Journal of Environment and Earth Science www.iiste.org
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.8, No.3, 2018

Knowledge and Adaptive Responses of Rice Farmers to Saline-water Intrusion on Swamp Rice-growing Fields in Lower River Region of the Gambia

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Acknowledgment
The authors address their profound gratitude to the German Federal Ministry of Education and Research (BMBF) and West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) for providing the scholarship to the corresponding author (M.B) and their financial support in conducting this research.

Abstract
Saline-water intrusion is a growing problem for sustaining agricultural productivity along River Gambia as results of sea-level rise. On this concern, the study attempts to examine farmers' knowledge and adaptive responses to saline-water intrusion on the rice-growing areas of Lower River Region (LRR) of The Gambia. Five villages practicing swamp rice farming along River Gambia were randomly selected in each of four randomly selected districts across the Region. Data were collected via semi-structured interview questionnaire from 240 farmer household heads and through 20 focus group discussions. Descriptive statistics in SPSS Software Version 23 were, therefore, used to analyze the data obtained from the respondents. Results revealed that 96% of farmers are aware of saline-water intrusion in the region, while 77.5% believed that there is an increasing trend of salinity over the last five years, which impacts their yields. Most farmers (>85%) believed that saline-water intrusion reduced both their yields and incomes. In term of adaptive responses, the major on-farm strategies included changing the planting date (59.60%), increased use of fertilizers and seeds (56.30%), intensive manure application (55.20%), and use of early maturing varieties (35.50%). The major off-farm strategies employed included use of weather forecast (18.60%), change from crop production to animal rearing (7.70%) and to marketing of agricultural products (7.70%). Challenges faced by farmers in adapting to saline-water included among others poor access to adaptation information, low extension services and limited access to improved crop varieties. The study recommends to Government and stakeholders to establish mechanisms to strengthen and enhance the quality of saline-water intrusion adaptation and information dissemination in the study area using farmers' preferred sources of information. Also, stakeholders and Government have to provide saline-tolerant rice cultivars to farmers and intensify the construction of soil and water conservation structures (anti-salt dikes and spillways) as well as training on livelihood diversification activities for farmers in the area.
Keywords: Adaptive Response, Climate change, Knowledge, River Gambia, Saline-water intrusion

1. Introduction

In the developing countries, climate change is expected to have a significant impact on the livelihoods of the rural poor. It is also noted that sub-Saharan Africa (SSA) Region is the most vulnerable to many adverse impacts of climate change owing to the dependence on rain-fed agriculture for food security, economic growth, coupled with low adaptive capacity (Kotir, 2011). Increased extreme weather events and climate related hazards, including floods, droughts, cyclones, storm surges and saline-water intrusion are affecting communities, ecosystems and infrastructures in many countries of SSA. Saline-water intrusion, considered to be a slow-onset hazard do not normally occur in a single, distinct event but emerges gradually over time, often based on a confluence of different events (Adamo, 2011). Slow-onset events adversely affect agriculture by overall decrease in productivity and loss of space (land, water, forest, etc.) for agricultural activities, which can drive out people who rely on it (FAO, 2016). Researchers and policy makers in general pay less attention to the slow-onset hazards because they creep gradually and may not cause serious crisis in their early phases (Grasso & Singh, 2009; Seng & Birkmann, 2011). The impacts of climate change have been reported to be enormous; for instance, in Bangladesh, salinity had induced severe loss and damage to farming households in the coastal areas (Rabbani *et al.*, 2013). Therefore, there is a clear need to respond timely and appropriately to climate change related hazards in order to avoid damages to people's livelihoods in certain situations before they reach an acute phase (UNOCHA, 2011).

Concentrations of greenhouse gases have increased thus leading to warming of the atmosphere and oceans (IPCC, 2013). Under a global warming climate, the amounts of snow and land based ice have diminished resulting in the melting and outflow of Greenland and Antarctica ice sheets into the seas and ocean thermal expansion (IPCC, 2013; Imura, 2013; Rignot *et al*., 2011; Sørensen *et al*., 2011; Shepherd *et al*., 2012; IPCC, 2001). Global-mean sea-level rise is one of the most certain impacts of global warming and climate change which is projected to occur in many parts of the globe, especially in the coastal zones. Global mean sea-level has risen at a rate of 1.7 mm (1.2 to 2.2) per year over the 20th century, with 1.8 mm (1.3 to 2.3) per year over the period 1961 to 2003, and a rate of 3.2 mm (2.4 to 3.8) per year observed by satellite altimetry between 1993 to 2003 (IPCC, 2007; Horsburgh and Lowe, 2013).

Sea-level rise and coastal erosion present serious long-term challenges to Gambia's development (NAPA, 2007). The Gambia with approximately 50% of the total land area being less than 20 m above sea-level, and about 33% of the country below 10 m above mean sea-level is one of the most vulnerable countries in Africa to the adverse impacts of climate change. Dynamic Interactive Vulnerability Assessment (DIVA) model projections indicate significantly higher sea-level rise in The Gambia than the IPCC predictions of 0.13 m in 2025, 0.35 m in 2050, 0.72 m in 2075 and 1.23 m in 2100 (in comparison with 1995 levels) (Brown *et al.*, 2011). A 1 m rise in sea-level could potentially inundate over 8% of the country's land area which includes over 61% of current mangroves, 33% of swamps and over 20% of current lowland rice-growing areas (Malanding, 2010). The inundation could effectively drown over 50% of the capital city of Banjul (rendering it virtually uninhabitable) and the towns of Barra, Jangjabureh and Kuntaur, together with the Port of Banjul, all ferry terminals, and harbour landings along the River Gambia (Jallow *et al.*, 1996). Sea-level rise could result in the salinization of shallow coastal aquifers, the primary source of potable water for the urban Gambia. Moreover, it is evidenced saline-water intrusion into River Gambia (part of which is fresh) and coastal aquifers comes from projected sea-level rise (Ervine *et al*., 2007; Webb, 1992; NAPA, 2007; Sanneh *et al*., 2014). Hence, with projected climate change, the saline-water front is expected to move upstream the river, thus reducing land availability and suitability for agriculture which could compromise efforts of ending hunger and ensuring food security in the country.

