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LINKING LIVELIHOOD IMPROVEMENT AND ENVIRONMENTAL CONSERVATION: CASE OF EAST ULUGURU MOUNTAINS IN TANZANIA

Mattee A.Z., Mahonge C.P.I.*, Nsenga J.V, and H. Kayeye

Sokoine University of Agriculture, Box 3035, Morogoro Tanzania
*Corrrespondence to: cmahonge@gmail.com

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ABSTRACT

Livelihoods improvement and environmental management need to be linked. In order to attain sustainable livelihoods and environmental management, it is important to empower natural resource users with skills on the interdependencies between livelihoods and natural environment. Among the strategies to achieve this is through an action research wherein various resource use options are tested and the interplay among the tested options is determined. In this paper, we present and analyse results obtained from an action research that focused on participatory improvement of farming practices and rehabilitation of watershed through tree nursery management and tree planting in Nyachilo village situated in the East Uluguru Mountains. In the farming trial, we tested conventional ridges, *ngolo*, contour, and traditional slash and burn flat cultivation (the control) technologies on the basis of their potential to improve yields and control soil erosion. The findings indicated that *ngolo* ranked the first whereas conventional slash and burn technology ranked the last; farmers showed a desire to learn about useful technologies to improve their traditional farming system. As for tree planting, there existed internal heterogeneities as reflected in the heterogeneous participation of local people in tree nursery management implying that in order to thoroughly understand the community, it is necessary to unpack it and analyze its constituent parts. We concluded that a though analysis of the dispersion of a given community is imperative as such scrutiny may lead to an accurate determination of the practical mix of the community strata for effecting the desired ends.

Key words: livelihoods, environment, participation, local people, heterogeneity

INTRODUCTION

Although strategies for livelihood improvement and environment conservation are linked (Dixon and Wood, 2003; Abbot and Hailu, 2001; McCornick et al., 2003; Dixon, 2005) because the security of livelihoods can be attained through utilization of natural resources, sometimes strategies of these interlinked sectors may be de-linked. Natural resources conservationists and practitioners may strategise to attain sustainable resource conservation while ignoring influences from livelihood-based strategies. By the same token, livelihood promoting practitioners may envisage improving living standards of the people through the use of natural resources without integrating environmental concerns. In essence, these two kinds of strategies may not sustainably proliferate without considering existing and potential influences on each other (Vosti and Reardon, 1997). Because people's livelihoods depend on the exploitation of the existing natural resources, in any specific area and at any particular time, strategies to improve the livelihoods should go along with strategies to sustain natural resources (Tengö and Belfrage, 2004; Rampal, 1993; Barrow and Fabricius, 2002).

In order to attain sustainable livelihoods and environmental management, it is important to, amongst others, impart natural resource users with necessary knowledge and provide them with

options so that they can improve their livelihoods while sustaining the natural environment. Among the strategies to achieve this, is through a participatory action research wherein various resource use options are tested and the interplay among the tested options are collaboratively assessed. Such assessment is critical for gaining better understanding of the community's rationality and the capacity in the use of locally available resources. From this assessment, it is possible to uncover active and deadlock areas and hence recommend appropriate strategies for sustainable livelihood and environmental improvement.

In this paper we assess the results from an action research that focused on participatory improvement of farming practices and rehabilitation of watershed through tree nursery management and tree planting in Nyachilo village situated in the East Uluguru Mountains. The paper is organised as follows. In the next two sections a research methodology is presented followed by description of the case study, then presentation and discussion of the research results, and finally conclusions from the research.

METHODOLOGY

Before presenting the methodology used in this research we briefly describe the research area, the East Uluguru Mountains. The East Uluguru Mountains are part of the Uluguru Mountains that stretch between 06°51' and 07°12' South and between 37°36' and 37°45' East and form one of the component blocks of the Eastern Arc Mountains of Kenya and Tanzania (Lovett, 1988; Lovett, 1990). The action research was conducted in Nyachilo village with elevation ranging from 500 m to 1200 m. above sea level. The average rainfall is over 1800 mm per year whereas the mean annual temperature varies from 23 °C to 17 °C at lower and upper limits respectively.

