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IMPACT OF SEAWEED FARMING ON LIVELIHOODS IN BAGAMOYO REGION

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Abstract

This study aims to examines the effect of seaweed farming on the livelihoods of coastal households living in Bagamoyo, Tanzania. The study adopted a mixed-methods research design which integrates both qualitative and quantitative approaches. Primary data were collected from 120 seaweed farmers in Bagamoyo by using a well-structured questionnaire, supported by focus group discussions and the key informant interviews. The study used both descriptive statistics, correlation analysis, and multiple regression analysis to assess the relationship between socioeconomic characteristics of seaweed farmers and the monthly income which is earned from seaweed farming. The study findings depicted that experience in farming and scale of production has significant influence in increasing the household income. Moreover, climate stress and recent occurrence of environmental shocks were marked as reducers of farmers earnings. On top of that, formal education proved to have a negative relationship with the income earned from seaweed-farming this suggest that the more farmers get educated increase the chance of them to pursue other alternative income activities. distance to markets and Cooperative membership has demonstrated to have insignificant influence. Qualitative findings additional revealed persistent challenges like fluctuation in the seaweed market prices, outbreaks of disease, and inadequate access to farming technologies which are well improved. The study concludes that farming of seaweed remains a significant livelihood strategy in Bagamoyo region but is extremely vulnerable to constraints like environmental and institutional. Inorder to boost seaweed productivity and ensure the long-term seaweed sustainability it was recommended to strengthen farmer capacity, improving seaweed farming inputs and more likely to enhance climate resilient practices.

Keywords: *Seaweed, Bagamoyo*

INTRODUCTION

Seaweed farming has grown into one of the world's most rapidly intensifying aquaculture sectors especially across Asian countries and East Africa. FAO (2020) reported that worldwide seaweed production exceeds 30 million tonnes annually. It is mostly driven by increasing carrageenan demand, agar, cosmetics, pharmaceuticals and bio-fertilizers. Studies like that of Bixler & Porse (2011) showed that seaweed significantly contributes to global aquaculture economies particularly in countries which are still developing where populations living in coastal depend heavily on marine livelihoods.

East African countries, including Kenya, Tanzania and Zanzibar have also adopted seaweed farming since the early 1980s. Msuya (2011) reported that Tanzania is one of Africa's principal seaweed producers with the majority of seaweed production centered in Zanzibar and the northern coastline of Tanga, Bagamoyo and Pangani. Fondo et al. (2010) revealed that seaweed cultivation is playing a significant role in poverty reduction and diversification of livelihood for coastal households in the region

In Tanzanian coastline, it was introduced in the late 1980s, since then seaweed farming has been providing income opportunities to rural communities especially women seaweed farming has appeared to be one of the most significant livelihood activities specially among small-scale coastal households which are more depended on natural resource-based economies. The main species cultivated are Eucheuma denticulatum and Kappaphycus alvarezii because of their high carrageenan content. These species grasp premium prices on the international market that making them as attractive cash crops for rural communities. (Oliveira & Alveal ,2013) It has also contributed to the reduction of poverty, economic diversification and the strengthening livelihoods of the local coastal communities (Msuya, 2011; Torell et al., 2010). Bagamoyo District which is located along Tanzania's northern coast, has also become one of the most important seaweed producing areas because of the favorable environmental situations, low intertidal zones and extended farming tradition. As world demand for seaweed species like carrageenan producing seaweeds like Kappaphycus alvarezii and Eucheuma denticulatum persist to rise, farming of seaweed in Bagamoyo presents more opportunities for improvement of economic condition of the household, women empowerment and sustainable usage of marine resources.

Despite the presence of this opportunities, seaweed farmers in Bagamoyo are facing persistent challenges which threaten the sector long term viability. All of these constraints which include seaweed market prices fluctuation, exploitation which is done by middlemen, the weak bargaining power of the seaweed farmers,

limited access to improved seaweed farming technologies, and insufficient value chain. Environmental challenges like increasing of the sea temperatures outbreaks of the disease like ice-ice syndrome, storm flows and water quality declining they both contribute to the reduction of the seaweed productivity and stability of the income. As a result of this, many seaweed farmers are experiencing little and unreliable returns which weakens their economic security and lessens their motivation to continue participating in the seaweed farming. Although the farming of seaweed is promoted widely as a strategy of poverty alleviation, these mentioned obstacles raise concerns about whether the seaweed farming sector actually brings sustainable livelihood benefits for farmers in Bagamoyo.

