salinity are defined by their understanding of factors influencing salinity and the consequences for crop production, and the way they judge the severity of the soil salinity for the fulfillment of their farming objectives in the light of the possibilities and constraints of their farming system (Kielen, 1996). Farmers' perceptions result from their knowledge of salinity occurrences, their farming experiences and salinity constraints. On the basis of this perception, the farmer defines a strategy to cope with salinity (Kielen, 1996).

There is similarity between farmer's perceptions and response to a particular stress in the environment. The response depends in most cases on socio-demographic factors that enable the farmer to respond to particular stress. The number of response strategies depends on how immediate or severe the problem is perceived to be by the farmer (Meze-Hausken, 2000). In short, the perception of a farmer largely depends on the amount of information available to them and the extent to which they are able to correctly interpret the information they have acquired in order to develop the right response to a given situation (Nelson and Quick, 1997).

For instance, most farmers' who perceive salinity as a problem might employ local adaptation options in response to salinity symptoms such as, planting of tolerant varieties, crop diversification and water management. Furthermore, farmers' perception of stress condition and weather variability might influence their investment decision and the resulting crop yield and food insecurity (Mamba *et al.,* 2015). Therefore, the objectives of the study were:

i. To determine farmers' perception on salinity problems affecting rice production.
ii. To examine farmers perception on factors contributing to salinity.
iii. To assess strategies to cope with salinity problem in their areas.

2.1 Materials and Methods

2.1.1 Location of study

The study was conducted in Chanzuru and Ilonga villages, Kilosa District, Morogoro Region. (Fig. 2.1). The location was selected based on the reported potential of the area with respect to rice production and the presence of salt affected soils in the various irrigation schemes within the areas. Morogoro region contains six administrative districts namely Morogoro Urban, Morogoro Rural, Mvomero, Kilosa, Kilombero and Ulanga. The study was conducted in Kilosa District which is located about 300 km inland from the coast and Dar es Salaam (Benjaminsen *et al*., 2009). Kilosa District is 14 245 km^2 in size making up about 20 per cent of the region (KDC, 2010); and has a population of 438,175 people (TNBS, 2013). The area has a semi-humid climate with an average rainfall of 800 mm annually. The early rain starts in November and ends in January followed by heavy rainfall between March and May. The district experiences a long dry season from June to October and the average annual temperature is 24.6^oC.

The district lies between 6°S and 8°S, and 36°30'E and 38°E. It borders the Tanga Region to the north and

Morogoro District to the east. In the south, it is bordered by the Kilombero District and part of Iringa Region (KDC, 2000). Kilosa District comprises mostly flat lowland that covers the whole of the eastern part called Mkata Plains.

Rice is a major crop grown in Ilonga and Chanzuru irrigated schemes by farmers, but there were other crops also grown by farmers such as maize, beans, and vegetables, beans, sunflower and ground nuts in upland plots between March and May. The irrigation schemes in Ilonga and Chanzuru are located about 15 km from Kilosa Town, and share similar source of irrigation. The irrigation scheme in Ilonga is positioned in the upstream area of Chanzuru irrigation scheme, and it's in more favourable condition in terms of the availability of irrigation water and the access to good drainage system. Unlike the Chanzuru scheme, the Ilonga has better irrigation infrastructure where most of the canals are cemented and well maintained.