Salinity is a major problem for rice production in The Gambia and it is affecting farmers especially, those who are on lowland areas by deteriorating soil fertility and structure (Drammeh, 2015). Rice is the staple food of the country and accounts for 25 - 35% of total cereal production of the country (Fatajo, 2010) with agriculture accounting for 20% of GDP (GBoS, 2013) and 75% of the country's labor force (NPC, 2015). Moreover, according to Webb (1992), climatic conditions had worsened to the extent where swamps rice fields in the lowest middle reaches of River Gambia, including Lower River Region of The Gambia were threatened by high salt concentrations and insufficient rinsing. Generally, saline-water intrusion makes the river water unfit for human consumption and affects adoption of irrigation practices (Abdullah, 2017; Al-tawash *et al*., 2013) especially for rice development. Analyses from 1943 to 1983 of climate parameters of the country depicted an increase of 1°C in the annual mean temperature and 20 to 25% reduction in the annual mean rainfall from 1943-2013 (AGRER, 2017). This will put more stress on River Gambia which is already undergoing saline-water intrusion in its lowest middle reaches (Webb, 1992). These studies while pointing out the growing salinization issue for the country's agricultural soil did not investigate adaptation strategies in place or that are needed. Local peoples living in such environment and whose livelihoods are, therefore, under threat had developed over years coping and adaptive strategies that appear to lack in the current literature. Moreover, to date, there is little empirical evidence on farmers' knowledge of saline-water intrusion. In a context of expected increasing climate variability and change and sea-level rise (SNC, 2012; NAPA, 2007; Jallow *et al.,* 1996) which may exacerbate saline-water intrusion on swamp rice growing-fields of the country, there is an important need to understand farmers' knowledge and responses to saline-water intrusion in order to avoid economy loss to the rural people, and hence ensure food security goals. This study is an attempt to reveal current adaptive strategies at farmers' level conducted to assess farmers' knowledge and adaptive response strategies to saline-water intrusion on rice growing areas of Lower River Region (LRR) of The Gambia so as to contribute to building rice farming communities' resilience to climate change impacts.

2. Methods and Materials

2.1 Description of Study Area

The study was carried out in four randomly selected districts in the LRR of The Gambia (Figure 1). The region is located in the southern bank of River Gambia and stretches about ninety-five kilometers (95 km) from Brumen Bridge in the west to Sofanyama Bridge in the east (Government of The Gambia, 2007). The overall population occupying the region is approximately 81,042 inhabitants (GBoS, 2013). Over 80% of the population depends on agriculture and natural resources as their livelihood and household income (Government of The Gambia, 2007) with rice being the major crop cultivated in the region (MOA, 2013). But also owing to the terribly low water flows of the River Gambia, rice hectarage in production in the lowest reaches of the middle zone, including LRR had dropped (Webb, 1992).

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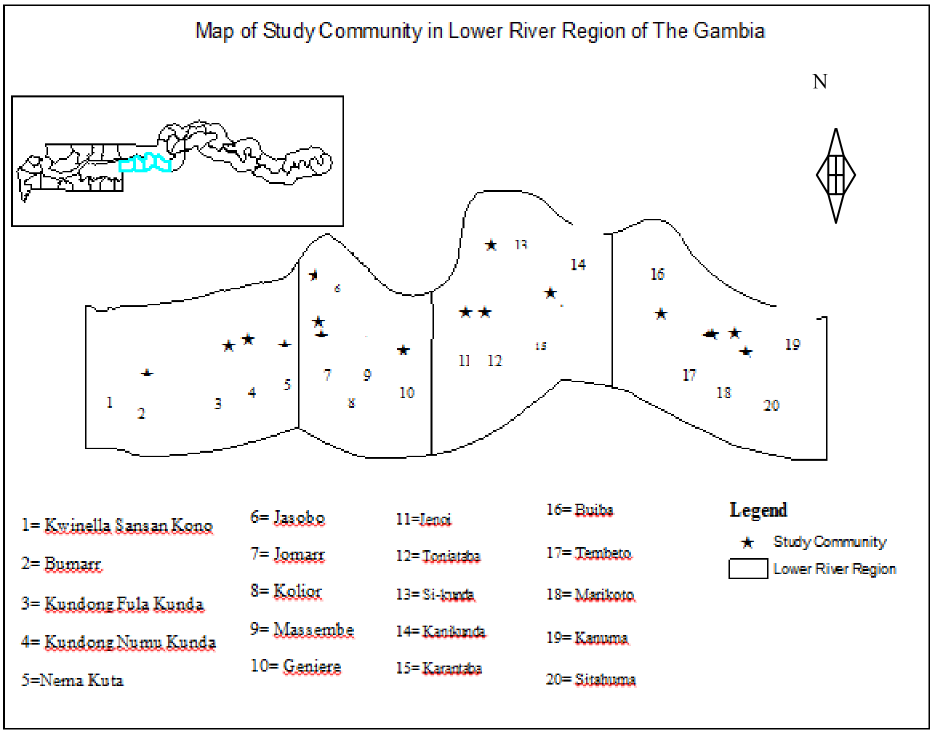

