SMALL SCALE AQUACULTURE IN RURAL ZAMBIA

BUILDING A FOUNDATION:

A CASE STUDY

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Professional Paper

Submitted in partial fulfillment
for requirements for the degree of
Master of Forestry

Northern Arizona University

May 2012

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ABSTRACT:

SMALL SCALE AQUACULTURE IN RURAL ZAMBIA:

BUILDING A FOUNDATION – A CASE STUDY

Robert O. Sather

In rural Zambia there exists the potential to reduce poverty and improve food security through aquaculture development. We review government efforts to realize the advantages to training rural Africans including Zambians in fish farming practices as well as motivating them to modify their efforts toward this end. In this case study the aim is to shed light on primary aspects relating to small scale changes and development of food security in rural Zambia. Key factors that contributed to the success of fish farming included: limited technology, motivation, gender equity, integration, economics, and the formation of a fish farming cooperative. The final recommendation to improve the economic and agricultural aspects of rural Zambian livelihoods gives strong consideration to the multiple uses of resources from a variety of avenues. It is important that cooperative integration becomes a pertinent component for the overall goal of building capacity for socioeconomic development. Support for these elements lies prominently within the development of leadership and sound communication with government

TABLE OF CONTENTS

Chapter 1: Aquaculture in sub Saharan Africa - a literature review

Chapter 2: Small scale cooperative aquaculture in rural North West Zambia: a case study of U.S. Peace Corps volunteer service

CHAPTER 1:

AQUACULTURE IN SUB SAHARAN AFRICA –

A LITERATURE REVIEW

I. INTRODUCTION

Food security is a pervasive ongoing issue in rural NW Zambian culture. Furthermore, there are ways to achieve greater food security and relieve poverty to an extent through the development of aquaculture (Brummet, 1999). The objective of this literature review is to present evidence that reinforces this conclusion and supports a portion of other previous studies regarding this outlook.

A farmer participatory view in terms of development of sustainable aquaculture within integrated agricultural systems was tested in Malawi in 1998 (Brummet, 2000). In the Brummett study, the production of fish harvested from ponds increased from 900 to 1500 kg/ha when integration of fish farming with sustainable agriculture was achieved. This clear evidence in Malawi, a prominent African leader in aquaculture development, provides a measure of optimism that sustainable aquaculture can be achieved in other countries in sub Saharan Africa. In addition, contributory agencies such as the U.S. Peace Corps can also derive benefit. The Peace Corps and the application of volunteer programs depend heavily on the sort of feedback that indicates that volunteer programs are successful (Trant, 2004). For example, aquaculture, being relatively new in parts of Zambia, initially required a model to formulate their program. Malawi, a longtime aquaculture provider served as a solid reference for emerging programs. Specifically, the Zambian Minister of Fisheries Director earned his graduate degree at the University of Malawi which specializes in aquaculture prior to heading up the division.

A comparative view of various systems aimed at instituting aquaculture in rural Zambia revealed many of the same obstacles found in other similar African cultures. For instance Harrison (1999) described three unfounded assumptions in terms of farmer motivation associated with development projects. They are firstly, that all members of fish farming households are regarded as equal, second, that cost benefit plays a part in the decisions of potential fish farmers to participate in aquaculture programs, and finally, that the production of fish is the most important outcome to villagers participating in programs. This particular case study experience in Zambia revealed the same perspective as Harrison, despite the minor caveat that in Zambia, although farmers could understand the benefits, they could not grasp the risk involved and became disillusioned at the advent of particular obstacles related to labor and marketing of yield.

From a developmental perspective Brummett and Williams (2000) clarified an approach that links local efforts in aquaculture to remote participants from the viewpoint that technical development and transfer of skills should increase production. Also, aquaculture has the added advantage of environmental and social sustainability. In Zambia, the idea of communal responsibility related to the environment appears obvious. However, other literature, particularly Thomas (1994) and also this study shed light on the deeper meaning of social responsibility and how obtaining it can lead to increased capacity for economic gain. There are socio economic and cultural factors that have significant effects on the acceptance level of technical programs introduced from the outside.

The integration of aquaculture processes with existing agricultural systems has been viewed as a particularly beneficial concept (Blele, 1998) despite the fact that there are many challenges to promoting and developing this idea. The existing agricultural monoculture in Zambia, which is inordinately dependent on the production of maize in rural areas with reference

to food resources, has been in effect for generations and has proven to be difficult to penetrate (Geheb and Binns, 1997). By penetration I am referring to influence and how to achieve it in a positive manner without alienating the constituency.

II. HISTORICAL-CULTURAL PERSPECTIVE

Tilapia (*Oreochromis spp*.), generally indigenous to Africa, have played an important role in the development of the aquaculture movement in Africa since the days of the colonial regimes that dominated African politics and economics from the post WWII era (Brummett, Lazard and Moehl, 2008). It was this resource advantage that led to research and development options and the semi-modern construction aspects of aquaculture (Sirrine, et.al., 2010). The early objective of the aquaculture movement was to produce a system to assist in feeding the communities and alleviate some of the poverty that has plagued rural societies in Zambia and other regions of Africa (Thornton, 2010). Research stations were developed in various countries including Zambia, Republic of the Congo, Uganda, Zimbabwe, Kenya, Central African Republic, Cameroon and Cote d'voire. Of the research facilities that were built most concentrated on tilapia, most notably *Oreochromis niloticus, O. mossambicus. O. macrochir, and O. aureus; Sarotherodon galilaeus, S. melanotheron; and Tilapia rendalli.* Other species included *Ctenopharyngodon idella* (grass carp), *Heterotis spp*. (boneytongue) and *Amphillidae spp.* (alien carp) (Monentcham, et.al., 2008). *Oreochromis niloticus* has been particularly prevalent; however it reigns more prominently outside of Africa. Within Africa *O. niloticus* is more of a delicacy, although many rural villagers use it as a protein supplement for their meager diets Thornton (2010).

In 1960, a survey estimated that there might have been as many as 300,000 aquaculture ponds in Africa (Pillay, 1977). By 1966 most were abandoned and the new estimate was a mere 20,000. Subsequently, the role of local government declined and thus began the advent of the non governmental international agency (NGO's). These units began a serious effort to return the artisanal farming society to previous levels and increase fish production despite past failures (Pillay, 1977). One of the most serious challenges at that juncture was the issue of sustainability. Local communities were not equipped socially and economically to provide the impetus and motivation to remain successful once the initiating agency withdrew. This aspect was particularly prevalent in the African countries. Asian areas produce more than African groups by a factor of approximately 5:1 in fish production (Little and Edwards, 1999) with Egypt being the leading African producer. African aquaculture contributes approximately 1.2% of aquaculture products produced worldwide, dominated by Egypt, Ghana, Nigeria and Zimbabwe (Hambrey, et.al., 2004). Inexplicably, a number of African governments began to deemphasize fish farming in the 1960's due to increased interest in other commercial enterprises. Many of these countries achieved their independence during this period and newly appointed political leaders with high ideals had other agendas (Meschat, 1967). For instance, there began a trend of high interest in mining of commodities and farmers who otherwise might have been involved in aquaculture, opted for the security of contract work for other countries such as China, Germany, or South Africa.

Despite previous declines, the World Food and Agricultural Organization (FAO) estimates that there has been an increase in Africa's inland fisheries since 1950 by a factor of eight times. This is an increase from 250,000 tons to 2,000,000 tons as of 1999. These figures

provide a measure of hope that in time African aquaculture will compare favorably with their Asian counterparts.

(Gordon, 2005). Contributing factors to these figures tend to not lie within the realm of traditional capitalistic ventures. The link to increased fish production is more likely tied to the need for economic security in light of other economic failures including over exploited commodities such as mining.

One factor, the Common Property Theory (CPT); Brox, (1990) proposed the idea that evidence of a common resource will lead to over exploitation and may be a factor related to declines in aquaculture in the short run. This so called "tragedy of the commons" concept although criticized in recent literature, may retain merit and local land tenure rights can serve as an illustration. Traditionally, these rights are strongly linked to rural societies and perhaps this is one reason why there may have been an increase in fisheries in Africa as declines in mining and other resource exploitation occurred. An important point here lies in the consideration of who had control of the land resources development and for how long. There are many cases where contractors secured property and hired locals to work on land that previously would have been assumed by local people for such operations such as farming or raising fish. Subsequently, land in these cases may have been over exploited and abandoned for lack of productivity (Gordon, 1954). It appears that the operations that use land and local labor for a relatively short tenure would not benefit locals in the long run. Fishers are believed to have been using new technologies on a small scale and benefiting without being categorized as venture capitalists. For instance, after the foreign operated land use practice played out, farmers returned to previous survival methods (i.e. farming and aquaculture) not having the expertise to use other means (Brox, 1990).

