Original Research Article

THE CONTRIBUTION OF NEW RICE FOR AFRICA (NERICA) FARMING TO LIVELIHOOD SECURITY OF SMALLHOLDER HOUSEHOLDS IN MIGORI, KENYA

ABSTRACT

Improved people's livelihoods have a great potential to solve food insecurity issues**.** The uptake and use of enhanced agricultural technologies have been identified as one of the best ways to improve yields of smallholder rural farmers leading to improved livelihoods and stable socio-economic growth. This adoption has been attributed to higher incomes, better nutritional conditions, access to food stability and prices, more employment opportunities, and improved payments for the rural poor. NERICA rice was one such agricultural technology introduced in many countries across Africa to enable smallholder farmers to achieve food security.

Previous studies on NERICA adoption in Africa show mixed findings on its effect on rural livelihoods. The main objective of this study was to examine the influence of NERICA rice agricultural technology on the livelihoods of smallholder households in Migori. The study on agricultural technology adoption and livelihood is of great concern to many stakeholders in Kenya because previous studies report low adoption of agricultural technologies in rural households of smallholders whose livelihoods depend on farming and are food insecure.

The study was carried out in Migori County. Multistage sampling was used by combining purposive and simple random sampling. Data was collected from 262 NERICA rice farmers selected using a simple random sample, 22 key informants were purposively selected and interviewed, and eight focus group discussions were conducted from purposively selected NERICA rice-farming villages. Quantitative data was analyzed using SPSS computer software. Qualitative data were analyzed using thematic analysis, and the integrated data was triangulated and used to write this report. The findings revealed that the adoption of NERICA contributed to the livelihoods of smallholder farmers by increasing their incomes, creating food security and enhancing their social capital.

Key Words: NERICA, Agricultural technology, rural livelihoods, food security, incomes, social capital, smallholder farmers.

1. INTRODUCTION

This study focused on adoption of new rice for Africa (NERICA) agricultural technology as an alternative source of livelihood in Migori Kenya. NERICA was introduced in 2009 to enhance the community's food security and improve the livelihoods of smallholder farmers. A study by Kibwage [7] reported that Migori county was food insecure due to the monoculture of tobacco and sugarcane, which took large acreages of land from the farmers, leaving them with minimal land to use for food production. The two crops gave poor returns to the farmers, which was inadequate to buy food or sustain a livelihood. The major crops grown are; traditional vegetables, beans, maize, groundnuts, and coffee on a small scale basis. In livestock farming, farmers keep free-range and zero-grazed cattle, sheep, goats, and poultry.

A study by Kenya Women Scientist Centre, [8] reported on the status of National Food Security which ranked Migori County at number 43 out of the 47 counties in Kenya regarding food insecurity. This showed that the people of Migori did not have adequate physical access to food and their livelihoods were weak. The county demographics and trends further reported a high population increase in Migori, creating more food demand, [9]. The county introduced New Rice for Africa (NERICA) varieties to increase the area under rice cultivation and double its resilience and yield performance. The county has acknowledged that it continues to experience food insecurity and livelihood challenges [9]. Although many farmers have introduced NERICA as new technology and received the inputs, there is currently no evidence that the introduction of NERICA has had any impact on alleviating this situation.

The livelihoods of the people have great potential to solve food insecurity issues. Action against hunger [10] defines livelihoods as different assets and activities that enable individuals or households to achieve their means of living. Smallholder farming, including animal husbandry, fishing, and non-farm activities, are the predominant livelihood systems in the developing world, characterized by high poverty levels and hunger [11]. To overcome challenges associated with rural agriculture, such as soil fertility, weather, and climatic variability, rural households in developing countries will have to deploy strategies such as agricultural intensification, technology adoption, and livelihood diversification to secure their livelihoods [12]and [13].

The uptake and use of enhanced agricultural technologies have been identified as one of the most excellent ways to improve yields of smallholder rural farmers, leading to improved livelihoods and stable socio-economic growth. This adoption has been attributed to higher incomes, better nutritional conditions, access to food stability and prices, more employment opportunities, and improved incomes for the poor rural Kasirye [14]. On a similar note, Kariyasa and Dewi [15] reported that adopting improved technologies enhances productivity, creates food security, improves livelihoods, and later translates to socio-economic development. This was echoed by Jain et al. [16] who reported that non-adopters of agriculture technologies can hardly maintain their marginal livelihoods and are more prone to socio-economic stagnation, which often results in deprivation.

Previous studies on NERICA adoption in Africa show mixed findings on its effect on rural livelihoods. A survey by Kijima [1] in Uganda showed a low adoption rate of NERICA at an estimate of 4 %. However, this study did not examine the effect of NERICA on the livelihoods of rural farmers. The study addressed the contribution of NERICA to household incomes, and this approach did not give a complete picture since the concept of livelihoods goes beyond household income. Similarly, Diagne et al. [2] conducted a study on NERICA agricultural technology adoption in Cote d' Voire and established the adoption rate to be at 4% only. The author examined the contribution to household food security but did not address other livelihood aspects. Diagne et al. [2] reviewed the factors that influenced the adoption of NERICA rice technologies in the Gambia. They evaluated the adoption rate at 40%, and the authors did not go further to show how this impressive adoption may have affected the livelihoods of the households of the NERICA farmers. Other studies in West Africa examined the adoption rates and factors that determined the adoption, but they did not examine the effect of NERICA adoption on Livelihoods. Their studies addressed single aspects of livelihood hence not addressing the concept of livelihood in totality. Adesina A. A [1]; African Rice Center [4]; Diagne et al., [2]; Doss et al. [5]; Dunstan et al., [6]. The authors of this paper concluded that the previous studies on NERICA gave fragmented results on the contribution of the rice on livelihood hence not giving a complete picture of the contribution of NERICA to the livelihoods of smallholder farmers.