Current literatures provide valuable understandings into the general environmental and socioeconomic contributions of seaweed farming in Tanzania however most these studies are focusing more on Zanzibar or assess broad national trends (Msuya, 2013). Few empirical research has been conducted to specifically study Bagamoyo despite its very unique environmental circumstances, different structure of the market and emerging community-based seaweed initiatives. The partial accessibility of localized research presents a clear critical research gap in understanding the actual contributions of livelihood, limitations and possible of seaweed farming in Bagamoyo. Also, few studies have applied inferential statistical methods to study whether farming of the seaweed significantly has influences on income of the household, gender empowerment, food security or resilience in Bagamoyo region. The lack of specific context and data driven evidence particularly restricts policymakers, development partners and practitioners from designing targeted interventions that could possibly strengthen the seaweed sector and improve seaweed farmer welfare.

The main purpose of this study is consequently to assess the impact of seaweed farming on the livelihoods of Bagamoyo farmers by investigative its social, economic, and environmental contributions and identifying the limitations that may hinder its efficiency. In addition to that also the study purposes are to fill the identified research gap by applying both descriptive and inferential analyses to assess the statistical significance of seaweed farming's contributions to the wellbeing of household. Through using this approach, the study offers a complete and localized understanding of the seaweed farming role which plays in improving livelihoods by offering evidence-based understandings that can also inform coastal progress strategies, planning of policy, and management of sustainable resource in Bagamoyo.

LITERATURE REVIEW

Economic Impact of Seaweed Farming

Various literatures have highlighted the economic benefits of seaweed farming. Msuya (2013) found out that seaweed farming provides steady income to thousands of women in coastal regions of Tanzania. The income earned often exceeding earnings receiced from fishing or small-scale agriculture. Chapman et al. (2015) also added that seaweed farming is especially valuable because of low costs of starting farming and relatively stable international demand and Minimal skill are required. Researchers like Kraan (2017) claim that seaweed farming decreases economic vulnerability by contributing to year-round income especially in areas where stocks of fishing have been declined. In Bagamoyo precisely, Mwambao Coastal Community Network (2018) reported that seaweed farming accounts for an important share of household cash income especially among households headed by women. However, economic constrains exist. Studies conducted by Msuya & Hurtado (2017) also show that farmers often face low farm-gate prices because of the dominance of middlemen and lack of direct access to international market. Additionally, Kimathi et al. (2020) revealed that climate changes is also related to declines in seaweed quality which further reduce market prices and leading to impacting income stability.

4. Social Impact (Gender, Empowerment, and Community Development) of Seaweed

Seaweed farming is broadly known for its transformative effect on gender dynamics and social development. Bryceson, (2002) revealed seaweed farming as a gendered livelihood, where women engaged in it are more than 80% of the producers in Tanzania. This aspect provides women with economic authority leading to better-quality involvement in financial decisions in the household. Torell et al. (2010) also highlighted different social benefits like increased women's financial self-sufficiency, improved household wellbeing in terms of food, healthcare and education, evolution of women-led cooperatives and stronger social networks in coastal communities. Furthermore, Msuya (2011) emphasizes that seaweed farming reinforces community interconnection through communal work groups, sharing farming areas, and cooperative strategies of marketing. In Bagamoyo, women's seaweed groups have grown into village-based organizations that advocate for improved pricing and market linkages.

Environmental Contributions and Ecological Impacts of Seaweed

Studies reliably display that seaweed farming is environmentally sustainable. Largo (2002) clarifies that seaweed advances quality of water by absorbing extra nutrients, mitigating eutrophication. Neish (2013) also reported that seaweed farms generate micro-habitats that support biodiversity and redevelop marine ecosystems. However, environmental stressors are also well noted and documented. Muthiga & Kawaka (2018) revealed that increasing temperatures of the sea surface led to disease eruptions and "ice-ice" syndrome leading to mass die-offs of Kappaphycus. Furthermore, Zuberi & Msuya (2020) reported that changeable weather patterns and strong waves cause farmers to move their sites which increasing costs of operation.

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Market Dynamics and Value Chain Challenges

Most reviewed literatures identify market limitations as a main barrier to maximizing seaweed benefits. A study conducted by Hurtado et al. (2014) reveals that blockages in East African seaweed markets, depending on a few exports' buyers, limited value chain processes at local level, Lack of infrastructure to process seaweed and poor access to accurate information related to market. Msuya et al. (2013), argue that developing local processing industries like carrageenan extraction plants might significantly upsurge revenue and reduce middlemen exploitations in the market.