The vegetation cover is dominated by *Pterocarpus-Combretum* woodland, and below 900 m is found Miombo woodland comprising *Brachystegia boehmii*, and *B. bussei* tree species and tussock grasses dominated by *Hyparrhoria rufa* and *Panicum maximum* (Lovett and Pocs, 1993). The riparian vegetation includes *Milcia excelsa, Khaya anthotheca*, *Ficus spp* and *Burkea Africana*

Action research methodology was used to test integrated livelihood improvement and environmental management practices in Nyachilo village in East Uluguru Mountains. Under this methodology, participatory plans were laid down and implemented, the performance of pilot activities was observed, reflections were made on the outcomes, and revisions were discussed by different actors including researchers and local people.

Pilot demonstration activities were established. While only one farming experimental plot was established on the upstream area, two tree nurseries were established, one on the upstream area and another on the downstream area of the study village. For both spatial localities and activities, gender dimension was considered wherein, not only did women participate in pilot activities, but also they assumed leadership positions farmers' groups. Besides integrating women in the action research teams, age was another important aspect that was integrated wherein various age classes (i.e. youth and elderly villagers) were represented.

Other complimentary methods included GPS points marking for the general/communal trial plot and individual/private farmer's trial plots to indicate how the technologies diffused from the general trial plot to the individual farmers' plots.

Farming and Tree Planting Experiments

In this section we briefly describe the evolution of participatory crops farming and tree planting trials in Nyachilo village.

During the first phase of the project titled "establishment of the technical prototypes of rural development activities for the integrated land resource management and environmental

conservation in the Uluguru mountains landscape" which was implemented from year 2004 to year 2007 by SUA Centre for Sustainable Rural Development, the following were among the main observations. One of the critical reasons for encroachment and degradation of natural forests and water sources was the decline of production for farm plots situated on the lower slopes of Uluguru mountains after consecutive cultivation practices. Another reason was the lack of alternative sources for wood based products for construction, cooking energy and other household purposes.

Based on these findings, the researchers (from Sokoine University of Agriculture) and Nyachilo farmers discussed a way forward and decided to establish trial interventions as an important step towards establishing solutions to unsustainable use of natural resources (farming land, forest, and water). The ultimate purpose was to simultaneously improve the livelihoods and conserve the environment (watershed). The proposed interventions entailed the establishment of a tree nursery, and of an on-farm trial to test and develop appropriate farming technologies in the area. These two interventions are interdependent in the sense that the revitalisation of farming practices for the abandoned unproductive plots on the lower slopes could reduce the encroachment of forests and watershed on the upper slopes. In a collaborative way, researchers and farmers resorted to experiment with conventional ridges, *ngolo* [1], contour farming, and traditional slash and burn flat cultivation (the control) practices. Maize (*Zea mays*) (Staha L. var), and beans (*Phaseolus vulgaris*) were tested. These decisions were based on farmers' priorities mentioned during participatory rural appraisal (PRA) conducted prior to the establishment of the action-based trials.

Because the geography of the village was heterogeneous, the aspect which translated into different weather conditions, wherein the upper area was colder than the lower, it was agreed that two tree nurseries should be established to cater for these climatic variations. Although all the farmers participated as one group in the general farming trial, they had to split into two groups each to manage one tree nursery at the upper and lower spatial positions of the research village.

RESULTS

Indicative Time and Labour Invested in the Preparation of the Trial Plot

Time and labour invested during laying-out of the trial plot are presented in Table 1.

The results in Table 1 indicate that the most time was used in the preparation of ridge plot and the least time was employed in the preparation of traditional slash and burn plot. For the ridge plot however, one less person participated in the preparatory work, and the practice was new to the majority of group members. Nevertheless, the time indicated in Table 1 should be taken as indicative, because the laying out of the trial plot was conducted as a participatory learning process entailing directing, practicing, questioning, and discussing.

Crops Performance (Yield) and Farmers' Perception and Ranking of the Tested Technologies

Farmers' ranking of the performance of the tested technologies is indicated in Table 2. Generally, the yields obtained from all sub-plots for all crops were poor.

The comparison of yield obtained from this study with that reported by United Republic of Tanzania (URT, 2006) for Morogoro region is summarized in Table 3. The yield from the present research is lower than the one provided by URT (2006). This poor performance was attributed to unexpected higher rainfall intensities that ruined the crops.

[1] An indigenous farming system which is a combination of ridges and pits on a sloping area. This indigenous farming technique originated in Mbinga District in Ruvuma Region.

