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Involving small holder farmers in the agricultural land use planning process using Analytic Hierarchy Process in rice farming systems of Kilombero Valley, Tanzania

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Despite the truth that the agricultural land use planning exercises have so far covered small and fragmented part of the African continent, the involvement of farmers who are among the direct beneficiaries of the outputs have been limited. This work demonstrates the contributions of farmers on the land use planning process for rice production in Kilombero Valley, Tanzania. Analytic hierarchic process (AHP) was used to assign scores of comparative importance of attributes for a suitable land for rice production. Scoring was done by three groups: farmers, extension staff, and joint group comprising both farmers and extension staff. Joint group scores were considered more refined as they were generated by discussions and consensus between the two groups. Results showed that the three groups sequentially ranked the attributes the same. However, the attributes actual scores were different. The farmers' scores were consistently close to the joint group's scores compared to the extension staff group. The closeness suggests superiority and consistence of farmers' perceptions of importance of the identified attributes used for this land use planning exercise. Thus, this study recommends more involvement of farmers in agricultural land use planning process for better and sustainable land use planning outputs.

Key words: Kilombero Valley, rice, land use planning, Tanzania, Analytic Hierarchic Process.

INTRODUCTION

Involving beneficiaries in the planning process is a way of increasing productivity and sustainability of resource utilization (Birendra et al., 2014; Pendred et al., 2016). Open and adequate involvement of beneficiaries minimize conflicts, provide in-built controls and incentives for decisions implementations, and provide policy alternatives that are more acceptable to the community (Wright, 1997; Herath, 2004). African small holder farmers have been at a receiving end of many decisions regarding land management practices. Often, this results

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to poor policy formulations, land resource use conflicts, poor crop and livestock productivity and increased land degradations (Turner et al., 2000; Mulder and Brent, 2006; Agbarevo, 2013).

Participatory land use planning has been suggested as a methodology toward sustainable land uses (FAO, 2004, 2005; Venema et al., 2009; GIZ, 2011). Despite the fact that the land use planning exercises have so far covered small and fragmented parts of the African continent, limited involvement of the direct beneficiaries has been common (Owei et al., 2010). Often, the people commissioned to do land use planning exercises use expert knowledge and tools which do not sufficiently involve farmers such as modern soil survey techniques, laboratory analyses, remote sensing, geographical information system (GIS), artificial intelligence, and other computer based models and programs (Malczewski, 2004; García et al., 2014). The land use planning processes come up with reports highlighting limitations, potentials and likely management strategies for sustainability of the current or proposed land use types (FAO, 1976, 2004, 2005; Collins et al., 2001; Kuria et al., 2011; Kihoro et al., 2013; Massawe, 2015). Participation of the current and potential land users in the process makes them own the process and outcomes of the work, thus enhances implementation of the best practices suggested by the reports.

Land resources are increasingly becoming scarce due to increased population, land degradation and climate change (Mueller et al., 2010; Elaalem et al., 2011). Sustainable use of the land is a critical factor in improving food production, especially in sub Saharan Africa where poverty and food shortages are currently more experienced, and population growth is faster than the rest of the world. The African population is projected to rise from 1.2 billion in 2015 to 2.4 billion in 2050 (You et al., 2014). This, therefore, necessitates prioritization of interventions which would sustainably tackle land degradation problems and sustainably increase food production, especially in areas that has great agricultural production potential due to availability of water resources and relatively fertile soils like the Kilombero Valley in Tanzania.

The Kilombero Valley covers an area of about 11,600 km^2 (Kato, 2007). It presents great potential for intensification of crop production, particularly low land rice production due to extensive network of seasonal and permanent rivers, and alluvial young soils. Like other parts of the country, the government of Tanzania has employed extension officers who offer technical support to the farmers to increase productivity. The working approach is predominantly putting the farmers; especially the small holders as receivers, assuming the extension officers know better and are the sources of solutions. This work is intending to demonstrate how small holder rice farmers in Kilombero can team up with the extension officers in land use planning process using a multi-stakeholders approach. Farming of rice, the third most important food crop in Tanzania (Wilson and Lewis, 2015) is characterized by many small holder farmers cultivating 0.2 to 4 ha of land (Massawe and Amuri, 2012; Tanzania Investment Center, 2013), with over 74% of production being under rain fed system (Wilson and Lewis, 2015). The average yields are low ranging from 1.0 to 1.5 t ha^{-1} (Bucheyeki et al., 2011), mainly due to poor agronomic practices.