Technological and Farming Method Challenges

Different literatures highlighted technological restrictions as a main obstacle to productivity. Studies conducted by Eklöf et al. (2012) indicated that traditional method known as "off-bottom" farming methods are most vulnerable to climate variation and diseases while deep-water farming and methods of floating line as proposed by Hurtado & Neish (2017) deliver better growth conditions but need higher investment and training.

METHODOLOGY

The study engaged a mixed-methods research design which combine both quantitative and qualitative approaches inorder to assess the effect of seaweed farming on the livelihoods of farmers in Bagamoyo region. Primary data were also gathered through a well-structured questionnaire administered to a randomly sample selected of seaweed farmers across major different coastal villages including Dunda, Kaole, and Mapinga. To ensure there is methodological rigor, a multi-stage sampling technique procedure was used and purposively seaweed producing villages were selected. This was followed by a simple random sampling technique of distinct seaweed farmers inorder to achieve balanced representation sample which include both gender, different age group and experience in farming. Further, qualitative understandings were collected through focus group discussions and also key informant interviews were conducted with local region leaders, extension officers, and buyers of the seaweed. In addition to that, Secondary data were obtained from different published reports, documents from the government and relevant academic literature. Before full collection of data, research instruments were pre-tested inorder to refine tune clarity and enhance study's reliability. On the other hand, Quantitative data were also analyzed using descriptive and inferential statistics including correlation and regression analysis in order to determine the statistical significance of seaweed's farming contributions to farmers wellbeing.

RESULTS OF THE STUDY

Descriptive statistical table

Variable	Mean	Std. Dev.	Minimum	Maximum
Monthly Income (Tsh)	167,800	54,320	82,000	298,000
Farming Experience (Years)	7.2	4.1	1	22
Number of Farming Lines	34	11	10	70
Education Level (Years)	6.8	3.2	0	14
Distance to Market (km)	3.7	1.9	1	9
Climate Stress Index (0–10)	4.9	2.3	1	10
Recent Shock (1 = Yes, 0 = No)	0.38	0.49	0	1
Cooperative Membership (1/0)	0.27	0.44	0	1

Source: Researcher own findings, 2024

The study surveyed 120 seaweed farmers in Bagamoyo and found that, on average, farmers earn about Tsh 167,800 per month from seaweed though earnings vary widely between households. Most farmers have around 7 years of experience, and typically manage about 34 farming lines, showing that the sector relies heavily on hands-on skills and physical effort. Education levels are modest, averaging about 7 years of schooling, and farmers usually live 3 to 4 km from the nearest market. Many farmers reported facing climate challenges, with a moderate climate stress score, and more than one-third experienced a recent climate or disease shock. Only a small portion belong to cooperatives. Overall, the numbers paint a picture of hardworking coastal farmers who depend greatly on seaweed farming but also face really environmental and economic pressures.

Results of Regression analysis on Factors Influencing Monthly Income of Seaweed Farmers (TSh)

Variable	Coefficient (Tsh)	Std. Error	t-value	p-value
Experience (Years)	11455	2686	4	0.000***
Number of Farming Lines	517	37	14	0.000***
Education (Years)	–10,785	5338	–2.02	0.046**
Cooperative Membership	–4,526	19330	–0.23	0.817
Distance to Market (km)	–729	537	–1.36	0.176
Climate Stress Index	–16,419	3761	–4.37	0.000***

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Recent Shock Experience	–59,150	21053	–2.85	0.005***
Constant	67630	31773	2	0.035**
Observations	120			
R-squared	0.631			
Adjusted R-squared	0.614			
F-statistic (7,112)	25.60*			

Source: Researcher own findings, 2024

From the table above, the regression results reveal that income from the seaweed farming in Bagamoyo is significantly influenced or affected by years of experience in farming production scale, climate circumstances, and exposure to shocks. This means that each additional year of seaweed farming experience increases farmer monthly income by approximately Tsh 11,455 whereas each additional line of farming contributes to an additional Tsh 517, this signifies that both farming acquired skills and capacity of production directly improve earnings. Contrarywise, years spend on formal education are related with lower income signifying that the more the person is educated the more educated individuals may split his/her attention between farming of seaweed and other economic activities. Furthermore, Climatic related factors have strong negative effects to earning thus worsening of climate stress reduces farmer's income by about Tsh 16,419 and facing a recent climate or disease shock also lowers income by Tsh 59,150 this is highlighting the seaweed farming vulnerability to environmental disruptions. Nevertheless, the cooperative membership and markets distance do not show any statistically significant effects on earnings. General, the model explains about 63.1% of the variation in income received from seaweed this indicate that experience production, scale of farming, and resilience of climate are the most significant determinants of seaweed farmers' livelihoods in Bagamoyo.