Figure 1. Map of Study Area

2.2 Sampling and Sample Size

A multi-stage sampling technique was employed to select respondents for the study. The first stage was the selection of one region in the country. The Gambia has six Agricultural Regions, but the Lower River Region was purposively selected because rice is the major crop of the region (MOA, 2013), therefore the predominant agricultural activity for thousands of poor rural households whose livelihoods depend on it. Moreover, saline-water has negatively affected rice production of the region which constitutes the major source of subsistence for its peoples. Simple random sampling technique was then used to select four districts from the six districts in the region. Therefore, two districts were selected in each area. Kiang Central and Kiang East, and Jarra West and Jarra Central were randomly selected and five villages from each district for the data collection. Villages selected were identified earlier as having swamp ecology. In the last stage, simple random sampling was used to select households from each village. Swamp rice cultivation is primarily done by women in The Gambia (Carney, 1998), a female adult of each selected household was interviewed but in the absence of the female, any of her daughters (more than 18 years) was considered for the interview. Krejcie & Morgan (1970) sample size formula was used (Equation 1) in computing the sample size for the study. Hence 240 rice farmers were interviewed for the entire study.

$S = X^2NP\ (1-P)\ /d^2\ (N-1) + X^2P\ (1-p)$…………………………..Equation 1

Where:

S = required sample size

X^2= the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841) that is 1.96 *1.96 = 3.841

N = the population size.

P = the population proportion (assumed to be 0.50 since this would provide the maximum Sample size)

d= the degree of accuracy expressed as a proportion (0.05)

To obtain the number of respondents from each village, the total number of rice farmers' households in each village (obtained during the listing) was divided by the total number of rice farmers' households for the study area (638) and the value multiplied by 240. Table 1 indicates the sample size for each selected village for the study.

Table 1. Sample for the study

Region	Districts	Villages	Total households	Sampled households	Percentage (%)
Lower River Region	Kiang Central	Kwinella Sansan Kono	31	12	5
		Kundong-Numukunda	38	14	6
		Bumarr	22	8	3.5
		Kundong-Fullakunda	47	18	7
		Nema Kuta	39	15	6
	Kiang East	Jasobo	43	16	7
		Massembe	34	13	5
		Geniere	42	16	7
		Jomarr	32	12	5
		Kolior	50	19	8
	Jarra West	Toniataba	30	11	5
		Kanikunda	31	12	5
		Jenoi	30	11	5
		Si-kunda	32	12	5
		Karantaba	32	12	5
	Jarra Central	Marikoto	15	5	2
		Sitahuma	29	11	5
		Kanuma	14	5	2
		Tembeto	26	10	4
		Buiba	21	8	3.5
Total	**4 districts**	**20 villages**	**638**	**240**	**100**

2.3. Data Collection and Analysis

Data were collected using a combination of quantitative and qualitative datasets for a detailed picture of the past and present situations. Quantitative data were collected using semi-structured questionnaires. Face to face interviews were used by the Research Team during the questionnaire administration. Therefore, questionnaires were filled by the interviewers from the answers provided by the selected respondents. Demography and socio-economic characteristics, knowledge on saline-water intrusion, adaptive responses and problems encountered during adaptation were sought out during farmers' individual interview. In addition, a total of twenty (20) Focus Group Discussions (FGDs) were conducted for the entire study, one in each selected village. The focus group discussions were conducted with a group of nine to twelve farmers. Quantitative data collected through individual interviews were analyzed in IBM SPSS Statistics Software Version 23. FGDs helped to triangulate and cross-check the information provided by farmers during individual interviews. Descriptive statistics such as frequencies, means, modes, standard deviations, maximum, minimum values were used to characterize farmers' demographic and socioeconomic data. Afterward, data on farmers' knowledge, the sources of saline-water information and adaptive responses as well as problems encountered in adapting to saline-water intrusion, were analyzed.

3. Results and Discussion

3.1. Demographic Characteristics of Farmer Household Head

Results show that rice farming in the swampy ecology in The Gambia is primarily dominated by women (Table 2). This is the reason why from the research conducted, 100% of the respondents were women. This corroborates with previous studies in the country where women are predominantly responsible for rain-fed and tidal swamp rice cultivation (NRDS, 2014; Carney, 1998). Such perpetuating mentality of the colonially imposed gender division of labor still confines men into cash crop production at the uplands and thereby rendering little or no maintenance assistance to the women at the lowlands (Maddox, 1996). This bias in the gender in the study area largely affects the production of rice as well as the number of hectarages that can be put into production, and therefore decrease rice production. On the other hand, it confirms Gaard's findings which revealed that women produce most of the world's food (Gaard, 2015).

