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Economic viability of Aqua-Model Village Scheme: a case study in West Tripura District

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ABSTRACT

The Aqua-Model Village Scheme (AMVS) was a concerted effort by Government of Tripura for development of fisheries in the state. The economic viability of AMVS implemented by Department of Fisheries, Government of Tripura during 2004-'05 to 2010-'11 was evaluated based on the responses of 80 farmers from both the adopted and non-adopted villages. Standard tools for economic evaluation were used for assessment of economic viability. The extent of adoption of recommended package of practices by the villages under AMVS indicated high adoption. Gross and net income was substantially higher in adopted villages compared to non-adopted villages indicating higher return of investment per hectare of scheme area compared to non-adopted villages. The results indicated the scheme was economically viable with net present value (NPV) of ₹ 312.43 lakhs, benefit cost (B-C) ratio of 1.35 at 15% discount rate and internal rate of return (IRR) of 53%. The scheme also remained viable with increase in costs by 10% and decrease in benefits by 20% under simulated scenarios. Therefore, the scheme may be replicated in similar area for the development of fisheries which in turn will help in increasing the income status of rural poor and also improve the nutritional security in the country.

Keywords: Aqua-Model Village Scheme, Benefit-cost ratio, Economic viability, Internal rate of return, Net present value

Introduction

Tripura is one of the North-Eastern Hill (NEH) States of India and economy of the state is based on agriculture and allied activities. Fisheries and aquaculture is considered to be one of the vital sectors for economic development of the state. About 22,164 ha of water spread area is under culture fisheries and 7,879 ha under capture fisheries (Government of Tripura, 2011a). The aquaculture sector of the state is presently undergoing a transition from a traditional activity to commercial activity. Aquaculture in Tripura has witnessed an impressive growth from 21.2 thousand metric tonnes (MT) in 1990 to 29.1 thousand MT in 2002-03 and 49.23 thousand MT during 2011 (Indiastat, 2012). In spite of the impressive growth in fish production, there exist large gap in demand and supply of fish in the state. The per capita availability of fish was about 9 kg against a demand of 11 kg. The demand was 8.28 kg in rural area and 13.2 kg in urban area during 2002-'03. This gap in supply and demand for fish attracted fish from other states like Andhra Pradesh, West Bengal and neighbouring country Bangladesh (Nandeesha, 2008).

Keeping in view of the large gap in demand and production of fish in the state, Government of Tripura, developed an ambitious perspective plan to attain self-sufficiency in fish production by the year 2011-12. Under the perspective plan, the Government of Tripura launched an area-based fisheries development programme called Aqua-Model Village Scheme (AMVS) to improve the efficiency in fish production during 2004-'05 (Government of Tripura, 2008). The strategies of the scheme were as follows:

- Bringing all culturable water areas under scientific fish culture with an average per hectare fish productivity of 3,050 kg year^{-1} by 2010-11.
- Entrepreneurship development among educated unemployed youth by organising Self Help Groups (SHGs) and encouraging women to participate actively in fisheries development.
- To develop one Model Aqua Panchayat in each block of the State.
- Reclamation of seasonal and silted water bodies to retain water up to the desired level for fish culture.
- Revitalisation of existing Fishermen Co-operative Societies/Self Help Groups for higher fish production.
- Improvement in the post-harvest technology for value addition and creation of transportation, preservation and marketing infrastructure.

Under this scheme, one aqua-model village was proposed to be developed in each rural development block of the state under its perspective plan. In this scheme,

farmers were mobilised and awareness about the improved package of practices through a series of training programme was initiated. The technology was also demonstrated in their pond in order to make the farmer understand the efficient use of farm resources which could lead to increasing return to scale in fish production (Singh, 2008). By the end of 2010-11, a total of 42 villages have been developed as aqua-model village by the Department of Fisheries (Government of Tripura, 2011b). Since the scheme was started in 2004-05, by the end of year 2010-11, the aqua-model villages developed during initial years of the scheme would have got sufficient time to make an impact in the area. An economic evaluation of the scheme is essential to provide justification for the investment of scarce financial resources and to strengthen the hands of decision makers for future investments. With this background, an attempt has been made to evaluate the economic viability of aqua-model village scheme implemented by Department of Fisheries, Government of Tripura.

