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Farmers' perception of salt affected soils and rice varieties preferences in the north-eastern Tanzania and their implications in breeding

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Abstract

Excessive accumulation of salts from improper soil and water management is a common problem in irrigated rice ecosystems. The problem if not properly addressed will be a major hindrance on efforts for irrigated agriculture expansion. Farmers' perceptions on salt affected soils, existing management practices and preferences for rice cultivars are major inputs to management plans and rice breeding research. The study was conducted in two villages of Korogwe district-Tanga Region, using both participatory rural appraisal and structured interviews. A total number of 100 farmers were randomly selected from two villages, interviewed individually and in groups. Results showed that 88% of the total respondents were aware of the problem and 48% claimed that the problem was increasing. The average of 25% and 50% regarded the problem in "very bad" and "bad" category respectively. Major varieties grown included: 1R56, IR54, IR64 and TXD 306 (SARO 5). These varieties are preferred for their high yielding, medium plant stature, early to medium maturity but claimed to be susceptible to salt damage. Improving these varieties for tolerance to salt and drought would enhance productivity with likely positive impact on food security in salt-affected areas.

Keywords: Rice; Breeding; Farmers' perceptions; Salt affected soils; Variety preference; North eastern Tanzania

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1. Introduction

The Government of Tanzania (GoT) under "Kilimo kwanza" (Agriculture first) resolution of 2009 is committed to transform its agriculture into a modern and commercial sector as strategies towards Tanzania's Green Revolution. Enhancing food security and developing sustainable agricultural production via developing large-scale and improving small scale irrigation schemes in the coastal plains and in the lowlands of the country has been among the main stroke. However, according to Alam (2006) and (FAO, 2000) irrigated agriculture is one of the major sectors seriously endanger by salt affected soils (SASs) especially in arid and semi-arid environment. Small-scale irrigation schemes in most semiarid marginal areas of the north-eastern part of the county dominate the production of rice and vegetables and SASs dominate most of surveyed rice irrigation schemes in the area (Kashenge-Killenga et al*.,* 2012). The yield of paddy rice is low due to the variable production environment, stress and limited access to improved varieties (Kashenge-Killenga, 2010; Kafitiri, 2004). Rice yields are low and averaging below 1.5 t ha^{-1} (FAOSTAT, 2003; Msomba et al*.,* 2002; Kanyeka, 2001).

Breeding for salt tolerant crops is one of cheap and useful and long term solution to resource poor farmers (Gregorio and Senadhira, 1993) in salt prone areas. For effective breeding, farmers' knowledge, constraints and preferences for cultivars should be clearly identified through research – farmer interaction and collaboration. Farmers can provide vital information on the existing problem, plant types, desired traits and insight into trade –offs they are willing to make among traits in design cultivar type (Sperling et al*.,* 2001).

A participatory rural appraisal (PRA) (Chambers, 1994) was introduced with the aim of narrowing the communication gap between scientists and farmers, therefore, useful to generate such information. Participatory methods are preferred as they recognize the value of farmers' local knowledge, their interests and ability to experiment and innovate, and their exchange of information and technology (Chambers, 1993).

According to Efisue et al*.* (2008) the production deficit can be overcome by the use of improved, high-yielding varieties adaptable to the existing production ecology. However, studies have been reported low adoption rate of improved varieties by the farmers in various crops such as rice (Paris and Atlin, 2002; Kafiriti, 2004; Fashola et al., 2007; Efisue et al., 2008), Maize (Derera et al., 2006) cassava varieties (Kamau and Migwa, 2009).

Several hypotheses regarding the adoption of improved varieties have been put forward (Derera et al*.,* 2006; Efisue., et al., 2008; FAO, 2009). One of the main reasons for this low rate of adoption seemed to be the fact that breeders fail to consider the special preferences of farmers especially those in the marginal areas (Derera et al*.,* 2006) Secondly, all the research work has been carried out by breeders at the experimental station, whereby the evaluation agenda and criteria are defined by the researcher. Thus the "promising" varieties brought to the growers/farmers reflected the breeder's opinion (FAO, 2009). Thirdly, varieties selected on research station may not perform well under farmers' field and management conditions (Morris and Bellon, 2004).

Most of rice cultivar in the north-eastern Tanzania improved for improved high yields and tolerance to pest and diseases. According to Manu-Aduening et al. (2006) traits such as high yielding and tolerance to pests and diseases may not be enough to ensure adoption of improved varieties. Environmental degradation such as: deterioration of water resources, loss of soil resource (such as an increase in salt affected soils), pollution, and night time temperature elevation due to global warming result in increases production constraints (Cassman, 2004). Furthermore, environmental factors (non-genetic factors) are diverse, therefore may have positive or negative impacts on genotypes. Such a situation suggests that the improved varieties for one environment might not adequately satisfying farmers' needs and preferences in another environment (Witcombe et al., 2003). It has been further observed that farmers in most of areas with edaphic problems have low level of understanding on soil qualities in relation to soil affected soils (SASs) (Mnkeni, 1996). Thus, such information has to be taken into account for varieties development.