Several attributes are used as inputs in the analysis to decide if a piece of land is suitable for a particular land use type (Marinoni and Hoppe, 2006; García et al., 2014, Massawe, 2015). The process considers not only the inherent capacity of a land unit to support a specific land use type sustainably, but also the socio-economic and environmental costs (Kuria et al., 2011; Samanta et al., 2011; Elsheikh et al., 2013). Thus, a decision about the best land use alternative is a result of a comparison of one or more alternatives with respect to one or more criteria that are considered relevant for the decision. Dealing with many criteria in making decision requires multi-criteria decision making (MCDM) approaches (Xu and Yang, 2001). The MCDM processes include use of scoring methods where, a score is used to express the decision maker’s preference in numerical value. The Analytical Hierarchy Process (AHP) method (Saaty, 1988) is among the most popular scoring methods (Xu and Yang, 2001; Marinoni and Hoppe, 2006; Saaty, 2008; Elaalem et al., 2011; García et al., 2014). AHP can deal with inconsistent judgments by providing a measure of inconsistency. The method can also be integrated into other analytical applications such as GIS to provide greater flexibility and accuracy (Marinoni and Hoppe, 2006; Ahmed et al., 2007; Perveen et al., 2008; Kihoro et al., 2013).

This work demonstrates the contributions of small holder farmers when working with government extension staff on the land use planning process for rice production in Kilombero Valley, Tanzania. A multi-criteria approach is used while employing AHP method.

METHODS

The study area

The study was conducted in Kilombero Valley, Tanzania (Figure 1). The valley is part of Rufiji Basin, and collects water from the Great Rift Valley Escarpment and the Mahenge Mountains (Figure 2). The study site is occupying the area lying between 9064697 and 9089031 m northing and 175422 and 197033 m easting (UTM zone 37 south). It covers land of about 300 km^2 within Mngeta Mchombe and Mbingu areas of Kilombero district.

The Kilombero Valley is crisscrossed by numerous permanent and seasonal rivers which contribute to the Kilombero River (Bonarius, 1975). The valley has annual rainfall ranging between 1000 and 1800 mm, with areas closer to the escarpment and Mahenge highlands getting higher rainfalls. The mean daily maximum and minimum temperature varies from 22 to 28°C, while the relative humidity is between 70 and 90%. Major part of the

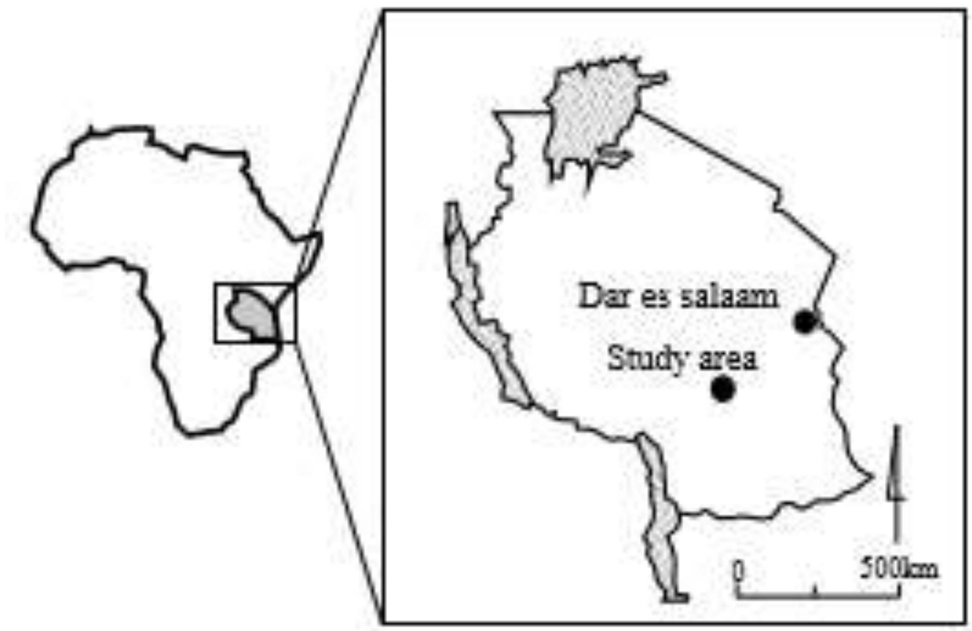

Figure 1. Location of the Kilombero Valley, Tanzania.
Source: Adopted from Kato (2007).

