

Factors Affecting Adoption of New Farming Technique Among Seaweed Farmers in Zanzibar: A Case of Selected Villages in Unguja

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Abstract: This study examined the factors affecting the adoption of new farming technique among seaweed farmers in two villages, namely Muungoni and Nyamanzi in Zanzibar. The nature of this study is quantitative. The study was governed by four objectives which were to examine the effect of environmental factors to the adoption of new seaweed farming technique, to examine the effect of social-psychological factors to the adoption of new farming technique, to examine the effect of institutional factors to the adoption of new seaweed farming technique, to examine the effect of economic factors to the adoption of new seaweed farming technique. Survey questionnaire was used as a method of data collection from 45 respondents using simple random techniques. A Descriptive analysis technique was used for data analysis and interpretation using SPSS V.23, and the findings were summarized in percentages and presented in tables and figures. The findings of this study indicated that environmental factors; social-psychological factors; institutional factors; and economic factors have effects on the new seaweed farming techniques in Muungoni and Nyamanzi Zanzibar. Therefore, the study recommended that the use of new seaweed farming technique can be achieved through effectively addressing all challenges, provision of financial assistance to the seaweed farmers, and awareness rising and sensitization through workshop campaigns, conference presentations, meetings, and discussions.

Keywords: Environmental Factors, Social-Psychological Factors, Institutional Factors, Economic Factors

1. Introduction

In Sub-Saharan Africa the scholars have identified several factors which lead to affect the technology of adoption, some of these factors are; assets, income, institutions, vulnerability, awareness, labour, and innovativeness by smallholder farmers [1]. Also, technologies that have a lower risk premium, less expensive and require few assets have a higher chance of being adopted by smallholder farmers in Africa. In Zanzibar, seaweed farming is another largest source of income to the majority of coastal communities (CCs) after tourism and cloves cultivation, which employs more than 30,000 people, majority of them are women [2, 3]. The intensive commercial farming of seaweed in Zanzibar Islands started in 1989 when private entrepreneurs established commercial farms using an imported strain of

Eucheuma/Kappaphycus from the Philippines (Msuya, 2011). The cultivation of seaweed in Zanzibar for the first time started in two villages, Jambiani and Paje, on the East Coast of Unguja Island [4].

Fifteen to twenty years ago, women seaweed farmers in Zanzibar, particularly Unguja Island planted *Eucheumacottonii* and *E. spinosum* seaweed varieties in shallow waters off the coasts. However, due to climate change (CC), surface water temperatures have increased from 31°C to 38°C. This has significantly affected seaweed growth, which decreased from 1,048 tons in 2001 to 58.4 tons in 2015, a drop of 94% [3]. Due to massive quantities of seaweed dying off before it had developed, the traditional pegs and rope seaweed farming in shallow waters become less and less profitable. Yet, farmers have had to switch from using the traditional floating line

method, where nylon ropes covered with seaweed are tied between two wooden pegs to cast method where the seaweeds are bound to rocks using rubber bands and tabular nets for use in deep water seaweed farming practices, where nets are stuffed with seaweed seedlings, which grow and multiply along their length when plated 2-6 meters under water.

Surprisingly, majority of farmers are not persuaded to use new technology. It is pertinent to note that more research and study is essential in order to understand clearly why improved agricultural technologies are not being effectively adopted, in order to address this issue [5] This is especially the case of seaweed farmers who are in most instances reluctant to adopt new farming techniques. From the foregoing, it is concluded that though a number of studies have been conducted across the world on technology adoption, there is dearth of literature on the specific factors that affect adoption of new farming technique among seaweed farmers. This is a serious gap that must be explored if the problem of low techniques adoption among seaweed farmers is to be addressed and agricultural productivity improved.

2. Problem of the Statement

Seaweed is an important smallholder crop in South District Unguja that serves as a source of income earnings to the local communities. In an effort to support and help seaweed farmers in Zanzibar to cultivate profitable varieties and raise the yields, the Department of Fisheries and Marine Resources (DFMR) introduced the new seaweed farming technique to the seaweed farmers. The DFMR in collaboration with the Institute of Marine Science (IMS) of the University of Dar es Salaam ran the project to introduce and equip new seaweed farming technique to the seaweed farmers in Zanzibar this is according to ZEXA report, 2014.