There exists ample evidence that fish farming can be a viable enterprise in Africa if managed well. One species the Nile Perch (*Lates niloticus*) primarily located in Lake Victoria, Kenya and presiding in other areas as well, has been utilized on a commercial basis for many years. The predatory nature of this species is one drawback. Other species, including 6 varieties of Tilapia (*Oreochromis spp.*) went extinct because of *L. niloticus* (Bailirwa et.al., 2007). However, entrepreneurs adapted and turned the production of *L. niloticus* into a cash cow. Some researchers believe that development of this *L. niloticus* may be unsustainable (Balirwa, et al., 2007). This is felt because demand began to exceed supply in 2002. The response in Uganda was to initiate cage farming practices to boost production. Data is sketchy regarding *L. niloticus* ecology in terms of its ability to be converted to a stock system wherein they might be raised in a hatchery as fingerlings and used to stock farmers' ponds. Questions remain about spawning related to seed (fingerling) production, wild fish fecundity in hatchery conditions, and growth rates. Feasibility studies from Uganda fisheries indicate difficulties; however they are positive that in time the fishery will survive (Anonymous, 2003).

According to Brummett and Williams (2000) the fish farming sector is diversifying as 42 countries produce 65 different species. This is a marked increase from 1984 where the numbers were approximately half of this level. The question is can such a diverse product sell itself on a commercial basis without proper infrastructure to handle differing requirements. For example, particular constraints in this arena include storage difficulties, poor market access, and equipment maintenance issues. These coupled with lack of local expertise, small budgets and political instability, lead to production problems (FAO, 1995). On the other hand, a diverse production can promote overall volume may offset irregularities in production.

III. ARTISANAL FARMING SYSTEMS

The vast majority of African fish farmers are functioning as small scale operations producing just enough yields to feed their families and provide extra income for their specific needs (King, 1993). The ponds are earthen and are built with hand labor. They are typically sized from 150m^2 to 500m^2 in surface area. The ponds generally produce from 10 to 50 kg of fish per year and harvests depend on species fecundity, water quality and management, and fingerling availability (Brummett, et.al., 2008). A portion of the harvest is consumed by the families while the remainder is usually sold locally or marketed to reasonably close communities for a slightly higher price than that of the local villages. Some of the yield is at times bartered for other crops which may be consumed or sold to government middlemen who market cash crop to other buyers. In most areas the barter system is more firmly in place and cash sales are at a premium. What little amounts of cash that are generated is used for occasional needs such as school fees, emergencies, medical supplies or funeral expenses (Satia, et.al., 1992). Artisanal fish farms are semi self contained units that require inexpensive inputs from farmers. A combination of manures, compost material and various organic materials from the farm are deposited regularly into the ponds and this mixture sustains the fish. Generally hardy species are introduced (i.e. tilapia, catfish) which also exhibit the characteristic of being prolific breeders (Brummet and Noble, 1995). It is not uncommon to see these ponds integrated into other aspects of the farm. Often they are operated in conjunction with vegetable gardens and an exchange of water and nutrients works to the advantage of both entities. This integration is important as studies have shown that integrated activities along these lines are at least six times more productive than those that are isolated operations (Brummett and Noble, 1995). It is the diversification in these systems that are of high value. In times of drought for instance, the fish pond may be a sole source of

sustainability to the farmer who has lost his staple of maize or other crop (Chikafumbwa, 1995) proposed that net cash income on integrated farms was as much as 18% higher than non integrated systems. One aspect is clear however, that at this simple level there is little economic growth owing to the fact that there is very little cash involved (Delgado, 1998).

For farmers that do build a number of ponds, and operate as small market entrepreneurs there are some advantages. Generally they are farmers with larger farm holdings and can afford to shift a portion of their assets into aquaculture. Consuming their crop is not usually a factor and most of the yield is sent to towns or cities and sold for a better margin of profit than they would have received in their local village. Often the proceeds are reinvested back into aquaculture system in terms of improved feed pellets, healthy fingerlings of a uniform species, and tools and construction materials for new ponds. Motivation appears to be the key as to why farmers that expand their interest in fish farming are more successful than more simple artisanal farmers. (Brummett, 1999). As is sometimes the case, prosperity in local cultures may suffer a penalty in terms of social considerations in the community. For example Harrison (1996) indicates that upwards of 30 % of the income of those individuals that earn additional profit is sacrificed in order to maintain good standing in the society. Those that refuse to contribute a hefty portion of their profits may be chastised and ostracized in addition to suffering threats, sabotage and theft of their production. In many cases the wealthier farmers of the spectrum are reluctant to take the lead in terms of coordinating with government officials to aid their contemporaries in development of aquaculture. Reasons are relatively unknown however it may be perceived that they are preserving their market niche and do not wish to share it. Other theories center around the idea that possibly these entrepreneurial farmers are fearful of government intervention on the behalf of the community and there maybe a negative impact (Phong, et.al., 2010).

Large scale aquaculture operations exist in Africa, mostly in Zambia, Tanzania, Mozambique, Zimbabwe, Ghana, Kenya and Uganda. All of these are heavily subsidized by foreign agencies and their training comes from those countries. Their markets are world wide; especially for tilapia species and production facilities are replete with automatic feed systems, processing operations, and foreign markets networks that buy fish by the tonnage. Cage based systems are the most prominent ones such as large tilapia cage operations developed in Zimbabwe modeled after the Scandinavian salmon cages used in northern countries. By comparison, an earthen 10 x 15m pond in Zambia produces approximately 25 – 40 kg of fish at harvest. This is attributed to $150m^3$ total area. Cage ponds in Zimbabwe produce the same amount of fish in $1m^3$. Unfortunately again there is a prosperity issue related to government control that causes problems. Zimbabwe restricts exports to the degree that companies are now beginning to diversify into other less troublesome countries such as Uganda which welcomes the opportunity (Brummett, et.al., 2008).

The constraints to productive aquaculture for Africa are clearly in line with other problems associated with commerce on the continent. For instance, prices fluctuate sometimes wildly in response to inflation. There are widespread infrastructure issues with negative implications for transport. Political instability and corruption are also widespread as governments change more often than any other region in the world. Often markets are not developed and research is rarely ongoing unless it comes from outside sources (Moehl, 2005). More specifically the challenges to aquaculture include several continuing problems. First, the quality of fingerlings is often low from a genetic standpoint. Tilapia (*Oreochromis spp.)* for instance do not respond well to improper hatchery procedures. Wild tilapia will out perform hatchery fish by a factor of 2:1 in breeding success (Brummet, 1999). African breeding programs are behind the

times in terms of their capacity to produce fast growing fingerlings. Additionally, foreign species are often introduced into African hatcheries making it difficult to develop high quality fingerlings.

The quality of fish feed is extremely important in fish farming as growth is highly dependant on this. In most cases some form of manufactured pellet food is desired however it is not always readily available (Halwart, 2005). If imported foods are cost efficient they are used such as is the case in Ghana and Nigeria. In other cases, high transport cost and low quality hamper their use. In cases where the farmer is manufacturing his own feed there are often issues with storage in terms of pests and possible theft. Recently there has been some experimentation with dried organic fertilizers; however there is often a reduction of output in these cases Moehl (2005). The main point concerning feeding fish is that until farmers are able to develop their fish farms on a collective basis and share the overhead costs of transportation, storage and take measures against poor quality feed, they will be at a serious disadvantage (Moehl, 2005).

A pervasive issue in fish farming in Africa relates to the extension services and their relationship to the fish farmers. One of the problems is some countries invest in very little more than a skeleton crew of overworked extension agents who become quickly disillusioned at their almost overwhelming task in improving fish farming. Often they do not have adequate equipment for construction, harvesting, weighing and technical gear for monitoring water quality. These weaknesses are often passed on to the farmers and little is accomplished in terms of building programs. What training programs there are to provide a quality effort are overly expensive, such as the recently devised program referred to as The Training and Visit (T&V) for Aquaculture in Africa. Country extension agents generally do not attend. An alternative to extension training lies in newly developed programs that offer combined learning with farmers

and extension agents (Sitwala, 2007). This approach may be important for the farmers to receive valuable technical assistance in the future (Shivakoti, et.al., 1997). An additional reason for optimism is that this concept has been extended in limited form to coordination of farmers, extension agents and research extension groups that pull together to solve specific problems. This process has been tested in Cameroon and has demonstrated a positive influence on fish yields. Increases have been five fold in some cases with farmers showing high levels of motivation to reinvest profits and endeavor to enter into cooperative structures with potential associates (Brummet, et. al., 2005).