Table 2. Socio Demographic Profile of the Respondents (N=240)

Variable	Frequency	Per cent
Gender of Household head		
Female	30	12.5
Male	210	87.5
Marital Status		
Single	2	0.8
Married	209	87.1
Divorced	2	0.8
Widowed	27	11.3
Age		
Less than 30 years	35	14.6
30 - 39 years	59	24.6
40 - 49 years	72	30
50 - 59 years	37	15.4
60 and above	37	15.4
Educational level		
Primary school	33	13.8
Secondary school	13	5.4
BSc.	1	0.4
Arabic	89	37.1
None	104	43.3
Household size		
1-5	34	14.2
6-10	118	49.2
11-15	49	20.4
16-20	24	10.0
21 and above	15	6.3

Table 2 revealed that (87.1%) of the respondents (swamp rice farmers) were married whilst (11.3%) were widowed and the same percentage of respondents (0.8%) was single and divorced respectively. This can be explained by the land ownership structure of swamp rice-growing fields in the area which allows primarily married women to own a farm. Furthermore, a positive implication of it could be more support in their farming activities from the spouse in terms of labor and help to acquire agricultural implements (materials and inputs). It also appeared in the findings that only few (12.5%) of the household heads are female meanwhile the majority (87.5%) are male.

In addition, results from the research indicated that the youngest and oldest ages of rice farmers were 22 and 80 years respectively with a mean age of 44 years. The majority of the population (54.6%) represents the active working group; aged between 30-49 years. Rice farming generally requires people who are physically apt to conduct farming operations on the field. Farming systems prevailing in The Gambia are in general manual and consequently, labor intensive. This is why very old and very young people are not predominantly involved in this economic activity. Contrarily, having farmers predominant in the active working group could yield positive effect on crop productivity (Otiloaiye et *al*., 2009).

Findings of the research also revealed that most of the farmers did not have formal education (43.3%). The education level in The Gambia is still averagely low and particularly in the rural settings. This could explain these findings. Moreover, this situation of low level of literacy can sometimes affect the aptitude of one person to perceive, understand and react positively to new technologies or strategies. For instance, Idrisa *et al*. (2012) reported that a minimum threshold in terms of educational qualification is necessary for understanding the scientific and technical nature of modern agriculture; which gradually tend to turn into climate-smart agriculture (CSA) inclined to build resilience to climate risks and uncertainties.

Majority of the respondents (49.2%) had a household size between 6-10 member with the lowest and highest household size being 2 and 36 members respectively and averagely 11 members per household. The country's last census (GBoS, 2013) indicated an average household size of 9.2 for the region which is quite similar to the values obtained in this study area. This could imply that large-sized rural households would be capable of providing the labor needed in the farm.

Table 3. Farming Experience, Land ownership structure, Farm size and Farm Network of Respondents

Variable	Frequency	Percent
Farming Experience		
Less than 5 years	6	2.5
5 - 10 years	25	10.4
11 - 15 years	35	14.6
16 - 20 years	50	20.8
21 - 25 years	31	12.9
26 - 30 years	28	11.7
31 years and above	65	27.1
Land ownership structure		
Family/Privately owned	240	100
Size of Farmland (hectares)		
Small-sized <5	236	98.3
Medium-sized 5-20	4	1.7
Farm Network		
No	240	100
Yes	0	0

Additionally, the results from Table 3 indicated that the majority (27.1%) of the farmers have at least 31 years farming experience, which shows that they are experienced enough to make wise decisions and choices on their farming activities. Additionally, they might be in a better position to understand environmental variations and changes which will help them to avoid crop failure and adjust to the new circumstances. Maddison (2007) in his study also indicated that educated and experienced farmers are expected to have more knowledge and information about climate change and adaptation measures to use in response to climate risks and challenges, including saline-water intrusion.

The analysis of the land ownership structure showed that all the respondents work on their own farms. This implied that swamp rice farmers have the plain right on their farms. This could be explained by the social organization prevailing within the study area and The Gambia at large where women are given land by their mother's spouse once they get married or part of the dowries or even borrow from friends or neighbors. In the case, of borrowed land, the farmer-borrower cultivates the land and is still considered as the owner of the parcel. In the end, the land is not taken back from him because of the conviviality and sharing characters of the rural Gambians.

Moreover, the results of the research revealed that 98.3% of the respondents operate on small-sized farm (< 5 hectares), with an insignificant number (1.7%) having a medium-sized farm of 5-20 hectares. This signals that farmers in the study area generally practice subsistence agriculture making them vulnerable to climate change hazards as reported by Idrisa *et al*. (2012) in their study in Borno State, Nigeria. Also, the study illustrated that the farmers did not belong to any established farm network or organization, which may affect their chance of getting access to donor support from established organizations, which would prefer to deal with them in organized structures or groups. From the research, the majority of the respondents blame climate change and deforestation for the change in temperature and rainfall observed in their region which could enhance salinization of the river. This corroborates with previous studies (NAPA, 2007; Ervine *et al*, 2007; Webb, 1992). This implies that farmers of the study area are aware of saline-water intrusion, its manifestations and causes.

3.2. Awareness and Knowledge of saline-water intrusion

The majority of farmers (96%) are aware of saline-water intrusion phenomenon. Most of the respondents (40%) have had their rice fields intruded by salinity for the first time in the last 5 years. The fact that more people have ever seen for the first time saline-water intrusion in recent years can be attributed to the increasing saline-water intrusion in the study area resulting from the increasing change in the climate (low rainfalls associated with sea-level rise around Banjul). According to Jallow *et al*. (1996), the capital city Banjul is likely to be at high risk of inundation by 2100 as the result of sea-level rise.