The main objective of this study was to examine the influence of NERICA rice agricultural technology on the livelihoods of smallholder households in Migori. The study on agricultural technology adoption and livelihood is of great concern to many stakeholders in Kenya because previous studies report shallow adoption of agricultural technologies in rural households of smallholders whose livelihoods depend on farming and are food insecure.

2. MATERIALS AND METHODS.

2.1 Description of the study area

The study was conducted in the villages of Awendo and Uriri Sub Counties in Migori County. Migori is located in south-western Kenya bordering Homa-Bay, Kisii, and Narok Counties. (Fig 1). The county comprises six administrative sub-counties: Uriri, Awendo, Rongo, Kuria, Migori, and Nyatike. The inhabitants are Luos, Luyha, Abagusii, Suba-Luos, Somalis, Nubians, Indians, and Arabs. The total population of Migori was 1,116,436 persons comprising 553,618 males and 580,214 females, Kenya National Bureau of Statistics [17].

The study purposively selected Awendo and Uriri sub-counties because they were the only ones where NERICA rice was grown; the two were identified to be food insecure because they were dominated by smallholder farmers who overly relied on monoculture of sugarcane and tobacco that gave them poor returns after waiting for 24 months [7]. Awendo is purely Luo-speaking people, while Uriri has inhabitants from Kuria and Maragoli who have been assimilated into the Luo culture and language over time. The county lies above 1500 m above sea level and descends 100 m at Migori River. The county experiences two rainfall seasons in a year; March to May and October to December. The temperatures range between 21^{o}C -35^{o}C. The soils are well-drained and tend to be loamy.

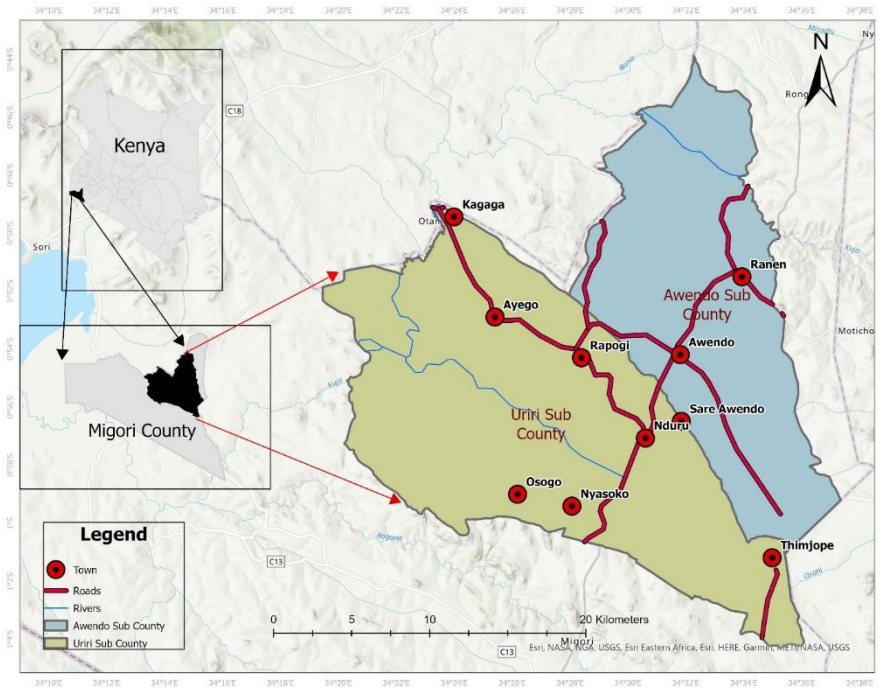

Fig 1: Map of Migori showing Awendo and Uriri Sub counties

Source: IEBC 2017

2.2 Study Design

The study was a mixed-method descriptive research design, encompassing qualitative and quantitative approaches. The study utilized the respective strengths of qualitative and quantitative approaches. According to Campbell et al. [18], mixed methods are a powerful way to enhance the validity of results. A Household survey, focus group discussions, and key informant interviews were conducted.

2.3 Data sources

Primary and secondary data were used in the study. The primary data were collected through focus group discussions (FGDs), key informant interviews(KIIs), and household interviews. The FGDs and KIIs took an in-depth approach whereby the respondents freely discussed the livelihood, food security and farming of NERICA and its effect on livelihoods. A checklist of questions was used to guide and narrow the discussions to relevant issues around the research objectives. Secondary data were collected from the documents with information pertinent to the study. Policy documents, including the National Rice Strategy [19], the Migori County Integrated Development Plan, County Annual Plans, and journal articles, were reviewed. Data of the household survey were triangulated with the qualitative data from the focus group discussions and key informant interviews. This is in line with Descombe [20], who supported using methodological triangulation with alternative data collection methods to complement or supplement the findings from other methods.