According to Ashby et al. (1996) researchers develop new technology without consulting target farmers in the process resulting into slow adoption or rejection of new technologies (Morris and Bellon, 2004). The objective of this study was to: determine farmers' perception on salt problems and establish farmers' needs and preferences for rice varieties in the targeted irrigated environments.

2. Material and methods

The study was conducted in two phases which includes participatory rural appraisal (PRA) - a suitable tool in the context of exploratory and discovery purposes (Phillips, 1968) and formal survey using standardized interview which is advantageous in the context of validation (Theis and Grady, 1991). Both formal and informal approaches were employed in data collection in order to enhance precision and high evidential value.

2.1. Description of the study area

The study was conducted in Tanga region due to its relative higher potential for rice production than Kilimanjaro region. Two villages were involved i.e. Mkomazi and Mombo villages of Korogwe district. Both villages are situated in a vast flood plain that is bordered by the Eastern Arc Mountain slopes of Pare mountains to the north-west and Usambara Mountains to the north-east. Mkomazi village is situated at 04^{o} 39'S and 38^{o} 04'E at an altitude ranging from 396.2 to 457.2 meters above sea level, whereas Mombo village is situated 38^{o}00'E and 4^{o}30'S at an altitude of 338.8 to 402.3 meters above sea level. These sites are within a semi-arid area with annual rainfall of 800-1200mm.

Most parts of the area are characterized by a weakly bimodal rainfall pattern. Short rain (Vuli) falls from October to December and long rains (Masika) falls from February to May. However, it is currently thought that the area rainfall pattern is changing to uni-modal as the short rains are extremely low. Local experience indicates the onset date and distribution of the rains in both seasons is unreliable and the situation is worsening with time. The mean annual maximum temperature (Tmax) is in the range of 29-31°C and the mean annual minimum temperature (Tmin) is 19-23°C. The mean annual range of temperature is 9°C.

The potential of the area with respect to rice production and reports on salt affected soils in irrigation schemes were major criteria used for selection of these sites. The two villages are representative of the major rice producing areas in the region. In these villages, rice is produced mainly as irrigated crop and a small portion as lowland rain-fed crop in the form of seasonal flooded bunds in valley bottoms. The villages have rice irrigation schemes which are characterized by different management systems. Mkomazi is a local (traditional) scheme which is characterized by poorly maintained infrastructure whereas Mombo scheme has well maintained and improved irrigation infrastructure.

2.2. Research team

The research multidisciplinary team comprised two scientists (a breeder and a social economist), village extension officers (VEOs) and enumerators was formed, met for a brain-storming session and rapport before the appraisal. This was done in order to determine what information was necessary and how it could be best obtained. The team went through a checklist of questions prepared for the appraisal and pre-tested the structured questionnaires.

2.3. Data sources

To capture all necessary information, both primary and secondary sources were used. Primary data sources were the district administrative officials, key informants at both district and village levels. Group discussions in PRA, interviews and field observation were the key methods for primary data collection. The main tool in the PRA were probing and brainstorming. The discussion was guided by an open semi-structured questionnaire to probe the farmers on a range of issues related to rice production under irrigated environments and the associated problems with emphasis on problems related to SASs and common varieties used. The PRA techniques applied were trend analysis, seasonal analysis (calendar) and ranking and scoring.

2.4. PRA planning and farmers' selection

The village chair person and extension officer helped to organize the meeting with other village leaders and farmers for rapport as well as organizing farmers for interviews. Farmers involved in the informal and formal interviews were randomly selected from the village register by the village and hamlet leaders with the help of the agricultural extension officer. For informal interview, a minimum of 20 farmers, balanced for gender (10 female and 10 males), were actively involved in each village. During the appraisal, the research team leader explained the purpose of the research and the need of selecting study sites. The group of farmers attending the meeting were divided into sub-groups of five people (gender was considered) of which each group addressed one PRA technique. A plenary session was done at the end of group discussions whereby each sub-group presented their findings to all farmers for general discussion.

Selection of interviewees for the formal interview was also based on village household list collected from the village office. Since the majority of villagers in the study area were rice farmers, a list of villagers were provided and the names of every second persons were picked from the list with some adjustments to make sure that women were well represented in the study. Sample sizes of 50 farmers from each village were selected from the list and visited in their homestead for interview.

A careful cross section of farmers involved combined traditional and innovative farmers, males and females, full time farmers and farmers with off-farm employment. In this case, the total sample size was 100 from the two villages. Individual farmers were visited in their home stead and interviewed. This enabled farmers to express their own opinions in a relaxed environment without any influence from the community. It also helped the team to learn more on farmer's environment and the type of life.