Table 4. Time of the year saline-water intrusion is most obvious

Time of the year saline-water intrusion is most obvious	Percentage
End of the dry season	55.8
Onset of the raining season	44.2
During the raining season	10.4
Onset of the dry season	35
During the dry season	45.8
End of the raining season	52.5

Table 4 revealed that for rice farmers in the study area, saline-water intrusion is most obvious at the end of the dry season (55.8%) and at the end of the raining season (52.5%) which is supposed to be normal due to the absence of rainfall. This suggests that in case of low rainfall during the year, saline-water is present even further in the raining season in the water used (from River Gambia) to irrigate the swamp rice-growing fields. In an increasing context of climate change and recurrent dry spells, salt is likely to be present during the raining season, because of low rainfalls while abundant rainfall could push the saline front back to the ocean and ensure required quality of freshwater for the growth of the crops. It could also imply negative effects on the rice plants. In some cases, it could lead to change in livelihood strategies. For instance, rice farmers have the tendency to delay the time of farming activities to avoid losses.

The findings from Figure 3 below show that farmers had perceived an incremental trend in the river's water salinity over the last five years. This signifies that River Gambia water's salinity keeps increasing over years, which could induce severe impacts on the soil and therefore reduce rice production.

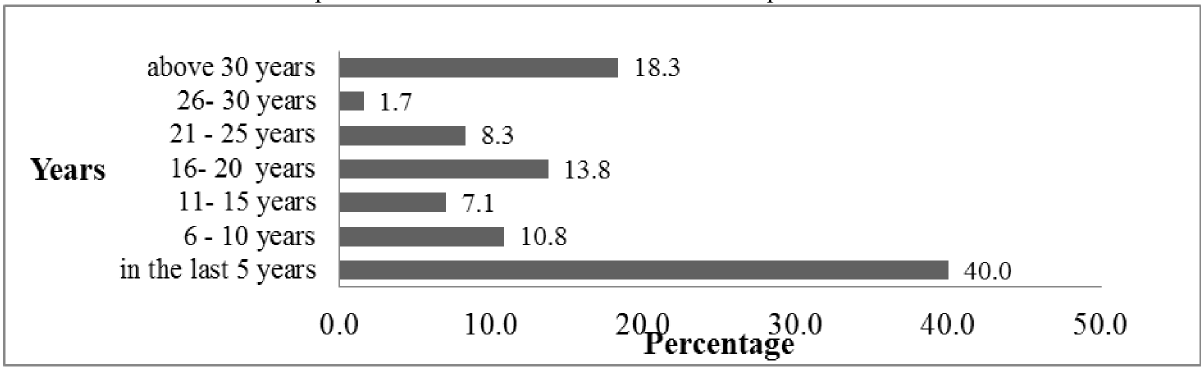

Figure 3. Farmers' Perception on the trend of saline-water intrusion in the study area over the last five years

3.3. Impacts and evidence of saline-water intrusion identified by the respondents

Table 5 shows that the majority (98.8%) of the respondents view saline-water intrusion on their rice fields as a problem. Most of the farmers (96.7%) stated that saline-water intrusion impacts their rice-growing fields, while 78.3% claimed that saline-water intrusion led to a reduction in rice production. Moreover, 77.9% believed saline-water intrusion can reduce the size of their arable land, while most asserted that saline-water intrusion can reduce their yields (95.4%) and incomes (85.8%). The majority of the respondents (50.4%) claimed that saline-water intrusion can negatively affect the fertility of their soils. In such conditions, yields can be expected to be low if no measure is being taken.

Table 5. Farmers' perception of saline-water intrusion

Do you think saline-water intrusion impact your rice fields?	Frequency	Percentage
Yes	232	96.7
No	8	3.3
How does it impact your rice fields? Increased Production		
Yes	1	0.4
No	239	99.6
Reduced Production		
Yes	188	78.3
No	52	21.7
Increased labor		
Yes	103	42.9
No	137	57.1
Reduced labor		
Yes	19	7.9
No	221	92.1
Increased rice yields		
Yes	0	0
No	240	100
Reduced rice yields		
Yes	229	95.4
No	11	4.6
Reduced cultivated area		
Yes	187	77.9
No	53	22.1
Increased cultivated area		
Yes	3	1.3
No	237	98.7
Reduced income		
Yes	206	85.8
No	34	14.2
Increased income		
No	240	100
Yes	0	0
Saline-water intrusion a problem	237	98.8
Saline-water intrusion as both problem and opportunity	2	.8
No opinion on problem or opportunity of saline-water intrusion	1	.4
Impacts of saline-water intrusion on the soil		
Reduces soil fertility	121	50.4
Affects soil structure	118	49.2
Changes the soil color	1	.4

3.4. Sources of Saline-water intrusion Information for farmers

Table 6. Sources of information on saline-water intrusion

Sources of information on saline-water intrusion	Frequency	Percentage
Radio	90	37.5
Television	6	2.5
Extension services	41	17.1
Farmers' Association	31	1.3
Farmer to Farmer	12	48.3
Local drama groups	24	10
Indigenous knowledge	69	28.7

The preferred sources of saline-water information by the farmers (see Table 6) are farmer to farmer (48.3%), followed by radio (37.5%), indigenous knowledge (28.7%) and extension services (17.1%). It is found that television (TV) and farmer's associations are far behind the preferred sources of information for the respondents with 2.5% and 1.3%, respectively. This is as the result of the fact that few rural farmers have TVs in their homes and the majority does not have a source of energy to supply their TVs even if they have. This is as the result of the fact that few rural farmers can afford TVs which could be explained by the fact that The Gambia's Human

Development Index value for 2015 is 0.452 which puts the country in the low human development category positioning it at 173 out of 188 countries and territories in the world (UNECA, 2017). Moreover, currently in the country radio programs are centered on weather forecast and good agronomic practices dissemination to the farmers through an Early Warning Project funded by UNEP (2015). Also, the findings could imply that farmer respondents in the study area are not part of a group or network or association which corroborates with the results found earlier on (Table 3).