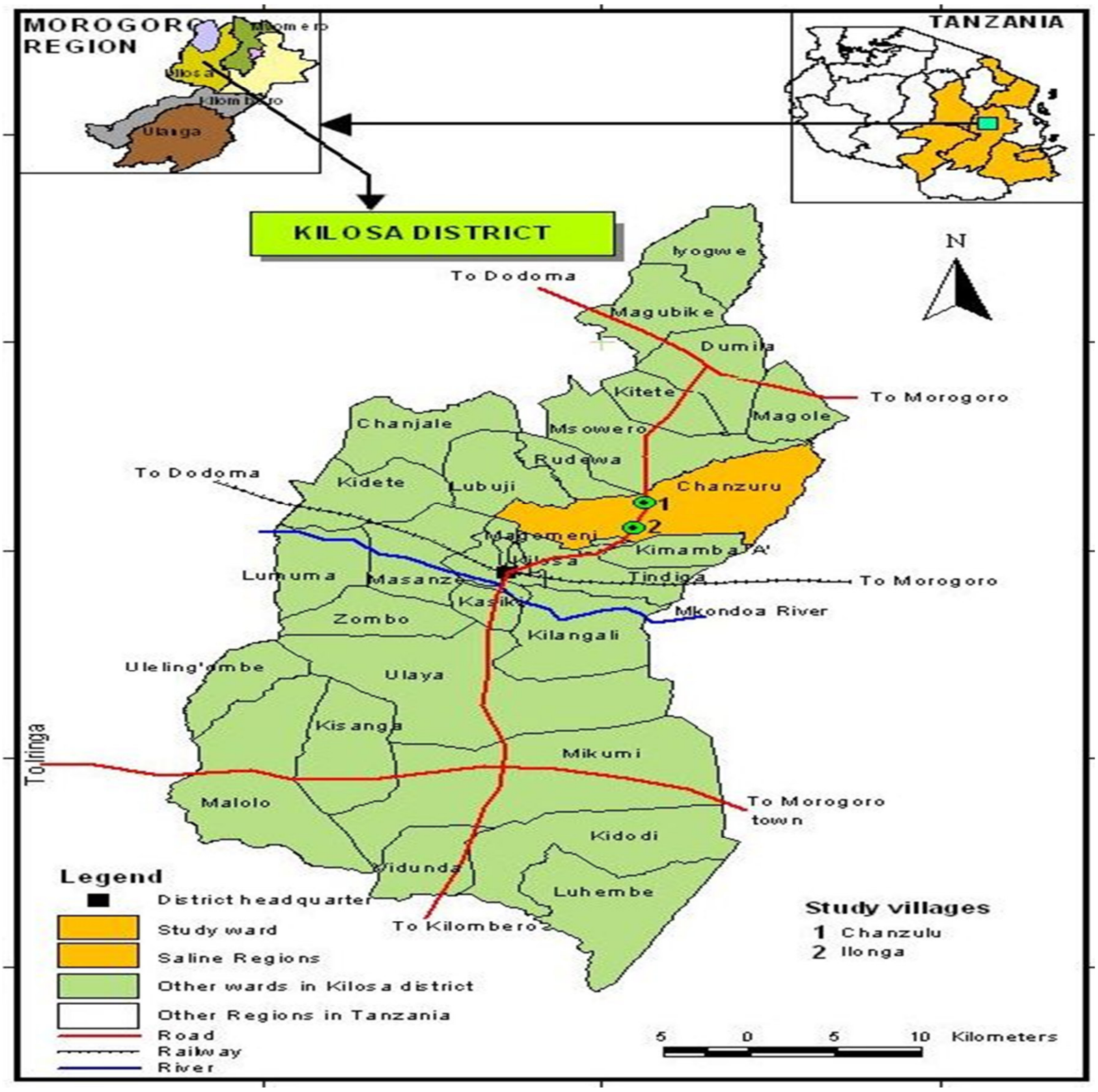

Figure 1: **Map of the study areas**

The two villages (Ilonga and Chanzuru) represent one of the major rice producing areas in Kilosa District. Farmers in these villages, produce rice mainly as irrigated crop and a small portion for lowland rain-fed rice production.