In a general sense it seems that many potential aquaculture operators are interested in extended government assistance and choose not to participate otherwise. Additionally, many are reluctant to make good on any loans they receive and are dismayed when adequate collateral is required to receive a loan. One belief is that government is defined as any organization, such as a bank, that can provide money or assistance (Lutsigens, Arias, Ligolini, 1992). One of the most difficult issues to contend with is problems with credit institutions and alleviation will depend on education and responsible growth of participants. To reiterate, the advent of cooperative structures, government intervention, private sector control and non governmental influence are a few of the approaches that have been tendered to solve problems. Brummet (2005) has indicated that these issues are not tenable unless used in concert with each other. Other persistent troubles are police interference, poor infrastructure for the sale of fish including dirty facilities, poor roads influencing transport, corruption towards transporters, and quality of product fluctuations Brummett (2005).

IV. SOCIO-ECONOMIC AND CULTURAL PERSPECTIVE

Aquaculture has had limited acceptance and has been constrained (Thomas, 1994). Because of this aspect, planning for aquaculture has been limited as well (Smith and Petersen, 1982). Thomas (1994) states that surveys indicated that scientific concerns were the least of their problems and that management and social issues were ahead of them. Coincidentally based on experience in Sri Lanka Alexander (1975) believes that a more thorough review of aspects of society is prerequisite before a scientific approach can be successful. Typically, fisheries scientists spend little time in communities and are trained in technology, not human relations. In Malawi, the International Center for Living Aquatic Resources Management (ICLARM) proposes a solution. This is an approach referred to as the Farmer-Scientist Research Partnership (FSRP). Essentially, farmers and scientists develop a partnership that addresses and finds solutions to problems that farmers face as opposed to merely recognizing them. The aim is to make the farmer comfortable with needed technologies as they emerge. Education is a key issue in this collaboration. Aspects are presented on a practical level and farmers eventually decide which technologies they will adopt and how through replicated experimentation and discussion. A variety of solutions are presented and a range of technologies emerges. The results are a high rate of acceptance of at least a minimum level of technology. FSRP has seen as much as an 86% rate for one area, 76% for two, and 24% for three areas of development (Brummett and Noble, 1995). The exciting thing about educating farmers in technology is that it can lead to a high level of sustainability depending on how they take to it.

There are other social and economic issues that exist related to community resource bases being appropriated by outside agencies that leave local people to fend for themselves. (Derman and (Ferguson (1995) go so far as to propose the “dispossession” of fishing communities on

Lake Malawi. The message is that socioeconomic change and development are altering the environmental platform which rural communities have depended on for years. The result is considered to constitute increased levels of poverty and a stagnation of economic development. Of concern are such entities such as expansive mining operations which alter the landscape, hydrology, flora and fauna. The term "ecocide" is used, with concern for construction efforts such as dams and plantations that modify water flow and negate fishing opportunities at the local level. In these cases, the question is who is to blame and is this on the minds of locals that suffer as a result of such modifications. Given this mindset, a blend of political views toward ecology and political economy is presented as not being mutually exclusive ideas (Blaikie and Brookfield, 1987). In Malawi, there is documented evidence of ecological degradation and human rights abuse in some instances. These cases involved villagers who have been displaced from their traditional fishing grounds by entrepreneurs in league with government officials. More recently, leverage against these processes has been applied; however it is rare that land tenure with regard to fishing grounds is retained when the adversary is linked to the government. More specifically, these are situations where new development (i.e. hotel and tourism construction along Lake Malawi), are subsidized by a repressive Malawi government regime. These developments led to environmental degradation in terms of hotel effluent, pollution, soil erosion, confiscation of property and eventually loss of fishing community livelihoods for locals. All of these dispossessions occurred in the name of capitalism and democratization without regard to consequences. Ironically, outside organizations such as the World Bank, International Monetary Fund (IMF), Overseas Development Authority (ODA), United States Agency for International Development (USAID) which previously helped bring an end to repression in Malawi, may be partially accountable Derman, et.al. (1993) question the biases in development assistance toward

large scale operators. In their view, these biases are responsible for such indignities as the forced removal of the Mdulumanja fishing community in Malawi in 1991. This was a direct effect of the privatization initiative promoted by the World Bank and the IMF for the building of the Grand Beach Hotel purchased by a Dutch citizen who petitioned to have the village removed. It is examples such as this that lead one to believe that there is a larger commercial evolution occurring at the expense of specific sectors of indigenous populations.

Surveys indicate that entrepreneurs are hesitant to invest in Africa because of governance issues including political instability, policy issues, suspect regulatory management problems and especially corruption Sachs, et.al., (1998). All of these detrimental factors affect development of aquaculture as well. Access to investment capital and high borrowing costs are problems as well, however institutional issues appear to outweigh them. Overregulation seems to be a particularly relevant constraint that has been revealed in certain circles regarding aquaculture (Anonymous, 2003). This malady is regarded as being more important than site selection and financing. For example in South Africa, aquaculture responsibility is divided between the Ministry of Agriculture and the Dept. of the Environment and Tourism. In addition, several other agencies have their hand in the decision process at the provincial level. Since South Africa enjoys a higher economic standard than many other African countries, it is often used as a model for under developed countries to apply governmental strategies toward operation. To their credit, there have been attempts to deregulate and create more of a “one stop” effort to handle what has been termed a very difficult situation in terms of farmers obtaining regulatory approval for aquaculture development. The aim of this project is to encourage investment in mariculture and aquaculture in South Africa.

By comparison, Zambia has experienced similar concerns with regard to aquaculture development related to environmental policy. Often approval for any farm development to occur, an Environmental Impact Assessment (EIA) must be undertaken. The approval is required despite the fact that the policy describes that it is intended only for very large scale developers (Hishamunda and Ridler, 2005). The Zambian Environment Council has also blocked the advent of fish cage culture on Lake Kariba because of the introduction of *Oreochromis niloticus* a tilapia which is considered an alien species (Koffi, et.al., 1996). This is clearly a case where government officials without practical knowledge or experience have lost sight of development opportunity and are unfortunately entrenched in red tape policy decisions. *Oreochromis niloticus* has been a significant contributor to aquaculture development for Zambia for decades. At what point in time does a species become considered indigenous.

In Zimbabwe, which has experienced severe difficulties because of a repressive political arena, the problems with developing aquaculture are exacerbated by macroeconomic policies that are in a constant state of flux. Inflation is among the highest in the world and interest rates are not conducive to investment. Additionally, the exchange rates are affecting the ability to recover operating costs for entrepreneurs as over valued rates are presented to them as they convert their cash. Also, the cost of credit in a new venture such as aquaculture is a problem (Hishamunda and Ridler, 2005). The lack of credit causes farmers to have difficulty in terms of collateral for loans. Interest rates may additionally be as high as 20% in some sectors including those associated with aquaculture.

Sustainabilit*y* in aquaculture is dependant on a diverse array of factors. It is important to clarify first the context within which the term sustainability is used. Muir (2005) suggests that it is a system of course; however it can be associated with efficiency that requires fewer inputs and

produces wide benefits and fewer wastes. Such a definition requires a more useful description when it is applied to aquaculture. Muir further proposes that there are specific indicators that clarify how to recognize sustainable practices. These are important to determine if choices made by managers are valuable to improve equity, economic development and ecological status. To begin, the avoidance of irreversible effects that may lead to permanent loss of resources is pertinent. For example, if a pond is built in the wrong area such as a dambo (a wetland area with excess iron deposits), the water can be fouled to such an extent that appropriate water culture, for growing fish feed via phytoplankton growth is impossible. The use of non renewable resources must be evaluated extensively. It might be reasonable to believe that there will always be a water source; however extended drought possibilities or flooding might preclude operations. Questions must be answered regarding what tradeoffs are available. It would be difficult to move to another pond site after putting forth so much energy in existing areas. Finances are a concern also when it comes to maximizing efficiency of resources. It becomes clear in this light that multiple use of resources such as might be found in integrated aquaculture is important. The basic principle of this discipline provides increased financial security upon the simple thought that the feed for one animal can be transferred in a different form to fertilize a fish pond. Subsequently, the effluent from the pond can be used to fertilize gardens and residue from that harvest can be funneled back to the pond. In this case a serious savings in fertilizer cost is realized and financial constraints are lessened. From a wider context, benefit can be seen from a reduction of the effect on biodiversity. More stability in this area should have positive long term effects on the environment and how changes in this might affect small scale aquaculture. An example of this could be found in predation or water quality both of which are paramount in successful fish farming (Stewart, 1995).