Individual interviews were done for comparing and/or supplementing the information obtained through PRA methods. The prepared questionnaires were pre-tested and adjusted accordingly. During the interview, practical demonstrations, drawings and observations were frequently used. For instance, farmers were asked to sketch maps of their field on the ground and show the size/portion affected by salts. This enabled the farmer to easily demonstrate and estimate the size of salt affected land area. Field visits were conducted to verify some of the information given during group discussions and individual interviews whereby the research team and volunteer farmers had a walk across several fields for observation.

2.5. Data analyses

The data generated from the group discussions, questionnaires and field visit were used for the analysis. Descriptive statistics through frequency means and percentages were calculated for different variables to explore relationships. Statistical analyses of both quantitative and qualitative data were performed in SPSS (Release 15) computer package (SPSS Inc., 2006).

3. Results and discussions

3.1. Farmers' perceptions on salt affected soils

During the appraisal farmers showed good understanding on the effects of salt affected soils in their fields and water sources. Generally, plants growing in these soils and visual soil characteristics sometimes give clues about the problem. The following local indicators are mostly used by farmers to characterize their fields: stunted plants, yellow striped plants on middle to upper leaves as a sign of high soil pH (indicating zinc and iron deficiency), whitish top soils with salty taste, Patches of bare land, growth of *Kuruwira or minywanywa* plants (salt bushes), salty taste sugarcane, blackish soils, water logging not caused by rising water table. Indicators for salty water are salty taste water, dry skin after bathing, using lot of soap when washing clothes.

Farmers listed the commonly used indicators and ranked them (Table 1). All the listed indicators were ranked equally in both villagers. Crop performance and yield were important indicators used by farmers, having been ranked number 1 and 2, respectively. Other indicators were soil colour, presence of specific indicator plant species, soil compactness (soil tilth) and visible salts on soil surfaces. The relative importance of indicators was similar in both villages.

Table 1. Ranking and scoring of salty soil indicators by farmers in Mkomazi and Mombo villages

Indicators	Total score		Mean scores		Rank	
	Mkomazi	Mombo	Mkomazi	Mombo	Mkomazi	Mombo
Stunted growth & Leaf burn	19	20	6	6	1	1
Poor crop yield	16	18	5	5	2	2
Soil colour	13	16	4	5	3	3
Indicator species	10	12	3	3	4	4
Soil tilth	8	11	2	3	5	5
Salt on soil surface	8	10	2	3	6	6

Scoring of indicators was based on a ranking scale from1-6, with 1 as the least important to 6 as the most important (n=100)

When the individual farmers were asked about the sources of salty soils in their field, only few (16%) could not explain. The rest (84%) were aware and had different perceptions on the actual source of salt problems in the soil. A large group (34%) claimed that it was nature of the soils in their field, 28% thought that it came naturally from sub soils when water table is low and evaporation is high, 14% attributed the problem salts movement from one field to another through irrigation water and 8% claimed that irregular use of chemical fertilizer might be the reason for salt accumulation in the fields (Figure 1).

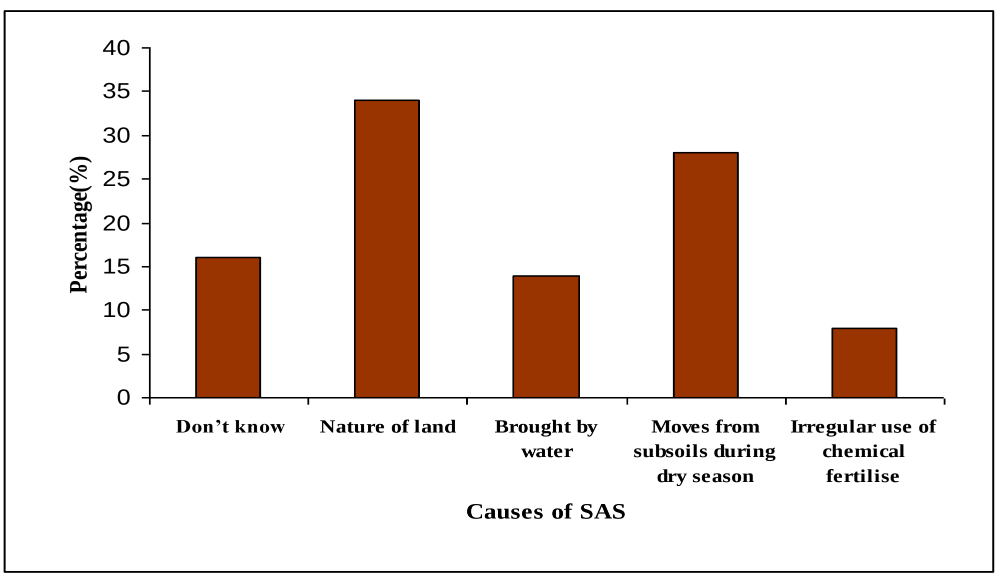

Figure 1. Percentage respondent on major causes salt problems in the soil (n=100)

Although no significant difference was found on the perception of the causes of salt affected soils among farmers in the two villages, their perception of its severity was observed to be different. Figure 2 shows that 30% and 20% of farmers in Mkomazi and Mombo, respectively, regarded the severity of salt affected soil as "very bad" category, whereas, the majority of farmers regarded the severity to be on the "bad" category. Mombo farmers were generally found to be more aware of the severity of the process of SAS and its impact in their areas and it seemed this level of awareness influenced positively in their management decisions.

