Global Livestock CRSP

The Potential for Culture of Nile Tilapia and African Catfish in the River Njoro Watershed

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Aquaculture systems have the benefit of being highly intensive with demonstrated economic returns. Aquaculture can be an efficient strategy for economical land use and serve as an alternative means of livelihood for rural communities. Consequently, fish farming can play a major role in environmental conservation and restoration programs by reducing extensive land use. However, regional variability in climate, soils, and water quality are limiting constraints on aquaculture success. This study was conducted to assess the potential for culture of two warm water fish species, Nile tilapia (Oreocromis niloticus, Linnaeus) and African catfish (Clarias gariepinus, Burchell) at the high altitudes of the River Njoro watershed. Growth performance of Nile tilapia and African catfish were evaluated for 180 days in ponds fertilized with organic manure and stocked at a rate of two fish per square meter for tilapia, and 0.5 fish per square meter for catfish. Results from this study demonstrated remarkable growth in Nile tilapia but poor growth and condition in African catfish. After several attempts, African catfish eggs fertilized for the study failed to hatch, most probably due to low temperatures and the poor water quality of the Njoro River. These results demonstrate the feasibility of Nile tilapia culture at high altitudes of the watershed, while African catfish culture was limited by poor growth performance and seed availability. The farming of Nile tilapia is therefore recommended in the Njoro River watershed as a potential alternative livelihood strategy to intensive agriculture.

Background

Kenya's economy is heavily reliant on agriculture with a clear need for improved sustainable agricultural development. Aquaculture systems have the benefit of being highly intensive with demonstrated economic returns. Aquaculture can be an efficient strategy for economical land use and serve as an alternative means of livelihood for rural communities. Consequently, fish farming can play a major role in environmental conservation and restoration programs by reducing extensive land use. However, regional variability in climate, soils, and water quality are limiting constraints on aquaculture success. This study explores the feasibility of intensive small-scale pond aquaculture for Nile tilapia *(Oreocromis niloticus, Linnaeus)* and African catfish *(Clarias gariepinus, Burchell)* at the high altitudes of Njoro river watershed where aquaculture has not previously been attempted.

Nile tilapia is one of the most important species among the commercially farmed tilapias in Africa and is widely farmed in Kenya. The species has favorable attributes for aquaculture and is highly attractive to consumers. This species of tilapia breeds readily in captivity, which can lead to overpopulation of fish ponds within a few months after stocking. The African catfish is co-cultured with Nile tilapia to increase fish yields and also to reduce fingerling recruitment from Nile tilapia in fishponds. However, unlike tilapia, the African catfish does not breed in captivity, and therefore seed availability can be a major problem in the culture of the species.

The success and propagation of culture stocks is not only governed by the biological characteristics of the target species but also by the local environmental factors. High altitudes, for example, are characterized by low temperatures, which may in turn adversely affect the rate of natural food production, growth, and the breeding performance of culture species. Therefore, for successful propagation of fish within a fishpond, it is important to understand the characteristics of the fish and the biotic and abiotic parameters of pond system. The present study was initiated by the SUMAWA project to evaluate the potential for culture of the two warm water species at high altitudes of Njoro River watershed.

Preliminary Findings

Four ponds, each measuring 300m^2 were constructed at Egerton University and conditioned for three weeks before stocking. The ponds were fertilized with organic manure and co-stocked with Nile tilapia and African catfish at rates of two and 0.5 fish per square meter, respectively. There was no artificial feed supplementation during the course of the experiment. The trials took six

*African catfish (*C. gariepinus*) pulled from a SUMAWA pond. The water quality parameters in the River Njoro watershed made it difficult to culture the African catfish in ponds at high altitudes. No eggs from this species hatched, indicating that attempts to get the fish to spawn were unsuccessful. Photo by David Liti.*

months during which growth performance and pond water quality changes were monitored. Artificial spawning was conducted with Nile tilapia using mature fish, which were purchased from Sagana Aquaculture Center.

The two culture species are presented in the photos, while fish growth data are presented in Table 1. From the photos, the good condition of Nile tilapia on the one hand (bottom), and the poor condition of African catfish (above) after six months of pond culture are clearly apparent. The range in weight (200-280g) for the males of Nile tilapia presents a reasonably good growth performance given that most of the fish reached 250g, a suitable size for food fish.

