Factors Affecting the Development of Rainbow Trout Fish Aquaculture: Case of Mathira West District, Nyeri County Kenya

Justus Nyaga Njue
Prof. David Macharia
Kenya

Abstract

This study focused on the general development of aquaculture as a fish farming system. Studies on aquaculture have dwelt on its growth (Hopkins, 1995; Brown, 1983; Karim et al, 2006). Rainbow trout aquaculture is a lucrative venture with figures in the year 2001 showing it to be the second most expensive fish in the country after Nile perch (Lates niloticus) in both fresh water fish and marine fish of the country, 1 Metric ton fetching approximately Ksh. 225,000 (Ministry of Fisheries Development, 2003). Despite this, information available on rainbow trout aquaculture in Kenya is limited. This negatively impacts investment in this area which has a very high potential of improving the livelihoods of the rural people in areas where trout fish aquaculture is feasible. Therefore, the purpose of this study was to fill this gap in knowledge by examining the factors affecting the development of aquaculture. Descriptive survey design, utilizing both qualitative and quantitative approaches was used. Several persons were interviewed comprehensively to find out the effect of rainbow trout aquaculture in their community. The study was located in Mathira West District focussing on a target population of 339 persons. The research instruments used were questionnaires, designed to gather objective data and interviews. Once collected, the data was analyzed through qualitative and quantitative methods. The study recommends that fish-farmers have the potential to improve on aquaculture despite the limiting factors of finances.

Keywords: Aquaculture; Economic Potential; Fish Farming Rainbow Trout

1.0 Background to the Study

Aquaculture has been the world's fastest growing food-producing sector with an overall growth rate of 11% since 1984. This sector can make an important contribution to poverty alleviation, food security and social well-being, and already does so in many developing countries (Mwangi, 2008). Currently, many agriculturalists strongly believe that we are entering a third revolution termed the 'Blue Revolution', that is, the aquacultural revolution. This transition seeks to achieve a balance between sustainability of resources, environmentally sound practices, productivity and profits in response to environmental damage resulting from the practices developed in the Green Revolution. The development of aquaculture is inevitable as demand for seafood products increase through population growth. It is no secret that the rising protein needs of an expanding world population will not be met by tradition capture fisheries. Although the world-wide gross tonnage from natural stocks predicted by some authorities has not been reached, many species, particularly "luxury" species such as lobster, shrimp, salmon and premium fin fishes, have been fully exploited. This trend can only continue and will result in diets of lesser diversity and quality. Aquaculture has thus, drawn increasing attention from many quarters as a modern culture practice in both developed and less developed countries (Allen, 1984; Hopkins, 1995; Bardach et al, 1972; Bardach, 1976; Brown, 1983).

In Kenya, fish farming development started in the 1920s with the arrival of European settlers while fish culture as a means of producing a source of protein for rural indigenous population began in the late 1950s and early 1960s. This followed a pattern similar to that observed in many African countries, characterized by small ponds, subsistence-level management, and very low levels of production (Otieno and Campbell, 1995; Ngugi et al, 2008). It has been established that Kenya is endowed with numerous aquatic resources with aquacultural potential. It has highly varied climatic and geographic regions, covering a part of the Indian Ocean coastline, a portion of the largest freshwater lake in Africa (Lake Victoria), and several large rivers, swamps, and other wetlands, all of which support an abundance of native aquatic species. These aquatic environments range from marine and brackish waters to cold and warm fresh waters, and many can sustainably contribute to the operation of ponds for fish production.

Although aquaculture has not contributed significantly to the economy of the country, the endowment of the country with these natural aquatic environments proof that its potential is very high (Ministry of Fisheries Development, 2003; Ngugi et al, 2008). Central province is one of the regions in the country endowed with such an abundance of aquatic environments and as such, the region has 1154 farmers who practice fish farming as an enterprise (Ministry of Fisheries Development, 2003).

For cold water fisheries involving the production of rainbow trout under intensive systems using raceways and ponds, Mathira West District has a great potential. For this reason, a government trout farm was built in the area in year 1948 (Kiganjo Trout Hatchery News Bulletin, 2009). However, though not yet quantified, only a small portion of these resources are utilized. The development of aquaculture subsector will increase full use of the resources, create employment for the youth and women and also increase rural incomes. However, not much has been realised out from it in Mathira West District of Kenya. This study therefore focused on the factors affecting the development of aquaculture in the area of study.