2.2.2 Research design

2.2.2.1 Sampling design

The target population was comprised of rice farmers in Ilonga and Chanzuru villages in Kilosa District, Morogoro Region. A list of rice farmers from each village was used as a sampling frame and a simple random sample of 30 farmers was selected from each village making a total sample of 60 farmers representing farmers of both villages. P3b4bh

2.2.3 Analytical method

2.2.3.1 Data collection

Semi-structured questionnaire was administered to 60 randomly selected smallholder rice farmers from the two sample villages. The enumerators were trained for two days prior to administering the questionnaire. The questionnaire was designed to reach a better understanding of farmers' knowledge on the effects and factors contributing to salinity as well as coping strategies for salinity conditions in the study areas. Data were collected on socio-demographic characteristics and variables relating to farmers' perceptions on soil salinity. Additionally, each respondent was asked to grade their perceived constraints based on a 0–3 point's scale (*i.e.*, ranging from "no problem" to "very serious problem").

2.2.3.2 Data processing and analysis

The perceived factors contributing to salinity constraints were rated and grouped into categories as "*no problem", "a problem", "a serious problem" and "a very serious problem*" as it relates to impacts on rice productivity in the study areas, and a ranking was conducted using the Problem Confrontation Index (PCI) as suggested by Ndamani and Watanabe (2015). The values of PCI were estimated using the following formula:

$$\mathbf{PCI} = P_{np} \times 0 + P_p \times 1 + P_{sp} \times 2 + P_{vsp} \times 3$$

PCI = Problem Confrontation Index
P_{np} = Number of respondents who said "no problem"
P_p = Number of respondents who said "a problem"
P_{sp} = Number of respondents who said "a serious problem"
P_{vsp} = Number of respondents who said "a very serious problem"

Farmers' perception on factors contributing to salinity was analyzed using descriptive statistics in SPSS version 20. The Chi square test was conducted to verify the significant level of association between farmer's perceptions and their determinants.

2.3 Results and Discussion

2.3.1 Farmer's Perceived effects of salinity on rice production in the study areas

Based on farmers' perception on the effects of salinity in the study areas, there were variations in the ranking of perceived problem by locations (Table 2.1 and 2.2). The PCI values obtained from farmers in Ilonga on the problem posed by salinity ranged from 43 to 47, indicating low perception of the problem. Farmers from Ilonga ranked "*salinity reduces yield*" as the most serious problem perceived by them and "*salinity reduces harvest*" was ranked as the least problem and problems such as "*salinity reduced harvest*, was ranked second.

In Chanzuru village, famers perceived salinity problem differently than farmers in Ilonga village as indicated by the higher PCI values for each problem. The PCI values obtained from Chanzuru village were quite higher than those from Ilonga village; they ranged from 61 to 68, which meant that these farmers perceived the problems as more serious than their colleague farmers in Ilonga. "*Salinity affects crop production*", "*salinity reduces rice yield"*, and "*salinity reduces harvest"* were ranked first second and thirds serious problems in the village.

A combined analysis of the problem differed in rank (Table 2.3). The PCI values for the problems ranged from 104 to 113 and the first serious common problem to both villages was that "*salinity affects crop production*" with a PCI value of 113. The least perceived problem was "*salinity reduces harvest*". Farmers in both villages perceived the severity of salinity problems in completely different ways; however, they all had some knowledge of each problem and its effects on their crops and yields.

Farmers' perceptions of salinity issues are critical in the development of solutions to soil management problems. The challenge is to listen and to learn from the knowledge of farmers, because the knowledge of farmers on soils problems offers a completely different set of scales with regard to land use, which has important implications for sustainable agriculture. This result is confirmed by (Nederlof and Dangbegnon, 2007; Kassa *et al.*, 2013).