A clearly marked sexual growth dimorphism (difference in form within a species) between the female and male Nile tilapia was observed in the study; the growth of males was double that of females. Differential growth in the species has been attributed to the prolific breeding in the female. However, given the low prevailing temperatures in SUMAWA ponds, the breeding activity in the current study would be much reduced. Thus, the sexual growth differences between the male and female Nile tilapia may have a genetic basis. Several attempts to induce spawning in African catfish were not successful, as the eggs failed to hatch. This was attributed to low temperatures and unfavorable water quality from the Njoro River.

*Nile tilapia (*O. niloticus*) taken from a SUMAWA pond. Efforts to raise Nile tilapia were more successful owing to the lower impact of cool temperatures on fish development in this species. The range in weight between 200 and 280g for the males presents a reasonably good growth performance (250g is considered a suitable size for food fish). Photo by David Liti.*

Table 1. Fish growth and water quality data from SUMAWA ponds.

Nile tilapia *(Oreochromis niloticus L.)*				
	Males	**Females**	**Size Range**	
Stocking weight (g)	20	20	**Males**	**Females**
Mean Harvest weight (g)	240.2±31.6	105.1±15.1	200-240g	80-120g
Growth rate	1.2±0.08	0.5±0.07		
Growth ratio	2.1	1.0		
African catfish *(Clarias gariepinus B.)*				
	Males	**Females**	**Size Range**	
Stocking weight (g)	15	15	50-80g	
Harvest weight (g)	77.7±6	76.8±8		
Growth rate	0.34±0.03	0.34±0.02		
Growth ratio	1.1	1.0		
Water Quality Parameters				
	Mean	**Range**	**Recommended**	
Temperature	19.4± 2.3	16-24	25-30	
Dissolved oxygen (mgl-1)	0.43± 0.25	0.09-0.96	>3	
pH	7.3± 0.34	6.7-7.3	6.5-9.0	
Alkalinity(mg CaCO3 l-1)	75 5	70-85	100-150	
Ammonia (mgl-1)	0.01	0-0.01	<1.0	
Nitrite (mgl-1)	0.01	0.01-0.02	-	

For pond water quality, temperature and dissolved oxygen (DO) are the two most important parameters that control fish growth (Table 1). In the Njoro ponds, temperature was sub-optimal (mean 19.4, and range16-24°C) for Nile tilapia, who's growth is optimized at (25-30°C). During periods of pond heating on sunny days, most of the heat was confined to the topmost water strata and insulated from penetrating the whole water column by a brief thermal structure that was established daily between 10.00 and 16.00 hours. The net effect was maintenance of water temperature below the optimum range for both species. Except during the periods of mixing, DO occurred at levels which would not adversely affect fish growth. It was concluded that temperature was solely responsible for the poor performance of African catfish, and that this species was more prone to adverse affects of low temperature when compared to Nile tilapia.

Practical Implications

Interactions with stakeholders in the River Njoro watershed have shown support for the development of aquaculture as an alternative livelihood strategy to agriculture in the region. SUMAWA scientists and collaborators from the Kenya Fisheries Department have used research fishponds as training and outreach facilities for local stakeholders, and have generated considerable interest in aquaculture among watershed communities. Furthermore, there is an apparent local market for fish, though further assessments on the economics of fish marketing and profitability of small-scale aquaculture in the region are recommended. The future success of pond aquaculture in the watershed, however, is hindered by the relatively cool temperatures of the region. While initial concerns regarding water quality, specifically dissolved oxygen levels, were allayed by this research, study attempts to raise African catfish *(C. gariepinus)* to market size were unsuccessful. Efforts to raise Nile tilapia *(O. niloticus)* males, on the other hand, were more successful owing to the lower impact of cool temperatures on fish development in this species, while females were markedly smaller. In conclusion, this study has succeeded in identifying the preliminary barriers and opportunities to fish farming in the River Njoro watershed, and has provided a baseline for further inquiry into the mechanisms for generating a sustainable aquaculture program with the potential to enhance rural livelihoods within the River Njoro watershed.

Further Reading

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The GL-CRSP Sustainable Management of Rural Watersheds (SUMAWA) project was established in 2003 and is a multidisciplinary research effort focusing on biophysical and human-related factors governing health in the River Njoro watershed in Kenya. The Principal Investigators are Dr. Patterson Semenye (Email: semenye@sumawa.or.ke) and Dr. Scott Miller (snmiller@uwyo.edu).

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East and West Africa, Central Asia and Latin America.

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