1.1Statement of the Problem

Underdeveloped countries are currently grappling with poverty and hunger with millions of people dying from malnutrition owing to shortage of animal protein. Kenya is no exception in this predicament. In many African countries, the quick production of greater amounts of animal protein by their own means is not only a central problem of the food economy, but also a prime question of economic importance, Ngugi et al, 2008) A comparatively small effort put in fisheries development will quickly result in improved standards of living and nutrition, help secure food security for domestic consumption and even for export, if the pre-requisites are fully recognized. Studies by Otieno and Campbell, 1995, show that Kenya is endowed with numerous aquatic resources with aquacultural potential. Most of these resources are located in rural areas where employment opportunities are scarce. Adoption of aquaculture will therefore open up new avenues for employment in rural areas by increasing self-employment opportunity, employment opportunity to work in aquaculture farms that use hired labour and also help in meeting the nutritional needs of the people.

The development of aquaculture subsector will increase full use of the resources, create employment for the youth and women and also increase rural incomes. The level of adoption of this technology remains relatively low
This study sought to examine the factors affecting the development of aquaculture and specifically the rainbow trout fish species in Mathira West District Central Province Kenya

1.2 Objectives of the Study

The study had the following specific objectives:

i. To determine the influence of knowledge on trout aquaculture on its development in Mathira West District.
ii. To evaluate how the cost of starting rainbow trout fish aquaculture affects the development of rainbow trout fish aquaculture in Mathira West District.
iii. To establish how availability of water and land affects the development of rainbow trout aquaculture in Mathira West District.
iv. To determine how availability of labour affects the development of rainbow trout fish aquaculture in Mathira West District.
v. To assess how demographic factors in Mathira West District community affect the development of trout aquaculture in the area.

2.0 Review of Literature

2.1The Concept of Aquaculture

Aquaculture entails the growing or farming of fish and other aquatic organisms in controlled environment for food or commercial purposes (Mbugua, 2008). Fish aquaculture can be broken down into two basic categories .With extensive fish aquaculture, fish are held in nets or cages in their native habitat, such as lakes, rivers or oceans. Intensive fish aquaculture refers to the containment of fish in ponds or tanks, where nearly all of their nutrition is provided by the fish farmer. Some examples of the most popular fish species raised in the world are: Salmon, Cod, Brook Trout, Brown Trout, Carps, Catfish, Rainbow Trout, Tilapias, Tunas and Perch. There are many more fishes that are cared for in captivity including numerous species of baitfish for recreational fishing and ornamental species.

2.2Current Status of Aquaculture in the World

Aquaculture is probably the fastest growing food producing sector in the world. During the past three decades, aquaculture has expanded, diversified, intensified and made technological advances. According to experts, the aquaculture sector has been growing with an overall growth rate of 11% since 1984. The potential of this industry to enhance local food security, alleviate poverty and improve rural livelihoods and social well-being has been well recognized. In fact, this contribution is already being realized in many developing countries (Mbugua, 2008). The present level of aquaculture production was driven out of necessity. Just as Agriculture became imperative to the existence of mankind, so now has aquaculture become the only sustainable method of producing high quality seafood. World fisheries statistics show that the world's demand for fish and seafood has exceeded the levels that hunting and gathering wild fisheries can support. Recent data suggests that aquaculture now accounts for over 50% of the entire worldwide seafood supply. It is estimated that at least an additional 40 million tonnes of aquatic food will be required by 2030 to maintain the current per capita consumption. Aquaculture has thus drawn increasing attention from many quarters as a modern culture practice in both developed and less developed countries (Allen, 1984; Hopkins, 1995; Bardach et al, 1972; Bardach, 1976; Brown, 1983).

2.3 History of Aquaculture in Kenya

Fish aquaculture development in Kenya started in the 1920s with the arrival of European settlers and was more often than not confined to recreation purposes. Fish culture as a means of producing a source of protein for rural indigenous population began in the late 1950s and early 1960s (Otieno and Campbell, 1995). This followed a pattern similar to that observed in many African countries, characterized by small ponds, subsistence-level management, and very low levels of production (Otieno and Campbell, 1995; Ngugi et al, 2008). It has been established that Kenya is endowed with numerous aquatic resources with aquacultural potential. It has highly varied climatic and geographic regions, covering a part of the Indian Ocean coastline, a portion of the largest freshwater lake in Africa (Lake Victoria), and several large rivers, swamps, and other wetlands, all of which support an abundance of native aquatic species. These aquatic environments range from marine and brackish waters to cold and warm fresh waters, and many can sustainably contribute to the operation of ponds for fish production. Although aquaculture has not contributed significantly to the economy of the country, the endowment of the country with these natural aquatic environments proof that its potential is very high (Ministry of Fisheries Development, 2003; Ngugi et al, 2008).