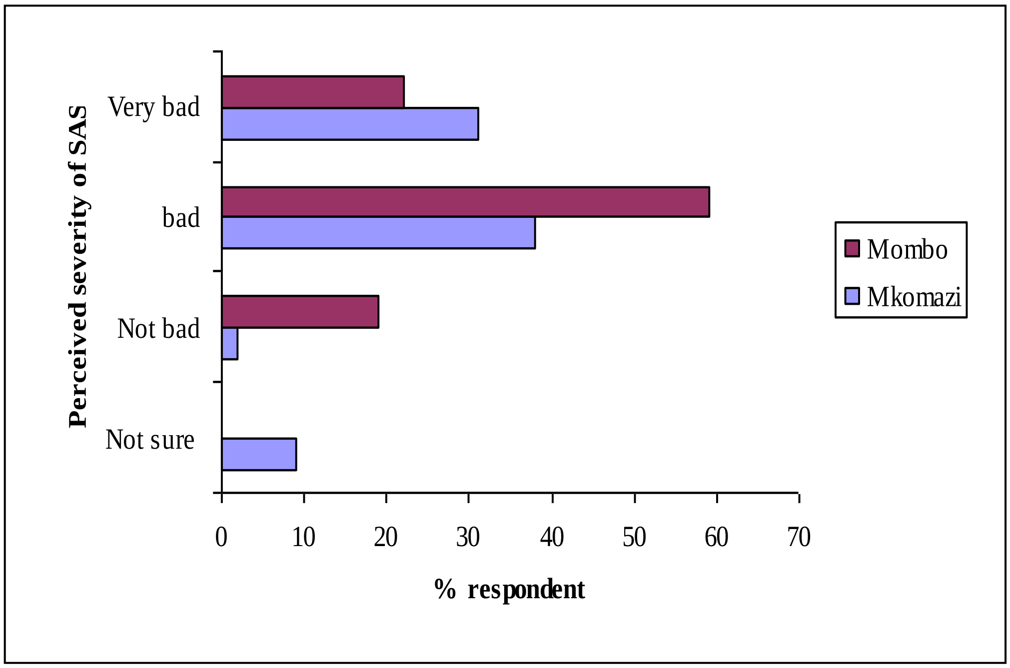

Figure 2. Salt affected soil status and farmers perception (n=50)

Farmers' perception of SASs and recognizing it as a problem is an important factor that influences the application of controlling practices. Kruger (2006) and Wickama et al. (2006) added that farmers' perceptions could be a good entry point for any intervention on the environmental conservation either by changing their perception through demonstrations or building on what they already know. The perception of problem and technology attributes by the farmer plays a very important role on whether or not the technology is adopted (Gould et al., 1989).

3.2. Rice cultivars preferences

Rice cultivars used by most of the farmers in the north-eastern Tanzania belong to the *indica* sub-species of *Oryza sativa.* A wide range of these has been obtained from other places in and outside the country. Most of them have medium plant stature, photoperiod insensitive, and are early to medium maturing. It was stated during the appraisal that farmers always experimented with new varieties and select those which meet their preferences and that are suitable under the local circumstances such as soils. However, some of the farmers preferred planting more than one variety to match with unexpected local environmental changes and/or to have a small portion of the field planted with aromatic variety specifically for their own food. This is also common practice to most of rice farmers elsewhere (Tesfai et al*.,* 2002).

The farmers were asked to list all the preferred varieties and to indicate the potential attributes of each variety. Eight varieties were listed and the specific reasons for their preferences were established (Figure 3 and Table 2). Mkomazi farmers showed to have a wider range of variety preferences than Mombo farmers. When farmers were asked to rank the varieties according to their preferences, pair wise ranking results showed differences in ranking of cultivar preferences between villages (Table 3). Varieties IR 56 and IR 54 were ranked equal high in Mkomazi whereas, IR 64 was ranked high in Mombo village.