Materials and methods

West Tripura District was selected for the study, as the district has 17 out of the total 42 aqua-model villages developed in the state, accounting for 40.48% of the total area developed under the scheme. From the district, two sub-divisions having highest area under fish culture were selected and from each of the selected sub-divisions, two blocks having highest area under fish culture were selected. From each of the selected block, one aqua-model village and another village wherein the scheme was not implemented, were selected. Those villages covered under the scheme were denoted as adopted villages and others as non-adopted villages. In order to ensure that impact of the scheme in the villages were captured, only those villages in which the scheme was started right from the initial year were selected. Non-adopted villages were selected based on the criteria of similar levels of aquaculture development across these villages and the distance of these non-adopted villages were at least 10 km away from the adopted villages, so that there is no percolation of even a residual impact of the AMVS. Samples of 20 farmers were selected from each of the adopted and non-adopted villages. Hence, a total of 80 farmers were selected from both the adopted and non-adopted villages making a total of 160 sample farmers. The primary data related to existing practices were collected by adopting the personal interview method using specially structured and pre-tested questionnaires. The data pertaining to the agriculture year 2010-11 were collected. The secondary data regarding the investment made in the scheme was collected from Department of Fisheries, Government of Tripura.

Adoption Index of recommended practices was developed by using suitable modification of formula given by Raheja *et al.* (1987) in order to determine the extent of adoption of new aquaculture technologies. Different farm business plan, cost and income measures were estimated following Salim and Biradar (2001). To evaluate the economic viability of the AMVS, the net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR) were computed following Gittinger (1982).

Since AMVS involves fixed investment, income stream for the whole life span of fixed investment were taken. However, it is difficult to generate the cash flows for the entire life span of fixed investment in the absence of observed temporal information on benefits and costs. The following assumptions were made based on Kumar *et al*. (1999), Mandal *et al.* (2007), Arya *et al*. (1994) and Nalatwadmath *et al*. (1997):

- The economic life of the AMVS was assumed to be 10 years.
- The income stream from the AMVS is uniform and constant over its entire life.
- Differential rates of discount (interest rate) are considered to test the sensitivity of investment to the change in capital cost.
- Other things being equal, fish culture technology was assumed to be constant at 2010-11 level.

The incremental costs and benefits from the scheme were generated and considered for the analysis.

Results and discussion

Adoption of recommended package of practices on sample farms

Extent of adoption of any technology influences the magnitude of its impact. Hence, it is essential to estimate the extent of adoption of different aquaculture practices recommended under AMVS in the area before evaluating the economic viability of the same. Therefore, prior to analysing the economic viability of the scheme, the extent of adoption of recommended package of practices was estimated with the help of adoption indices and is presented in Table 1. It is evident from the table, that overall composite adoption index was 71.05% for adopted villages which was significantly higher than that of the non-adopted villages (43.15%). This may be also due to the fact that farmers of adopted villages were more endowed with resources for adopting scientific fish culture practices. However, when practice-wise indices were compared, it becomes more clear that in adopting most of scientific aquaculture practices like liming, application of cow dung, urea, single super phosphate and mustard oil cake (MOC), farmers of adopted villages were far ahead of farmers of non-adopted villages. This reflects the impact of scheme on adoption of

Table 1. Composite indices of adoption of recommended aquaculture practices

Practices	Adopted villages	Non-adopted villages
Pond preparation	33.75**	23.75
Seed stocking	109^{NS}	114.90
Liming	57.36**	38.12
Cow dung	59.28*	12.73
Urea	61.79*	23.10
Single super phosphate	26.81*	3.17
Pelleted feed	8.55^{NS}	4.03
Mustard oil cake (MOC)	86.10*	28.89
Composite adoption index	66.05*	43.15

* indicate significant difference from non-adopted villages at 1% level of significance
** indicate significant difference from non-adopted villages at 5% level of significance
^{NS} indicate non-significant difference

different practices across all the farms of adopted village. Adoption was highest for seed stocking (109%) followed by mustard oil cake (86.1%), urea (61.79%), cow dung (59.29%), liming (57.36%), pond preparation (33.75%), single super phosphate (26.81%) and use of pelleted feed (8.55%). Adoption indices of different practices in non-adopted villages shows adoption level was highest for seed stocking (114%) followed by liming (38.12%), mustard oil cake (28.89%), pond preparation (23.75%), urea (23.1%), cow dung (12.73%), pelleted feed (4.03%) and single super phosphate (3.17%). Comparison of seed stocking by farmers of both the adopted and non-adopted villages indicated very good adoption of stocking practices. Besides, there was improvement in adoption of all the practices in adopted villages over non-adopted villages. The table clearly indicate that fish farmers of adopted villages were good adopters of the recommended package of practices.