However, because the impact of weather conditions was constant for all sub-plots, farmers had to compare the performance of different technologies regardless of generally poor yields realised. To the farmers, *ngolo* ranked first because of its ability in controlling soil erosion as evidenced from the comparison of the amounts of eroded soils deposited in the collecting wire-mesh at the farming trial plot. Also, when farmers compared the vigour of the crops, *ngolo* ranked the highest compared to crops raised under other technologies.

Farmers' Evaluation of the Tested Technologies

After the first phase of the trial, farmers that participated in it were asked to evaluate the performance of the tested technologies, and specifically comment on the strengths and weaknesses of each technology, as well as mentioning the lessons learnt from the trial. The results of the evaluation are indicated in Table 4.

Generally, farmers remarked that *ngolo* performed better than the other three technologies regardless of the general poor yield obtained across all technologies. However, farmers were aware that poor crops performance in terms of yields was attributed to unexpected higher rainfalls that ruined the crops. They recommended the trial to be repeated.

Scaling Out of Outcomes of the Project at Farmers' Level

Farmers have a desire to learn about the useful technologies, and improve their traditional farming system. This argument is substantiated by the fact that farmers tried to make *ngolo* trials at their own farm plots, as indicated in Figure 1 (prepared through GPS points marking) showing the diffusion of *ngolo* technology from the general trial plot to individual farmer's plots.

This desire was activated by their witness of the comparatively good performance of crops under *ngolo* management system. However, as with the general trial plot, though initially the performance of beans at the farmers' fields was good, later the crop was ruined by higher rainfall intensities and thus less than expected yields were realised (Table 2).

Comparison of Quantity of Eroded Soils for the Trial Farming Technologies

Comparison of the quantity of eroded soils for the tested technologies is presented in Table 5. The results indicate that more soil was eroded from the contour plot (7 tones/ha), followed by the slash and burn (5 tones/ha), ridges plot (4.1 tones/ha) and lastly *ngolo* plot (2.8 tones/ha). On average, the slope of the area was 45%. The results for soil erosion show that contour ditch does not seem to be appropriate for the area.

However, though slash and burn and contour plots experienced more soil erosion and less yields, comparing the two, some maize yield was realised for contour plot as indicated in Table 5, but nothing was realized at all for slash and burn flat cultivation. Generally, *ngolo* technology seems to be appropriate for the area regardless of the higher indicative time (5hr) invested during its preparation (Table 1). Based on the findings in terms of yields and amounts of the eroded soils, and the overall poor performance of the traditional slash and burn technology, the farmers remarked that it is worthwhile to invest some more time with *ngolo*, and realize good outcomes, than the fear to invest more (i.e. practicing slash and burn) but realize poor outcomes. On the basis of time investment, farmers were of opinion that costs in terms of time could be reduced by promoting the use of social capital such as an association of farmers (farmers groups) to assist one another at farm preparation stage.

Yields at Individual Farmers' *Ngolo* Plot

Similar to the situation observed at the general trial plot, though the initial growth and general performance of bean crop in the private farmers' plots seemed good, low yields were finally realized. Number of cultivated *ngolos* together with amount

of seed sown and yield realized from the *ngolo* are indicated in the Table 6.

According to these farmers, the initial performance of the crops was good, but prior to pod formation some flowers were washed away, and thus fewer pods were formed per plant. Yet, the formed pods rotted, due to the continued high moist conditions.

Tree Nursery Management and Planting

Table 7 compares farmer groups that were involved in the management of tree nursery and in tree planting activities. Two farmers groups from the upper and lower geographic localities of the project area were involved. Through these findings it is possible to suggest possible considerations for the local actors to appropriately participate in environmental management.

From Table 7 we note that the tree nursery established on the upper locality of the village was well managed by farmers group itself till the time of planting out to the field. During planting out, members in the upper locality shared the trees amongst themselves, each taking a number he/she could afford planting (from 50 – 200 tree seedlings). Unlike the upper locality, in the lower locality of the village, where the second tree nursery was established, it necessitated the involvement of school pupils in the management of this nursery because the inhabitants in this locality abandoned the tree nursery. However, when tree seedlings were ready for planting out, all the seedlings questionably disappeared from the tree nursery. When the follow up was made, it was uncovered that the same inhabitants of the lower locality uprooted the tree seedlings from the tree nursery and planted the trees in their fields. Though these inhabitants would not actively participate in the management of the tree nursery, their act of picking trees from the nursery and planting into their own fields implies that these residents understood the importance of trees. However, as indicated in Table 7, economic and institutional drivers motivated the local people in the lower locality to pick trees from the tree nursery and plant them out in their fields though the residents had previously abandoned the tree nursery.