Farmer to farmer communication is the predominant source of information for rice swamp farmers of the study area since in the Gambian's society; especially in its rural settings, socialization through sharing and chatting under "Bantabas" is typical. Moreover, farmers justify this situation by affirming that few of them who have got information on saline-water intrusion from the extension services (whose coverage is low in The Gambia) are compelled to inform and educate other farmers on the issue. Others declared that during their visits in some of the neighboring villages, in Senegal for example (a neighboring country which also is threatened by saline-water intrusion); where they have seen some improved ways of dealing with salinity on the rice fields, they would apply those techniques once back in their fields. In such cases, the farmer educates his colleagues back home to improve upon their farms' situation of increased salinization and reduce crop failure. Indigenous knowledge comes in the third position of sources of saline-water intrusion information. This confirms that saline-water information dissemination is predominantly done among the farmers by the farmers themselves at their community level. It is proved that communicating an innovation through farmer accepted and trusted sources would increase the rate of acceptability and dissemination of that innovation or information (Kutir *et al.*, 2015). There is a high use of indigenous knowledge in the study area on saline-water related matters. Also, women farmers in the study area have a way of transferring knowledge and skills to their daughters or daughters-in-law so as to sustain rice cultivation which is a tradition in the rural Gambia. Moreover, rice being the major crop that is cultivated in the region (MOA, 2013), farmers make sure they pass on their knowledge to generations to come so as to sustain the tradition and to continue feeding their families.

The low percentage observed for the extension services (17.1%) illustrates that saline-water intrusion information is poorly addressed by the extension services in the region. This is as a result of low extension services coverage in The Gambia with 1 extension agent for 1500 farmers (MOA, 2013). Similar results from Oduniyi (2013) in Mpumalanga province of South Africa also revealed poor access of rural farmers to extension services. This could adversely affect farmers' adaptation to saline-water intrusion as extension officers are responsible for educating and training farmers on agricultural issues. As a result of lack of extension services by most farmers, farmers stay powerless or use their own technologies which might not necessarily be adequate to sustainably face issues that are more complex, as climate change-induced hazards. The local drama groups commonly called locally "kajelengo" have been associated with educational programs in The Gambia, especially in climate information through the early warning Programme currently run in the country. These local groups are constituted by the farmers themselves who after being trained give back to the community the information they have received. According to the farmers, they have not received any training on saline-water intrusion but they sensitize themselves based on their own experiences and indigenous knowledge since most of their members are generally active elderly persons.

Table 7. Type of information on saline-water intrusion and assistance received from institutions

Type of information received by farmers on saline-water intrusion		
Sensitization/Awareness	79	47.6
Impacts of saline-water	66	39.8
Adaptive measures	21	12.7
Assistance from institutions		
Yes	38	15.8
No	202	84.2
Type of institutions		
Government	35	92.1
NGO/CBO	1	2.6
Community members	2	5.3
Nature of assistance		
Food provision/supply	5	13.5
Construction of soil and water conservation structures	30	81.1
Land donation from neighbors	2	5.4

Table 7 indicates that awareness on saline-water intrusion is the major type of information that most of the respondents (47.6%) received in the study area. Adaptation to saline-water information content is only at 12.7%. This could be explained by the fact that expertise is lacking on the field of mitigation or adapting to climate-related hazards in Africa generally and The Gambia in particular. To illustrate it, very few farmers who received extension services visit their rice fields affected by saline-water intrusion. For instance, they revealed that extension agents visit the fields just to see the situation and go back.

Regarding the assistance received by farmers to respond to saline-water 84.2% stated that they have not received any type of assistance when their fields got intruded by saline-water. This gives the current assistance coverage of 15.8% in the study area on saline-water intrusion and related matters. This could incur huge losses and poor yields for the farmers. The largest part of the assistance received by the respondents came from the Government (92.1%). The assistance entailed construction of soil and water conservation structures (81.1%), food provision/supply (13.5%) and land donation (5.4%) to the affected households. The construction of water and soil conservation structures has been reported by farmers to be projects run by the government. This is true because, a large number of lowland development projects have taken place in the region (from GALDEP, LADEP, and NEMA to FASDEP to mention a few). These projects constructed causeways, bridges and anti-salt dikes within the region. However, it is not actually enough according to farmers of the region who in most of the discussions called for government assistance.

Most of the respondents who received assistance from NGOs or CBOs affirmed that these aids are in term of coping and adaptive strategies which are shifting into animal rearing and vegetable gardening for livelihood diversification.

Community members provide support to people affected by saline-water intrusion by donating part of their lands to the affected colleagues. Some affected communities identified to have had most of these cases of assistance from other villages are Kanikunda and Karantaba which have been given free swamp land by Jenoi, Toniataba, and Si-Kunda Villages in Jarra West District. This could be explained by the presence of vast swamping areas in these three villages. Therefore, there is available land for their relatives. On the other hand, affected farmers had to walk from one village to another for their farming activities which is time-consuming and tiring for farmers. These are some of the challenges that many of the affected farmers have reported.