2.4 Sampling and sampling procedures.

Multistage sampling was used, whereby a combination of purposive and simple random sampling procedures was used. Migori County was purposively selected in the first stage of the sample out of the 47 counties in Kenya, based on a study on the national food security status that ranked Migori number 43 out of the 47 counties in terms of national food insecurity status. In the subsequent stage, Awendo and Uriri Sub counties were purposively selected because they were identified as the most food-insecure owing to their monoculture of sugarcane and tobacco, which had occupied large acreage of their land with minimal returns and little land left for food crops. The two sub-counties were the only ones farming NERICA rice, having been identified by the Migori County Government for the rice intervention for food security. Purposive sampling was further used to determine the villages of the rice farmers. Finally, the rice farmers were selected using a simple random sample, creating a sampling frame.

The representative sample size of the household interviews was computed. The sample size was calculated from a finite population at a 95% confidence level and 5% of variability using the Krejcie and Morgan [21] sampling model given by

$$n = \frac{X^2 Npq}{d^2(N-1)+X^2 pq}.$$

Where, n = the desired sample size, X^2 = Chi-square value for 1 degree of freedom at 95% confidence level, N = Target population, p = population proportion, q = 1 – p, d = degree of accuracy (margin of error) expressed as a proportion (0.05). Given the target population of 822 NERICA farmers, the sample size was determined to be

$$\mathrm{n} = \frac{3.481*822*0.5*0.5}{0.05^2(822-1)+3.841*0.5*0.5} = 263 \text{ farmers}.$$

From the above sample, the study distributed it proportionately to the two sub-counties, Uriri and Awendo, whose populations were 226 and 596 farmers, respectively. These samples are given as

$\frac{226}{822} * 263 = 72\ farmers\ \ and\ \frac{596}{822} * 263 = 191\ farmers$, respectively.

Eight villages were purposively sampled for FGDs. The eight villages spread across the two sub counties purposively selected for the study. These include Kamuresi, Nyarombo, Nyakuru, Nyambicha, Oyuma, Mori, Pinyowacho, and Thim Jope. The villages spread across the two sub-counties of Awendo and Uriri. Eight focus group discussions were conducted, one in each of the purposively sampled villages,

constituting 10-12 rice farmers. The researcher facilitated the discussions and outlined the goals of the study.

A checklist of questions was used to guide the discussions and made field notes. Twenty-two key informant interviews were conducted. The Key informants from the relevant stakeholders in the rice value chain were purposively sampled and interviewed using an interview guide. These included the sub-county extension officers, sub-county agricultural officers, the director for agriculture, and the crops officers in both Awendo and Uriri. The community's old and resourceful rice farmers were purposively identified and interviewed. These were the ones the community regarded as opinion leaders because they represented the community in cultural activities, rites, and rituals. A total of 22 key informant interviews were conducted as follows; 1 county director for agriculture, one county crops officer, two sub-county agriculture officers, three sub-county extension officers, three village elders, three old and resourceful NERICA rice farmers, two rice researchers from KARLO Kibos and JAICA and one rice promotion officer from the National Office Ministry of Agriculture.

2.5 Data collection methods

The primary data were collected using a mixed-method approach. Quantitative data were collected through household interviews, while qualitative data was collected using focus group discussions (FGDs) and key informant interviews (KIIs), and later integrated. The household interviews were conducted using a structured questionnaire with open-ended and closed-ended questions. A checklist of structured questions corresponding to the study's variables was used to guide the FGDs and KIIs. This was meant to provide in-depth information on the adoption of NERICA rice and its contribution to household livelihood security.

The data analysis methods used were descriptive and qualitative thematic analysis. The structured questionnaire data were cleaned, coded, and analyzed for descriptive analysis using Statistical Package for Social Sciences (SPSS) Version 23. Descriptive statistics of the main variables of the study were calculated and presented using frequency distribution and percentages.

Regarding qualitative data, transcriptions of field notes from the FGDs and KIIs were grouped into emerging themes corresponding to the study objectives. Notes were written along with the emerging themes, and appropriate conclusions were drawn. The FGD and KII data were demonstrated using vignettes from the corpus of quantitative data, which further reflected the findings' authenticity. Both results were triangulated and used in the preparation of this article.

3. Results and discussion

3.1 Main sources of household livelihoods of the NERICA rice farmers

The primary sources of livelihood for the NERICA farmers included farming, business, and employment. Some farmers practiced agriculture only as a source of household livelihood while others engaged themselves in off-farm activities such as small-scale business; other farmers combined both business and farming. These sources provided income and wealth, which they used to sustain their household livelihoods.

Table 1 below shows that 74.4% of the respondents and 45% of their spouses drew their income mainly from farming. Further, 14.1% and 9.5% received their income from agriculture and business. It was also noted that despite some of the residents having other sources such as employment and mining, they also practiced farming as a source of income. Cumulatively, it was determined that 91.2% and 54.9% of the respondents and their spouses depended on agriculture as a source of income respectively. Nearly 18.3% of the spouses were reported to have no income source, while 17.6% were deceased.