These findings indicate that administratively one community (Nyachilo village) manifests internal heterogeneities as reflected in their heterogeneous participation in tree nursery management implying that in order to thoroughly understand the community, it is necessary to unpack it and analyze its constituent parts. Such unpacking can follow spatial heterogeneities, socio-economic differences, gender lines, intra-ethnic cultural diversities based on the external influences (exposure), or a combination of these, etc. This heterogeneity in social participation dimension is a manifestation that local areas are not only diverse in terms of spatial and climatic scales but also in terms of a socio-cultural scale.

Although Table 7 indicates some similarities and differences in the participation of the two community groups in the management of tree nurseries, it is yet difficult to exclusively attribute the observed differences to intra and inter-cultural diversities. The interactions between the intra and inter-cultural diversities and participation of the local people in livelihood improvement and environmental conservation are worthy of further analysis.

Table 1: Indicative time and labour used in laying-out of the trial plot

Technology	Plot area (m^2)	Number of units	People participated	Time used (hrs)
Ngolo	200	50	17	5
Ridges	200	16	16	6
Contour	200	4 contour ditches	17	4.5
Slash and burn	200	Not applicable	17	2

Table 2: Crops yield and farmers' ranking of the tested technologies at the demo-plot

Sub-plot Aspect	Ngolo	Contour ditch	Ridges	Flat cultivation
Soil erosion control (ranking)	1st	3rd	2nd	4th
Crop yields:				
• Beans	28.9 kg/ha	0	22.9 kg/ha	0
• Maize:	400kg/ha	220 kg/ha	320 kg/ha	0
o Total Dry weight (TDW) for 23 stems	290 kg/ha	70 kg	160kg/ha	0
o Cobs + grain + sheath	230 kg/ha	60 kg/ha	140 kg/ha	0
o Cobs + grain	160kg/ha	99 kg/ha	40 kg/ha	0
o Grain				
Farmers' ranking	1st	3rd	2nd	4th

Table 3: Comparison of yield obtained from this study with average yield according to URT (2006)

Crops	**Yield** (tonnes/ha)			
	Present study			**URT 2006 (Past Study)** (Average yield)
	Ngolo	Contour ditch	Ridges	
Maize	0.16	0.099	0.04	0.6
Beans	0.0289		0.0229	0.42

Table 4: Farmers' (qualitative) evaluation of the tested farming technologies

Technology Aspect	**Ngolo**	**Ridges**	**Contour**	**Slash and burn**
Crops growth	Robust plants compared to those grown under the other farming technologies	Next to ngolo	Next to ridges	Nothing remained since all crops were washed away by rainfall
Management practices	• Plot preparation took more time	• Plot preparation took less time than ngolo	• Plot preparation more took time than ngolo	• Least time used for plot preparation
	• Weed infestations was minimal; were removed through uprooting by hand	• More weeds, Weeding was done using a hand hoe	• Less weeds, and were removed using a hand hoe	• Almost the whole plot was covered by weeds
Soil erosion	• Least soil eroded	Lesser soil eroded	Less soil eroded	• More soil eroded than the other three technologies

Table 5: Eroded soils for the experimented farming technologies

	Ngolo	**ridges**	**Contour**	**Slash and burn**
Amount of eroded soil	55.6 kg/100 m^2 (2.8 tones/ha)	82.2 kg/100 m^2 (4.1 tones/ha)	131.10 kg/100m^2 (7 tones/ha)	96.67 kg/100m^2 (5 tones/ha)

Table 6: Yield performance of farmers' ngolo trial plots

Farmer	**Ngolo number**	**Estimated sown bean seeds (kg)**	**Estimated yield (kg)**
The first farmer	10	1	1½
The second farmer	34	¾	1