Despite the widely known roles, merits and usefulness of adopting new seaweed farming technique for high-value and profitable varieties/seaweeds, majority of seaweed farmers continue using the traditional floating line method. Yet, less remains to be known on the factors affecting the adoption of new seaweed farming techniques among seaweed farmers in Unguja, Zanzibar. Following the high level of government intervention in the seaweed farming, the adoption of the new seaweed farming technique remains questionable to the majority of seaweed farmers. Therefore, this study is addressing to answer the following four questions, these are;

- 1) What is the effect of environmental factors to the adoption of new seaweed farming technique?
- 2) What is the effect of social-psychological factors to the adoption of new farming technique?
- 3) What is the effect of institutional factors to the adoption of new seaweed farming technique?
- 4) What is the effect of economic factors to the adoption of new seaweed farming technique?

3. Agriculture Change Theory (ACT)

Theory of Change is the process of describing all the building blocks required to bring about a long-term goal. It describes the process of social change by making explicit the perception of the current situation; its underlying causes, the long term change desired and the thing that need adjustment for the change to happen [6]. The theory suggests that the research system which was solely public sector driven should be empowered to develop technologies especially varieties and good agronomic practices. These practices should be communicated through the extension agents to the farmers; the farmers in turn are expected to produce, sell their produce and make good profit. The theory is relevant to this study as it explores the ways of change in agriculture production. Technology change in agriculture is guided by the linear model as farmers will change from traditional methods to new methods which can be sustainable and give the most benefits to the farmers, specifically in production. The study seeks to identify different new technologies use in seaweed farming and their contribution on seaweed production. The agriculture change theory (ACT) highlights that the change from old to new techniques is much higher when three main partners; farmers, researchers and the extension agents accept it. The theory is therefore extremely potential to the study because it assists the acceptance of change by all agricultural stakeholders on the use of various modern technologies in seaweed production and how this influences farmers to ignore traditional methods.

4. Empirical Review

This section discusses studies on what have been done by different authors concerning the factors affecting adoption of new farming technique among seaweed farmers. The followings are some of them.

According to Yoon, Lim and Park [7] the scholars are investigating on several factors in Korea which mostly affect the adoption of the smart farm. More interestingly, the study is relying on the model of Rogers' innovation diffusion theory and existing models of adoption of information technology in organizations. According to this model it is clarified that in the normal condition, the adoption of new technology is normally influenced by many factors among them are; relative advantages, complexity, and compatibility of the technology, the innovativeness and IT knowledge characteristics of the CEOs, financial costs, human resource vulnerability and lack of skills, competitive pressure, government support and the change to the digital environment. These factors were categorized according to TOE framework, investigated, and empirically tested using survey data to determine their influence on the adoption of smart farms. The results showed that the compatibility of technology, financial costs for the organization, and the digital environment change influence the adoption of smart farms.

Also, Okonji and Awolu [8] they conducted study at Ekiti

State in Nigeria related to this area of study. They are directly concentrated on inspecting the factors determining the adoption of improved maize technologies. They used sample of the population and survey questionnaire were used to collect their whereby the regression and descriptive analysis were used for data analysis of this study. The majority of maize producers in the study area were married, fairly educated and of middle age. The results further showed that the maize farmers were faced with a series of problems such as inadequate credit, bad road network, high-interest rate and lack of collateral. Meanwhile, the adoption of improved maize technology by the farmers was significantly influenced by the use of manure, appropriate planting techniques, use of herbicide, extension visit, and educational status of the farmers.

Although, Upadhyaya [9] argued that the technology adoption is a big subject of concern and so are the factors responsible for adoption, their research is oriented to review some of the works done on the topic in different contexts. Mainly some of the articles related to technology adoption, continuity and discontinuity were studied for the secondary data source. It was found that extension service and education level of household head were major and pointed by most of the researches as main factor to be considered. Some other factors are education of household head, size of the farm, involvement in farmer's group, market distance, household wealth, family size, experience, training attended and minor factors were found to be gender of respondent, transportation facility, insurance scheme, number of male or female in family, area occupied by technology, geography, fertilizer use, attitude etc.