Table 1: Farmers' perception of Salinity problems affecting rice farming in Ilonga village (n = 30)

Constraints	Very serious problem	Serious problem	Problem	No problem	PCI	Rank
Salinity reduces rice yield	7	10	6	7	47	1
Salinity affects crop production	6	9	9	6	45	2
Salinity reduces harvest	6	9	7	8	43	3

Table 2: Farmers' perceptions of Salinity problems affecting rice farming in Chanzuru village (n = 30)

Constraints	Very serious problem	Serious problem	Problem	No problem	PCI	Rank
Salinity affects crop production	9	20	1	0	68	1
Salinity reduces rice yield	8	17	5	0	63	2
Salinity reduces harvest	10	11	9	0	61	3

Table 3: Salinity problems affecting rice farmers in Chanzuru ward, Kilosa District (n = 60)

CONSTRAINTS	Very serious problem	Serious problem	Problem	No problem	PCI	Rank
Salinity affects crop production	15	19	17	9	113	1
Salinity reduces rice yield	14	26	12	8	110	2
Salinity reduces harvest	18	29	6	7	104	3

2.3.2 Farmers' Perceptions on factors contributing to salinity

Table 2.4 presents the perception of farmers on factor contributing to salinity by location. During the study, farmers identified four factors which they perceived were responsible for salinity problems in their fields/schemes. Those factors were poor quality irrigation water, inadequate rainfall, poor drainage system, and wrong use of fertilizer in the schemes; however, the perception of these factors varied from village to village. Descriptive statistics and chi square test was conducted to describe the perceptions of the farmers in each village and to verify the significant level of association between farmer's perceptions and locations (villages) respectively. The differences in farmers' perception per location for the various contributing factors to salinity were significant for poor drainage system (x^2= 8.149, p<00.05) and poor quality of irrigation water (X^2=10.36, p<.01). This indicates that there were signification association between the two villages in terms of the drainage infrastructure and the quality of water used for irrigation and factors contributing to salinity occurrence. Poor drainage system and poor quality irrigation water were highly associated with farmer's perception of factors contributing to salinity in the two villages. Farmers perceived these factors as being the ultimate factors responsible for the problem of salinity in their fields. The wrong use of fertilizer and the inadequate rainfall were not significantly associated with the problem of salinity as perceived by farmers in both villages (X^2=.42, p >0.05; and X^2=0.089, P= 0.76) respectively. More farmers in Chanzuru village considered poor quality water and inadequate rainfall as major factors contributing to soil salinity, than farmers in Ilonga village.

Farmer's perception can be influenced by socio-demographic characteristics (Ngigi, 2009). Furthermore, perception on salinity is shaped by individuals' background and nature and degree of engagement with the environment (Rahman, 2009). Therefore, these factors were also analysed to determine the level of association between socio-demographic characteristics and the farmer's perception on factors contributing to salinity (Tables 2.5). The study revealed that farmer's perceptions were more associated with location than socio-demographic characters, except for sex and household size. Gardebroek *et al.* (2010) reported that perceptions are context and location specific due to heterogeneity in factors that influence them such as, education, gender, age, resource endowments and institutional factors. The perception on poor quality irrigation water was significantly associated with sex of respondent and household size (X^2=11.25, p < 0.01 and X^2=4.05, p < 0.05) respectively. This implies that perception of few factors contributing to salinity was more influenced by the sex of respondent and the size of the household to which a farmer belonged.

Table 4: Perception of farmers on factor contributing to salinity by location

Actors contributing to salinity	Ilonga village Problem	Ilonga village No problem	Chanzuru village Problem	Chanzuru village No problem	X^2	P-value
Poor drainage system	8 (13.3%)	22 (36.7%)	19 (31.7)	11(18.3)	8.148	0.004
Inadequate rainfall	7 (11.7%)	23 (38.3%)	8 (13.3)	22 (36.7%)	0.089	0.76
Poor quality of irrigation water	12 (20%)	18 (30%)	24 (40%)	6 (10%)	10.36	0.001
Wrong use of fertilizer	5 (8.3%)	25 (41.6%)	6 (10%)	24 (40%)	0.42	0.52

Note: Frequency and percentage on bracket.

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Table 5: Perception of farmers on factors contributing to salinity using socio-demographic characteristics

Table 5a.

