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An Economic and Impact Analysis of Water User Cooperative Societies on Sustainable Rice Production in Tungabhadra Command Area of Karnataka

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Abstract

The present study was conducted to evaluate the comparative economic and externality cost associated with paddy cultivation in active water user cooperative societies (A-WUCS) and passive WUCS (P-WUCS) in Tungabhadra (TB) command area of Bellary district. The findings of the study indicated that returns per rupee of expenditure realized was 1.27 more in A-WUCS as compared to P-WUCS (1.22) in head reach region. Net economic and externality gain was of ` 3177 in A-WUCS as compared to P-WUCS in head reach region. On the other hand, it was ` 5472 in A-WUCS as compared to P-WUCS in tail reach region. Thus, proper education and training may be imparted to motivate farmers in P-WUCS to enroll them as a member to realize net economic and externality gain as that of A-WUCS. WUCS should implement the existing bylaws effectively to facilitate equitable distribution of water among head and tail reach farmers.

Keywords: Externality, paddy, PIM, sustainability, WUCS

India is the largest producer of rice in the world, which accounts for 106.54 million tonnes, out of which 59 per cent of rice crop is cultivated under wetland (Anon, 2015). Karnataka is the major rice growing state with the production of 4.05 million tonnes covering 77 per cent of irrigated area. Rice cultivation is a dominant economic activity in rural areas.

However, physical, economic and environmental issues contrive rice production in Karnataka state particularly in Tungabhadra (TB) command area . The physical constraints include poor operation and maintenance of canal system and persistence deprivation flow of irrigation water to tail end farmers. The major economic constraints are low productivity and high cost of production and environmental issues *viz.*, emission of greenhouse gases (GHG) like methane and nitrous oxide particularly from rice farming.

In India rice is grown under aerobic condition and it accounts for 3.2 per cent of the world total CH_4 emission (Anon., 2010). Whereas, the excessive use of nitrogenous fertilizer emits 50 to 138 Gg of N_2O annually (Roy and Misra, 2003; Kyuma, 2004; Choudhury & Kennedy, 2005 and Bhatia *et. al.*, 2013). There is a linear relationship between the nitrogenous fertilizer and N_2O emission besides leaching of nitrate to non-point sources (Wassmann *et al.,* 2000; Li *et al.,* 2004). Thus, all these issues result in unsustainable rice production system.

National water policy mainly focusus on Participatory Irrigation Management (PIM). PIM primarily involves farmers in planning, operation and maintenance of the canal irrigation system and it also collects water cess and ensures equity in distribution of water among head and tail reach farmers (Anon., 2002). Further, it provides advisory services for effective utilization of inputs and scheduling of irrigation which helps in reducing subsidy burden on government as well as environmental pollutions and thus helps in achieving sustainable rice production system.

The Government of India initiated Participatory Irrigation Management through the command area development (CAD) program in several states. Accordingly, Karnataka state amended its Irrigation Act of 1965 (Anon., 2000) and PIM was brought under the ambit of Cooperative Act, which are called as water user cooperative societies (WUCS). At present there are 2662 WUCS, covering an area of about 13,63,000 ha.

Recent studies indicated that WUCS plays a major role in realizing higher net returns and equity in distribution of water among tail and head reach region in command area (Suhaschandra, 2016 and Rohit, 2007). As there are very few studies in this field, the present study was conducted to evaluate the economic and externality cost associated with paddy cultivation under Active WUCS as compared to Passive WUCS in both head and tail reach in TB command area.

METHODOLOGY

The present study was conducted at TB command area of Kuruguda taluk in Bellary district. Purposive multistage random sampling technique was employed to select the sample farmers. The CADA officials, Munirabad were consulted in selecting WUCS. Two WUCS were selected for the study representing one from A-WUCS and other from P-WUCS. For the field level study 80 sample farmers were selected comprising of 20 farmers each from A-WUCS and P-WUCS in both head and tail reach region, respectively.

The cost and returns analysis technique was used to estimate the economics of paddy cultivation. The externality cost associated with paddy cultivation and the method of estimation is depicted in the Table I. Externality cost consists of government cost (fertilizer subsidy and irrigation subsidy) and environmental cost (environmental damage cost and greenhouse gas emission cost). Partial budgeting technique was employed to estimate comparative economic and externality cost of paddy cultivation in head and tail reach regions of two WUCS.