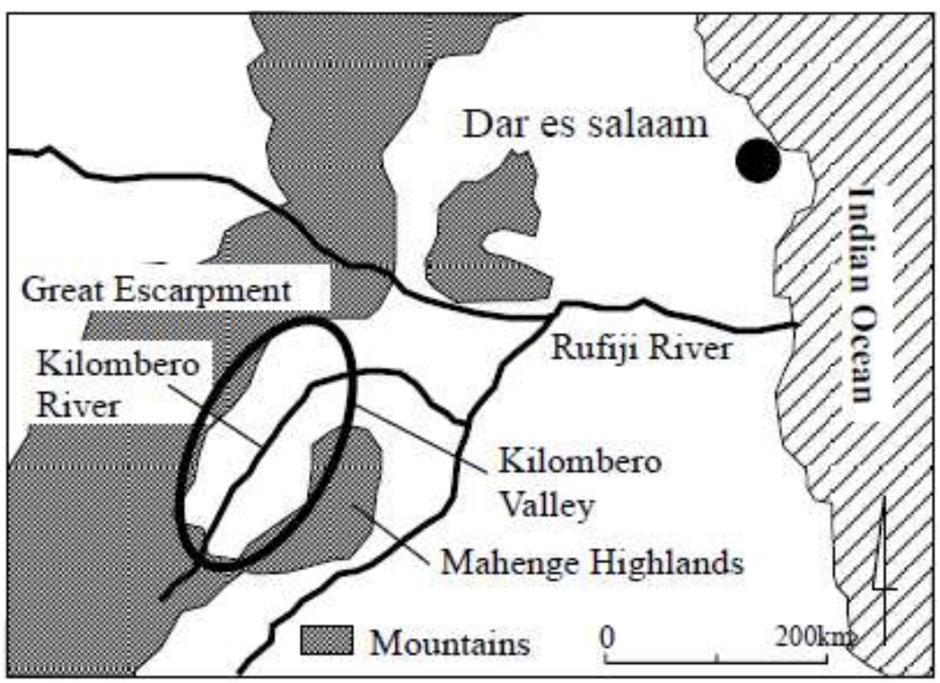

Figure 2. The Kilombero Valley.
Source: Adopted from Kato (2007).

study area is used for agriculture, mainly small holder's lowland rice production. Natural vegetation is dominantly tall grasses, mainly elephant grass (*Penisetum purpureum*), guinea grass (*Panicum maximum*), *Hyparrhenia* species and reed (*Phragmites mauritianus*) which cover protected areas close to the centre of the valley. The soils of the area are generally young alluvial soils.

Identification of the multi-criteria evaluation attributes

The attributes to be considered for the multi-criteria land evaluation for rice production suitability were identified through a combination of literature search and focused group discussions. Four lead farmers and five extension staff from three wards (Mchombe, Mngeta and Mbingu) covering the study area were used in the discussion. The lead farmers were identified with help from respective ward leaders and extension staff based on a set of criteria which included: active participation in farm activities (farm ownership and engagement in rice production), evidence of relatively higher productivity emanating from improved agronomic practices and adoption of extension services compared to other farmers, active participation in previous trainings offered by different facilitators with focus on agricultural production, and active participation in farmers groups activities including leadership roles.

The following attributes were identified as important for rice production, hence were included in the multi-criteria suitability analysis for rice production:

(1) Soil physical properties: These included physical attributes of the soil that have influence on flooded rice production, water infiltration rates, surface runoffs, workability, rooting, and water holding capacity (Landon, 1991; Lal and Shukla, 2004).
(2) Soil chemical properties: These included attributes such as levels of soil pH, soil organic matter, soil micronutrients and macronutrients (Havlin et al., 2005; Brady and Weil, 2010).
(3) Accessibility: This referred to the roads/paths network. For this criterion, reference was made on how easily people can reach their farms (Marinoni and Hoppe, 2006).
(4) Distance to market: This criterion referred to distance from the farms to village centres or sub towns where buyers normally put buying posts (García et al., 2014)
(5) Surface water resources: This criterion referred to the network of rivers and streams. Distances to rivers and streams are related to amount and duration of floods which are crucial for lowland rice production (Bonarius, 1975).
(6) Terrain: This referred to the shape and steepness of the slope gradient of the land (Gallant and Wilson, 2000).