Table 1: Main Sources of Income for the Respondents and their Spouses

The main source of income (Occupation)	Respondent		Spouse	
	Number	Percent	Number	Percent
Farming only	195	74.4%	118	45.0%
Business only	15	5.7%	18	6.9%
Employment only	8	3.1%	6	2.3%
Farming & business	38	14.5%	25	9.5%
Farming & employment	7	2.7%	2	0.8%
None	-	-	48	18.3%
Deceased	-	-	46	17.6%
Total	**263**	**100.0%**	**263**	**100.0%**

Even though the farmers were engaged in a portfolio of livelihood activities, farming was noted as the leading social-economic activity and source of livelihood that was heavily relied upon by the farmers. The study is in line with Sen [22], who reported that farming is the main source of household food and livelihood in rural African countries. It equally shows that any intervention such as NERICA farming meant to improve the welfare of community members should be embraced more to enhance livelihoods. Similar sentiments were echoed by Chambers [23], who observed that farmers create a portfolio of activities through diversification of crops or crop farming and off-farm activities such as business enterprises, all meant to cushion them from external shocks and sustain livelihoods. The authors went further to examine the total monthly income of the NERICA farmers to establish their income capacity to support their livelihoods.

Table 2 shows that most respondents (39.4% of the respondents) earned between Ksh1,000 - 5,000 Ksh per month while 30.8% of their spouses earned similar income, 3.0% of the respondents had no earnings while their spouses with no earnings accounted for 39.2%, 21.3% made between 5,000 - 10,000 Ksh, their spouses who earned similar amounts accounted for 16.7%, and 25.1% of the respondents earned between. 10,000 - 20,000 Ksh per month, while 6.8% of their spouses earned similar amounts. A small proportion of 5.3% of the respondents earned above Kshs. 20,000 per month, while 4.9% of their spouses earned an equal amount.

Table 2: Total monthly household income

Income levels	Respondent		Spouse	
	Freq	Percent	Freq	Percent
None	8	3.0%	103	39.2%
Below 1000	14	5.3%	4	1.5%
1,001-5,000	105	39.9%	81	30.8%
5,001-10,000	56	21.3%	44	16.7%
10,001-20,000	66	25.1%	18	6.8%

20,001 and above	14	5.3%	13	4.9%
Total	**263**	**100.0%**	**263**	**100.0%**

The income earnings mentioned above imply that most respondents in the study area had low-income levels, which could hinder them from adequately addressing their household livelihood needs. The level of household income is a determinant of poverty levels and purchasing power of a household. This is an indicator of the social-economic status of the household members. It reflects the quality of their assets and capital that sustain livelihoods. In this study, the income levels would inform if the respondents could sustain a livelihood throughout the month and make other investments that could cushion them for future unforeseen risks and shocks, and adopt new agricultural technologies.

3.2 Wealth status of the farmers before the adoption of NERICA Rice

The authors used proxy indicators to determine who was a wealthy farmer in the study area. Table 3 revealed that regarding wealth indicators, 15.2% lived in permanent houses while 84.8% lived in non-permanent houses. 85.9% did not own any motor assets, while 13.7% owned motor assets. However, of the 36 households, only 2.5% lived in a permanent house and owned a private car, and only 0.4% lived in a non-permanent house that held a commercial vehicle. 12.9% of households owned motorcycles, with 10.0% living in permanent dwellings and 13.5% living in non-permanent homes.

Table 3: Housing and Motor-Asset Ownership

Lives in	**Owns**								**Total**	
	No Asset		**P. Car**		**C. Vehicle**		**Motorcycle**			
	Freq	**%**	Freq	**%**	Freq	**%**	Freq	**%**	Freq	**%**
A Permanent House	35	87.5%	1	2.5%	0	0.0%	4	10.0%	**40**	**15.2%**
A Non-Permanent House	192	86.1%	0	0.0%	1	0.4%	30	13.5%	**223**	**84.8%**
Total	**226**	85.9%	**1**	**0.4%**	**1**	**0.4%**	**34**	**12.9%**	**263**	**100.0%**

The above findings show that majority of the households were not able to accumulate assets that could be used to create wealth. This implies that with the low wealth indicators, the farmer's livelihoods could be weak since wealth reflects the amount of income accrued in the family. Wealth is an indicator of a farmer's ability to access new technologies and to manage the potential risks. The wealth status will further inform the intensity of adoption by a farmer Doss [5]. This is in line with Langyito and Mungoma [24], who found a positive relationship between high-yielding varieties adoption and the wealth status of the rural farmers.

3.3 The effect of NERICA adoption on farmers' livelihoods.

Figure 2 shows that 92.4% of the respondents concurred that growing of NERICA had improved their livelihoods, while only 7.6% indicated that increasing of NERICA faming had not improved their livelihoods in any way.