Other indicators of sustainability are abundant and fall into social, environmental and economic classes (Katz, 1987). They appear to be interdependent and blend together with one affecting the other with varying significance. For example, investing socially in a cooperative effort with his constituents may produce benefit in the long run over the solitary entrepreneur that does not enjoy the economies of scale that he/she otherwise might. More recently, efforts have been made by the FAO to clarify a more detailed indicator profile as well as multiple criteria analysis (Gompiero, 1997). The sustainable livelihoods concept has the support of the UK Department for International Development (DFID) and has been reviewed by Carney (1998). This framework for identifiers of sustainability centers on the natural, social, human, physical and financial aspects of aquaculture development. The depth of this work revolves around intervention via various "entry points" that become clear as linkages between vulnerable groups and program developers are defined. One sticking point along these lines is the skill and educational gaps that arise among different households. The identifiers from the framework noted above can categorize assets and deficiencies and point toward remedies on a cooperative level. Subsequently, these interventions can help reach national and global objectives more readily without such a high degree of consumer dissatisfaction (Ahmed and Lorica, 2002).

V. CURRENT AND FUTURE ASPECTS

To encapsulate the state of fish farming in Africa is a difficult proposition as it is in a constant state of flux. Some countries have prospered while others falter. Most are responding in this vein to political change and marketing fluctuations. For instance in Kenya, where there were boom years in the 1980's; things have leveled off a bit (Gaheb and Binns, 1997). One conclusion drawn is that there is a dichotomy between fishing and farming and sales vary depending on the

season and the market (Odhiambo, 2002). It is important to note that people reengage in fish farming after the millet and maize harvest and remain for four to five months. The effort they expend is directly related to the productivity of the crop season. More recently, the demand for fish has increased and put more pressure on Lake Victoria. Despite this fact, people have begun to invest in small shops, rentals and and other enterprises and are fishing less than in previous years. There is a demand that is not being met. As a consequence the fishery is having problems generating enough scale to provide growth (Gehab and Binns, 1997). In Kenya there is a more concerted government effort scaled to address some of the issues. One of the most important is field based research, followed by agricultural extension outlets and deregulation in favor of consumers. Large fishing cooperatives have existed in Kenya for a number of years. It is suggested that these become more transparent. Accountability is a widespread concern and linked heavily with corruption and extensive trust issues. On a more specific level Kipkemboi, et.al., (2007) specified that finger pond development in Kenya, a burgeoning concept has saved farmers as much as 55% in production costs. It is ideas such as this that provide optimism about fish farming and seem to shed light on the problem of over regulation and illicit advice regarding how to prosper. It is posited that a reverse evolution where fish farming would prosper such as this might take 10 years or more to realize (Dovie, et.al., 2005). These concerns will have to be provided with solutions before the fishery industry can advance and become sustainable.

An interesting case study provided by Tichler, et.al., (1998) describes the participation of local fishers in fisheries data collection in Zambia. In this study, artisanal fishermen collected data on the size of harvested fish for one year in the Bangweulu swamps of northeastern Zambia. And were able to collect large amounts of information. The objective was to obtain sufficient data for an adequate stock analysis for species assessment. The point here is the involvement of

locals in assessing their own future potential as fish farmers. Additionally, participants were paid a nominal amount which was not too expensive for the research team. Since the participants were paid and monitored for irregularities, and replaced for under productive work, the data resulted in an acceptable level of reliability. Since this time, the effort has been expanded in Zambia to other districts and used successfully in Lake Mweru and corroborated by local administrators of that area. The work here compares well with the work of Ramburg, (1993) and Pomeroy and Williams, (1994) who indicates that there is growing recognition among fisheries managers that cooperation with consumers in the management of fisheries is highly valuable. It was apparent in the Bangweulu swamps that fishermen were proud of their participation and desired to be further involved.

VI. CONCLUSION

A substantial number of evaluations of African aquaculture have all come to similar conclusions: that aquaculture is a very important factor for livelihoods at a variety of levels and will be for some time (Brummet, Lazard and Moehl, 2008). The efficiency, scope and development of aquaculture is going to be determined by several factors that will interact and demonstrate dependency upon one another in varying degrees (Muir, 2005). For example, technical input is one of the most valuable assets for aquaculture. Antiquated methods can not produce the volume required to make a viable program (Stevenson, et.al., 1999). In addition, there must be a balance between environmental impact, resource management control and other entities such as transport initiatives, government intervention, market strategy and cooperative association if progress is to be made (Muir, 2005).

The development of aquaculture is probably destined to continue to exist as a diverse system. Fluctuations in markets, strategy and resources cycle with the different political and

economic regimes of the places where aquaculture is practiced. Economic performance will be a strong determinant of where the industry will end up and who will be the leading practitioners in the industry. There is the potential for a more positive core to emerge concerning an integrated approach that exhibits increased knowledge as to how successful patterns may be realized in aquatic program management (Muir, 2005). By contrast, the short term solutions may be much more volatile as government and social concerns vary extensively. For aquaculture to meet local and national objectives for food security and safety (Chimatiro, 1998) and the reduction of poverty, individual investors, political regimes and government agencies should attempt to address the following basic concerns (Muir, 2005).

1. Support a framework for aquaculture development similar to the one proposed by Koffi and Lazard (1996).
2. Target achievable growth through government extension services for under represented local artisanal fishermen in small business markets.
3. Make credit available to small market investors
4. Encourage partnerships for farmers, NGO's, extension and cooperatives for the delivery of key services.
5. Coordinate large scale operators with small scale production and develop subsectors accordingly with the objective of future integration.
6. Invest in infrastructure and facilitate a reduction in law enforcement corruption.
7. Invest in research
8. Establish standards for environmental impact

CHAPTER 2

SMALL SCALE COOPERATIVE AQUACULTURE IN RURAL NORTH WEST ZAMBIA: A CASE STUDY OF U.S. PEACE CORPS VOLUNTEER ASSISTANCE

I. INTRODUCTION

Aquaculture development in North West Zambia presented an opportunity for local villagers to realize partially the objective of improved food security and economic sustainability. Since this particular area is and has been under developed and under represented by the government agenda in Zambia for economic growth, the North West served as an example of the potential of what might be achieved. Previous efforts in aquaculture have resulted in dubious levels of success due to lack of organization, poor motivation, corruption, and infrastructure instability, all leading to inefficiency and poor to non existent growth Harrison (1996).

Initially, the justification for the effort came from U.S. Peace Corps volunteer occupation and feedback that indicated that there was potential, however little implementation (Anonymous, 2003-2011). Historically, volunteers had felt a sense of failure due to both cultural misunderstanding and lack of government support regarding both institutions. Subsequently the U.S. Peace Corps made the decision to continue the effort by assigning a fourth generation volunteer to the area that resulted in the work that this case study is based upon. Normally the philosophy of the Peace Corps is to extend a great deal of latitude toward rural development in light of the number of obstacles that are presented (Anonymous, 2009). This case was an ardent example of that edict.

This case study is a description of the aforementioned potential and illustrates how a small portion of that ideal was achieved in North West Zambia by U.S. Peace Corps efforts over a two year period from July 2009 to October 2011. A specific sub sector of the North Western Province of Zambia, Matushi village (located in Mufumbwe district) is singled out. Success in this area offered the potential to serve as an example to the Peace Corps and Zambian government that this rural sector could improve its outlook with the right motivation and organization.

More specifically, the goal is to represent the aspects, conditions, activities and results of my Peace Corps volunteer service and graduate student work at Northern Arizona University. Service was performed in conjunction with and in accordance to a memorandum of understanding to include the U.S. Peace Corps, Zambian Ministry of Agriculture, Zambian Department of Fisheries (DOF) extension services and with assistance by the Zambian Wildlife Authority (ZAWA)

A secondary aim of this description is to indicate with clarity the implications of previous efforts by a variety of counterparts involved and to provide a sound perspective of future potential by subsequent Peace Corps Volunteers. Within this intent it should become clear that success in this regimen will be dependent upon a valid understanding of previous efforts and a sound correlation to a positive management potential.