2.4 Current Status of the Fisheries Sector in Kenya

The fisheries sector plays an important role in the national economy of Kenya, contributing 0.5% to the GDP in the year 2006. This sector is also an important economic activity to the fishing communities and is a major source of livelihood. The sector supports about 80,000 directly and about 800,000 people indirectly. A total of Ksh. 8.7 billion to fishers was produced in the country while fish exports earned the country approximately Ksh. 5 billion (Ministry of Fisheries Development, 2006). These fortunes, acquired from the fisheries sector, are set to dwindle, not only in Kenya but also in the entire world. According to Valdimarsson (2007), the wild capture fisheries potential worldwide is largely at its limit: it has reached a plateau. Increase in wild capture fisheries would have to come through restoring over fished populations by vastly improved management practices. All projections point to increased demand for fishery products in the future, and it is evident that aquaculture will play a crucial role in satisfying that demand. According to the aquaculture survey concluded in 2006 by the department of fisheries, the total area under aquaculture stood at 722.4ha which include culture-based fisheries. The production from this utilized area was shown to average 4,200,000Kg per year. According to Aloo (2006), aquaculture was contributing 0.5% of the total national fishery production with the bulk of production coming from tilapia species. Most of the aquaculture in Kenya is done under extensive and semi-intensive aquaculture systems (Mbugua, 2008). Central province is one of the regions in the country endowed with such an abundance of aquatic environments and as such, the region has 1154 farmers who practice fish aquaculture as an enterprise (Ministry of Fisheries Development, 2003).

2.5 Aquaculture in the Economy and Creation of Employment

Aquaculture opens up new avenues for employment in rural areas by increasing both self-employment opportunity and employment opportunity to work in aquaculture farms that use hired labour. This allows rural households to improve their health standard, ensure food security, supplement their incomes, alleviate poverty and promote social equity and prosperity in rural areas (Karim et al, 2006; Mbugua, 2008).

Already, aquaculture has directly employed over 8,000 and 12,000 people in Canada and Norway respectively, not to mention the indirect jobs created. In fact, aquaculture has reduced the unemployment rate from 90% to 30% in the Aboriginal community of Klemtu, British Columbia in the west coast of Canada

(http://library.thinkquest.org/05aug/00548/farmed--economy.html http://www.aquaculture.ca/files/economic-benefits.php).

A good example of the types of employment created by aquaculture can be depicted in fresh water fish farming. The type of people employed in fresh water fish culture include fish seed producers and traders, including the nursery people, vendors, fish farmers, fish-farm workers and fish traders stand to benefit. Apart from these people who are directly involved in fish industry, manufacturers and traders of fish feed, food distributors, ice makers and distributors, transporters and related work groups, benefit from business oriented aquaculture. The cost of creating employment through this approach is by far the least expensive. In fact it can be accomplished with available resources and without dependence on external resources (Karim et al, 2006; Terril, 1995).

In Bangladesh, a survey carried out in Khulna, Satkhira and Cox's Bazaar areas, it has been found that year-round shrimp farming yields much higher returns and employment than year-round rice farming: gross return is 170% higher while employment is 130% greater and labour income is nearly 100% higher. The average productivity is also higher by about 20%. Thus, shrimp farming can make important contributions to employment and income of the ordinary rural labourers who are predominantly poor (Karim et al, 2006). Although this has been achieved in the mentioned parts of Bangladesh, it is yet to be established if that is the case in the current area of study. The potential of trout fish aquaculture in improving the livelihood of the farmers and the general economy of the country cannot be overstressed. Already, developed countries are reaping the benefits of trout aquaculture. In the year 1994, the annual production of trout fish alone in the USA was about 226,960 Metric tons, worth well over US$ 100,000,000 (Ksh. 7.5 billion) with sustainability of trout culture being very positive with respect to market and product quality (Brannon, 1995). In Kenya, total trout production for three years,2001,2002, and 2003 was 23, 17, and 29 Metric tonnes respectively giving a total of 69 Metric tonnes worth Ksh.17,265,000 (Fisheries Department, 2003). With improvement and support to trout fish farmers in the country, figures as high as those attained in the USA can be achieved in the country and boost our economy. Trout fish aquaculture is a lucrative venture with statistics in the year 2001 showing trout as the second most expensive fish in the country after *Lates niloticus* in both fresh water fish and marine fish of the country, 1 Metric ton fetching approximately Ksh. 225,000 (Ministry of Livestock and Fisheries Development, 2003). Despite this, information available on trout fish aquaculture in Kenya is limited. This negatively impacts on potential investment in the industry despite its potential. Focusing on trout fish aquaculture, the findings and recommendations from this study will contribute useful information in identification and examination of the impact of the rainbow trout fish species to the rural community.