3.5. Adaptive Responses to Saline-water Intrusion used by farmers

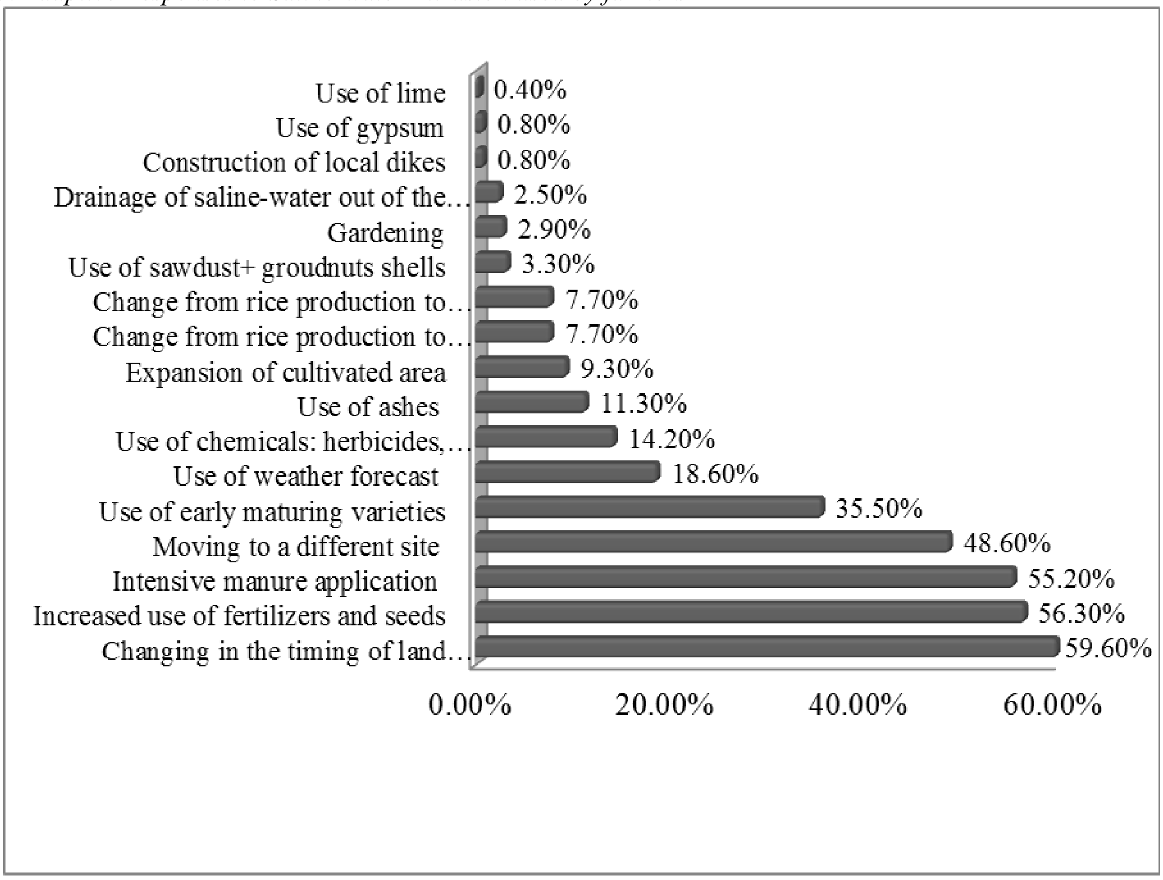

Figure 4. Saline-water intrusion Adaptive Responses used by farmers in the study area

The field survey revealed adaptive responses employed by farmers in the study area (Figure 4). The majority of farmers (59.60%) used changes in the timing of land preparation as major adaptive responses to saline-water intrusion owing to the late onset of the rainy season. Other major adaptive responses to saline-water are: increased use of fertilizers and seeds (56.30%) and intensive manure application (55.20%) to increase rice productivity, moving to a different site (48.60%) to avoid areas under saline-water intrusion, use of weather forecast to adjust the planting time to the variability in the distribution of rainfall during the raining season, use of ashes (11.3%) and use of chemicals: herbicides and pesticides (10.8%) to neutralize the salinity. Change from farming to other sources of livelihoods like marketing and animal rearing (7.70% respectively) was a way to diversify their livelihoods and ensure their food security. On the other hand, use of sawdust + groundnut shells, changing to vegetable gardening, drainage of saline-water from the rice-growing field, construction of dikes with local materials, construction of contours, use of gypsum and lime are also used by farmers of the study area to adapt to the negative impacts of saline-water intrusion on their swamp rice-growing fields.

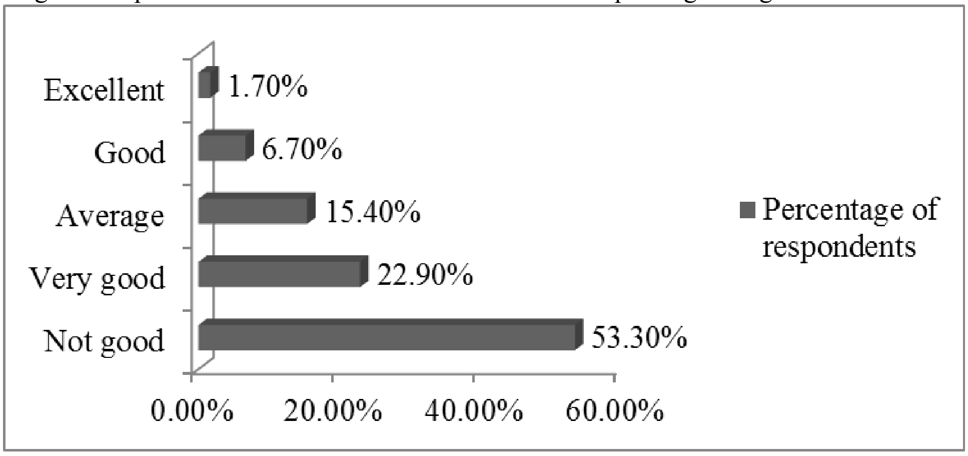

Figure 5. Perception of the respondents on their farm's ability to adapt to saline-water intrusion