Since 1994, at the request of the Department of Fisheries (DOF), Zambia, a Rural Aquaculture Promotion (RAP) program has been implemented by the U.S. Peace Corps in terms of human resource management at the local level regarding aquaculture, otherwise referred to as fish farm operations. Of primary interest is the intent of providing technical assistance to local practitioners in developing motivation, skills, management and extension service. U.S. Peace

Corps volunteers work closely with DOF and Department of Agriculture officials in determining the breadth and scope of operations and pertinent methods of implementation. A further interest is to develop farmer capacity leading to productive management of farm ponds, increase yields of fish and to provide a foundation to expand capacity to integrated permaculture systems. This would diversify the business interests of the farmer and thus increase income and economic security measures (Jensen, 2009).

Secondary channels of perspective revolve around providing assistance in terms of suppression of the HIV/AIDS epidemic, malaria and other diseases through intervention techniques, nutritional supplementation (Bardach, 1985) and education. In addition, volunteers organize farmer cooperative groups, teach technical aspects of fish farming, small business skills, and provide motivation to increase capacity to thrive in a competitive market.

I was a fourth generation volunteer in the Matushi village catchment area. Previously a foundation was established for capacity building by earlier volunteers and resulted in an encouraging view of the potential for further development. Cooperative units were organized providing incentives for fish pond business and associated agricultural systems. The successes and failings of specific entities rested on the shoulders of the individual farmers and the communications between DOF, Peace Corps and the farmers. The efforts in retrospect appear to have been sporadic and fluctuated with the attitudes of the practitioners. I worked with a competent counterpart who analyzed the previous situation and took initiative to provide incentives for improvement. The work included identification of pertinent factors of success that were applicable to specific parameters of this population. A diagnostic system of analysis regarding strengths, weaknesses, opportunities and threats was devised in order to determine potential. Subsequently, specific motivators were applied to key individuals that were important

contributors to overall efforts to advance change with regard to sustainability in business interests, integration of other supplementary factors and cooperative development.

II. DEMOGRAPHICS

There were over 60,000 people living in the Mufumbwe district in 2011 and this figure is rising rapidly. The average number of children per family is near six (Zambian census data, 2010). Within the Matushi catchment there is a reported population of 10,000 according to Zambian census data of 2010, although this is a conservative estimate. The majority of the people live along the M-8 highway and many of them shift to the field sporadically to tend to crops in the rain season. Women do much of this work and children are often either taken with them or left alone in the village to fend for themselves. Men are in the field during harvest time.

Village Profile

There are 8 separate individual geographic units that comprise the Matushi village as a whole, each with a headman providing supervision. These are presided over by the Chiefs that reside in Mufumbwe. People respond strongly to the Headmen and Chief's rule although government rulings are considered the final word as villages are adhering to modernization. In terms of structure there is the Matushi basic school with more than 1500 students, the health clinic, and the resource center which provides a small library, solar powered telephone charging, meeting hall and some storage. A small market serves the community with shops for food and a gathering area for people to commune. Hammermill units dot the area to grind maize for ease of consumption and sales. The local boma, analogous to a small town, 27 km to the East provides a greater variety of personal and business needs to the community. People travel there to sell their maize, fish and buy other items. More specific “hard to find” items are found in Solwezi at 280 km distance. At least 7 different denominations of religious services exist here with the most

dominant being Catholic. The local boma houses a Catholic priest who makes visits to the village. Travel is a concern here as many villagers struggle to get their products to market. Regular minibuses run along the M-8 highway and are very crowded with people and tend to be behind schedule frequently. The ride is 10,000 Kwacha ($10 USD) for mazungos (white people) and less for villagers. Drivers are erratic and accidents do occur. More prosperous villagers use motorbikes while the less fortunate use bicycles and ox carts. Walking is not uncommon. Peace Corps volunteers are taught KiKionde language for this area although it not spoken all that frequently but it is understood. More prevalent is Chokwe, Lunda and Luvale. Of the 73 languages spoken in Zambia, I have heard approximately 8 spoken here on a regular basis. Chokwe and Lunda are the most often heard. Culturally speaking, the villagers exhibit several notable traditions and exercises. Among these are the circumcision ceremonies for young boys at ages 10 – 13 years, the Wali initiation where young girls are taught about sex, babies and homemaking, and witchcraft and exorcism practices. Children engage in the Makishi ceremony where they dress in traditional garb and chase in a make believe manner. Occasionally, there will be seen the flying coffin ceremony. Upon death, a person is placed in a coffin and paraded through streets and villages soliciting for donations. Certain superstitions are believed by villagers regarding responsibility and punishment for the person's death.

Village Livelihood

Matushi is a subsistence farming community and is primarily invested in the sale of cash crops to government buyers who purchase in bulk at the conclusion of harvest season. Staple crops include the following: cassava, maize, sweet potatoes, rape, tomatoes, cabbage, and onions. Villagers also eat fish caught from the Kabompo river and sold locally, bushmeat as it is

available, caterpillars, rats and mice and lizards taken by catapult hunting. Services in Matushi are available and include carpentry, brick making, charcoal production, some metal work and oxcart rentals for transport of maize and other crops. Maize is milled here and people use the maize as barter for other items such as fish and vegetables. The staple diet of nshima a maize mash derivative is prevalent here and it is eaten daily by most villagers with rape or other relish. People drink unfiltered water from bore holes and wells and monkoyo, a local drink made from maize. There is ample evidence of the consumption of alcohol in Matushi and some evidence of drug use which are generally perceived as serious vices. At present there is no commercial activity in Matushi to speak of other than the sale of maize to the government. The potential does exist for commercial fish sales in the advent that adequate refrigerated storage and transportation are developed, following a more expansive pond construction effort.

Infrastructure and Institutions

As previously outlined there is a health clinic, two basis schools, a recent tarmac road, minibuses, large transport buses and two cell telephone towers for use. The M-8 road is lined and contains signs for bus pickup locations. Recently, there has begun a tree clearing process along the road for the eventual placement of power lines connected to the national grid system. Communication across regions is done primarily by cell phone although the bush note system remains in place. Recently a copper mine has opened in Matushi and is in its developmental stages. They have hired approximately 25 locals and if, beyond the initial exploratory stage, they open up a fully functioning mining operation, they plan to hire approximately 200 people. The pay for working at the mines ranges from $100 – 250 USD per month. The Peace Corps volunteer conducted training for villagers in interview skills for these jobs whereupon several were hired.

III. PHYSICAL DESCRIPTION OF THE MATUSHI CATCHMENT AREA

The advent of aquaculture into this region has benefitted by the existence of a variety of natural sources of water that are conducive to the production of fish ponds and the potential for expansion into permaculture systems. The advantage of this variety of sources has been and will continue to enhance the quality of the efforts to bring about sustainable economic change to the Matushi catchment area. Specific descriptions of post attributes are as follows:

Location

Matushi, in the North West Province is located 27km west of the Mufumbwe (boma) and 280km Southwest of Solwezi, the North West Province headquarters. Furthermore, Matushi is approximately 9 hours drive Northwest of Lusaka, the capitol of Zambia and the location of the Peace Corps National Headquarters.pproximately 15km to the south lies Munyambala and 30 km to the West is Kashima. Transportation to Matushi along the M-8 road is very well served as the road had been recently surfaced with tarmac and is very even. Traffic along the road is sparse and local villages and bomas line the route, generally receded from the road with markets adjacent to them. Access to outlying village areas is by well travelled paths and dirt roads.

Topography

The Matushi village is situated at an elevation of approximately 1000 meters and is surrounded by gently rolling hills and valleys. In general the area is a tall grass plain sloping in a northerly direction toward the Kabompo river and its associated floodplain. Further north the terrain begins to undulate more decidedly, leaving significant depressions in the wet season. There are no mountainous areas in this region.

Hydrology

To the South of Matushi the Kabompo River and associated floodplain runs west toward the Zambesi River. The dambo area between the river and Matushi consists of alternating marshland in the wet season and tall grass plains in dry periods. There exists a system of streams coursing through the dambo area that are frequently used by local villagers for irrigation of crops and personal use. It is adjacent to these streams that the vast majority of the potential for aquaculture exists. Following is a listing of the important streams in the Matushi environs:

1. Matushi stream
2. Kabwe stream
3. Wishimanga stream
4. Chitembala stream
5. Paradise stream

All of these streams are part of the Kabompo River waterhed and are associated with three other rivers in the area; namely the Mufumbwe. Dongwe and West Lunga. Matushi has a relatively high water table and there a number of natural springs that are occasionally useful for dams and pond construction during the dry season particularly in September and October. The spring activity in the area is of sufficient strength to provide source water for the Paradise and Chitembala streams. There is a third stream to the south of Matushi that feeds the Munyambala area.