Poverty has some adverse implications for the economic growth of a country. Poverty is the principal cause of malnutrition and inadequate saving. Both contribute to low productivity and meagre income of the workforce. Malnutrition causes ill health and morbidity among the poor people, reducing their ability to do productive work. A low savings rate prevents the poor from investing adequately in human and physical capital which leads to their lower productivity. Wages or incomes of the poor are accordingly depressed. The poor are thus caught in a vicious circle of poverty. Widespread poverty may also give rise to criminal activities. Hence, there is a price to be paid for poverty in terms of reduced economic growth (Karim et al, 2006). Therefore, it is imperative that poverty be reduced on an urgent basis in order to unlock the growth potential of the economy. Aquaculture has the potential to contribute in poverty alleviation and boost the country's economy as witnessed in Thailand and Philippines where 93% and 86% of fish farmers respectively concurred that aquaculture was an enterprise that gave the most cash (Terril, 1995). In our country, the Kenya Integrated Household Survey of the year 2005/2006 indicated that 46% of the rural population living near perennial and seasonal water bodies fall below the poverty line. This is despite the potential of these water bodies in fish aquaculture. Aquaculture, by its very nature, can be practiced mostly in rural areas.

3.0 Research Methodology

3.1Research Design

This study adopted a descriptive survey design utilizing both qualitative and quantitative approaches in order to gain an understanding on factors affecting trout fish aquaculture on the community in question. According to Orodho, 2003, and Kombo, 2002, descriptive survey is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals. It can be used when collecting information about peoples' attitudes, opinions, habits and any of the variety of education in social issues. Crabree & Miller (1992) observes that this design explores meanings, perceptions, relationships, associations and patterns based on personal experience of the phenomenon being investigated. The design allowed the researcher to generate both numerical and descriptive data that was used in measuring the relationship between variables. Being an exhaustive study of the factors that influence the development of rainbow trout aquaculture in the community of Mathira West District, this method enabled the researcher to fully understand the behaviour patterns of the various people in the study.

3.2Research Instruments

The study was carried out using two types of research instruments namely the use of the survey questionnaires and the interview method. The questionnaires were for the local leaders and teachers while the interviews were for fish farmers and the fisheries personnel.

3.2.1Questionnaires

Respondents were issued with carefully designed questionnaires to collect the data. Satyanarayana (1989) argues that questionnaire should gather objective data. They were administered personally to the respondents. They contained both closed and open-ended questions to allow the respondent record their responses independently. The close-ended questions provide subjective data while open-ended question insights into the respondent's feelings. The questionnaire had a standardized vocabulary and ease of questions to avoid ambiguity and enhance understanding. They were developed through consultations with classmates, my supervisors and other researchers. The researcher used two types of questionnaire. One was for the teachers and the other for local community leaders. They gave the information as envisaged in the research questions. These questionnaires were structured to give information on personal bio-data, information on aquaculture, financial issues, availability of water and land, socio-cultural issues and finally on government policies.

3.2.2 Interview Method for Data Collection

The researcher used the structured interview method that involved subjecting every informant in a sample to the same stimuli for instance asking each informant similar questions, (Kombo & Tromp, 2006). This involved face to face interviews focused towards individual fish farmers and fisheries personnel. The researcher did so in person because of the need to establish the accuracy and efficiency of the programme. A discussion with these respondents was important to establish directly the problem; its manifestation and development.