Furthermore, Li et al. [10] they conducted study in Southern China to shows how the adoption of new technology taking place. They come up with the concept of "Litchi" which mean of traditional tree crop grown in Southern China. Sustainable development of the litchi industry is reliant on technology adoption by farmers. The top grafting technique allows for the introduction of new, quality litchi varieties. The fact that these new varieties ripen earlier or later than the traditional ones helps stabilize litchi prices. Selling new litchi varieties can increase farmers' incomes through higher prices of quality varieties and stabilizing prices by staggering the harvest periods. However, the rate of adoption of top grafting among farmers is low, and up till now, more than half of the litchi trees in China are still traditional litchi varieties. The results show that farmers owning larger litchi orchards are more likely to adopt top grafting compared to ones owning smaller orchards. Litchi information accumulation, including experience and training, significantly influences farmers' technology adoption levels. Moreover, a positive attitude toward technology also significantly influences technology adoption behaviors.

However, Kumar, Engle and Tucker [11] conducted study on the factors driving aquaculture technology adoption. Primary data was used to conduct this study. This study acknowledged that the adoption of new technology has to play a vital role in the development of the world in

consistency of increase proclivities in agricultural industry. On top of that, the study has summarized some of important factors that influence the decision in technology adoption in aquaculture. These factors are: (1) method of information transfer, (2) characteristics of the technology, (3) farm characteristics, (4) economic factors, and (5) socio-demographic and institutional factors. Fish farmers have tended to adopt technologies that are perceived to be more advantageous than others in terms of productivity, cost efficiency, and ease of management. Price of aquaculture products and profit expectations from business ventures were key economic factors influencing adoption decisions.

Notwithstanding, Udimal et, al., [12] analyses factors that influence the adoption of (Nerica) rice technology in the Northern Region of Ghana. Both logit and probit models were used in the analysis. The results from the two models are consistent with each other; they have similar signs for each variable but slight difference in the magnitude of the coefficients. Factors such as farm size, credit access, on-farm demonstration, tractor ownership, and family labor had positive influence on (Nerica) rice technology and statistically significant. The age, and profit orientation of the farmers had negative influence on the adoption on (Nerica) rice technology and statistically significant.

Finally, Asfaw and Neka [13] examined factors affecting adoption of introduced soil and water conservation practices: The case of Wereillu Woreda (District), South Wollo Zone, Amhara Region, Ethiopia. Mixed research methods design was employed in order to conduct the study. Questionnaire, focus group discussion, in-depth interview and field observation were used to collect data. A binary logistic regression model was employed to analyze the collected data. The analysis result showed that sex of household heads, education status of household heads, access to extension services and training were positively correlated at significantly level with the adoption of the introduced soil and water conservation practices. On the other hand, the age of household heads, off-farm activity, and distance of farmlands from homesteads influenced the adoption of introduced soil and water conservation practices negatively.

5. Methodology

The study was conducted at Muungoni and Nyamanzi villages in Unguja-Zanzibar. Muungoni village is located in Central District Unguja while Nyamanzi is located in West B District Unguja. These villages were purposively selected for this study based on their good records of seaweed farming. Also, Muungoni and Nyamanzi villages were given preference for the study because they have seaweed producers who participated in both shallow water seaweed farming and deep water seaweed farming. This study adopts cross-sectional survey design. This design was used on the basis that it allows collection of data from different groups of respondents at single point in time and at once and can be used to determine the relationship between and among variables. This study employed quantitative research methods.

The quantitative research approach is employed in this study since it allows the researcher to explore, explain a phenomenon, and interpret data statistically in a wider and easy ways. The rationale for choosing this research design is because of its suitability for a study where positivism philosophy has been adopted, such as this study.