DISCUSSION OF FINDINGS

The findings of the study reveal that seaweed farming in Bagamoyo is significantly contribute to the improvement of the household income, together with farmers' experience and scale of production evolving as strong predictors of earnings received. The positive relationship effect of experience in farming whereby an additional year increases monthly income received by approximately Tsh 11,455 line up with previous research display those experienced farmers hold better technical and practical skills, stronger market networks, and improved practices of farm management. Similar observations were also reported by Msuya (2011) and Msuya and Hurtado (2017), they found out that that experienced seaweed farmers in Tanzania attained higher yields due to more familiarity and being aware with environmentally suitable sites, selection of seed, and seasonal variations. Similarly, Hamed et al. (2017) reported that experience in farming enhances farmers' resilience enabling them to adapt easily and quickly to the uncertainties in the market and environmental.

The positive influence of lines of farming (production scale) is also consistent with studies presenting that seaweed farming profits are highly depending on the scale. Each extra farming line raised farmer's monthly income by Tsh 517 this is supported by the findings from Eklöf et al. (2012) and Fröcklin et al. (2012) reported that larger plots lead to higher output and also improved bargaining power with buyers. Thus, expansion of farming infrastructure like ropes provision, stakes, and facilities used in seaweed drying can also significantly boost earnings.

Unpredictably, this study found out that higher levels of formal education are related with lower seaweed farming income. This means there is an inverse relationship between formal education and income received from seaweed farming. This result mirrors findings obtained by Lange and Jiddawi (2009) in Zanzibar, who reported that better educated individuals often pursue other alternative occupations which are outside marine farming. As a result, this reduces the time and energy allocated to seaweed farming activities. This may also reflect the low technology, nature of seaweed farming which is labor-intensive, which offers restricted returns relative to other employment opportunities for educated individuals.

The strong negative relationship of climate stress and shocks is dependable with the broader literature highlighting environmental vulnerability in farming of seaweed. Unfavorable climate condition reduced income by Tsh 16,419, while recent shocks lowered it by Tsh 59,150 these findings are similar to Hurtado et al. (2019) and Msuya (2020) who reported that temperatures rising, ice-ice disease and strong prevailing currents have extremely reduced seaweed productivity along the East African coast. Previous studies conducted in Zanzibar and Kenya correspondingly show that climate change threatens both the quantity and quality of Kappaphycus alvarezii and Eucheuma denticulatum which are the main cultivated species (Badmus et al., 2021; Raju et al., 2022). All of these consistent results underscore the crucial need for climate resilient farming innovations like deeper-water farming and also the introduction of heat tolerant seaweed varieties.

The lack of significant relationship from cooperative membership is quite different with studies that highlight the importance of collective action. For example, Msuya (2013) and Brummett et al. (2014) found out strong farmer groups may improve access to training, credit and markets. The insignificant result in Bagamoyo may either indicate weak or inactive cooperative structures, low bargaining power or low involvement among farmers an institutional gap requiring policy attention.

Generally, the results of this study line up very closely with the available existing literature, supporting the understanding that farming of seaweed remains an important but environmentally vulnerable livelihood activity in coastal Tanzania. Establishment and strengthening climate resilience, improving skills of the farmer, and enhancing scale of production appear as important strategies for increasing the socioeconomic benefits of seaweed farming in Bagamoyo

CONCLUSION

This study examined the impact of seaweed farming on the livelihoods of farmers in Bagamoyo and it has established that the activity remains very important, though it is vulnerable, economic source for coastal households. The findings from the study revealed that experience in the farming and scale of production significantly improve monthly income. Moreover, underscoring the value of practical information and knowledge, acquisition of the skill, and increased capacity of farming in improving welfare of the household. At the same time, the negative relationship of climate stress and recent environmental shocks point out the fragility of the seaweed farming sector and the show urgent need for climate adaptive measures. The surprising inverse association between formal education and income proposes that seaweed farming is yet to attract more individuals with fewer livelihood alternative options, raisin the need to advance the sector's economic viability to hold skilled labor.

Overall, this study concludes that farming of the seaweed delivers more meaningful livelihood opportunities in Bagamoyo but it requires targeted interventions like strengthening groups of farmers, farming inputs expansion, extension services enhancement, and investing in climate resilient farming technologies to maximize its contribution to sustainable development of coastal communities. Addressing the gaps will not only upsurge productivity and incomes but also guarantee the long term stability of the industry in the face of growing environmental pressures.

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