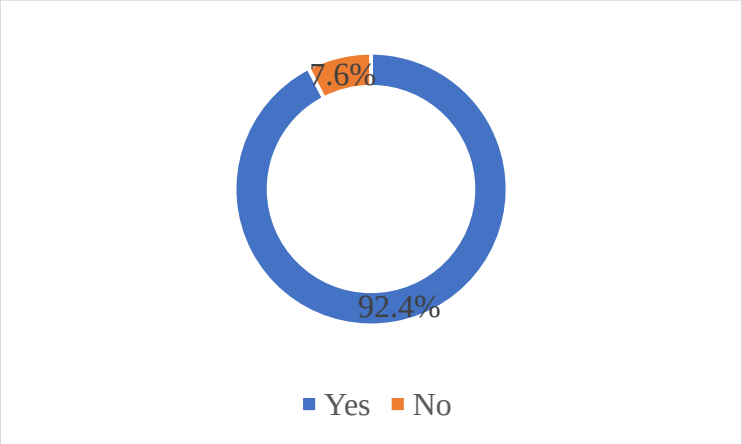

Figure 2: Improvement of livelihood due to NERICA

An FGD discussant from Nyakuru remarked,

"NERICA rice has improved food availability in my household; I can sell five gorogoro (5 Tins) of rice and make a thousand shillings, and now I have more money in my pocket which I can use to buy any other type of food or address other needs in my household."

These findings were further supported by the FGD discussions as shown above, where the respondents indicated that after farming the rice, their livelihoods improved in terms of more income and more food on their tables. They managed to add more food to the existing types and sold rice within the community to those who did not have. Through selling of rice, they earned income which supported their livelihood needs. The authors examined further if the adoption of NERICA had made their households food secure or not.

Table 4 revealed that 92.1% of the respondent affirmed that planting of NERICA had improved their household's food security. Out of this, 80.3% indicated that their households were better off regarding food security, and 14.6% indicated that food security had remained more or less the same. In comparison, 5.2% stated that they were worse off. NERICA rice was introduced in the community to create food security. For these farmers, there was more food because the rice added to the existing foods such as maize and traditional perennial foods. Given that rice could be sold to create income, it meant that with the available income, more food could be purchased from the local markets to fill that gap. This implies that rice filled the gap of food insecurity in the households of the rice farmers.

Table 4: level of food security as explained by the farmers.

			Household food security			Total
			Better off	More or less the same	Worse off	
Has planting NERICA improved your food security	Yes	Freq	187	34	12	233
		Row percent	80.3%	14.6%	5.2%	100%
		Column percent	91.7%	94.4%	92.3%	92.1%
	No	Freq	17	2	1	20
		Row percent	85.0%	10.0%	5.0%	100%
		Column percent	8.3%	5.6%	7.7%	7.9%
Total		Freq	204	36	13	253
		Row percent	80.6%	14.2%	5.1%	100%
		Column percent	100.0%	100.0%	100.0%	100%

3.4 NERICA Adoption and Food security

Table 5: Test for the association between improvement in food security and general livelihoods and the adoption of NERICA technology

Food security	**Adoption of NERICA**			Total
	Low	**Medium**	**High**	
Yes	11	30	175	216
No	6	13	18	37
Total	17	43	193	253
Chi-square =1.227; df=2; *P*=.034				
Improvement in livelihoods	**Low**	**Medium**	**High**	**Total**
Yes	10	34	179	223

No	7	9	14	30
Total	17	43	193	253
Chi-square =1.921; df=2; *P*=.001				

The study findings in Table 5 show sufficient statistical evidence to conclude that the people's improvement in food security and general livelihood depended on the adoption of NERICA rice technology at a 95% confidence level. This implies that the NERICA programme achieved its goals to a great extent by creating food security and enhancing the livelihoods of the farmers and similar sentiments were echoed in the FGDs as shown below.

Focus group discussant from Uyomo, Uriri Sub County remarked,

"NERICA *rice has increased some more food in my household, without rice we had to buy snacks such as bread, mandazi to eat in the morning with tea but now we can eat rice and tea for breakfast and save the 20 shillings or 50 shillings for buying the snacks. This cuts my expenses and improves my income*. *We also eat the rice for lunch and supper; this has reduced buying maize from the market; we now buy only wheat flour for chapatti, sugar, and cooking fat; we save the rest of the money."*

Before the introduction of NERICA rice, most farmers reported having been food insecure in their households because they focused more on sugarcane which did not pay, and did not have adequate access to food. Maize production was inadequate as food crops such as cassava, groundnuts, and sweet potatoes were not doing well. The majority of the households subsidized their food by buying from the local market while others got food in form of gifts from friends and relatives. This finding echoed Sen [23], who reported that in Africa, food security is achieved through farming however, the shortfall can be accessed from friends and relatives in form of gifts. Even though these farmers reported that they had bought other foods from the market, they did not have adequate income to purchase sufficient amounts of food, given that their income levels were low, as shown in this study.

Focus group discussant from Pinyowatcho remarked,

"We are happy to have rice now because when a community member is having a ceremony, rice is bought to cook for visitors. When a girl gets married, we can cook rice for the in-laws; rice is helping us to manage the festivities in our communities unlike before when we used to cook ugali."

3.5 How NERICA was used to enhance livelihoods.

Out of the respondents who indicated growing NERICA had improved their livelihoods in Figure 1, the findings in Table 6 show that the Majority of NERICA rice farmers, 70.4% of them, spent their income proceeds from NERICA for their households either directly by consuming it, or indirectly by selling it to address household livelihood needs. 49.0% used the proceeds to pay school fees, and 28.0% spent their money on entertainment.

Table 6: Use of income realized from NERICA.