Based on the nature of the study, population of this study was seaweed farmers, village leaders and seaweed farming committee officers. As recorded during the study, the population of seaweed farmers in the study area was 347. Purposive sampling was used in this study to select a sample size only 45 from a total population of 347. This decision is made based on the basis that in order to get reliable information/data for this specific research it need to consider those who are engaged in using new seaweed farming techniques from that area. Therefore, research got the information from the responsible peoples (Sheha and seaweed officers) that only 45 seaweed farmer were ready in adoption of new seaweed farming techniques. The household seaweed farmers in study villages were

surveyed and information were collected using household questionnaires that involved closed-ended questions so as to obtain potential information for the study. A descriptive statistical techniques were used for data analysis using Statistical Package for Social Sciences (SPSS) version 23 [14].

6. Study Findings

a) Demographic profile of the respondents

Demographic questions are designed to help survey researchers to determine what factors may influence respondents' answers, interests, and opinions. The demographic data are an important part of the study and should be examined carefully and as such, the readers are encouraged to consider reading this part careful [15]. For the case of this study only gender, age, marital status, educational attainment, occupation and income were examined;

Table 1. Demographic profile of the respondents.

Variable	Category	Muungoni		Nyamanzi	
		Frequency	Percentage	Frequency	Percentage
Age	25-34	8	23	2	20
	35-44	19	54	4	40
	45-54	5	14	2	20
	55-64	2	6	1	10
	65+	1	3	1	10
Gender	Male	10	31	1	10
	Female	25	69	9	90
Education level	Primary	9	26	2	20
	Secondary	20	57	6	60
	College	1	3	0	0
	University	0	0	0	0
	No formal education	5	4	2	20
Marital status	Single	0	0	0	0
	Married	11	31	5	50
	Divorce	9	26	2	20
	Widow	15	43	3	30

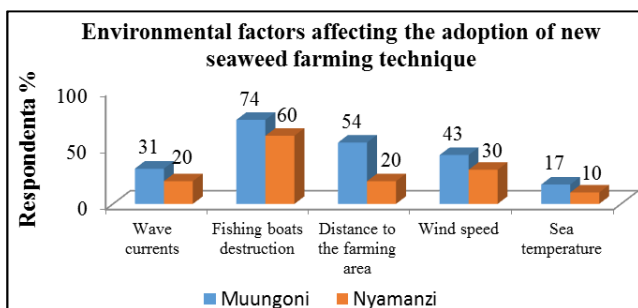
The surveyed respondents for this study belonged different age groups. The age groups of respondents were as follows; 25-34 years 23% from Muungoni village and 20% from Nyamanzi village, 35-44 years 54% from Muungoni village and 40% from Nyamanzi village, 45-54 years 14% from Muungoni village and 20% from Nyamanzi village, 55-64 years 6% from Muungoni village and 10% from Nyamanzi village, and age group of respondents of 65 years and above was 3% and 10% from Muungoni and Nyamanzi villages respectively as shown in table 1 This result is inline of the fact that most of respondents provided information during this study had an age above 34 years, which was viewed as reliable age of respondents willingly to provide required information for the study. The issue of age group in adoption of new farming techniques is very important as it determines the extent to which new farming techniques are taken into consideration in improving farming systems and yield from time to time. Normally, the age group from 35 and above is more willing to adopt new farming techniques to change their

farming systems Also, in this study gender issue was actively considered; therefore, both genders were given equal chance to participate in this study. About 45 respondents were selected to participate in this study, and household questionnaires were distributed to the seaweed farmers, who were either men or women. Information about sex of respondents as obtained through the questionnaires showed that 31% of respondents from Muungoni village and 10% from Nyamanzi village were men, while 69% from Muungoni and 90% from Nyamanzi were women as illustrated in tale 4.3. This variation of gender representation in this study was unintentional. In fact, most of the families visited had women being involved in seaweed farming. Thus large number of females participated in the study than males. Sex of respondent influences an individual to adopt new farming techniques. Previous studies reveal that males are more active and conscious in adopting new farming techniques than their counterpart due to the fact that they can easily engaged in and afford them than females.