4.0 Research Findings

4.1Knowledge of Aquaculture

The fish farming knowledge being mentioned here is the state of knowledge about facts, information, skills, technical know-how, understanding, etc. for fish production technologies. From table 4.5, it is observed that 71% of the fish farmers had obtained knowledge about trout fish aquaculture while only 29% did not obtain knowledge on trout fish aquaculture. 73% of the teachers and 75% community leaders had not obtained knowledge on fish farming, while only 27% and 25% respectively had obtained such knowledge.

From the findings, knowledge on fish farming was positively related to the probability to adopt trout fish aquaculture. The sign of the variable was consistent with prior expectations. This implied that respondents who had acquired knowledge on aquaculture were more likely to adopt trout fish aquaculture than those who did not have such knowledge. This is similar to the finding that the availability of extension services has positive influence on the probability to adopt farm technologies (Polson and Spencer, 1991; Kaliba et al., 1997; Baidu-Forson, 1999; Burton et al., 1999; Kimenye, 2001).

4.2 Aquaculture Sensitization

Table 4.1 shows the respondents' level of sensitization on fish aquaculture.

Table 4.1: Respondents' Level of Sensitization on Aquaculture

Scale	Frequency	Percentage Incidence (%)
Frequently	10	12
Occasionally	6	8
Rarely	30	37
Never	34	43
Total	**80**	**100**

On average, this research found that the level of sensitization on fish aquaculture was to be poor. This is depicted on table 4.6 where only 12 % of the respondents were frequently sensitized on the subject. A big percentage of the respondents (43%) were not sensitized on aquaculture while 37% and 8% were rarely and occasionally sensitized respectively. The 12% value of the frequently sensitized respondents indicates that there is need for the government to improve on the efforts being put towards sensitization of the public on aquaculture.

Respondents were also asked to explain the important modes of sensitization of the community on the promotion of aquaculture. Based on the findings, majority of the respondents agreed on the dire need for spirited campaigns to promote aquaculture due to the overriding benefits that accrue from the project. All possible media such as public meetings, printing of brochures or even advertisements over the radio was a sure way to reach out to the people. Aquaculture of rainbow trout fish is one venture that can eliminate poverty as attested by the respondents because the increase in disposable income would help the farmers in improving their living standards.

4.3 Financial Income in Aquaculture Development

This section discusses the financial income of the respondents in relation to fish aquaculture development.

4.3.1 Annual Income of the Respondents

The table below shows the annual income of the respondents in this study.

Table 4.2: Annual Income of the Respondents

Annual income (Ksh.)	Frequency	Percentage
30,000 and below	25	31.25
30,000-40,000	8	10.00
40,000-50,000	17	21.25
50,000-60,000	8	10.00
Above 60,000	22	27.50
Total	**80**	**100.00**

Mean annual income = Ksh 42,125
Range = 20,000
Estimated cost of starting trout aquaculture = Ksh. 60,000

Table 4.2 shows the annual income levels of the respondents. The estimated cost of starting trout aquaculture is Ksh. 60,000 which is above the culture of other types of fish like tilapia which costs an estimate of Ksh. 40,000. This explains why it is difficult for the community to embrace trout aquaculture. The study reveals that most of the respondents' annual income (72.50%) falls way below the bench mark for starting trout aquaculture. Only 27.50% of the respondents earn an annual income above Ksh. 60,000. This reveals that from all the identified variables, financial strength is the major constraint in starting trout aquaculture in the community.

Trout fish aquaculture is more likely to be adopted if it was more profitable than the mentioned competing economic activities. This is consistent with findings by Napier et al. (1991), and Baidu-Forson (1999), who indicate that farmers adopt a technology which promises greater reward than existing practices. One of the objectives of undertaking fish aquaculture was to generate cash income. However, in achieving that objective, fish aquaculture competes with other activities for household resources as depicted.

The low profitability of fish aquaculture relative to other economic activities was attributed to small pond sizes, some ponds were located too far from homesteads, poor management due to non-availability and/or high opportunity cost of inputs, stocking of poor quality fingerlings, low stocking density, unreliable market, animal predation, human theft, and pond overcrowding leading to poor growth of fish

4.4 Availability of Land and Water for Aquaculture

This section discusses the importance of land and water in aquaculture development.

The land question posed whether ownership basis was either freehold or rental. Table 4.8 shows that majority had freehold (78.75%) and therefore any agricultural practices on the land would be viable. This facilitates projects such as building of ponds fish aquaculture. Even the land topography was quite conducive for establishing such ponds. Only 21.25% respondents owned land on rental basis.