Attributes scoring

The Analytical Hierarchy Process (AHP) method (Saaty, 1988) was used to give scores to the identified attributes. Lead farmers and extension staff were used for this exercise. Firstly, each group performed their own scoring. Secondly, a joint group comprising farmers and extension staff performed a joint scoring of the attributes. Hence, three sets of scoring were done.

In the process of scoring the criteria (attributes), a pairwise preference matrix was prepared. The verbal terms of the fundamental Saaty's scale (1-9) (Saaty and Vargas, 1991) were used to assess the preference between two compared criteria at each instance in the matrix and to translate the verbal judgement to quantitative information (Table 1).

Each one of the comparison matrices assumed the form:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (1)$$

where a_{ij} represents the pairwise comparison rating for attribute i and attribute j. The matrix has reciprocal property, thus if $a_{ij} = x$, then $a_{ji} = 1/x$ where x ≠ 0.

The comparison (preference) matrices were used as inputs in BPMSG AHP online priority calculator (Goepel, 2014). The outputs from the calculations were the consistence ratios (CR), the Principal Eigen values and weights of the attributes.

The matrices were solved using the eigenvector method to derive the priority vectors and the maximum eigenvalue. The eigenvector method utilizes Equation 2.

$$\sum_{n}^{j=1} a_{ij}\, w_j = \lambda_{max} w_{ij}\, , \forall i a_{ij} (a_{ij} = \frac{1}{a_{ij}} \; and \; a_{ij} > 0) \quad (2)$$

where i and j represent coordinate positions in the matrix and the corresponding preference ranking on the Saaty scale and λ_{max} represents the maximum eigenvalue. The second half of the equation shows the matrix is reciprocal and non-negative. The equation generates the weight/priority vector w_i, of each attribute. The weights for all attributes must add up to 1 (Equation 3).

$$\sum_{i=w}^{n} w_i = 0 \quad (3)$$

The weights were then used to rank the attributes from most important to least important. A consistency ratio (CR) was calculated to determine whether or not the scoring groups had been consistent with their scoring (Equation 4). Revisions of the preference matrices were done when the CR was above 10%.

$$CR = \frac{CI}{RI} \quad (4)$$

where CR is the consistency ratio, CI is the consistency index, and RI is the random consistency index. The consistency index can be represented as:

$$CI = \frac{(\lambda_{max} - n)}{n-1} \quad (5)$$

where n is the number of performance indicators and λmax is the maximum eigenvalue.

Attribute scores and ranking were generated for each of the three groups. The rankings were compared for each group, and the calculated attributes scores were compared using percentage differences between the farmers, extension staff, and joint groups.

RESULTS AND DISCUSSION

AHP criteria scores by extension staff group

The preference matrix of the attributes prepared by Extension Staff group is shown in Table 2. The highest preferences were recorded in comparisons of surface water resources and soil chemical properties against distance to markets. According to the verbal scale definitions (Table 1), the group has sufficient evidence that availability of water and soil fertility status are more important than distance to market for rice production at the highest possible order of affirmation. Most of the farmers sell some or most of the harvested rice immediately after harvesting to pay debts and cover the harvesting and transportation costs (Ngailo et al., 2016). Buyers set buying posts within the fields, and village centres, while some go to the farmer's specific fields

Table 1. Fundamental Saaty's scale for comparative judgments (Saaty and Vargas, 1991).

Intensity of importance	Definition (verbal scale)	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favour one activity over another
5	Strong importance	Experience and judgement strongly favour one activity over another
7	Very strong importance	An activity is favoured very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals	If activity *i* has one of the above numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	

Table 2. Extension staff group's preference matrix on factors important for rice production land use type.

Criteria	Soil physical properties	Soil chemical properties	Accessibility	Distance to market	Surface water	Terrain
Soil physical properties	1.00	0.33	5.00	7.00	0.20	3.00
Soil chemical properties	3.00	1.00	7.00	9.00	0.50	9.00
Accessibility	0.20	0.14	1.00	2.00	0.17	0.33
Distance to markets	0.14	0.11	0.50	1.00	0.11	0.25
Surface water resources	5.00	2.00	6.00	9.00	1.00	7.00
Terrain	0.33	0.11	3.00	4.00	0.14	1.00

Table 3. Criteria weights and ranks derived from extension staff's preference matrix.