On the side of level of education, this study comprised the people with different educational backgrounds. Those respondents with the primary education were 26% from Muungoni village and 20% from Nyamanzi. Those who attended secondary education were 57% from Muungoni village and 60% from Nyamanzi. About 3% from Muungoni village had attended college education while no single respondent had attended college education from Nyamanzi village. Similarly, result shows that only 14% from Muungoni village and 20% from Nyamanzi had not attended formal education. This result implies that most of the respondents in the study area received only compulsory education (secondary education). Having low level of education, therefore, made most of the farmers less aware and inactive on new farming technique. Consequently, they rely much on their old seaweed farming technique hence continue achieving low farming outputs. However, some farmers had been engaging themselves in new seaweed farming technique (deep sea farming), despite their lack of formal or low level of education. Nevertheless, education is reported to be one of the key factors that determine the adoption of new farming techniques among farmers [16]. Formal education has a positive effect on farmer's awareness and understanding of the existing, ways of adopting and use of new farming techniques for improving their farming activities and outputs [1]. Although, the findings from this study show that 31% of surveyed seaweed farmers from Muungoni village and 50% from Nyamanzi were married, 26% from Muungoni and 20% from Nyamanzi were divorced, while 43% from Muungoni and 30% from Nyamanzi were widows as shown in table 1.

b) Effect of environmental factors to the adoption of new seaweed farming technique

In this specific objective a researcher was interested to measure how environment factors affecting the adoption of new seaweed farming techniques in their area. The respondents were required to react on the mentioned factors by the researcher for how these factors affect their adoption process and the following results is presented in the figure below.



Source: Field data, 2022

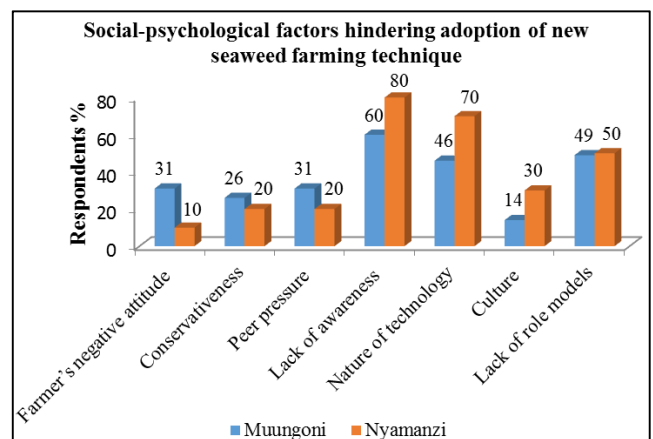
Figure 1. Environmental challenges limiting adoption of new seaweed farming technique.

Results reveal that large number of respondents from Muungoni village 74% and Nyamanzi 60% reported that

fishing boats destruction limits the seaweed farmers to adopt new seaweed farming in the area. The results further indicated that the distance from the shoreline to the farming area limits the farmers to adopt new seaweed farming technique in the area, and this was represented by 54% and 20% of respondents from Muungoni and Nyamanzi villages respectively. Similarly, 43% and 30% of respondents from Muungoni and Nyamanzi villages responded that wind speed in the area constrained seaweed farmers from adopting new seaweed farming technique. Likewise, 31% and 20% of surveyed respondents from Muungoni and Nyamanzi villages showed that wave currents constrained seaweed farmers from adopting new seaweed farming technique in the area. Few respondents, 17% from Muungoni village and 10% from Nyamanzi were constrained by sea temperature in adopting new seaweed farming technique in the area as illustrated in Figure 1. This result gives an implication that the deep water farming of seaweed is suitable for men rather than their counter part women. However, if the strong efforts are taken to train women in diving, they will do equal the same. This result is consistency with the study of Yoon, Lim and Park [7] the scholars are investigating on several factors in Korea which mostly affect the adoption of the smart farm. The results showed that the compatibility of technology, financial costs for the organization, and the digital environment change influence the adoption of smart farms.

c) Effect of social-psychological factors to the adoption of new farming technique

In this specific objective a researcher was intended to examine how social-psychological factors affecting the adoption of new seaweed farming techniques in these two villages. The respondents were required to respond to the questions asked by providing their opinion on the mentioned factors. The results acquired were presented in figure below.



