TECHNICAL AND SOCIOECONOMIC FACTORS INHIBITING DEVELOPMENT

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1. INTRODUCTION

Aquaculture development in Africa is believed to have started in Egypt 2500 years BC as depicted by bas reliefs of tilapia reared in ponds. This is even before carp culture was initiated in China, but despite this early start, fish farm production in Africa currently yields less than 0.1% of the world total of farmed fish. The reintroduction of aquaculture in Africa essentially took place after World War II. By 1960 over 320,000 ponds had been built in 30 countries. Over 140 species of fish were cultured but most countries chose the tilapia, in view of the ease of production. The high fecundity of this species in ponds can create overcrowding, resulting in a small end product. This undoubtedly discouraged farmers, for in the 1960s, interest declined. With the emergence in the 1970s of new fish farming concepts and a realisation that African small scale subsistence farmers could benefit, saw renewed activity such that by 1983 over US$ 100 million was allocated in aid grants (Anon, 1984). Large scale commercial enterprises however have hardly developed and only 10-15 projects are in operation, half produce under 100t/yr and there are about 20 pilot projects.

The 10-year development plan for Africa reported by FAO/ADCP in Ghana in 1975, (FAO, 1975) has far from reached its goal. At the time a contradiction in objectives and an absence of adequately trained personnel were concluded as the major constraints to development. Remedial action was recommended and a 10-year development plan for 9 countries planned to realise 514 500t/yr by 1985. Current production remains low, between 7-144 thousand tonnes, but statistics are confused and overestimated such that the lower value is more likely to approximate actual yields. Aquaculture therefore has a poor track record and Anon (1981) in an analysis of the situation suggests that between 1975-1980 aquaculture actually declined at a rate of 13%/ year.

2. THE CONCEPT OF VILLAGE AQUACULTURE IN AFRICA

Characteristic of rural developments in Africa, village level aquaculture is generally small scale, operated either by individual subsistence farmers, artisanal or community groups employing relatively unsophisticated techniques for the purpose of additional food production often integrated with other farming systems. Practised as a sole or part-time occupation, often dependent upon public sector involvement either for funding or support services, production units are small and yields low.

Generally fish exist in harmony with their natural environment, natural selection having determined the genetic make-up most likely to be successful. Fish are therefore tolerant of a certain range of environmental conditions and can co-exist with a limited pathogen burden. An aquaculture system must strive to recreate optimum conditions, should stress occur due to any one unfavourable parameter a loss in performance or mortality results. This interrelationship is expressed in Fig. 1. The potential capacity for growth of a species is therefore determined by its genetic make-up; however the realisation of this potential is a feature of environment and stress within an aquaculture system (Fig. 2). Whereas the biological implications of this are beyond the present text, it is apparent therefore that village level aquaculture cannot be expected to develop just anywhere. To be a success, species selection is important to choose a fish capable of performing well under the prevailing conditions and management must ensure that the full potential is realised by optimising the growing climate (ie fertiliser, feeds, oxygenation, etc).

The tradition of fish culture in Africa is limited, with examples to be found mainly in Egypt, Benin, Togo, Mauritius and Cameroon. The implications are that before aquaculture can become common practice in rural sectors there is an absolute need for technological transfer.

Table I presents an analysis of the factors affecting developments after Anon (1981).

Discussed below are some of the factors inhibiting development, not necessarily presented in any order of importance.

3. TECHNICAL ASPECTS

Fish farming is a foreign concept to the rural farmer. Technical input is therefore necessary, but when aquaculture was first introduced to Africa, little was known of the biology of indigenous species. Introductions of exotics took place but the need for specialised hatcheries often placed these fish beyond village level practices. Pioneering efforts were necessary which meant the State had to bear the cost of research and later oversee the extension to the farmer. Poor understanding of the

biology of the fish selected undoubtedly hampered early developments and still persists today. The group most favoured, the tilapia, also exhibit a unique trait of innate prolific breeding and soon there are more mouths to feed than food available. Fig. 3 illustrates that if only 5% of stocks are female, after 9 months if food is unlimited, 5t/ha/yr production can be achieved but the harvest would be of 250,000 fish, of which only 5% may be of a large and acceptable table size. Hand sexing for small males or use of predator stocking to control emergent fry are potentially unsophisticated techniques which could be employed by the farmer. More successful methods of hybrid crosses or hormone treatment to produce all males require technical input and a certain hatchery infrastructure which must be provided by the State as the level of technology and capital requirement is beyond the scope of the rural farmer.