Use of money from NERICA	**Responses**				**Total**	
	Yes		**No**			
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Water	42	17.3%	201	82.7%	243	100%
Food	171	70.4%	72	29.6%	243	100%

School fees	119	49.0%	124	51.0%	243	100%
Medical services	49	20.2%	194	79.8%	243	100%
Shelter	28	11.5%	215	88.5%	243	100%
Clothing	62	25.5%	181	74.5%	243	100%
Entertainment	68	28.0%	175	72.0%	243	100%

The above findings indicate that there were livelihood needs that the farmers were not able to address adequately before the adoption of the rice, which they started addressing with the income from the rice. This was similarly mentioned in the FGDs.

The respondent from Achego village in Awendo sub-county remarked,

"I *took two bags of rice of 50 kgs each to Kanyawanga secondary school where my son was studying, and the headmaster calculated and told me the amount of money I could offset the school fees for my son. This made me happy because my rice translated to money for the school fee. I felt the value of the rice*."

The education of children was highly valued in most households. Having learned children was perceived as a source of wealth for the family because educated children secure jobs and earn income that can support their parents and uplift the social-economic life of the entire household. They can also improve the well-being of their siblings by paying for their education and thus improving the lives of many family members. Educated children can also support themselves by sending money to their parents through remittances to buy food or other household needs. Given that majority of the farmers had little income to support their livelihoods, the education of their children needed a boost, and the income from the rice came in handy for this particular purpose. On this basis, most rice farmers used the proceeds from the rice or used rice as collateral to pay for their children's education.

A discussant from Nyakuru Village remarked,

"*When any family member falls sick, I don't have to take them to the hospital; as you know, hospitals can be costly. I can sell rice in the small rural shops or to my neighbors to get money for medicine. I go to the pharmacy and buy pain killers, antibiotics, and cough syrups for my children."*

The health of the household members is essential when it comes to sustaining a livelihood. If a family member was unwell, medical expenses would use up the family's savings and assets, which might weaken their livelihoods. This is why most households were keen to ensure the members' health was stable. It was revealed from the findings that some of the income from the NERICA rice was used to pay health and medical bills of the entire household. The respondents reported that most of them could not afford hospital fees, so they relied on buying over-the-counter medicines with advice from the pharmacist. These findings are in line with Chambers [23], who asserted that human capital is one of the five capitals that are very important in sustaining a livelihood; similarly, Ellis [24] reported that internal shocks such as illness or death of a breadwinner could destabilize a stable household livelihood.

Key informant from Nyambija village remarked,

"I had for a long time thought of constructing a good house for my family, but the income I got from farming was very little, which I used to support my family. For a long time, I continued living in a simple hut. Later I started farming NERCIA rice and saved the money to construct a brick house."

It was observed that some of the rice farmers used their income to construct good-quality houses. A good quality house signifies prestige, especially in rural communities like Migori. A good quality house by rural standards means a permanent home made of bricks or stones, sand and cement, and an iron roof. In rural communities with low income, one may find very few such houses. This is because it takes a good amount of money to build one, and most rural folks may not be able to make given the competing livelihood needs and the limited incomes. The families with good quality houses are associated with affluence and well-educated children who are successful and may have supported their parents in constructing such houses. Because of the prestige and the perception given to such families, many people try to save money to build a near similar house. This implies that rice, in this case, was seen to have improved the social status of the farmers.

Woman discussant at FGD in Nyakuru remarked,

"*Sometimes, when I sell rice, I give my husband some of the money to go and entertain himself with his friends in the village Centre. This money helps him to buy his friends a cup of tea so that he can share time with them. Sometimes I also use the money to travel to my home to visit my people and share time with them".*

Entertainment is one of how the income from the rice was used for. The report from the FGDs showed women gave out some of the money to their husbands for entertainment. People in the rural community valued social gatherings in their friend's or neighbors' homes, shopping centers, or churches. Men met with other men in local shopping centers, especially in the afternoons and evenings after they had worked on their farms, to relax and catch up with community news; this was done over a cup of tea, a bottle of a bear, or local brew which was paid for by the men themselves. Such forums were necessary because they formed a venue for social learning, venting over family disputes, and gaining advice from the elders. During this time, many networking and friendships were formed with neighbors and relatives. These forums were also important because they created social cohesion within families, neighbors, and the entire community. This implies that NERICA rice facilitated social stability and social networks, which were very important for sustaining a livelihood. Through these formed relationships, support came in times of need.

The findings revealed that some of the NERICA farmers spent the income from the rice to buy water. Water is essential in people's livelihoods; clean water is necessary for cooking and other domestic use. The Migori County livelihood profile showed that the county does not have adequate clean piped water. Some of the farmers were living in places where water was inadequate. These families were forced to buy water through vendors who charged them. A container of 20 liters of clean water costed 5Khs, especially in Awendo and Uriri sub-counties. On this basis, some of the NERICA farmers thought it wise to spend part of the income from the sale of the rice to buy water for domestic use, which went a long way in improving their livelihoods.

3.6 NERICA rice and improvement of Social Capital

Table 7 shows 87.1% of the respondents have acquired more friends since they started farming NERICA, while 90.5% indicated their happiness improved after planting NERICA rice. Moreover, 9.5% of the respondents stated that they married more wives due to farming NERICA. In comparison, 9.9% showed that their ability to conduct ceremonies improved due to NERICA farming.

Table 7: NERICA and improvement in social capital.