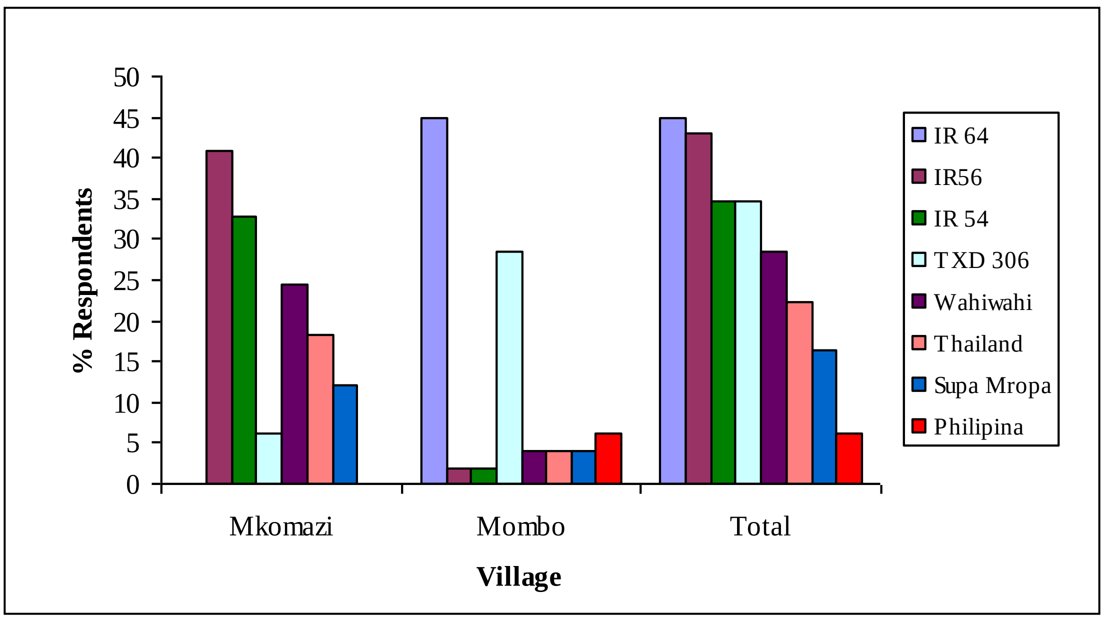

Figure 3. Major cultivated varieties in the study areas (n=100)

These results were confirmed during survey study that IR 64 is cultivated by majority (45%) of farmers followed by TXD 306 (Sarro) which was cultivated by 28% of the farmers and very minimum numbers of farmers cultivated IR 56 and IR 54 in Mombo area. On the other hand IR 56 followed by IR 54 were the major varieties cultivated by 42% and 36% of respondents respectively in Mkomazi village, very few farmers (7%) cultivate TXD 306 in the village. The results indicated further that the improved varieties (IR 64, IR56, IR54, TXD 306, Thailand) were more preferred over varieties than local land races (Wahiwahi, Supa-mropa and Philipina). However, farmer in Mombo village use more improved varieties which are also reflected by higher production varieties than in Mkomazi village.

Table 2. Traits for major cultivated varieties in Mkomazi and Mombo villages

Mkomazi Varieties	Characteristics
IR 56	Medium height, medium maturing, drought tolerant, high yield, Good market, Swell during cooking but poor taste (Mainly for marketing)
IR 54	Medium height, medium maturing drought tolerant, high yield, Good market, Swell during cooking but poor taste (Mainly for marketing)
Thailand	Medium height , good taste, good market and milling quality, good yield
Kahogo	Good taste, aroma and milling quality but susceptible to harsh environment
Wahiwahi	Very early maturity, Poor taste, poor market and susceptible to harsh environment
TXD 306 (Sarro 5)	High yield, good taste and milling quality, slightly late maturing tolerant to harsh environments
Mombo Varieties	Characteristics
IR 64	Medium height, high yield, slightly tolerant to drought and diseases (Mainly for marketing)
TXD 306 (Sarro 5)	High yield, medium height, good cooking qualities (Taste and aroma)
Wahiwahi	Earliness
Thailand	Good taste, good market and milling quality, good yield

Table 3. Pair - wise ranking of varieties preferred by farmers

Variety preferred by farmers in Mkomazi						
	IR 56	Thailand	Kahogo	Wahiwahi	Sarro 5	Total
IR 54	Both	IR 54	IR 54	IR 54	IR 54	5
IR 56	*	IR 56	IR 56	IR 56	IR 56	5
Thailand		*	Kahogo	Thailand	Thailand	2
Kahogo			*	Wahiwahi	Sarro 5	1
Wahiwahi				*	Wahiwahi	2
Sarro 5					*	1
varieties preferred by farmers in Mombo						
			TXD 306	Thailand	Wahiwahi	Total
IR 64		*	IR 64	IR 64	IR 64	3
TXD 306			*	TXD 306	TXD 306	2
Thailand				*	Thailand	1
Wahiwahi					*	0

3.3. Varietal traits preferred by farmers

High yielding, earliness and aroma were the tree major traits that were emphasized by all respondents interviewed in the study area (Figure 4). The rest of the traits included long and compact panicles, high tillering, and medium height and strong culms with 58%, 66% and 60% of respondents, respectively. Aroma, less sticky and swelling was the major preferred grain cooking qualities with 65%, 57% and 48% of respondents respectively.