Ironically, despite this problem of pond overpopulation, generally a large number of farmers are unable to obtain seed. Due to limited funds a farmer may only afford one pond. At harvest there is no means to hold potential seed fish (ie a second pond) and the farmer is dependent on other sources, generally his neighbour. Selection at harvest is for larger fish thus only smaller fish, assumed to be fry, are restocked or passed on. This presents a negative selection for size and in time farmers will be trading in genetically inferior stock. State hatcheries are essential to provide seed and to boost the genetic pool.

Therefore the state must bear the cost of research to develop techniques suitable for use under local conditions. Too often however research has been of an impractical nature often duplicating previous results. Hitherto unexplored is the use of tilapia in salt water, an environment in which the species can survive and grow but do not reproduce and therefore presents scope for mariculture by coastal villages or fishermen.

At subsistence levels generally extension agents are needed at a rate of 30 ponds per agent. Absence of adequate training institutions has meant that trainees have not kept pace with demand. Further, to be effective, extension agents need to be mobile (ie bicycle or motorcycle) an important feature in view of the distance between farmers. Extension agents need to work out of a centre which through its successful production of fish serves as demonstration and source of seed supply to farmers. Often however for reasons of insufficient funds, poor management or lack of incentive, such centres do not function and are a poor example for extension.

4. SOCIAL ASPECTS

Present demographic patterns emphasise a need to increase protein production and trends in world fishery landings suggest a limited

scope for further increase in fish production. An alternative, such as fish farming, is therefore to be considered but a large portion of Africa has non fish eating traditions. Those areas most likely to benefit from increased fish production are generally those most distant from the fishery where it is often unlikely that people are accustomed to eating fish. Conversely introduction of fish farming in communities where the fishery is abundant is not likely to have the same incentive, for the long term benefits may not be immediately obvious and consequently Governments accord fish farming a low priority.

Conflict between use of manures as fertilisers for traditional crops and the use of crop by-products as well as domestic wastes as livestock feeds meant that aquaculture was in competition with long established practices. Compounded by the emergence in the 1960s of a new political reform, a bad track record and poor demonstration history meant aquaculture was abandoned for more traditional practices.

Government agencies, such as the Fisheries Department, were assigned the task of responsibility for village level fish culture development. However the low priority awarded to aquaculture meant little attention was paid to development, extension agents in the field lacked incentive, were poorly supervised, underpaid and generally of low morale such that they became disinterested in development. Staff rotation policy meant semi-trained persons were assigned extension work. Further, Fisheries Departments had a reputation for ensuring that fisheries legislation were implemented. Consequently extension agents were assigned law enforcement tasks. Suspicion amongst villagers meant that extension agents were distrusted, hampering any possibility of fish farm work.

5. ECONOMIC ASPECTS

The economics of an aquaculture operation are adequately summarised by Shang (1981):

$$Y = QP - C$$

Where Y = net income per unit area

Q = production

C = cost of production

P = price received.

Perhaps the most critical factor is that the low priority accorded to fish farming means that Government capital and recurrent budgets are

low, often less than 1% of total Fisheries budget. Without funds all other aspects of extension are not possible. In an appraisal of the situation, Balarin (1984) considers African nations require to develop 1800 ha/yr of fish ponds to sustain fish protein requirement. At an estimated cost to the state of US$ 955/t output (1975 prices) each nation would have to spend annually USS 20 million on aquaculture. FAO estimates suggest US$60 million. Aquaculture development therefore is dependent upon external aid and up to 1985 over US$ 80 million is planned for projects in Africa with about US$20 million counterpart contribution. Major inputs are by the USAID/PVC in the form of extension services, French bilateral aid, FAO/UNDP support projects, IFS research grants and a mixture of capital item by EEC, World Bank, GTZ and ODA. In theory this aid should realise an additional 100,000t/yr production.

Traditionally, fishery resources have provided fish at low cost, often making fish protein the most inexpensive food item available to the rural poor. This low price therefore does not justify investment such that little commercial development has taken place. The cost of feeds and fertiliser supplements to enhance production can represent 50-70% of production cost and are therefore likely to find minimal use in village ponds where there is no surplus of such items. An integrated approach either combined with irrigation to make use of waters already pumped or to use irrigated crop wastes or weeds or in combination either in rice fields or with livestock rearing makes economic sense for a more efficient use of resources. Here lies the possible future trend in rural aquaculture.

6. CONCLUSION

In summary it is possible to say that the low priority given to aquaculture development has meant insufficient funds to develop techniques, establish the necessary infrastructure and adequately train sufficient personnel to provide an extension service. Absence of any tradition of fish farming has meant village projects are totally dependent upon Government inputs but the support given extension is lacking in incentives to increase production. This and the current low price of fish as well as a poor history of success has led to disillusionment and an abandonment of what once was a potentially thriving industry. To be a success massive foreign assistance is now necessary but emphasis must be toward intensification.