Social capital	**Responses**				**Total**	
	Yes		**No**			
	Freq	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**

Social relationships	209	79.5%	54	20.5%	263	100.0%
More friends	229	87.1%	34	12.9%	263	100.0%
Increased assets	96	36.5%	167	63.5%	263	100.0%
More children	39	14.8%	224	85.2%	263	100.0%
More wives	25	9.5%	238	90.5%	263	100.0%
Ceremonies	26	9.9%	237	90.1%	263	100.0%
Leadership in the community/in church	97	36.9%	166	63.1%	263	100.0%
Happiness	238	90.5%	25	9.5%	263	100.0%

3.7 Social capital and adoption

Table 8: Test for the association between improvement in social capital and the adoption of NERICA technology

	Adoption of NERICA			
Social capital	**Low**	**Medium**	**High**	Total
Improvement	11	27	162	200
No improvement	6	16	31	53
Total	17	43	193	253
Chi-square =11.761; df=2; *P*=.003				

From the study findings in Table 8, there is a significant statistical association between improvement in social capital and adoption of NERICA rice farming as indicated by the *P*-value =.003, which is less than 0.05 the level of significance. This suggests that the adoption of NERICA rice farming has significantly led to improved social capital such as increased assets, enhanced social relationships, and happiness, amongst others. Similar findings were echoed in the FGDs as shown below.

A woman from Nyakuru village Awendo sub-county remarked,

"I now have more friends than before; they all refer to me as mini Michele, they come to my home, and I take them to the farm to see rice, but if it has been harvested, I cook for them with beans, and some even want the rice to go and cook, I am happy with the recognition even our area chief pays me a visit, and I can feel respect from him and the other people".

A respondent from Nyambicha, Awendo remarked,

"My sister heard that I am now a rice farmer; since we had not been in touch for a long time, she came to my place to witness, and she ended up staying for one week. During that time, I was harvesting rice, and she helped with the harvesting and shelling of the rice; I ended up giving her some to take to her home. Since then, we have formed a good relationship; she calls me often, and she is willing to send her daughters to help me with the planting next time".

.

Findings from the FGDs and Key informant interviews revealed a substantial improvement in social relationships; some of the respondents said they had created new friends during the interactions in meetings and visitations to other rice farmers' homes to learn how to plant the rice. They shared a plate of rice with beans or chicken, and as they kept interacting they became friends; rice was one common thing that brought them together and solidified their friendships. Some used to be friends, but over time the ties had weakened; with the introduction of the rice, they revived and strengthened their friendships. These same friendships were extended to other social activities such as table banking and sharing possible ways to create investments for themselves within the community. This implies that NERICA rice adoption improved their welfare through the creation of friendships that supported and expanded their livelihoods

Adoption of rice created opportunities for outstanding rice farmers to be appointed as leaders in the community. Leadership in the rural community is essential. The people carefully choose a leader by looking at how he leads his family. A leader is known by how his children present themselves at home and in public. Most of all, he should also be a successful person in livelihood issues like farming to guide the community in which direction to go with their farming. The leader should be a person who communicates well. Such people then are given leadership positions as village elders, sub-chiefs, and chiefs. Some rice farmers reported being given leadership positions as sub-chiefs and village elders. Through their hard work and helping the farmers form self-help groups and connecting them with the extension officers. Attending seminars and workshops inside and outside their county, gave them exposure and recognition for their hard work and capacity to lead the people and enhance the appointment as local leaders. This implies that the rice adoption had gone beyond farming to leadership and guidance in the community.

Adoption of the rice enabled the farmers to expand their families; It was reported that some had married more wives because more work was required on the farms that needed more management. Some felt there was plenty of food in their household, and they could get more children because they could feed them, unlike before.

Rice farming enabled the farmers to hold more ceremonies. Ceremonies in the rural community, especially the Luo community, are held for many reasons. There are ceremonies to thank the ancestors for good things like good harvest, the birth of a child, and to morn a departed member of the community. During these ceremonies, many foods are cooked, and cows, sheep, and goats are slaughtered. Rice and *ugali* are cooked, and the traditional vegetables accompany them. Neighbors, relatives, and friends are part of the ceremony; they come with gifts and food to celebrate. The number of people that turn up depends on how much one has created their networks. Traditions are, however, held when the livelihoods are good, meaning there is food to be eaten. Ceremonies are limited in situations where livelihoods are weak, for instance, in times of drought or floods and misfortunes. The study established that with the adoption of NERICA rice, more ceremonies were being held in the communities because there was more food and income to take care of the things required during such times.

Some respondents talked of happiness as one thing that came in with the adoption of NERICA rice; they indicated that there was food to eat, money to solve some livelihood needs in their households.They

made friends, which totaled up to their happiness. Social capital is a significant aspect of sustaining a livelihood in the rural community. The relationships and networks people build over the years are crucial in managing their lives, livelihood activities, and the entire livelihood system. Good relations with kinships, neighbors, friends, and other members of the community are very beneficial to each of the members of the community. Through these relationships, a lot is shared regarding information, including new agricultural technologies, social issues such as marriages, burial ceremonies, and any community engagement.