Criteria	Weight	Rank
Surface water resources	0.414	1
Soil chemical properties	0.316	2
Soil physical properties	0.139	3
Terrain	0.066	4
Accessibility	0.039	5
Distance to markets	0.025	6

waiting to collect the fresh harvests. In their FAO (2015) report on the rice value chain in Tanzania, Wilson and Lewis (2015) describe the rice value chain as being dominated by a large numbers of small-scale producers, an unknown (but undoubtedly immense) number of middlemen who operate across every link, and a similarly unknown number of small processors. This might be the reason for the lowest preference the distance to market attribute got when compared with surface water resources and soil chemical properties. However, it should be noted that costs of transportation and harvesting increase with distance from the village centres where majority of the buyers set their buying posts.

The criteria weights calculated from the matrix and their respective rankings are shown in Table 3. Results show that surface water resources criterion was given higher importance for rice land use type in the study area by the extension staff compared to other identified criteria. It scored 41.4%, followed by soil chemical properties (31.6%) and soil physical properties (13.9%). Distance to market and accessibility of the farms were given the lowest two priorities by scoring 2.5 and 3.9%, respectively.

Given the major land use type being lowland rice production, it is not surprising to see availability of water being ranked the highest by this group. With rain fed

Table 4. Criteria weights and ranks derived from farmers' decision matrix as compared to extension staff group weights.

Criteria	Weight (by farmers)	Weight (by extension staff)	Rank
Surface water resources	0.419	0.414	1
Soil chemical properties	0.245	0.316	2
Soil physical properties	0.200	0.139	3
Terrain	0.076	0.066	4
Accessibility	0.033	0.039	5
Distance to markets	0.026	0.025	6

system being the dominant (Wilson and Lewis, 2015), it is also not surprising to see topography (terrain) ranked just below the soil properties. The production system banks on water loging resulting from seasonal rains and to a large extent, the overflows of the rivers which receive water from the Mahenge highland and the plateau which direct the water to the valley through numerous rivers and channels down the rift valley wall extending a distance of over 100 km west of the valley.

AHP criteria scores by lead farmers group

The criteria weights derived from the farmers' matrix are shown in Table 4. The order of ranking of the criteria from the most to the least important was similar to that of extension staff's group (Tables 3 and 4). However, there were differences in actual weights given to the criteria by each group, indicating differences in perceptions about the importance of each criterion on rice productivity and sustainability between the extension officers group and the farmers group. This is not new when comparing experts and common users of land resources. Overlaps may appear among criteria between the groups of the stakeholders, and the criteria may be perceived having the same importance by both groups. However, the difference can be seen in terms of hierarchical order of those factors and their respective priority values. In a study of community users' and experts' perspective on community forestry in Nepal using AHP (Birendra et al., 2014), both groups believed that community forest management was generally a positive strategy for forest management. However, the level of magnitude of scores given by the two groups differed. Community users combined positive priority value was found to be 76%, while that of the experts was found to be 69%. Groups consisting of people with similar expertise and working on the field but in different setting have also been found to have different opinions. For example, in a resilience-based approach for comparing expert preferences across two large-scale coastal management programs in Masan Bay, USA and Puget Sound, Korea study; the technical experts in the two regions showed several significant differences in their preferences for management objectives (Ryu et al., 2011).

The extension staff and the farmers groups appeared to give almost similar magnitude of weights to the surface water resources which is also the highest ranked criteria. Extension staff gave it a weight of 41.4%, while farmers gave it 41.9%. Close magnitude of importance was also given on terrain and distance to markets (Table 4). This indicates farmers and extension staff had more or less similar perceptions on importance of some of the criteria identified for low land rice production.