Fig. I The Interrelationships and Interactions between Fish, Environment and Pathology in an Aquaculture System which lead to Stress and Mortality.

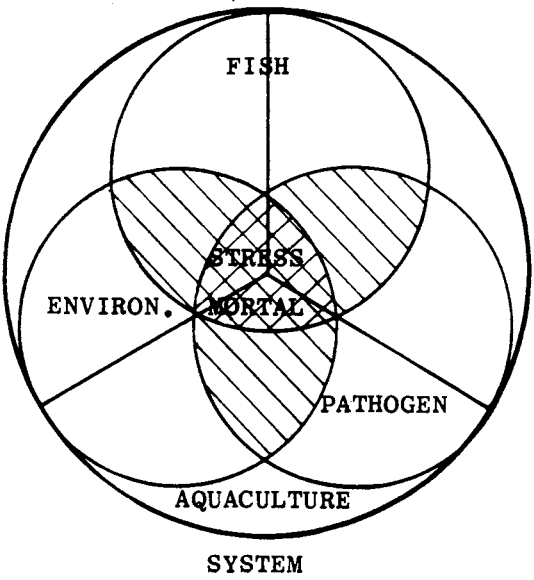

Fig. 2 The Relationship between the Potential and Realised Performance Capacities and the influence of the ultimate (genetic) and proximate (environment and stress) limiting factors on the geometric configuration of the capacities.

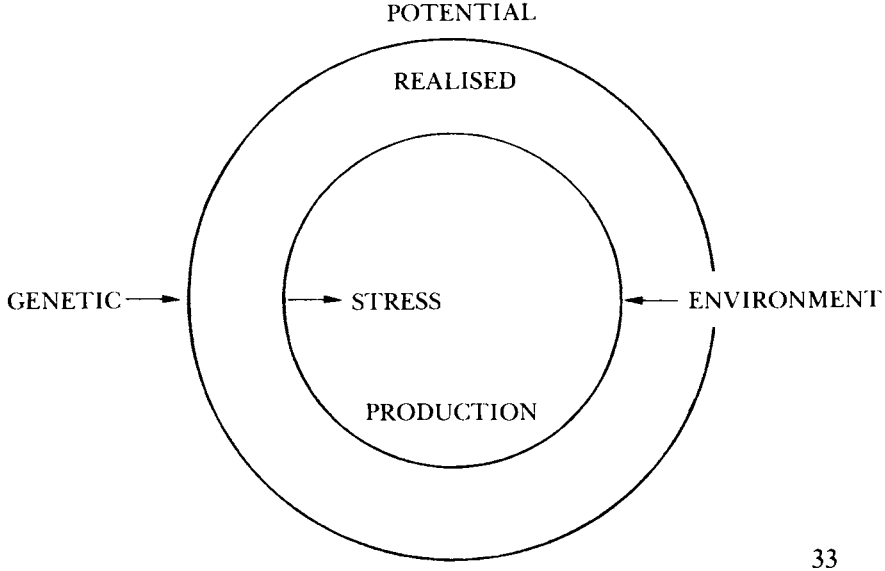

Fig. 3 Hypothetical Reproduction Potential of Tilapia in Ponds Stocked with only 5% Females