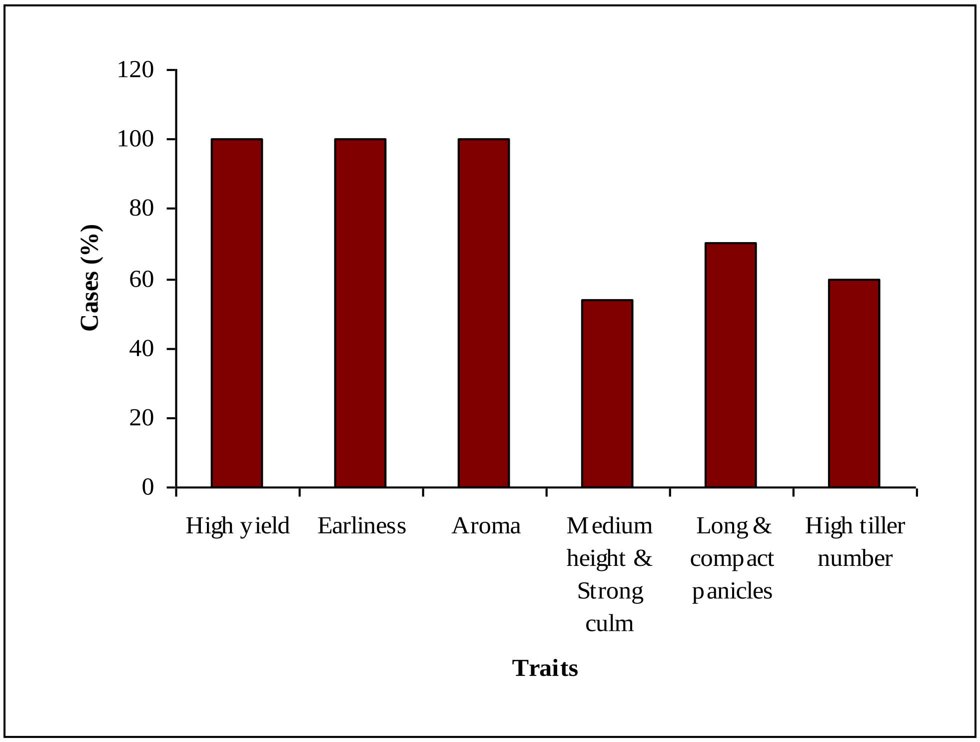

Figure 4. Rice traits preferred by farmers in Mkomazi and Mombo villages (n=50)

About 70% of the respondents in Mombo and 76% from Mkomazi were of the opinion that major varieties grown in both villages were non-aromatic. These varieties were however high yielding and slightly tolerant to harsh environment (water stress and salt tolerant). A number of varieties have been abandoned due to the fact that they lack the specific qualities (Table 4) preferred by farmers.

Poor yield, cooking qualities, lodging and late maturity are the major reasons for abandonment of some of the varieties. A list of abandoned varieties was made (Table 4) and results indicated that Wahiwahi (means the earliness) - a local early maturing variety and Supa/Mropa – a local highly aromatic variety were abandoned by the majority of farmers. Despite its earliness trait, about 40% of respondents abandoned Wahiwahi due to lodging and poor yield characteristics. More than 37% of respondents abandoned a local variety, Supa, due to its very late maturing characteristics despite its aroma and good cooking quality.

Results indicated that farmers, especially in Mombo and Mkomazi, preferred a cultivar that would combine high yield potential, early maturity and aroma. However, yield potential and earliness were the main basis that the majority farmers' grew IR 64, IR 54, and IR 54. Studies results therefore implied that these trait preferences should be highly considered during development of salt tolerant rice cultivars for these areas. Variety TXD 306 showed also to have good grain yield qualities despite of its late maturity, therefore incorporating genes for earliness and salt tolerance would increase the potential of this cultivar in the area.

Table 4. Major abandoned varieties and major reasons for their abandonment

Abandoned variety	% Respondents		Total (n=50)	Major abandon reasons
	Mkomazi (n=25)	Mombo (n=25)		
Supa-Mropa	21.4%	14.3%	35.7%	- Very late maturity
Shingo ya mwali	2.4%	4.8%	7.1%	- Late maturity
Wahiwahi	19.0%	21.4%	40.5%	- Poor yield, Logging - Susceptible to drought
Thailand	2.4%	4.8%	7.1%	-Late maturity, Poor yield
TXD 85	0%	4.8%	4.8%	- Poor cooking quality - difficulty to thresh
TXD 40	0%	2.4%	2.4%	- Poor yield - Poor cooking quality
Afaa mwanza	0%	19.0%	19.0%	- Very poor cooking quality
Moshi wa Sigara	7.1%	2.4%	9.5%	- Low yield, late maturity
Maganda manne	11.9%	.0%	11.9%	- Low yield - late maturity
Kifumba	4.8%	.0%	4.8%	- Low yield - late maturity
Total	42.9%	57.1%	100.0%	

3.4. Local seed system

Result indicated that 96% of farming households in Mkomazi and Mombo villages are dependent upon informal seed sources. Seed flow occurred through farmers' social networks. These communities managed their rich rice diversity through bartering, gifts, borrowing seed or seedlings, and purchases. The absence of well formulated seed delivery system increases the use of inadequate varieties. This has also been reported by Fashola et al. (2007). Research institutions should provide appropriate and location-specific technological packages. The extension services should ensure farmers use correctly and systematically recommended technical packages. A farmer's ability to adopt those technologies depends on the linkages among research institutions, extension services and farmers.