4. conclusion

The paper has shown that agricultural technology adoption in rural households of smallholder farmers has the capacity to improve the livelihoods of the people in terms of income, food security and social capital. The study has further shown that even though the new agricultural technology may be new in a community, it will not displace the existing local crops, but it will be integrated into the existing livelihood system and therefore expand their livelihoods just as NERICA rice did in Migori. The study further noted that agricultural technologies that are meant to create food security in a community may expand their meaning to include creating unity, reconstructing social relationships and creating leadership in a local community hence expanding the meaning of livelihoods.

REFERENCES

1. Kijima, Y. and Otsuka, K. & Sserunkuuma, D. (2011). An Inquiry into Constraints on a Green Revolution in Sub-Saharan Africa: The Case of NERICA Rice in Uganda. World Development. 39. 77-86. 10.1016/j.worlddev.2010.06.010.

2. Diagne, A. (2006) The Diffusion and Adoption of NERICA rice varieties in Cote d'Ivoire. The Developing Economies 44:2 June 2006.

3. Adesina, A. A. and Baidu-Forson, J. (1995). Farmers' Perceptions and Adoption of New Agricultural Technology: Evidence from Analysis in Burkina Faso and Guinea, West Africa. Journal of Agricultural Economics 13:1-9.

4. Africa Rice Center (WARDA) /FAO/SAA. (2008). NERICA®: The New Rice for Africa – a Compendium. Somado, E. A., Guei, R.G. and Keya, S.O. (Eds.). Cotonou, Benin: Africa Rice Center (WARDA); Rome, Italy: FAO; Tokyo, Japan: Sasakawa Africa Association. 210 pp.

5. Doss, C. R and Morris, M. L. (2001). How does gender affect the adoption of agricultural innovation? The case of improved maize Technologies in Ghana. Journal of Agricultural Economics 25:27-39.

6. Dunstan, S., Dorward, A., Gorge A., Dayo P. and Diji O. (2006). Evaluation of Adoption of NERICA and other improved upland varieties following varietal promotion activities in Nigeria.

7. Kibwage, J. K. (2007). Diversification of Household Livelihood Strategies for Tobacco Smallholder Farmers: A case study of introducing Bamboo in South Nyanza Region, Kenya.

8. Kenya Women Scientist Centre (KWSC) (2014). National Status of Food Security in Kenyan counties.

9. Migori County. (2013). Migori County Integrated Development Plan. Migori, Kenya.

10. Action Against Hunger (ACF). International 2010 Annual Report. (n.d.)., https://www.actionagainsthunger.org/sites/default/files/publications/ACF-intl-annual-report-2010.pdf\.

11. Davis, J., and Lopez-Carr D. (2010). Migration, remittances and smallholder decision-making: Implications for land use and livelihood change in Central America. Land Use Policy, 36, 319–329. https://doi.org/10.1016/j.landusepol.2013.09.001.

12. Otaha, I.J. (2013). Food Insecurity in Nigeria. Way Forward. African Research Review, 7, 26-35. - References - Scientific Research Publishing. (2013). Scirp.org.
13. Abafita, J., and Kim, K. R. (Eds.). (2014). Determinants of Household Food Security in Rural Ethiopia: An Empirical Analysis. Journal of Rural Development/ Nongchon-Gyeongje. https://doi.org/10.22004/ag.econ.196613.

14. Kasirye (2010). Constraints to agricultural technology adoption in Uganda: Evidence from the 2005/06- 2009/10 Uganda national panel survey.

15. Kariyasa, K., and Dewi, Y. A. (2013). Analysis of factors affecting adoption of integrated crop management farmer field school (icm-ffs) in swampy areas. International Journal of Food and Agricultural Economics, 1(2), 29-38.

16. Jain R ., Arora A. and Raju S. (2009). A Novel Adoption Index of Selected Agricultural Technologies: Linkages with Infrastructure and Productivity: Agricultural Economics Research Review 22; 109-120.

17. Kenya Population and Housing Census Volume I: Population by County and Sub-County - Kenya National Bureau of Statistics. (2019). Kenya National Bureau of Statistics.

18. Campbell, B.M., Thornton, P., Zougmore, R., van Asten, P. and Lipper, L. (2014). Sustainable Intensification. What is its role in climate-smart agriculture? Environmental Sustainability, 8:39-43.

19. Ministry of agriculture, livestock, fisheries and cooperatives state department for crop development and agricultural research. (n.d.). National rice strategy 2012.

20. Denscombe, M. (2010). The Good Research Guide: for small-scale social research projects. 4th edn. Open University Press, England, 389pp.

21. Krejcie, R. V., and Morgan, D. W. (1970). Determining Sample Size for Research Activities. Educational and Psychological Measurement, 30(3), 607–610. https://doi.org/10.1177/001316447003000308.

22. Stiglitz, J., Sen, A., and Fitoussi, JP. (2009, December 1). The measurement of economic performance and social progress revisited: Reflections and Overview. Ideas.repec.org.

23. Chambers, R. (1995). Poverty and Livelihoods: Whose reality counts? ID discussion Paper, 347, Brighton.

24. Langyintuo, A. S., and Mungoma, C. (2008). The effect of household wealth on the adoption of improved maize varieties in Zambia. Food Policy, 33(6), 550–559.

25. Ellis, F., and Freeman, H. A. (2004). Rural livelihoods and poverty reduction strategies in four African countries. Journal of development studies, 40(4), 1-30.