Source: Field data, 2022

Figure 2. Social-psychological factors hindering adoption of new seaweed farming technique.

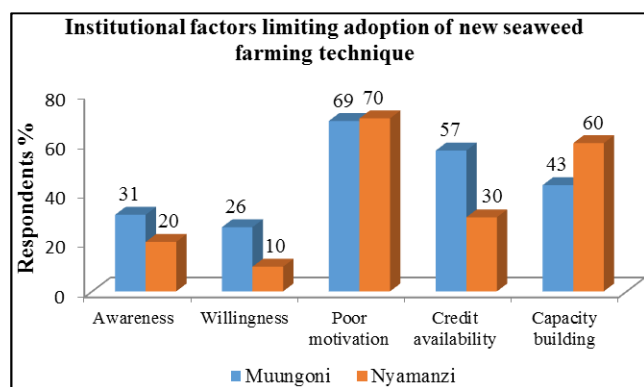
As shown in Figure 2 60% and 80% of respondents from Muungoni and Nyamanzi villages reported that lack of awareness limits the adoption of new seaweed farming

technique in the area. Similarly, 46% and 70% of respondents from Muungoni and Nyamanzi villages pointed out that nature of technology constrained seaweed farmers from adopting new seaweed farming technique in the area. Results further indicated that 49% and 50% of respondents claimed the lack of role model as a constraint among seaweed farmers in adopting new seaweed farming technique in the area. Other responses were as shown in Figure 2. This result is inline of the fact that lack of awareness among the seaweed farmers, nature of technology together with role model are the biggest social-psychological factors challenges in adoption of new seaweed farming technique in the study area.

This result is more or less similar to the results of the study by Mignouna et al, [17] that conservativeness, illiterate, weak belief on ensure high yield of new technology; Lavison [19]; that, lack of awareness among the farmers on the use of modern farming techniques constraints the farmers' decision and extent of adopting new farming techniques. In addition, this finding is resembled with the finding of Okonji and Awolu [8] who conducted a research to investigate the factors determining the adoption of improved maize technologies among farmers in Ekiti State, Nigeria. The results showed that the maize farmers were faced with a series of problems such as inadequate credit, bad road network, high-interest rate and lack of collateral. Meanwhile, the adoption of improved maize technology by the farmers was significantly influenced by the use of manure, appropriate planting techniques, use of herbicide, extension visit, and educational status of the farmers.

d) Effect of institutional factors to the adoption of new seaweed farming technique

In this specific objective, different indicators/factors were mentioned in the list of statements and respondents were supposed to provide their opinion and the results are shown below.



Source: Field data, 2022

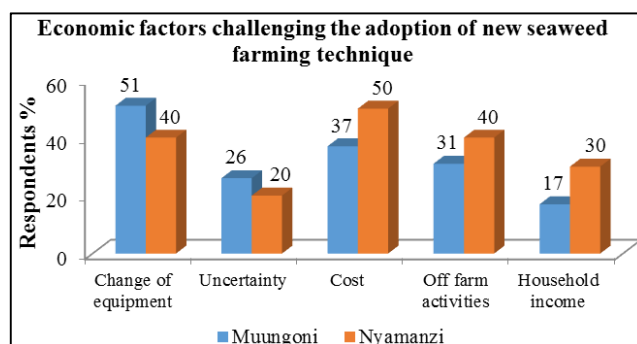
Figure 3. Institutional factors limiting adoption of new seaweed farming technique.

Findings reveal that large number of respondents, 69% and 70% from Muungoni and Nyamanzi villages reported poor motivation as a limiting factor in adoption of new seaweed farming technique in the area. Equally, 57% and 30% of respondents from Muungoni and Nyamanzi villages asserted