4. Conclusion

The study therefore concluded that through participatory methods the following information was generation:

- Soil degradation through increased salt affected soils and drought were identified as the major factors responsible for irrigated rice yield decline in both villages. The awareness on existing of salt affected soils problem in farmers' field was high, and the majority of farmers perceived SASs as a hostile problem that need a serious attention as it cause a dramatic yield losses. The majority of farmers claimed that the problem was increasing and there is no strong mitigation efforts advocated to remedy the problem.
- Major varieties grown included: 1R56, IR54, IR64 and TXD 306 (SARO 5). These varieties are high yielding but susceptible to salt damage. Salt tolerant varieties are unavailable. Furthermore, the information on the availability and the use of salt tolerant varieties is also unavailable to farmers in these communities. This was also related by the very low use of improved agriculture technologies. Implying that, improving farmers' preferred rice varieties for salt tolerance will provide a great contribution towards increasing rice yields and improve livelihood of the farmers in salt affected soil communities
- The study revealed that most preferred traits of rice cultivars were high yield potential, early maturing, aroma, medium plant stature, tolerance to salt and drought. Improvement of these characters in new varieties for salt tolerance would enhance productivity with likely positive impact on small farmers' food security, incomes and livelihoods.
- There is no official awareness and capacity building program to promote practices that would alleviate SASs problem. People do some copying strategies as their own choice. Furthermore, the absence of well formulated seed delivery system increases the use of inadequate varieties. Though this is a need-based activity, its sustainability requires awareness and a strong technical involvement.

Therefore, the use of integrated management practice which will involve the use of salt tolerant varieties, improved drainage, use of soil amendment and improve farmer knowledge and information on the SASs problem is highly advocated. In this case, the suitable rice ideotypes should be developed for different environment according to farmers' needs and, this should be complemented by the possible methods to amend the SASs problems from the technical as well as the socio-economic point of view. Furthermore, efforts for prevention of the problems developing in the currently non-salt affected areas in the region and its vicinity are highly recommended.

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References

Alam, S.M. (2006), "Profiting from saline tolerant crops", http://www.dawn.com/2006/10/23/ebr4.htm. Accessed on May 2008.

Cassman, K. (2004), "Global warming 'threatens rice yields", Proceedings of the National Academy of Sciences of the USA 101, 9971, SciDev.Net. 29 June 2004.

Chamber, R. (1993), "Participatory Rural Appraisal (PRA): Analysis of Experience", *World Development,* Vol. 22, No. 9, pp 1253-1268.

Derera, J., Tongoona, P., Langyintuo, A., Laing, M.D. and Vivek, B. (2006), "Farmer perceptions on maize cultivars in the marginal eastern belt of Zimbabwe and their implications for breeding", *Africa Crop Science Journal*, Vol. 14. No. 5, pp. 1–15.

Efisue, A., Tongoona, P., Derera, J., Langyintuo, A., Laing, M. and Ubi, B. (2008), "Farmers' perceptions on rice varieties in Sikasso region of Mali and their implications for rice breeding", *Journal of Agronomy and Crop Science*, Vol. 94, pp. 393–400.

FAO (2000), "Agriculture - Land - Water - WAICENT - FAO Search", http://www.fao.org, Accessed in October 2007.

FAO (2002), "Food and Agricultural Organization Database", FAO, Rome. Online publication. http://www.fao.org, Accessed on March 2009

FAO (2003), "Food and Agricultural Organization Database", FAO, Rome, Online publication. http://www.fao.org, Accessed on March 2008.

FAO (2009), "Farmer participatory research: the turning point for cassava development in North-eastern Brazil", http://www.fao.org.docrep/007, Accessed on 10 Sept 2009

Fashola, O.O., Oladele, O.I., Alabi, M.O., Tologbonse, D. and Wakatsuki, T. (2007), "Socio-economic factors influencing the adoption of Sawah rice production technology in Nigeria"*, Journal of Food Agriculture and Environment*, Vol. 5, No.1, pp. 239-242.

Gould , B.W., Saupe, W.E. and Klemme, R.M. (1989), "Conservation tillage: The role of farm and operator characteristics and the perception of soil erosion", *Land Economics*, Vol. 65, No. 2, pp 167-82.

Gregorio, G.B., and Senadhira, D. (1993), "Genetic analyses of salinity tolerance in rice (*Oryza sativa* L.)", *Theoretical and applied genetics*, Vol. 86, pp 33-338.