Land size was positively related to the probability to adopt fish aquaculture. The sign of the variable was consistent with prior expectations. Over 63.33% of fish farmers owned 1.5 acres of land or above as compared to 36.67% of fish farmers who owned 1.5 acres of land or less. This was as expected farmers owning bigger farm size were more likely to adopt fish farming than those owning smaller farm sizes. This finding is consistent with Kimenye, 2001, and Bussolo et al., 2007. A possible explanation is that farmers producing on larger farm sizes had spare land for fish farming and were commercial and produced small marketable surpluses to satisfy some level of household financial needs (Polson and Spencer, 1991) and have a high probability to take up new and/or unfamiliar activity such as fish farming. Akinola (1987) shows that because farm size was an indicator of the level of economic resources available, the probability to adopt a new technology increases as the resource base increases. Conversely, farmers producing on small farm sizes had less spare land for fish farming and produce mainly for consumption, were less flexible in accepting new ideas and tended to be risk-averse.

The land size ownership trend was also true for the other respondents whose majority (62%) owned 1.5 acres of land or more while 38% owned less than 1.5 acres of land. Overall, 62% of the respondents owned 1.5 acres of land or more while 38% owned less than 1.5 acres of land. This meant that availability of land for trout aquaculture in Mathira West district was not a major constraint and if the other factors are addressed, most of the community members will embrace trout fish aquaculture.

4.5 Availability of Water for Aquaculture

It is inferred that rivers are well distributed in the district thus providing adequate water supply. This is facilitated by the proximity to the Mt Kenya Forest. The main rivers are Sagana, Nairobi, Ragati and Thegu (All these are gazetted trout rivers, Fisheries Act Cap 378). Other streams and rivulets intersperse the district. Water is managed by Tana and Athi Water Board which is mandated to license water captures for any activities including irrigation, domestic consumption and for fish pond development.

Water was actually not a big problem due to the adequate rainfall and well distribution of the rivers that fed fish farms. However, the problem of drought at certain times of the year was highlighted hence bringing in a reduction of water volumes to as low as 14% in main rivers. Water quality and its sustainability is the key to development of aquaculture of rainbow trout.

4.6 Perception towards Aquaculture

The table below shows the perception of the respondents towards fish aquaculture.

Table 4.3: Respondents' Perception towards Fish Aquaculture

Perception	Frequency	Percentages (%)
Positive	51	64
Neutral	9	11
Negative	20	25
Total	**80**	**100**

Source: Researcher (2013)

Data in Table 4.3 reveal that 64% of the respondents had a positive attitude towards trout aquaculture and 11% were neutral possessing no opinion regarding the questions and statements posed to them. Further 25% of them had negative perception towards trout aquaculture. With 64% positive perception towards aquaculture, the overall expression of attitude of the respondents was good.

So, it might be said that the respondents possess a good and favourable mentality about trout fish aquaculture. On average, this is consistent to Rahman et al, 1995, on the study about farmers' technical knowledge and attitude towards modern methods of fish culture.

5.0 Discussions of Findings

This section gives a detailed discussion of the findings in the study on the factors affecting the development of aquaculture. During the study, it was found out that financial challenges posed a big problem in the development of trout aquaculture. Aquaculture has not contributed significantly to the economy of the country despite the fact that there is endowment of the country with these natural aquatic environments hence its potential is very high; Ngugi et al, (2008). The study found out that even where financial resources are available, other factors such as competition for economic land influence the decisions to the establishment of aquaculture enterprises. Trout fish aquaculture is more likely to be adopted if it was more profitable than the other economic activities. This is consistent with findings by Napier et al. (1991), who indicates that farmers adopt a technology which promises greater reward than existing practices. One of the objectives of undertaking fish aquaculture was to generate cash income. However, in achieving that objective, fish aquaculture competes with other activities for household resources.

The study found out that trout aquaculture is a technical innovation whose success strongly relies on the technical know-how by the practitioner. In this case, a large percentage of the respondents interviewed (43.75%) had no knowledge at all on fish aquaculture. This fact expresses the low level of adoption of trout aquaculture which agrees with Mheen-Sluijer (1991), and Rahman (1995) that knowledge on aquaculture influences the adoption of fish aquaculture. People who have acquired knowledge on aquaculture are more likely to adopt aquaculture than those who do not have such knowledge. This is similar to the finding that the availability of fisheries extension services has positive influence on the probability to adopt aquaculture technology.