Soils

The soil in the Matushi area can be very mixed but is generally fairly fertile as evidenced by the prolific nature of the maize crop production. Soil in Matushi is referred to as clay based (acrisols), sand (arenosols) or black soil with other evidence of soil with higher concentrations of

iron and aluminium Anonymous (2009). Occasionally, the type of soil is a factor with regard to fish pond development. Heavy iron and copper deposits tend to affect the water quality in the ponds and this must be neutralized with heavier ash applications to the ponds.

Flora

Flora is abundant in the Matushi area and is under heavy use by villagers. Varieties of it are used for such things as ropes, planks, fuel, food, building, beekeeping, blockading, shelter, etc. In terms of fish ponds there are several species that are very useful for feeding fish and also for the production of plankton, the dominant food source for Tilapia which is the primary species grown in Matushi ponds. The production of charcoal is popular here, however most of is sold elsewhere as most of the villagers use wood for cooking and heat. Typical species include *Moringa oleifera, Sesbania sesban, Leuceana leucocephala, Senna spectabilis, Lantana camara, Bidens pilosar* and *Dimorphotheca aurantiaca* which are all particularly useful in fish ponds. One species, *Tephrosia vogelii* is poisonous to fish and should be avoided in ponds. The *Moringa* tree is a multi use plant that is medicinal, nutritional and good for fish ponds. It is referred to as a miracle tree due to the many traditional uses for it (Chilufwa 1999).

Fauna

The area is semi diverse in wildlife; however the physical numbers of animals has been in decline for many years. Much of the reason for this is due to habitat destruction, hunting and poaching, all due to the subsistence level of living in Matushi. Contained with the area is the West Lunga National Park and adjacent wildlife refuge. Within its borders are a variety of species to include the following list:

Chlorocebus pygerthrus, Vervet monkey

Papio hamadryas, Baboon

Crocodylidus niloticus, African crocodile

Hippopotamus amphibias, Hippopotamus

Varanus,spp., Monitor lizard

Phacochagerus africanus , Warthog

Tragelaphus scriptus , Bush buck

Aepyceros malampus, Impalas

Lycaon pictus, Wild dogs

Loxadonta africanum, Elephant

Hyaenidae crocuta, Hyena

Panthera leo , African lion

Dendroaspis polylepis, Black mamba

Naja nigracollis, Hooded Cobra

Dispholidas typus, Boomslang

Bitis arietans , Puff Adder

Poaching is a persistent problem and bush meat is sold along the M-8 highway. Occasionally dog will be passed off as bush meat to travellers and people have been known to become very ill eating it. Snakes are mostly found near waterways but can also be prevalent at households, especially in gardens and near toilets and bathing showers. Snakes also frequent ground holes where children can poke into and become bitten. In Matushi village there were 43 cases of snakebite in the first year of service.

IV. AGRICULTURE AND AQUACULTURE

Agricultural Development Organizations

The Ministry of Agriculture and Livestock is a ruling agency containing the Department of Fisheries. This department works closely with the Peace Corps Volunteers as an advisory consultant and provides advice, fingerlings for stocking ponds and nets and scales for harvesting and weighing fish. In addition they provide seminars to local villagers interested in fish farming. The DOF extension agents survey progress for fish farmers and report to higher levels of the ministry for record keeping purposes.

Agricultural Practices

Originally, it was intended that a permaculture system would be instituted in Matushi to diversify the business interests of the farmers and help them evolve out of a monoculture and

into multi dimensional interests (Anonymous, 2002). It was planned to acquire a grant that would be used by the cooperative to create a structured system that would include first a piggery followed by other entities (Mollison, 1991). Pigs would be purchased and housed as a brood stock and offspring would be loaned to produce secondary offspring (Anonymous, 2007). A portion of these would be returned to the original stock. Secondly, poultry would be purchased and be handled in the same manner. Both pigs and chickens could be used to fertilize ponds. Third, beekeeping would be introduced and bee boxes would be bought to produce a bee stock. Farmers would build boxes by direction and receive bees in exchange for a return contribution of profits to the cooperative. Fourth, rabbit rearing would be introduced as a food source and income generating product. Portions of offspring would revert back to the cooperative. Lastly, farmers would surround the environs of their ponds with all of these concepts as well as a vegetable garden and several species of trees and shrubs conducive to feeding fish ponds. These include *Luceaena*, *Sesbania and Moringa*, as examples, all of which are especially conducive to feeding Tilapia species (Chilufwa, et.al., 2009). Eventually it would be advantageous to create a nursery for this element (Jensen, 2009).

Initially it was attempted to secure a grant large enough to initiate a foothold in this permaculture program. The application was denied by Peace Corps supervisors for the reason that it appeared the project was too complex. It was suggested that a reapplication should be submitted for a reduced version of interests. A secondary grant application was submitted and the responsibility for it was passed on to subsequent volunteers replacing me as a volunteer. Additionally, there is ongoing correspondence between generational volunteers at site in Zambia and myself.

Farmers in this region are similar to most other farmers in Zambia as they have been growing only a few basic subsistence crops for generations. They are reluctant to change to other systems. The idea of conservation farming was introduced to them to facilitate learning to utilize other species of plants in an alley cropping style for fertilizers, one of their biggest expenses. Crop rotation and composting are other ideas that have been introduced. Most villagers listened but exhibited little intention of changing their system. The introduction to double digging in gardens to foster improved root growth was taken in a slightly more positive vein.

Fish Farming Methods

History and Status: Matushi was first attended to by the Department of Fisheries, followed by Peace Corps intervention in 2004. There have been five generations of Peace Corps in Matushi, Three previous volunteers have indicated a presence of upwards of fifty or so ponds in existence and operating at various times. These numbers appeared to be dubious and it was assumed that the ponds were obsolete or extant without management. As a 4th generation volunteer, I found that there existed approximately 15 ponds, only half of which were in use. A portion of these ponds were no longer serviced by Peace Corps volunteers at the behest of Peace Corps officials due to animosity toward previous volunteers over personal issues. In a 2 year period I had dealings with 7 pre existing ponds and 25 additional ponds were demarcated. Of this number, farmers have actually dug and stocked 16 ponds with fish; 12 of which have harvested fish.

Pond development in the Matushi area had not been flourishing in previous years as intended by Peace Corps. This was due to high levels of complacency resulting in individual farmers acting independently. Older Cooperative groups are still in existence; however they have been poorly managed and appear to be stagnant. The overriding opinion of the reason for this is the lack of leadership and a negative point of view by villagers due to a presiding feeling that the

government in any form should provide incentives free of charge much the same as NGO's often do (Anonymous 2010). Disappointment at the lack of these amenities led to apathy and sometimes resentment toward government officials.

People in Matushi savour the idea of having fresh fish and appeared to be readily willing to pay for it. With the market demand having been high, people paid as much as $3.00 USD per kg. The various methods of fishing in the Matushi area included netting in the Kabompo river, trapping with baskets in streams, poisoning with local plants, using poles and line and fish ponds. Fish were bought from the nearby Kabompo river as well as from ponds. These are identified as *Oreochromi niloticus*, bream, *Suluriformes fam.*, barbelfish, *Alestiidas hydrocynus*, tiger fish and *Limnothrissa miodon*, kapenta which is processed dried. Most fish were sold at the local level to other farmers. Although in its infancy, the concept of prepaid purchasing from the boma began to take hold. As a beginning, the DOF had been servicing this interest, however eventually farmers were expected to solicit their own market from the boma. Also, there was beginning to be an interest shown in selling fish to the local copper mine operation which was just beginning. At this stage multiple fish pond operations were beginning to occur due to the development of a cooperative organization recently put in place. Farmers were expected to build their ponds together, harvest independently or with help from each other and market singly. All cooperative members at this time managed one pond with second ponds intended to be built. Peace Corps indulged in business seminars frequently with the intent to convince farmers of the value of multiple ponds and the advantages of working together. Most have understood the meaning and value of such operations and a few leading individuals embraced the idea whole heartedly.

Results of Fish Farm Development: Farmers in this period of Peace Corps service harvested ponds during the dry season of 2011 totalling 215.5 kg of fish and realizing a total value of ($700 USD) for an average of 22.50 kg per farmer. The following is a list of specific farmers who have produced results and harvested.