The two soil based parameters: soil physical properties and soil chemical properties received different magnitudes of importance by the two groups. The extension staff gave soil chemical properties importance score of 31.6%. To farmers, the criterion was less important and they gave it a 24.5% score. The importance of soil physical properties scoring by farmers did not differ much with soil chemical properties as compared to the perception of the extension staff on the two parameters (Table 4). To extension staff, the two soil properties received much different weights, where soil chemical properties were ranked higher than soil physical properties. Understandably, soil physical properties such as soil texture and soil depth can be more important factors in deciding on agricultural land use because they are not easily modifiable. Soil chemical properties can be modified in relatively shorter times by application of agricultural inputs such as fertilizers and lime (Brady and Weil, 2010)

The magnitudes and directions of differences in perceptions per each criterion for the two groups as indicated by differences in the criteria weights shown in Figure 3. The extension staff group perception of the importance of soil physical properties on rice production was lower by 30.5% compared to that of the farmers group. Their opinion about the importance of soil chemical properties was higher by 29% compared to the farmers' while that for accessibility was also higher by 18.2%. The extensions staffs perception of importance was lower than the farmers' perception on terrain by 13.2%. Farmers and extension staffs appear to agree on the magnitude of the importance of surface water resources and distance to market, as extension staffs scoring of the criteria was only 1.3 and 3.3%, respectively

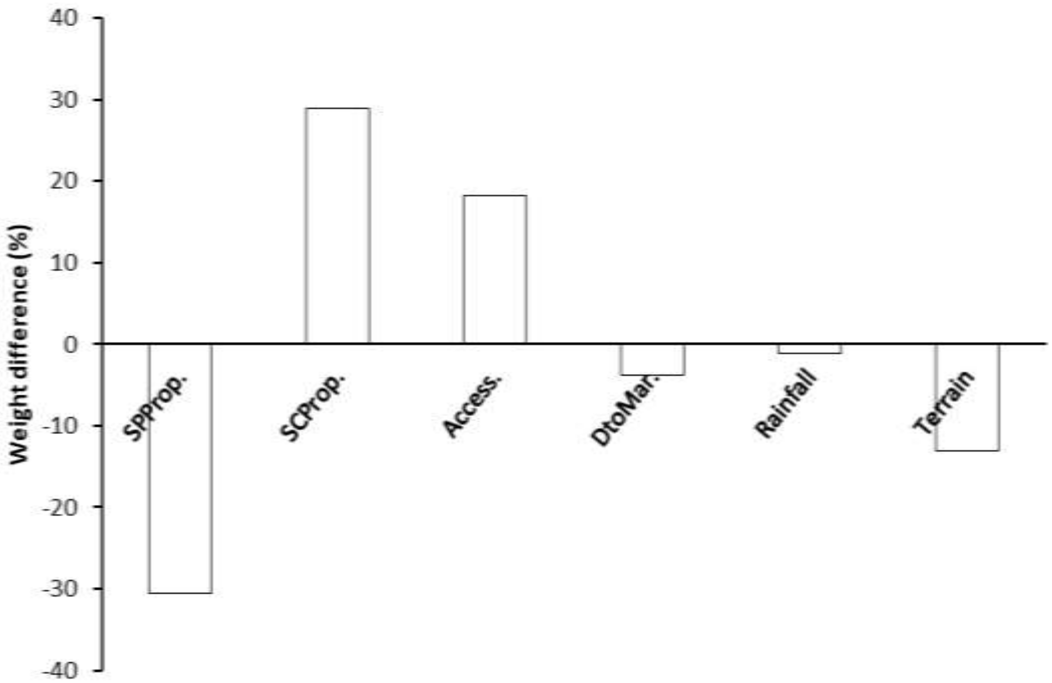

Figure 3. Extension staff's and farmers' differences in perception of importance of criteria identified for allocating the land for rice production in Kilombero Valley. At value 0, there was no difference in perception between the farmers and extension staff on the importance of that attribute for rice production. Negative values imply extension staff gave lower importance to the attribute than farmers by that value. Positive values imply extension staff gave higher importance to the attribute than the farmers by that value. SPProp. = Soil physical properties; SCProp. = Soil chemical properties; Access. = Accessibility; DtoMar. = Distance to markets; Rainfall = Surface water resources; Terrain = Terrain.

below the farmers scoring.

There were no clear explanation on what lead to the differences in perceptions between farmers and extension officers. Despite comparatively low level of formal education of the farmers to that of extension staff, they appeared to quickly and comfortably grasp the whole AHP exercise and relate it to their farming activities. This was confirmed by the low inconsistency results from their first preference matrix before revision (CR = 11.5%). Other studies of similar nature have also recorded higher consistence by the beneficiary consisting of less formally educated group. For example, in an AHP study which looked at developing and prioritizing performance indicators for Maria Island Marine Nature Reserve in Australia involving groups of managers, fishers, and researchers were the most consistent group (Pendred et al., 2016).