The study found out that some members of the community are hesitant to start aquaculture of trout fish due to the inherent fears of the uncertainties such as market, predation, and poaching, adverse weather pattern among others. For successful trout aquaculture to be undertaken there should be in-reaching sensitization to all the community members so that they can gain enough knowledge to enable them venture into fish aquaculture authoritatively. The findings of this study therefore commensurate with the authoritative sources in the literature review and the five variables; viz knowledge of fish aquaculture, financial capital, availability of land and water, availability of labour and socio-cultural issues in aquaculture development.

6.0 Conclusion and Recommendations

The conclusions for the study are based on the findings and the analysis from the precedent chapters. It was noted that trout fish aquaculture development in Mathira West District is faced with many challenges to become a major contributor in the economy of the people and on poverty reduction. The objective of this study was to identify those factors which affect the development of rainbow trout fish aquaculture in Mathira West District, Kenya. The study concludes that financial constraints was identified as the major limiting factor to aquaculture development since most of the members of Mathira community were found to have inadequate income and thus cannot venture into trout fish aquaculture since it is highly capital intensive.

Knowledge on the other hand contributes to adoption of aquaculture of rainbow trout. This goes hand in hand with the degree of sensitization through varied media such as seminars, workshops and even in meetings. This is so because trout aquaculture demands hands-on technical know-how on all husbandry techniques in order to succeed.

The study has revealed that women are more adopters to trout aquaculture than men due to its current subsistence nature. However, with increased sensitization and commercialization, it is likely that more men will adopt the enterprise. Similarly, trout fish farmers were more likely to be farmers who own bigger farm sizes and have bigger household sizes because they can easily expand and commercialize their enterprise and also access labour input for their farms easily. Finally the results have shown that farmers were more likely to adopt trout aquaculture if the technology was profitable and less risky.

Conclusively**,** the research observes that trout aquaculture is likely to be adopted by more educated members of the community due to the technological input that have to be learned and that the educated people can easily assimilate that knowledge.

6.2Recommendations

The study set out to find out the factors that affect the development of aquaculture of rainbow trout. It makes the following recommendations which will enhance the attainment of the research objectives. The results have spurred some interesting and important recommendations which include:

6.2.1Financial Constraint and Marketing

Fish farmers should be encouraged to form and actively participate in cooperative organizations that empower them with strength of numbers yet allow independence of sole proprietorship. This will help them acquire capital and funds from financial institutions since fish farming, and in particular, trout fish aquaculture is a highly capital-intensive enterprise. These cooperatives will also ease the problem of marketing.

6.2.2Training on Aquaculture Development

Training on aquaculture development should be intensified for the women and youth since aquaculture appears to be particularly attractive to disadvantaged groups (women and the youth), thus helping to address positively inequality issues.

Specialized training on aquaculture should also be introduced to all educational levels to address the problem of shortage of skilled labour on aquaculture.

6.2.3 Promotion of Aquaculture

Promotion of aquaculture should target farmers with resources necessary to adopt the technology. Farmers reluctant to adopt aquaculture should be encouraged to take up aquaculture through integration of aquaculture with traditional agriculture which provides the opportunity for risk management and cash flow diversification.
The government should expand aquaculture demonstration centres and projects to boost the existing ones to eliminate some of the problems often encountered by fish farmers during the start-up phase of new operations.

6.2.4 Aquaculture Research

Aquaculture research should be geared towards development of aquaculture technology that aims to improve the profitability of fish farming so that it can compete with other economic activities. This can be achieved by investigating the possibility of reducing the risk of losing fish, shortening culture cycle to target market size fish, use of low cost inputs and/or through integrating fish farming within the existing farming system.

6.2.5 Fisheries Policy

The government should develop fisheries policies that encourage farmers to adopt fish aquaculture as an enterprise.

6.3 Suggestions for Further Research

i. The study revealed that generally more women had ventured into fish aquaculture. This study therefore suggests that further research be conducted in this field to find out why majority of women in rural areas are embracing aquaculture than men.
ii. Research on cost effective innovative technologies on fish aquaculture which can thrive well in the rural communities could be undertaken.
iii. Research on people's perception in the practice of modern fish aquaculture technology.
iv. Research on the impact of modern aquaculture technology to the people.

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