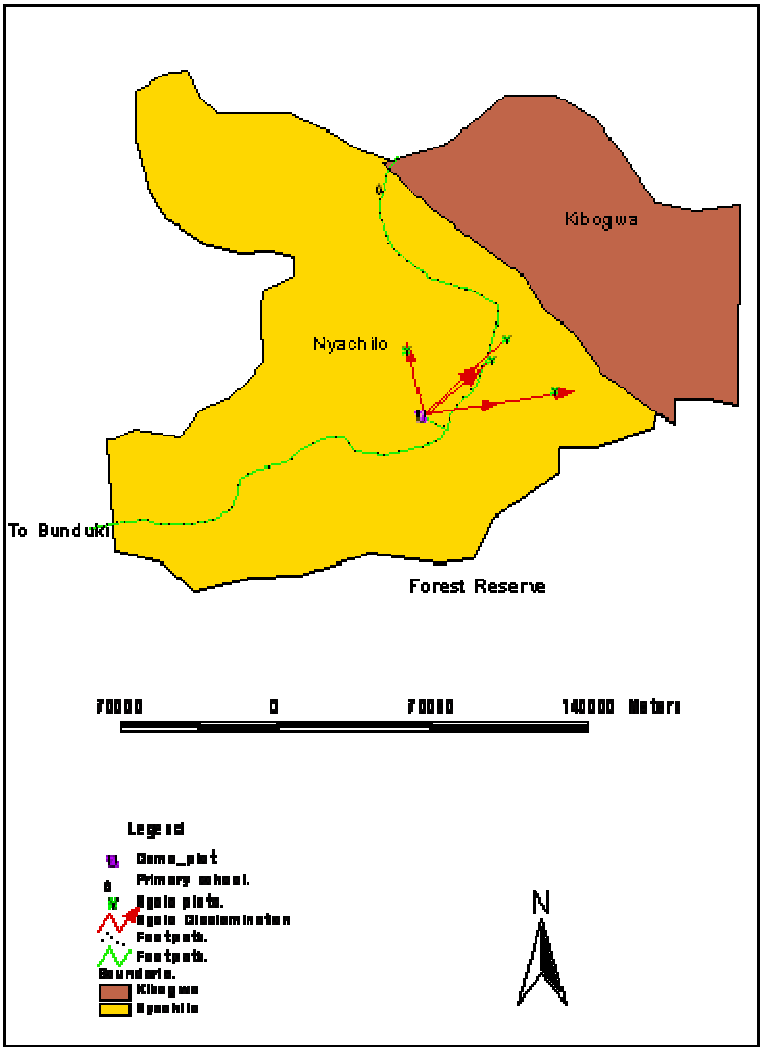

Figure 1: Diffusion of *ngolo* trial from the common demo-plot to individual farms

Table 7: Comparison of farmers groups that were involved in tree management in the study area

Attribute/characteristic	**Upper locality tree nursery managing group**	**Lower locality tree nursery managing group**
Participation in the management of the tree nurseries	Good	Poor
Support in the management of the tree nurseries	NIL	The tree nursery was abandoned so the village government asked a primary school to take care of the tree nursery
Location of the group members	From both the upper and lower localities of the project area	From only the lower side of the project area
Date the group was formed	Mostly members from a road maintenance group formed in 1999	Mostly members from a road maintenance group formed in 1999
Trees at the planting out stage	The group members formally shared the trees and each planted around the homestead and other areas	All the trees questionably disappeared from the tree nursery. Though the school was the new caretaker and had wished to have some tree seedlings, it ended up not getting any.
Reasons for questionable disappearance of tree seedlings from the tree nursery		-Seeing a tree being purchased at 60,000 Tsh by pit-sawyers from outside the project area -Notice for strict enforcement of by-laws against forest encroachers/degraders by forest officials
Exposure (to where)	Some members have had lived in Dodoma and Dar es Salaam, and still have relatives in these regions. -encounter with outsiders e.g. WCST, forest officials, etc.	Some members have had exposure to Zanzibar and Dar es Salaam and still have relatives in these regions
Culture	Most members for the group on the upper side of the project area hold hybrid inland –coastal culture	All members for the group on the lower side of the project area hold coastal culture