Both extension staffs and farmers participate in rice production by owning farms. However, the farmers participate directly in the farming practices by leading the family labour force, and working with hired labour. The extension staffs have lesser time to do the day to day management of their farms compared to farmers because of the employment commitments. This may lead to less exposure of extension staff to real challenges facing the farmers. In a study by Amalu (1998), he noted that several among qualified scientists are knowledgeable in pure basic research but grossly inexperienced in applied or adaptive research methodologies. This can be true also when it comes to extension services where extension staff might lack hands-on experience in farming activities.

AHP criteria scores by the joint group for rice production land use type

The first decision matrix from the joint group showed high inconsistency (CR = 23.5%). The high inconsistency indicates the difficulty the joint group had in reaching consensus during preparation of the preferential matrix. A revised matrix with CR = 7.9 was later generated by the joint group. The calculated criteria weights and ranks based on the revised decision matrix shown in Table 5, together with scores from individual farmers and extension staff groups' scores for comparison purpose.

The results of criteria ranking by the joint group were similar to those ranked by extension staff and farmers groups separately. This, again, shows groups general agreement on importance of one criterion over the other.

Table 5. Weights and ranks of criteria from extension staff's, farmers', and joint group.

Criteria	Extension staff group		Farmers group		Joint group	
	Weight	Rank	Weight	Rank	Weight	Rank
Surface water resources	0.414	1	0.419	1	0.462	1
Soil chemical properties	0.316	2	0.245	2	0.234	2
Soil physical properties	0.139	3	0.2	3	0.19	3
Terrain	0.066	4	0.076	4	0.052	4
Accessibility	0.039	5	0.033	5	0.036	5
Distance to markets	0.025	6	0.026	6	0.025	6

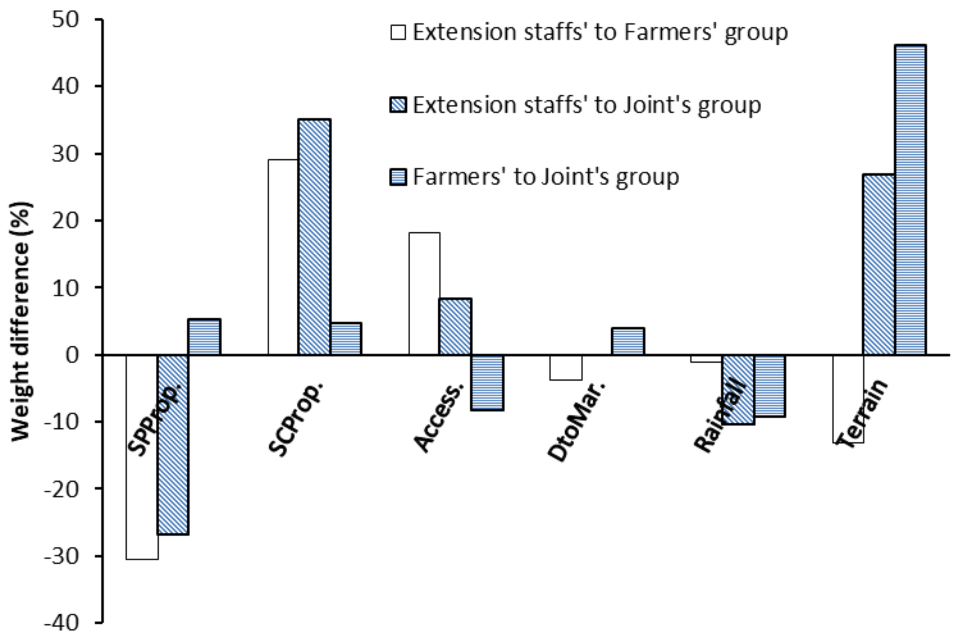

Figure 4. Extension staff's, farmers', and joint group's differences in perception of importance of criteria identified for allocating the land for rice production in Kilombero Valley. At value 0, there was no difference in perception between the groups on the importance of that attribute for rice production. Negative values imply the group gave lower importance to the attribute than the one it is compared with. Positive values imply the group gave lower importance to the attribute than the one it is compared with. SPProp. = Soil physical properties; SCProp. = Soil chemical properties; Access. = Accessibility; DtoMar. = Distance to market; Rainfall = Surface water resources; Terrain = Terrain.

However, there were differences on weights given for each criterion, differing from both the farmers and the extension staff groups.