	Sex					
	Male		Female			
Perceived constraints	**Problem**	**No problem**	**Problem**	**No problem**	**X^2**	**P-value**
Poor drainage system	15 (25%)	25 (41.7%)	12 (20%)	8 (13.3%)	2.73	0.09
Inadequate rainfall	8 (13.3%)	32 (53.3%)	7 (11.7%)	13 (21.7%)	1.6	0.21
Poor quality of irrigation water	18 (30%)	22 (436.7%)	18 (30%)	2 (3.3%)	11.25	0.001
Wrong use of fertilizer	7 (11.7%)	33 (55%)	5 (8.3%)	15 (25%)	0.47	0.49

Table 5b.

	Marital status					
	Single		Married			
Perceived constraints	**Problem**	**No problem**	**Problem**	**No problem**	**X^2**	**P-value**
Poor drainage system	8 (13.3%)	9 (15%)	19 (31.7%)	24 (40%)	0.04	0.84
Inadequate rainfall	4 (6.7%)	13(21.7%)	11 (18.3)	32 (53.3%)	0.027	0.87
Poor quality of irrigation water	10 (16.7%)	7 (11.7%	26 (43.3%)	17 (28.3%)	0.014	0.907
Wrong use of fertilizer	2 (3.3%)	15 (25%)	10 (16.7%)	33 (55%)	1.003	0.314

Table 5c.

	Education					
	1-5 members		Above 5 members			
Perceived constraints	**Problem**	**No problem**	**Problem**	**No problem**	**X^2**	**P-value**
Poor drainage system	20 (33.3%)	23 (38.3%)	7 (11.7%)	10 (16.7%)	0.14	0.708
Inadequate rainfall	10 (16.7%)	33 (55%)	5 (8.3%)	12 (20%)	0.246	0.62
Poor quality of irrigation water	28 (46.7%)	15 (25%)	8 (13.3%)	9 (15%)	1.66	0.198
Wrong use of fertilizer	9 (15%)	34 (56.7%)	3 (5%)	14 (23.3%)	0.082	0.774

Note: Frequency and percentage on bracket.

Table 5d.

	Age					
	20 to 40 years		Above 40 years			
Problem		**No problem**	**Problem**	**No problem**	**X^2**	**P-value**
Poor drainage system	14 (23.3%)	23 (38.3%)	13 (21.7%)	10 (16.7%)	2	0.157
Inadequate rainfall	9 (15%)	28 (46.7%)	6 (10%)	17 (28.3%)	0.024	0.878
Poor quality of irrigation water	19 (31.7%)	18 (30%)	17 (28.3%)	6 (10%)	3	0.083
Wrong use of fertilizer	8 (10%)	27 (45%)	6 (610%)	19 (31.7%)	0.159	0.69

Table 5e..

	Household size					
	1-5 members		Above 5 members			
Perceived constraints	**Problem**	**No problem**	**Problem**	**No problem**	**X^2**	**P-value**
Poor drainage system	14 (23.3%)	19 (31.7%)	13 (21.7%)	14 (23.3%)	0.197	0.657
Inadequate rainfall	7(11.7%)	26 (43.3%)	8 (13.3%)	19 (31.7%)	0.561	0.454
Poor quality of irrigation water	16 (26.7%)	17 (28.3%)	20 (33.3%)	7 (11.7%)	4.05	0.044
Wrong use of fertilizer	7 (11.7%)	26 (43.3%)	5 (8.3%)	22 (36.7%)	0.067	0.795

Table 5f.	**Years of experience**					
	1-15 years		**Above 15 years**			
Perceived constraints	**Problem**	**No problem**	**Problem**	**No problem**	X^2	**P-value**
Poor drainage system	18 (30%)	23 (38.3%)	9 (15%)	10 (16.7%)	0.063	0.802
Inadequate rainfall	10 (16.7%)	31 (51.7%)	5 (8.3%)	14 (23.3%)	0.026	0.872
Poor quality of irrigation water	24 (40%)	17 (28.3%)	12 (20%)	7 (11.7%)	0.116	0.734
Wrong use of fertilizer	7 (11.7%)	34 (56.7%)	5 (8.3%)	14 (23.3%)	0.693	0.405