DISCUSSIONS

A decision making process of a farmer is influenced and shaped by various factors (Wilks and Murphy, 1986; Willock et al. 1999; Scott, 2005; Negash, 2007). Though we can, in no way, exhaust all the influencing factors, in this study, the important factors were time, labour, availability of alternatives, knowledge power to exploit potential knowledge and performance especially in terms of yields/benefits. Although environmental stability is important for sustainable management of farmers' fields, environmental conservation concern may not receive immediate farmers' attention perhaps because of ignorance of inevitable interdependencies between livelihood security and environmental sustainability, and/or the lack of alternative ways for ensuring livelihoods security. By comparing interacting influences from diverse factors a trade-off can be made of the most important and appropriate ones for specific farmer's environment. It is important that farmers

get informed on potential opportunities and constraints, then, be imparted with practical skills to enable them to make appropriate decisions (Colle and Yonggong, 2002).

Though farmers - in idealistic thinking - would have wished to have an option that is time, cost, yield and labour effective, in a realistic sense, it is almost impossible to have such a perfect situation. Farmers therefore have to select an option of which the output-input ratio is positive. The case we have presented reflects this contention. Although some much more time was invested - in terms of time and labour - in the preparation of *ngolo* compared to the traditional slash and burn cultivation system, the high yield potential indicated by *ngolo* plot incited farmers' desire to carry out more trials on *ngolo*. As introduced earlier, the farmers argued that it was worthwhile to invest more resources and realise higher harvest than to invest less and end up with poor harvest. The challenge is now on how farmers may devise coping strategies to reduce the cost in terms of labour and time invested. As we have seen in this research, social support networks can be among the options that can be adopted to achieve such labour and time efficiency (Rahadi and Widagdo, 2002)

Integration of practical soil harvesting structure (e.g. *ngolo* and contour ditches) was an imperative attribute for passing on knowledge to the farmers about options for sustainable land resource management. It may not be easy for farmers to believe that their conventional farming system negatively affects the environment and subjects their livelihoods system to the vulnerability in terms of poor long-term crop productivity. Through on-farm training on the interdependencies among soil erosion, deterioration of the soil fertility and poor yields farmers may be made to adopt sustainable land resource management techniques (Kingsley, 1999).

The use of two farmers' groups from the same community to analyse the community participation in environmental management has provided a room for substantiating assertion that the community is not homogeneous regardless of the presence of mainstream political and administrative identity within one community boundaries (Biot et al., 1995; Agarwal, 2001; Cornwall, 2000; Falconer 2000; Fajber, 2005). This indicates the existence of internal politics in the externally-viewed-one community (Leach et al. 1999; Le 2004; Cheong, 2004). Gaining insights on the dispersions of the community through testing the same attribute among different sections of the community (e.g. multiple farmer groups approach in this study) may be a significant approach for understanding how homogenous or heterogeneous the community is. The dispersions are important as key messages to interventionists that the community's logics, rationalities, view points, and so forth are variable based on diverse attributes, some of which may be hidden from the eyesight of an outsider. Understanding of such latent attributes needs a thorough analysis of the unpacked components of the community. Through such a process, it is possible to understand the diverse internal community logics and politics and translate these to sustainable livelihood and environmental management strategies.

CONCLUSIONS

- Farmers have shown a wish to change and improve their traditional farming system (traditional slash and burn) by moving from the common trial plot to their individual *ngolo* trial plots.
- For the farming trial, *ngolo* technology has proven to be superior in-terms of yields, and of reducing soil erosion. However, a more analysis is required on other variables such as a time and labour invested in the preparation of the *ngolo* technology. Besides, although some symptoms on the possibility of marrying livelihood and environmental interests started to manifest, the attainment of such a marriage would require much more and long-term efforts of imparting

people with skills at diverse spatial and temporal positions.

- Intra- and inter-cultural diversities appear to be among the factors that influence the heterogeneous participation of local people in livelihood improvement and environmental conservation. However, further research is needed to substantiate and concretise this proposition.

RECOMMENDATIONS

Strategies are required for making the *ngolo* technology acceptable to the farmers/communities. Such strategies include awareness creation, continuous pilot scale study for improvement, and creation of farmers association to ease information dissemination and to create social capital to cater for labour demand. This is important because *ngolo* technology still has some shortcomings such as long duration for plot preparation, which might decline farmers' interest in continuous application of the technology. As such, further research is required on the feasibility of the suggested strategies for the *ngolo* technology.

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