FISH POND HARVEST TABLE

Name	Harvest volume	Value ($3.25 per kg)
Esther Samunguya	30.5kg	518,000 Zkw ($105 USD)
Mr. Samupai	47kg	800,000 Zkw ($160 USD)
Mr.Mfwefwe	26kg	442,000 Zkw ($85 USD)
Mr. Chipinda	28kg	476,000 Zkw ($90 USD)
Mr. Sachindele	35kg	595,000 Zkw ($120 USD)
Mr. Kasaji	22kg	405,000 Zkw ($75 USD)
Mr. Wachata	5kg	85,000 Zkw ($15 USD)
Mr. Chisupa	25kg	425,000 Zkw ($80 USD)
Mr. Musogela	10kg	170,000 Zkw ($65 USD)
Mr. Winford	9kg (7x10pond)	153,000 Zkw ($60 USD)
Totals	**215.5kg**	**($855 USD)**

The potential for fish farming is significant in Matushi because of the dambo (wetland) terrain and prevalent water sources. A farmer managing 10 ponds could realize a profit of as much as 16 million ZKW ($800 USD) with twice per year harvesting and selling at 17 ZKW per kilogram. More recently beginning fish farmers have harvested as much as 47 kg from a 10x15 meter pond. The added value is that harvesting farmers could then pay others to manage their fields or ponds and respond to business development with business purchases such as freezers, trucks for transport and harvesting equipment Appleford, et.al. (2002).

In terms of organized fish farm groups there have been two in Matushi village. The first was the Liya Liya women's group of twenty five who approached the Peace Corps volunteer in

2009. Their intent was to obtain a grant from an NGO and to receive fingerlings from the DOF. It was perceived that their ponds were in disarray and there was little effort put forth to attend to them. It was also advised that the operation was servicing one family, most of which were members of the cooperative to the disservice of the other members. Alleged improprieties associated with grant money from this group forced abstinence from that avenue. The second group, the Twotale Cooperative was formed according to protocols (Anonymous, 2009) and they dug several operating ponds in Matushi. Potential for this group remained strong as they responded to Peace Corps advice and teaching. Leadership in this group appears to be undertaken by fair minded individuals to include important Peace Corps counterparts.

V. DISCUSSION

The evolutionary linkage of aquaculture to skill transfer and subsequent success does not appear at first observation to be as simple as the view expressed by (Brummet, 1999). In the case of Zambian aquaculture and the development described in this manuscript, several issues related to success are identified and will be discussed separately.

Technology

An observation was made that levels of technology vary and availability can be sparse in remote areas. More succinctly, the desire and motivation to use technology, which is analagous to a cultural shift was often the more overriding issue. Evidence for this became evident in educational settings and labor projects in several instances. For instance, often it was difficult to influence villagers to locate ponds in the most practical areas. These locations would be measured and assessed for applicability by very simple primitive instruments that would be defined as being several levels below modern scientific technology (i.e. primitive handmade clinometer for measuring slope). The low level of technology was looked upon with suspicion

and often inappropriate locations were selected for ponds. Thomas (2002) concurs that in Nigeria, due to a poor understanding of socio-economic and cultural factors by researchers, technology was not adopted by the community. In a particular instance in Zambia where the suggestions for the design of the ponds were not adhered to, the result was failure of the pond to flourish and produce yield. Specific examples of this failure to adopt ideas are three fold. First, the berm slopes were not constructed at the correct angles which inhibited reproduction in Tilapia species. Tilapia will not mate on flat terrain. Second, the location was poor resulting in the inability to fill the pond from existing streams as well as difficulty in draining it if the filling problem was solved by alteration of the water source. Third, the usage of recommended sources of flora conducive to best contribute to phytoplankton development, the basic diet and nutritional source for Tilapia species as gill feeders (Oliva-Teles, 2012) were viewed often as inconvenient and were replaced by inefficient plant life. Therefore when mixed with manure and ash, the resulting green algae lacked the necessary development of zooplankton essential for adequate Tilapia species growth (Dickson, 1987). Yields were subsequently smaller than other farmers who accepted modern technology, listened and followed directions.

The reasons for this level of reluctance in both Nigeria and Zambia are consistent with the findings of Harrison (1996) in earlier views regarding motivation for digging fish ponds. She believes that farmers sometimes engage in aquaculture not because of the merits of technology, but rather the "culture of development." This short term aspect of fish farming is consistent with the results observed in this case study in a percentage of cases where maintenance of ponds became lax once the euphoria of being involved in something new waned to a degree. Harrison proposes that not all fish farming households are equal, and that decision making does not include cost benefit analysis, and production is not always the most important outcome to

fishermen. In certain cases the impetus for being involved in fish farming may be more a status symbol than for economic gain. In Matushi village there seemed to be an emphasis on bragging rights with regard to yield output. Aspects of this behavior were especially prevalent in discussions concerning the advent of this region's first female fish farmer.

Gender equity

Gender equity is an element that is not generally well understood by Zambians and especially males. Despite this trend the emergence of equal standing between males and females in fish farming in this village was a positive event. The initiation of the first female independent fish farmer, Ms. Esther Samunguya, was met at first with a slight bit of anxiety by an otherwise all male contingent of farmers in the cooperative. She eventually exceeded their expectations in her harvest and the males accepted it although some were anxious about it. This effort served to motivate males to respond to the first success of a female fish farmer in Matushi village and it appears that she will be accepted as a viable and respected business competitor in fish farming.

It became clear that gender differences were factors that could be overcome and other motivated female responses toward success in fish farming began to emerge. This mini cultural change provided evidence that cultural innovation may be a key factor in aquaculture development in rural Zambia. It appears that a shift was inevitable partially due to the fact that women have been involved in pond management in Zambia, however ownership and credit for development has always been the domain of men (Harrison, 1996). In more recent times there are specific divisions of labor in household motivation and Harrison points out that in Zambia this is changing as a result of the emergence of changes in the nuclear family. The operation of the household may not be a matter of joint utility and the decisions made (i.e. whether or not to dig a fish pond) may vary in terms of mutual interest. In Zambia, the quality of marriage can be

perceived as transitory in many cases and the adoption of separate economic strategies is a perception observed (Evans, 1989). Additionally, women may choose to participate in fish farming as a hedge against future independence depending on the stability of the marriage. In this respect, many women in Zambia are single parents due to the influx of disease, particularly the AIDS virus which affects so many households. Also, divorce is a straight forward personal process in rural Zambia subject to the preferences of the male. This fact combined with the tendency for polygamy in Zambia has far reaching effects on women. Thus the financial status of females is discretionary and many are marginalized due to these cultural aspects.

Economics

In terms of cost benefit, a long term view is required and many of the participants exist culturally with the short view and lack of business regimen needed to develop a sustainable system Hishamunda, et.al. (2005). The cost of maintaining a pond for an extended period is the most pertinent factor for long term success. Farmers without this insight generally fail immediately. Others, who exhibit the ability to delay gratification may succeed if their motivation is maintained. In this case study, it appeared that the cooperative structure was key in that the followers would feed off the success of the leaders as long as they worked together.

Harrison (1996) indicates that the importance of external associations with other individuals and working groups supersedes any extended reliance on technology for fish farming. Farmers referred to in this case study in Zambia exhibit a tendency to default to traditional methods, however it was shown that further questioning revealed a deeper desire for an emergence into a more technological world. Evidence for this thought could be seen by observing their interests in for example securing telephone communications, expressing and seeking out improved transportation, showing the beginnings of computer use for more positive

contact with other businesses, increased travel to cities to use amenities and indicating the desire to sell their produce to government subsidized programs. I believe the desire for technology exists and is increasing in pace and scope.

A view of the educational community serves to verify this point. In Matushi village where we introduced the beginnings of solar power for use with telephones and a computer, the high level of interest and desire was evident. It was understood that power was key and there was constant expression of the need for it by educators so they might improve teaching and gain access to the internet since books were a rarity. Educational leaders made it clear that they perceived that technology and subsequent improvement in education was the way out of poverty. In the case of fish farming, a secondary economic resource in the minds of farmers, the questions remains regarding how it is linked to farming in general.

Integration

Integration is a key factor in developing aquaculture and as stated earlier, the penetration level into the monoculture that exists in rural Zambia has a complex solution. Gaheb and Binn (1993) examined this issue in Kenya at Lake Victoria. They found that farmers delving into the fishing industry varied their interests based on the degree of threat to their livelihoods. In times of difficulty with farming, fishing took on a more important role. Exploitation of the fishing resource became evident in times of severe drought. In Zambia, drought is rarer and fish farming is more of a personal choice than a requirement. However, in both cases, farmers tended to use the easiest solution for survival and then revert to less strenuous solutions once their security is more assured (Sirrine, et.al., 2010).