Costs and returns in fish production

As a backdrop to the economic evaluation of the AMVS, cost of production as well as productivity of aquaculture practices in the farms of both the adopted and non-adopted villages were estimated and are presented in Table 2. Perusal of the table indicates the differential pattern of productivity and cost of production among farmers of the adopted and non-adopted villages. The total cost of production was higher in case of adopted villages (₹ 1,20,785 ha^{-1} year^{-1}) than the non-adopted villages (₹ 1,02,855 ha^{-1} year^{-1}). Despite higher cost of production, gross and net income was substantially higher in adopted villages compared to non-adopted villages, indicating higher return on investment in scheme. The net income from aquaculture in the adopted villages (₹ 43,469 ha^{-1} year^{-1}) was higher than in non-adopted villages (₹ 30,243 ha^{-1} year^{-1}) and this was mainly due to higher adoption of technology in adopted villages.

Table 2. Costs and returns from fish production on sample farms (₹ ha^{-1} year^{-1})

Particulars	Adopted villages	Non-adopted villages
Fixed cost	27,773.81	24,118.30
Variable cost	93,011.76	78,737.63
Total cost	1,20,785.57	1,02,855.93
Yield (kg ha^{-1} year^{-1})	1,741.81	1,351.22
Average price (₹ kg^{-1})	94.30	98.50
Gross income	1,64,254.57	1,33,099.26
Net income	43,469.00	30,243.33

Investment in the AMVS

Although the scheme is implemented by Department of Fisheries, the scheme had several source of investment like Fishery Department, North Eastern Council (NEC), Panchayati Raj Institute (PRIs), Additional Central Assistance (ACA) and peoples contribution (farmers' investment on their own farm). Year-wise investment in the scheme is presented in Table 3. The total expenditure under the scheme was ₹ 313.14 lakhs spread over seven years. The year-wise investment includes establishment expenditure also. All departments have funded the scheme as a part of their developmental activities in the state.

Table 3.Year-wise investment made in the AMVS

Year	Investment (₹ in lakhs)
2004-05	36.84
2005-06	36.84
2006-07	36.84
2007-08	36.84
2008-09	55.26
2009-10	55.26
2010-11	55.26
Total	313.14

Economic viability

Economic evaluation of any scheme is essential to justify use of scarce financial resources and helping the policy makers for future strategy and investments decision. The incremental costs and returns from the scheme were estimated and are presented in Table 4. The incremental costs consist of initial investment and the additional costs of fish farming on the farms of adopted villages over those incurred in the non-adopted villages. The incremental annual cost was estimated to be ₹ 17,929.64 ha^{-1} $year^{-1}$and ₹ 212.68 lakhs for 1,186.18 ha, the total area of the scheme, for the year 2011-12. Incremental benefits consisted of additional gross income from farm area of adopted villages in comparison to farm area of non-adopted villages. The incremental gross return worked out to ₹ 31,155.31 $ha^{-1}year^{-1}$ and ₹ 369.56 lakhs for the total area under the scheme.

The economic viability criteria *i.e.*, net present value (NPV), internal rate of return (IRR) and benefit-cost (B-C) ratio were worked out at 15% discount rate. The sensitivity of performances of AMVS and their impact on economic feasibility are summarised in Table 5. Perusal of the table indicates that at 15% discount rate, the scheme registered a positive NPV of ₹ 312.43 lakhs, B-C ratio of 1.35 and IRR of 53% for the scheme as a whole. This indicate higher rate of return on capital invested compared to the opportunity cost of capital (rate at which banks are generally extending long-term agricultural loan) and thereby confirming the economic viability of the AMVS. At higher discount rates of 18, 20, 23 and 25%, scheme remained viable with positive NPV of ₹ 236.69 lakhs, ₹ 197.20 lakhs, ₹ 150.29 lakhs and ₹125.43 lakhs and B-C ratio of 1.33, 1.31, 1.28 and 1.26 respectively.