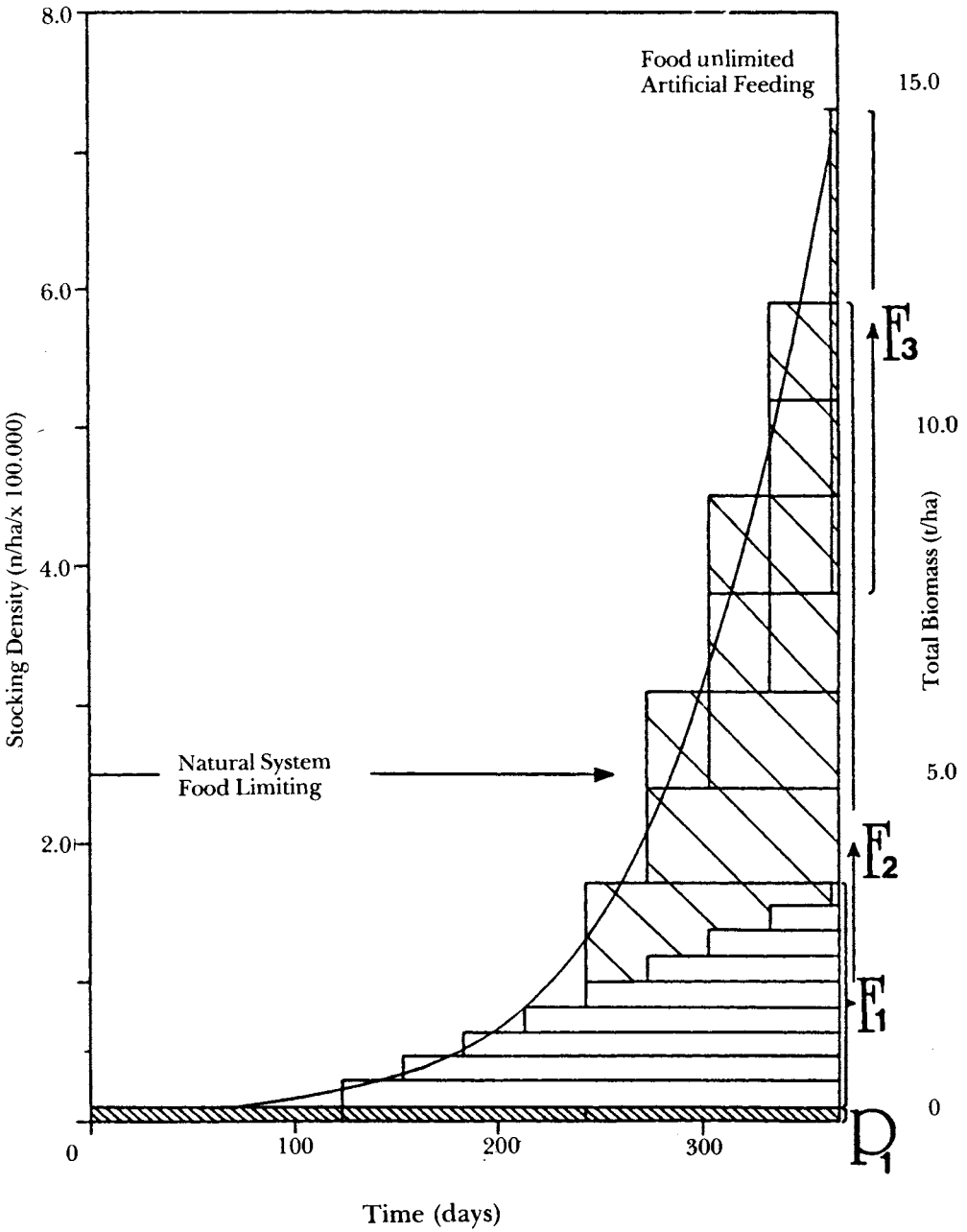

Table 1: Major Factors Affecting the Development of Aquaculture in Africa

FACTOR	SUB-FACTOR	COMMENTS	RATING	MEAN		SIGNIFICANT
			AFRICA	WORLD	VAR	DIFFERENCE
ENVIRONMENT	PHYSICAL	Suitability of land and water (including quality and quantity) in relation to requirements of aquaculture species	1.12	2.91	0.94	XX
	INSTITUTIONAL	Government policy, planning, programmes (such as training, extension services and financial assistance) and controls, legal requirements, political/economical stability	−1.08	1.88	1.77	XXX
	SOCIAL	Infrastructure, stage of political development, traditions, life style, education of level	−0.15	2.80	1.72	XXX
SPACE	LAND	Availability of space for aquaculture at acceptable cost	1.29	2.52	0.82	XXX
	WATER	Availability of space in lakes, bays, coastal zone for aquaculture at acceptable cost	1.00	2.46	0.76	XXX
TECHNOLOGY	CULTURE METHODOLOGY	State-of-the-art for growing selected species and local availability of methodology	0.35	2.59	1.33	XXX
	PRODUCT TECHNOLOGY	State-of-the-art of handling, preservation, processing, packaging, storage, distribution and local availability of methodology	1.23	3.23	1.33	XXX
PRODUCTION	PLANNING/MANAGEMENT	Business decision re-site selection, plant design, culture-system, operations, capital formation and business management	0.04	2.23	1.32	XXX
	INPUTS	Availability of seed, feedwater, utilities and materials at acceptable costs	1.69	1.81	0.34	NSD
	OPERATIONS	Management, labour, and farm operations needed to grow selected species to marketable size	−0.15	1.76	1.30	XXX
	COSTS	Fixed and operational costs in relation to revenues	2.00	1.74	0.32	NSD
MARKETING	PLANNING/MANAGEMENT	Decisions re-product form, processing methods, marketing strategy and business management	1.19	2.56	1.28	X
	DEMAND	Domestic and export demand and prices	2.54	2.88	0.57	NSD
	OPERATIONS	Processing, preserving and packaging the products, distributions and quality control	1.27	2.44	1.13	X
	REVENUE	Market development, sale price in relation to production and marketing costs	2.38	2.74	0.38	NSD
	OVERALL MEAN RATING		0·98	2.44	0.98	XXX

KEY: −5 = Unfavourable; 0 = Neutral; +5 = Favourable; *SOURCE:* Anon (1981)