Kafiriti, E.M. (2004), "Integrating conventional and participatory research: Experiences from trials with rice farmers in South-eastern Tanzania", Doctoraatsproefschrift nr. 595 aan de Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen van de K.U. Leuven, Belgium.

Kamau, J. and Migwa, Y. (2009), "The secret for semi-arid areas", In: *Proceedings of the Programme for Africa's seed systems,* The march toward a green revolution in Africa: Improving the lives of farmers through stronger seed systems. 5-8 October 2009, Bamako, Mali.

Kanyeka, Z.L. (2001), "Rice Research in Tanzania: Past, Present and Future Strategies", *In: Improvement of Rice in East and Southern Africa Region through research.* Proceedings of a Workshop on Rice Research in Kenya, Malawi, Zambia and Tanzania, 12th to 16th March 2001. KATC Chekereni Compound Moshi, Tanzania.

Kashenge-Killenga, S. (2010), "Breeding investigations for salt tolerant rice genotypes, studies on the extent and farmers perceptions of salt affected soils in Northern-Eastern Tanzania", A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in Plant Breeding. University of KwaZulu-Natal, Pietermaritzburg, Republic of South Africa

Kashenge-Killenga, S., Tongoona, P., Derera, J. and Kanyeka, Z. (2012), "Irrigated rice-based farm characteristics and production constraints in selected salt affected areas of North-eastern Tanzania", *Journal of Advances in Developmental Research*, Vol. 3, No.1, pp. 14.

Kruger, E. (2006), *Participatory research in Agriculture and development*, Farmer support groups, Milner road UKZN – Scottsville, South Africa.

Manu-Aduening, J.A., R.I. Lamboll, G. Ampong Mensah, J.N. Lamptey, E. Moses, A.A. Dankyi and R.W. Gibson (2006), "Development of superior cassava cultivars in Ghana by farmers and scientists: The process adopted outcomes and contributions and changed roles of different stakeholders", *Euphytica*, Vol. 150, pp 47-61.

Mnkeni, P.N. (1996), *Salt affected soils: Their Origin, Identification, Reclamation and management*, Inter Press. Ltd, pp. 250.

Morris, M.L. and Bellon, M.R. (2004), "Participatory plant breeding research: Opportunities and challenges for the international crop improvement systems", *Euphatica,* Vol. 136, pp 21-35.

Msomba, S.W., Penza, H.A., Kibanda, J.N., Tusekelege, A., Mkuya, M., Mbapila, J.C., Kafiriti, E. and Kanyeka, Z.L. (2002), "Proposal for Release of an Improved Aromatic High Yielding Rice Variety TXD 306 (SARO 5)". A Paper presented to the National Variety Release Sub-Committee and National Seed Production Committee. November, 27-28, 2002, Selian, Arusha, Tanzania.

Paris T.R., Singh, A., Cueno, A.D. and Singh, V.N. (2008), "Assessing the impact of participatory research in rice breeding on women farmers: A case study in Eastern Utter Praddesh", *Indian Journal of Experimental Agriculture*, Vol. 44, pp 97–112.

Paris, T. and Atlin, G. (2002), "Farmers and scientists-building a partnership for improving rainfed rice in eastern India-phase", In Bellon M.R. and Reeves J. (ed.) *Quantitative analysis of data from participatory methods in plant breeding.* Mexico, DF.

Phillips, B.S. (1968), *Social research; strategy and tactics*, 4th printing, London.

Singh, B.N. (2001), "Breeding for adverse soil problem in Rice". In Nanda. S.N (ed). *Rice breeding and genetics: Research priorities and challenges*. Science publisher, Inc. New Hampshire 03748. USA.

Sperling, L., Ashby, J.A., Smith, M.E., Weltzien, E. and McGuire, S. (2001), "A framework for analyzing participatory plant breeding approaches and results", In: Hocde, H., Lancon, J. and Trouche, G. (Ed), *Selection participative*, Montpellier, 5-6 Septembre 2001.

SPSS (2006), "Statistical Programme for Social Science", SPSS for Windows Release 2006, SPSS Inc.

Tesfai, M., Dawod, V. and Abreha, K. (2002), “Management of salt-affected soils in the NCEW "Shemshemia" Irrigation scheme in the upper Gash valley of Eritrea”, DCG Report No. 20.

Theis, J. and Grady, H. (1991), “Participatory Rapid Appraisal for Community development. London”, Save the Children Fund report accessed in 2008.

Wickama, J., Nyaki, A., Senkoro, C. and Kashenge-Killenga, S. (2006), “Improving rice and maize yields in Kilombero district through use of participatory approaches to establish nutrient recommendations”, Consultancy report. Mlingano, NSS, Tanga.

Witcombe, J.R., Joshi, A. and Goyal. S.N. (2003), “Participatory plant breeding in maize: A case study from Gujarat, India”, *Euphytica*, Vol. 130, pp. 413-422.