These similarities in Kenya and Nigeria as well as areas of Asia (Phong, et.al., 2010) to the Zambian experience demonstrate much of the same pattern in sub-saharan African aquaculture. These require a deeper look and the following ideas may be of value in rural Zambia.

VI. RECOMMENDATIONS

Foundation

In essence there is now a solid foundation cooperative in Matushi with key specific leading officials having begun to fish farm. This included a Headman, School headmaster, two health clinic officials, an elder villager and a future Peace Corps counterpart. The original intention was for fish farmers to be members of a cooperative organization and to expand their pond systems to 10-12 ponds each. Having achieved this, the basic structure of building a system of fish farming began to emerge. I highly recommend that coordination among farmers be continued and expanded upon. Farmers, working together and producing an average yield of 25 kg of fish per pond began to realize a potential profit of $50 – 75 $USD bi annually. It was observed that two farmers managed to hire digging crews to begin expansion. The effort cost them approximately $40 USD for the labor. In addition they may have required security which could cost an additional $25 USD per year unless their ponds are near to their living space as only a few were. Security was rare and farmers paid the price of the lack of it in pilferage of their yield. It was highly recommended that they relocate to the pond areas, especially if they plan to build 10 or more. Eventually, the cooperative members might attain the use of a vehicle for transport and a freezer to store fish. This would lead to the eventuality of selling in bulk as a commercial venture which would be highly profitable.

Cooperative Development

Bringing people together to work cooperatively was difficult but extremely important for success. It is believed that with the seed of coordination planted, the opportunity existed to key in on the individuals in the Cooperative more intensively. All of them are honest hardworking people whom were carefully chosen. The proliferation of the Cooperative and its leadership was the most important key factor. Without this element I am inclined to believe that most farmers would tend to lose motivation. The attendance at meetings and cooperative labor projects was fair but remained sporadic. A key point was that individuals should be asked to pay their dues at monthly meetings and not be allowed to forego this requirement at their leisure which they often did.

It was important for the Cooperative to open up a bank account which they had not done yet in my tenure. Multiple signatures should be required to withdraw funds and receipts should be tendered at meetings for all purchases. For this end to be accomplished, members should be further schooled in budget practices. The Cooperative should also be registered in Lusaka, the capital of Zambia. A grant request should be submitted to Peace Corps early on in the tenure of the succeeding Peace Corps volunteer, within a few weeks after community entry if possible. Upon receipt, these funds which can reach upwards of $5,000 USD should be deposited in the Cooperative bank account. In addition, it is recommended that the new Peace Corp volunteer research the Zambian Ambassador's grant opportunity which can exceed $20,000 USD. This would afford the unique opportunity for the Cooperative to operatate on a commercial basis, which is the long term goal.

Technical Development

I felt that the brood stock program in Matushi needed to be developed per the Rural Aquaculture Tech Manual, U.S. Peace Corps, Zambia, 2009. One villager, a counterpart had agreed to allow the use of one of his 4 ponds for this venture. It was built according to specification with the proper slopes for optimal breeding conditions. The aim was to create a separate nursery and holding pond in addition to the main pond. Fish would then be segregated by species and sex for a more pure genetic application to ponds. The brood stock would be replenished from the ponds as they are harvested. The point of this is that it would relieve the Ministry of Fisheries of the burden of supplying fingerlings to farmers which incidentally were usually of low quality and expensive.

The value of having a tree nursery in Matushi cannot be overstated. There are specific species of trees and shrubs mentioned earlier that have a significant effect on the growth of Tilapia species and on the quality of their nutrition. The result of their sustained usage is larger harvests and bigger more robust fish. This was evidenced by the results of a few of the fish farming cooperative members who followed a strict feeding regimen and derived positive benefits from it. Attempts to begin a nursery were met with difficulty in that seedlings could not be easily obtained from the agriculture unit. Later, they became more amenable to new ideas since they have combined with the ministry of Fisheries and observed fish farming results. The Peace Corps should approach them for more solid advice on tree nursery development.

The Dept. of Fisheries was very cooperative in terms of assisting with pond development and I recommend that Peace Corps reciprocate by placing increased numbers of volunteers in the Matushi catchment area. Officials helped diligently in urging farmers to cooperate with Peace Corps despite a degree of tension between them. It was believed much of the previous animosity

perhaps due to jealousy and envy has been alleviated and more cooperation was realized. I recommend that all fish farming operations be coordinated with the Ministry of Fisheries and that frequent collaboration with them is executed regarding future development. .

It is also recommended that permaculture systems be explored further and implemented. The previously described system is highly modifiable and should be looked into further (Mollison and Slay, 1991). Note that there are research elements within it that may have to be altered.

Peace Corps

I recommend research in the area of Peace Corps rural aquaculture promotion service. Initially, there was intended to be a research element for this service; however it became improbable due to the apathetic view of farmers to build ponds in the beginning. It seemed that if farmers begin to build multiple ponds, a portion of these could be used to determine optimum crop yields based on variances in feeding strategies. For instance, unsophisticated observations demonstrated significant differences in yields between farmers that had ponds close to their home sites as opposed to further in the field. Also, farmers that had ponds closer to Peace Corps volunteers who subsequently observed them at a greater rate received better feedback and higher yields. Finally, water quality should be looked at as well by Peace Corps representatives. Matushi has a good deal of iron deposit evidence and farmers that build in those areas might need to apply more ash to neutralize the effects of iron on water quality (Degefu et.al., 2011).

Farmers needed to understand that they were responsible for their own market upon harvest (Abbott, et.al., 2007) and to not rely on Peace Corps volunteers to find them a market. The intent was to teach them self reliance which was partially successful; however they remained in need of motivation on a continual basis.

During this period there was reluctance by me as a Peace Corps volunteer to extend myself too extensively toward the villagers interests. It was feared that they may become overly dependent and constantly require guidance in their work. Through early trial and error it was learned how to hold back to the point where villagers would understand that Peace Corps volunteers would not be responsible for their shortcomings in business. In the beginning this was met with derision based on the realization that things were not given to them. Later as things worked out better, villagers appeared to rely on themselves to a greater extent. For instance, they were not assisted as much by Peace Corps volunteers beyond the initial stages of building or harvesting ponds. Also, they were not waited for when they failed to attend meetings for inconsiderate reasons. Subsequently significant effort was extended on an individual basis with each farmer and group sessions were eventually avoided. This required a bit of diligence in visiting farmers individually, however it paid off strongly. Culturally speaking it was valuable to commune with the locals to a great extent It became clear that one could be friendly, however not necessarily friends as you would otherwise be taken advantage of by this fine line of interaction.

In terms of secondary projects it would be a good idea for Peace Corps Volunteers to be more interactive with the Matushi school system. The principal and his assistant were solid contacts for this. There was a hand in starting a small library and help to begin the process of getting computers to the school at a highly discounted price which was very rewarding. They should arrive subsequent to this tenure and instruction in their use would be valuable. Solar panels were installed in the resource/library last year, but more are needed for computer use. Grant money can be used for this. Also, the school participated in a letter writing project with American school children at the World Wise Schools project. A visit was paid the American

school in Indiana upon return to the U.S. and it is highly recommended that this writing program be continued. It would be helpful for volunteers to collaborate with the new mining operation that has recently been put into operation. The contractor is American and this may assist the Peace Corps goals.

Visits from Peace Corps headquarters officials were well taken and appreciated. It would be advantageous in the future to see a more concerted communication in terms of specific constructive criticism regarding the elements of the program. For example, it would have saved a degree of effort by having guidance in the grant procedure as well as possibly a historically oriented consultation regarding the nature of the previous Matushi Peace Corps effort. Most of the information came from village sources and was sporadic and conflicting in nature. Eventually, things were reasoned out at the expense of time.

VII. CONCLUSIONS

Rural aquaculture promotion is on the rise in Matushi village and subsequent Peace Corps volunteers have an excellent opportunity to proliferate this program to its maximum potential. There are between 25 and 40 working ponds in the area and there could be 100 fish ponds in Matushi by 2014 and as many as 300 or more in the next decade. Specific trustworthy leaders have been ferreted out and should be taken advantage of. The keys are cooperative expansion and wise use of grant money. In my opinion Peace Corps can now look forward to a long tenure in North West Zambia.

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