Percentage differences in criteria weights between the joint group and the former two groups are depicted in Figure 4. The farmers' group prioritization of soil physical properties criteria was higher by 5% while that of extension staff was lower by 26.8% compared to the joint group prioritization of the same criterion. On the soil chemical properties criterion, farmers' scoring was higher by 4.7% while that of the extension staffs was higher by 35% over the joint group's scoring. It can be observed that the farmers' group scores for both physical and chemical soil properties were very close to the joint group's scores as compared to those of the extension staff. On the importance of accessibility, farmers' criteria were lower by 8.3% while those of extension staff were higher by 8.3%. The extension staffs' perception of the importance of distance to market criteria was the same as that scored by the joint group, while that of farmers group was up by 4%. There was no much difference between the farmers and extension staff differences against the joint group on the groups' priorities given to the surface water resources criteria. The farmers' weight was lower by 9.3% while that of extension staff was lower by 10.4%. On terrain, the joint groups' results suggest that the farmers group emphasized the importance of terrain by 46.2% while the extension staff was 26.9%.

From these results, it is observed that famers' weights were generally very close to the joint group's weights except for the terrain criterion (Table 5 and Figure 4). The differences between farmers' weights and joint group's weights are less than 10% for five out of six criteria, while only two criteria have their differences below 10% for the extension staff's weightings. This suggests that the farmers' were more consistent on assigning scores to the criteria compared to the extension staff. The farmers' consistence might be attributed to the hands-on experience they have in rice production, or un-preparedness of the extension staff.

The high inconsistence demonstrated in the side of the extension staff suggests the need to involve farmers in decision making process for better and sustainable land use planning. While studying farmers' perception of effectiveness of agricultural extension delivery in Cross-River State, Nigeria, Agbarevo (2013) found that extension delivery scored poor performance especially with farming system research and farmers training programmes partly due to being inadequately prepared for face to face dialogue with farmers. Another explanation could be giving up by extension staff group, since farmers have more stakes on the exercise. Despite the measure of inconsistence during the decision making using AHP scoring method, it is difficult to assess how group consensus was reached. Group interests may influence the final decision. For example, in a study conducted in Australia to incorporate community objectives in improved wetland management using AHP, it was observed that the conservation group predominantly preferred option where no investment is made and the wetland is maintained in its pristine condition, the business group predominantly preferred option where maximum investment can be made, while the recreation group predominantly preferred option where some investment is also made (Herath, 2004).

These results may lead to refocusing of decision making process for projects and programmes involving small holder farmers in Africa, where the top down approach has been common and the experts, including extension staff assume superiority in knowledge (Beynon et al., 1998; World Bank, 2007; Agbarevo, 2013). The process can also be used in policy formulation.

While this study has employed AHP method in land use planning for rice production, the strength of the tool can be applied in other decision making processes requiring involvement of all stakeholders. The tool has been used elsewhere in issues requiring stakeholders participation in decision making processes in public administration, environmental management, sustainability and energy issues, and agricultural policies (Duke and Aull-Hyde, 2002; Oddershede et al., 2007; Xu et al., 2012; Chávez et al., 2012; Kurka, 2013; Kukrety et al., 2013). Despite the flexibility of the AHP and that it can be adapted to different needs and contexts such as in ranking, choices, resource allocation, prioritization and conflict resolutions; the evaluation and analysis in AHP can become complicated when the number of the options and criteria are becoming higher (Bharwan et al., 2013). Also, it should be noted that the success of the AHP method depends on correct structuring of the decision problem, how the pair wise comparisons are carried out, and provision of credible answers by the respondents.

Conclusion

This work involved farmers in a land use planning process whereby six attributes identified as important for rice production were scored and ranked using AHP. Farmers and extension staff agreed on overall importance of each identified criteria by ranking them the same, but differed on the scores of some of the attributes. Farmers' scores of the attributes were consistent and made a better representation of the rice growing situation in Kilombero Valley, such as not putting overemphasis on soil chemical properties, which can be addressed by application of appropriate fertilizer or lime, over the soil physical properties, which cannot be easily rectified. This study demonstrated the ability of the farmers to influence the land use planning process in a positive way since they know their areas better by working on it. Involving the land users in such exercises will contribute towards sustainable land uses and improved agricultural production. Similar process can be adopted to get participation of all stakeholders in policy formulations.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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