2.3.3 Farmer's coping strategies for sustainable livelihood

Tables 2.6 to 2.8 present farmer coping strategies in relation to perceived salinity problem in their fields. In Chanzuru ward, farmers cultivated other crops in addition to rice as alternative crops for food and income, but the amount of land area allotted to each crop also varied between the two villages. Farmers who perceived salinity as a serious problem allotted more land for each crop production. In Chanzuru, farmers cultivated rice on 1 to 7 acres of land with an average of 2.3 acres. In Ilonga, farmers allotted 1 to 4 acres of land for rice cultivation with an average of 1.61 acres. In terms of maize cultivation, farmers in Chanzuru allotted 0 to 3 acres for cultivation (average land area of 1.04 acres) while Ilonga farmers allotted 0 to 9 acres with an average area of 2.48 acres. The average area allotted for beans cultivation was slightly more for Chanzuru farmers than Ilonga farmers, but sunflower cultivation was allotted similar land areas for both villages.

In addition to the cultivation of other crops as a mean of alternative sources of food and income, most rice farmers also cultivated some selected salinity tolerant rice genotypes in areas perceived to have high salinity in their fields, so as to minimize yield reduction in those areas. Five percent of farmers in Ilonga cultivated Saro-5 (TXD-306) and 6.7% cultivated Kisegese as salinity tolerant rice genotypes. In Chanzuru, 18 % of farmers cultivated Saro-5(TXD-306) and 10% percent cultivated Kisegese as salinity tolerant rice genotypes. Crop diversification strategies have been incorporated in several development programs worldwide to improve household income in less-developed areas (Papadimitriou and Dent, 2001). Besides, crop diversification also helps for proper utilization of agricultural resources including land, water and other resources through providing farmers with viable options to grow different crops on their land (Fetien *et al*., 2009; Wondimagegn *et al*., 2011; Degye *et al.,* 2012; Rehima *et al*., 2013).

Table 6: Farmer's coping strategies (area cultivated under different crops)

	Chanzuru			
	Rice	Maize	Beans	Sunflower
Mean (acre)	2.32	1.04	2.3	2
Min(acre)	1	0	1	1
Max(acre)	7	3	3	3
Std. deviation	1.73	2.47	0.76	0.69
	Ilonga			
	Rice	Maize	Beans	Sunflower
Mean (acre)	1.61	2.48	2	1.9
Min (acre)	1	0	1	1
Max (acre)	4	9	3	3
Std. deviation	0.97	0.53	0.82	0.76

Area cultivated per crop (acres)

Table 7: Farmers coping strategies [Growing tolerant rice varieties (Ilonga)]

Tolerant variety	**Response**	**Frequency**	**percentage**
Saro-5 (TXP-306)	Yes	3	5%
	No	57	95%
Kisegese	Yes	4	6.7%
	No	56	93.3%

Table 8: Farmers coping strategies [Growing of tolerant rice varieties (Chanzuru)]

Tolerant variety	Response	Frequency	Percentage
Saro-5 (TXP-306)	Yes	11	18.3
	No	49	81.7
Kisegese	Yes	6	10.0
	No	54	90.0

2.3.4 Farmers' sources of information on salinity problems

The source and quality of information received by farmers influence their perception; Velandia *et al*. (2010) reported that the use of information sources are complementary to extension, but farmers prioritize some sources over and above others based on the importance these sources play in decision making processes.