that credit availability constrained seaweed farmers from adopting new seaweed farming method in the area. Similarly, 43% and 60% of respondents from Muungoni and Nyamanzi villages pointed out that capacity building limits the adoption of new seaweed farming technique among the seaweed farmers in the area. The results further show that some respondents declared awareness as a limiting factor in adoption of new seaweed farming technique in the area, and this was argued by 31% and 20% from Muungoni and Nyamanzi villages respectively. Few respondents, 26% and 10% from and Nyamanzi villages said that willingness among the responsible seaweed institutions hinders the adoption of new seaweed farming technique in the area. This results implies that even though the government of Zanzibar introduce new method of seaweed farming with good intention of improving seaweed outputs and the livelihoods of seaweed farmers, implementation from some responsible institutions remains a little bit problem. In connection with Upadhyaya [9], the results above is quite similar with study conducted in the area of technology adoption is a big subject of concern and so are the factors responsible for adoption. It was found that extension service and education level of household head were major and pointed by most of the researches as main factor to be considered. Some other factors are education of household head, size of the farm, involvement in farmer's group, market distance, household wealth, family size, experience, training attended and minor factors were found to be gender of respondent, transportation facility, insurance scheme, number of male or female in family, area occupied by technology, geography, fertilizer use, attitude etc.

e) Effect of economic factors to the adoption of new seaweed farming technique

In this specific objective, the researcher was intended to examine how economic factors can affect the adoption of new seaweed farming techniques at Muungoni and Nyamanzi. Descriptive statistics such as (frequencies and percentages) were used to analyses the findings for this objective. Researcher engaged respondents whose responses were intended to answer this question clearly and the results were summarized in the form of figure below.



Source: Field data, 2022

Figure 4. Economic factors on adoption of new seaweed farming technique.

As indicated in Figure 4, 51% and 40% of respondents from Muungoni and Nyamanzi villages reported that change of

equipment used in practicing seaweed farming limit the adoption of new seaweed farming technique in the area. Also, results indicated that high cost of introduce technique limits their farmers in using that technique in their farming, and this was reported by 37% and 59% of respondents from Muungoni and Nyamanzi villages respectively. Other respondents in the area, 31% and 40% from Muungoni and Nyamanzi villages revealed that off farming activities slow seaweed farmers from adopting new seaweed farming technique. Equally, 26% and 10% of respondents from Muungoni and Nyamanzi villages said that uncertainty limits farmers from adopting new seaweed farming technique in the area. The results further reveal that some respondents 17% and 30% from Muungoni and Nyamanzi villages reported household income as a challenging factor in adoption of new farming technique in the area. This result is inline of the fact that change of equipment, high cost of technique, specifically hiring of experts to deliver capacity building to the farmers, off farm activities that give high amount of earning to the individuals, and low household income of some individual farmers are the major barriers in adopting new method of seaweed farming in the study area and even other coastal areas where seaweed farming is dominant activity of the locals.

In supporting this result, a study conducted by Udimal et al., [12] in Sub-Saharan Africa on the impacts of technology adoption on smallholder agricultural productivity justifies that assets, income, institutions, vulnerability, awareness, labour, and innovativeness by smallholder farmers affect technology adoption. Also, Ouma et al. [18] adds that the cost of hiring skilled labors that have knowledge of using and operating the modern farming methods constrains the adoption.

Furthermore, this finding is consistency with the study of Li et al. [10] which argued that Litchi is a traditional tree crop grown in Southern China. Sustainable development of the litchi industry is reliant on technology adoption by farmers. The results show that farmers owning larger litchi orchards are more likely to adopt top grafting compared to ones owning smaller orchards. Litchi information accumulation, including experience and training, significantly influences farmers' technology adoption levels. Moreover, a positive attitude toward technology also significantly influences technology adoption behaviors.

7. Conclusion and Recommendation

Based on the findings, this study concluded that the New seaweed farming technique contributes to the livelihoods of seaweed farmers in the area. It also influences social improvement of the seaweed farmers through improving housing of the seaweed farmers, assisting seaweed farmers to own valuable assets, simplifies seaweed farmers to pay school fees for their children, and enables seaweed farmers to afford medical treatment for their households.

Relying on the observed findings, this study recommended that, despite the fact that new seaweed farming technique contributes to the livelihoods of seaweed farmers in the area

by influencing the household income of seaweed farmers as well as influencing social improvement of the seaweed farmers. Off farming activities remain to be the secondary alternatives for financing the local communities in Zanzibar, particularly coastal poor.

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