A decrease of 10% in benefits and 10%increase in costs was considered independently as well as simultaneously. The resultant NPV was positive, B-C ratio was more than unity at all the discount rates, indicating the worthiness of investments made in the AMVS even under the most adverse fluctuation in benefits and costs occurring simultaneously.

Further, a decrease of 20% in benefits and increase in costs by 10% was also considered for sensitivity analysis of the scheme. The resultant NPV remained positive and B-C ratio greater than unity at 15% discount rate which indicates the economic viability of the scheme. However, NPV became negative and B-C ratio less than unity at higher discount rates (18, 20, 23 and 25%) which indicates that scheme will not remain economically viable under this scenario, if discount rates go higher.

The field level results reported in this paper do confirm that the economic viability of the scheme holds good even if the benefits decreased by 20% and costs increased by 10%. The resultant NPV was positive and B-C ratio greater than unity at 15% discount rate. The IRR was also high indicating that the scheme continued to be productive in terms of benefits despite scaled up simulated cost constraint. Therefore, the study suggests that the scheme may be replicated in similar area for the development of fisheries. This could help in increasing the income and employment opportunity for rural poor and lead to higher standard of living.

Table 4. Generalised incremental cost and incremental return (₹ in lakhs)

Year	Initial investment	Incremental annual cost	Incremental gross return	Incremental total cost	Area coverage (ha)	Cumulative area covered (ha)
2004-05	36.84	0	0	36.84	0.00	0.00
2005-06	36.84	24.66	42.85	61.50	137.53	137.53
2006-07	36.84	42.70	74.19	79.54	100.60	238.13
2007-08	36.84	83.61	145.28	120.45	228.18	466.31
2008-09	55.26	127.46	221.48	182.72	244.58	710.89
2009-10	55.26	167.87	291.70	223.13	225.37	936.26
2010-11	55.26	206.45	358.74	261.71	215.20	1151.46
2011-12	0.00	212.68	369.56	212.68	34.72	1186.18
2012-13	0.00	212.68	369.57	212.68	0.00	1186.18
2013-14	0.00	212.68	369.56	212.68	0.00	1186.18
2014-15	0.00	212.68	369.56	212.68	0.00	1186.18
2015-16	0.00	212.68	369.56	212.68	0.00	1186.18
2016-17	0.00	206.45	358.74	206.45	0.00	1151.46
2017-18	0.00	167.87	291.70	167.87	0.00	936.26
2018-19	0.00	127.46	221.48	127.46	0.00	710.89
2019-20	0.00	83.61	145.28	83.61	0.00	466.31
2020-21	0.00	42.70	74.19	42.70	0.00	238.13
2021-22	0.00	24.66	42.85	24.66	0.00	137.53

Table 5. Economic viability of the scheme and sensitivity analysis

Discount rate (%)	Costs (C)	Benefits (B)	NPV (₹ lakh)	B-C ratio	IRR (%)
15	Original	Original	312.43	1.35	53
18	Original	Original	236.69	1.33	53
20	Original	Original	197.20	1.31	53
23	Original	Original	150.29	1.28	53
25	Original	Original	125.43	1.26	53
15	Original	10% decrease	197.06	1.23	40
18	Original	10% decrease	142.99	1.20	40
20	Original	10% decrease	115.06	1.18	40
23	Original	10% decrease	82.20	1.15	40
25	Original	10% decrease	64.98	1.13	40
15	10% increase	Original	246.04	1.27	46
18	10% increase	Original	182.77	1.24	46
20	10% increase	Original	149.93	1.22	46
23	10% increase	Original	111.10	1.19	46
25	10% increase	Original	90.64	1.17	46
15	10% increase	10% decrease	130.67	1.14	32
18	10% increase	10% decrease	89.07	1.11	32
20	10% increase	10% decrease	67.79	1.10	32
23	10% increase	10% decrease	43.01	1.07	32
25	10% increase	10% decrease	30.09	1.05	32
15	10% increase	20% decrease	15.30	1.01	17
18	10% increase	20% decrease	-4.63	0.99	17
20	10% increase	20% decrease	-14.36	0.97	17
23	10% increase	20% decrease	-25.07	0.95	17
25	10% increase	20% decrease	-30.26	0.94	17

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