The study found three sources of information on the causes of salinity (Figure 2.2) in the two villages. Farmers mentioned self-discovery as the main source of information on salinity problem. The second source of information was extension services followed by information from colleague farmers. Extension was expected to be best source of information, but it seemed like the extension was not doing much to educate the farmers on the existing problems, that's why they sought to share information among themselves (especially for farmers in Chanzuru). Extension services in the villages were ineffective, but the cause was not investigated during the study; the cause could probably be due to the shortage of extension officers in the areas. This is similar to the previous study which found that inadequate number of Agricultural Extension officers is a barrier to farmer accessing quality information. According to Isinika and Mdoe (2001) and Aina (2006) it has been noted that because of the low numbers of Agricultural Extension Workers, farmers hardly obtain new information on problem threatening theircrop production in the areas.

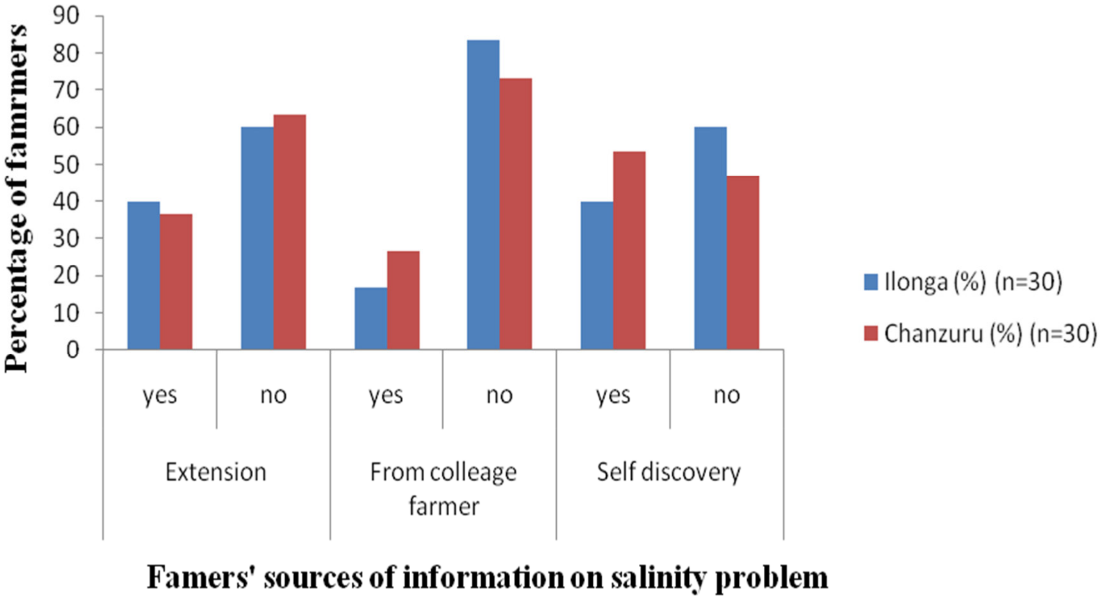

Figure 2.: **Farmers' sources of information on salinity in study areas in Kilosa district, 2016.**

2.4 Conclusion and Recommendation

2.4.1 Conclusion

i. The results indicated that farmers in the two villages clearly perceived soil salinity problem differently as well as the factors contributing to the salinity problem, and most farmers discovered the problems by themselves rather than form extension service providers.

ii. Farmers, in Chanzuru village perceived salinity problem more as a serious problem to crop production than farmers in Ilonga village.

iii. Poor quality irrigation water and poor drainage system were the main contributing factors to the occurrence of salinity, in the two villages.

iv. Salinity was a serious constraint to rice production in the study areas as indicated by the Problem Confrontation Index (PCI).

v. Farmers adapted crop diversification strategy which probably served as alternative sources of food and income.

2.4.2 Recommendations

i. Effective extension program for the dissemination of useful agricultural information and farmer education on problems in the field is required for better handling of the problem in the field.

ii. There is a need to link farmers with institutions specialized in intervention programs to help farmers manage the salinity problem in their fields.

iii. Farmers would need to cultivate more salinity tolerant rice genotypes for improved yields in these saline environments.

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