Despite the wide range of adaptation strategies employed by farmers in the study area, Figure 5 shows that most of them (55.3%) rated their farm's ability to adapt to saline-water intrusion as not good, whilst 15.4% said it is average (22.9%) rated their farm's ability to be good, 6.7% to be very good and 1.7% to be excellent. This means that more than half of the study sample size affirmed not being able to face or adapt to the impacts of saline-water intrusion. For instance, in many cases, farmers stated not being able to rely on their harvests as they used to do in the past where the harvested rice from their swamp fields can sustain the feeding of their families up to the next growing season without buying imported rice. It is no longer the case, with the drastic drop in the yields; they can no more fully rely on their farms. The reason why some of them ate once a day or made extra expenditure on the family's feeding. In other cases, they go in for other activities like charcoal mining, vegetable gardening to be able to meet the household food consumption needs. Farmers reported cases of malnutrition, pregnancy failure, and other related hardships.

3.6. Problems encountered in adapting to saline-water intrusion

The major challenges reported by the farmer-respondents include the following in Table 8.

Table 8. Problems encountered in adapting to saline-water intrusion

Problems encountered by farmers in adopting to saline-water intrusion	**Percentage**
Poor/Low extension services	78.8
Lack of financial resources	77.9
Poor access to information source relevant to adaptation	76.3
Poor response to saline-water intrusion by the government agencies	75
Limited access to improved crop varieties	74.6
Limited knowledge of adaptation measures	74.2
Non-availability of credit facilities	74.2
High cost of fertilizers and other inputs	74.2
High cost of improved crop varieties	73.8
No availability of farm inputs	73.8
Absence of government policy on adaptation to saline-water	73.8
High cost of irrigation facilities	72.9
Risk of adaptation	72.1
Non-availability of farm labor	69.6
lack of access to saline-water information forecasts	64.6
Ineffectiveness of indigenous strategies	61.3
lack of access to saline-water information forecasts	64.6
Traditional beliefs do not allow me to use the adaptive strategies	35
Type of land tenure system practiced in my area	14.2

These above-mentioned challenges faced by swamp rice farmers tend to exacerbate burdens caused by saline-water intrusion on the lives and livelihoods of farmers. It clearly depicts areas where improvements need to be done and priority areas for strategies, policies and projects implementation.

4. Conclusions and Recommendations

4.1. Conclusion

Most farmer respondents from the study belong to the active age group, which has the positive tendency to boost rice production in the study area, hence ensuring food security for many households. However, it has been reported, even though the majority of the farmers had generally good knowledge on saline-water intrusion causes and impacts, they are limited in terms of knowledge on how to adapt effectively to saline-water intrusion. The main conclusion drawn from the study is that farmers have a wide range of sources through which they access saline-water intrusion information. Farmer-to-Farmer, indigenous knowledge, radio broadcast and extension service were the most preferred sources of saline-water intrusion information for farmers in the Lower River Region.

Also, it is highlighted that farmers got assistance (construction of soil and water conservation structures, food provision and land donation) from three types of institutions (Government, NGOs/CBOs and community members respectively). Moreover, farmers developed various adaptive responses to saline-water intrusion which range from on-farm to off-farm adaptation and mostly from farmer-to-farmer information and indigenous knowledge acquired over time in the study area.

4.2. Recommendations

Saline-water intrusion in The Gambia is a critical issue that has not yet drawn a lot of attention from Government and other stakeholders, even by researchers since most of the adaptive responses to saline-water intrusion in the study area are carried out by farmers themselves. It is recommended that Government, NGOs and other stakeholders give more attention to communities of the region by increasing their interventions for sustainable adaptation/response measures and mitigation to saline-water intrusion; since in most of the cases, saline-water intrusion adaptation appeals to hard adaptation which is costly. Government and other stakeholders need to make adaptation (response) as a priority area, especially for saline-water intrusion. Information pertaining to saline-water intrusion should be communicated through farmer preferred sources such as neighbor farmers, radio and extension agents.

Farmers are encouraged to collaborate to form farmer associations to enable them to have easy access, support and assistance from donors and government agencies to improve their knowledge on saline-water intrusion and enhance their adaptive capacity to saline-water intrusion. Villages identified to be more affected by saline-water intrusion need to get urgent attention from decision makers. There is a need for government to strengthen the institutions and create an enabling environment, including integration of climate resilience considerations into development or sectoral planning to enable farmers to successfully respond to climate risks as well as provision of saline-tolerant rice cultivars to farmers, construction of adequate anti-salt dikes and training for farmers on livelihood diversification activities.

Authors' contributions: This paper is part of M.B's MSc Degree Thesis with the other authors serving as advisors. M.B designed the research methodology, collected the data, analyzed the results of the study and developed the paper. Authors S.Y and J.M.S corrected, reviewed the research design and the manuscript draft. Authors A.B and Y.S.K provided constructive comments on the paper.

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Glossary

CBO: Community Based-Organization
FASDEP: Food and Agriculture Development Project
GALDEP: The Gambia Lowland Development Project
LADEP: Lowland Agricultural Development Programme
NEMA: National Agricultural Land and Water Management Development Project
NGO: Non-Governmental Organization