TABLE I

Method of estimation of externality cost of paddy cultivation in WUCS of TB command area

Particulars	Quantity and units	Calculations	Sources
Government cost			
Fertilizer subsidy [Nitrogenous fertilizer (NF)]	120 kg	Economic cost of NF (20.87) – Retail price of NF (11.65) (120 *20.87 - 120*11.65) = 1125	Anon, 2018
Irrigation subsidy	44 acre inch of water	Economic cost of canal water (ECCW) – Water cess prevailed in study area(44*15.83[1] - 150) = 546	Nagaraj *et al.,* 2002
Environmental cost			
Environmental Damage Cost (EDC)	120 N kg.	N Kg per acre * EDC of 1 Kg of N 120 * 7.28[2] = 873.6	Blottnitz *et al.,* 2006
GHG emission cost	7.40 kg. CH_4	CH_4 emission * CO_2 equivalents[4] * GHG cost of 1 kg CO_2[5] 7.40*25*0.4819[3] =89	Methane inventory formula[3] (Bhatia *et al.,*2013) Pardis, 2014; Anon, 2007

Note: 1. Economic Cost of Canal Water (ECCW) 2016 of Rs. 15.83 per acre-inch of water = 12 (ECCW of Nagaraj *et. al.,* 2002)* compounding @ 2 per cent of SDR (Social Discount Rate)

2. EDC per kg of N per acre of 2016 Rs.7.28 = A*B*C Where, A= 0.31 Euro (EDC provided by Blottnitz *et. al .,* 2006) , B= Average exchange rate of 2016 (1Euro = 53.91) and C = Ratio of WPI of 2016 to 2006.

3. Methane inventory formula: CH_4 emission of rice per year = ($EF_{i,j}$ * $A_{i,j}$), where, $EF_{i,j}$ = Seasonal integrated emission factor for i, j condition kg CH_4 per acre

$A_{i,j}$ = Annual harvested area of rice for i and j conditions acre per year

i ,j represents water regimes under paddy cultivation and methane emission respectively.

4. 1 kg of CH_4 = 25 kg of CO_2 (Anon, 2007).

5. GHG emission cost per kg CO_2 of 2016 Rs. 0.4819 = 0.4632 (Pardis, 2014) * compounding @ 2 per cent of SDR.

Results and Discussion

Comparative economics of two WUCS in head and tail reach regions

The comparative economics of paddy cultivation in both WUCS is depicted in Table II. It was observed that returns per rupee of expenditure realized were highest in A-WUCS of both head (1.27) and tail (1.22) reach region as compared to P-WUCS. This was mainly due to higher yield per acre in head region and lower cost of cultivation in tail reach region of A-WUCS. Further, it is also observed that in A-WUCS sufficient water availability during critical stages of crop growth, access to advisory information with regard to irrigation scheduling, inputs usage and timely availability of quality inputs were responsible for realization of higher net returns as compared to P-WUCS.

Economic and externality cost of paddy cultivation in Active and Passive WUCS in head reach region

Economic and externality cost of paddy cultivation in A-WUCS and P- WUCS in head reach region are presented in the Table III. The findings clearly indicated that, the farmer can save upto ` 682 which is mainly due to advisory information for effective utilization of inputs and timely availability of quality inputs. The cultivation of paddy in A-WUCS has reduced subsidy burden on government by ` 206 (56+150), which is mainly due to judicious usage of nitrogenous fertilizer and recovery of water cess. The reduced environmental cost (` 77) is mainly due to lesser environmental damage cost ( ` 43) and lower greenhouse emission cost (` 34). This reduction is mainly attributed to farmers practising three times aeration of rice fields (30th, 50th and 85th day of transplanting) in A-WUCS as compared to single aeration (30th day of transplanting) practices under P-WUCS. Thus, methane emission is relatively less in A-WUCS. Similar observations made by the Bhatia

Table II

Comparative economics of paddy cultivation in active and passive WUCS in head and tail reach in study area

Particulars	Active WUCS		Passive WUCS	
	Head	Tail	Head	Tail
Paid out cost of farmer (Rs./acre)	25627	24555	26309	24686
Cost of cultivation (Rs/acre)	44415	38311	47660	40583
Yield (q)	30.25	26.50	30	24
Market price (Rs.)	1825	1725	1850	1750
Gross income (Rs./acre)	56206	46712	57240	43910
Net income (Rs./acre)	11791	8400	9579	3326
Cost of production (Rs./q)	1468	1445	1567	1655
Returns per rupee of expenditure	1.27	1.22	1.20	1.08

Table III

Economic and externality cost of paddy cultivation in active and passive WUCS in head reach region in study area (Rs/acre)

Particulars	Paddy crop	Cost (in Rs)	Added cost	Reduced cost
1. Farmers cost	AHP	25627		682
	PHP	26309		
2. Government cost				
2.1 Subsidy burden on nitrogenous fertilizer	AHP	1124		56
	PHP	1180		
2.2 Subsidy burden on irrigation	AHP	546		150
	PHP	696		
3. Environmental cost (EC)				
3.1 EDC due to nitrogenous fertilizer	AHP	874		43
	PHP	917		
3.2 EC due to GHG emission	AHP	89		34
	PHP	123		
4. Net returns			Reduced returns	Added returns
	AHP	11791		2212
	PHP	9579		
Total (1+2+3+4)				3177
5. Net economic and externality gain				**3177**

Note: 1. AHP: Active Head Reach Paddy,
2. PHP : Passive Head Reach Paddy.
3. Externality cost: Government and Environmental cost

et al. (2013) indicated that flooded rice ecosystem (1.14 Tg) have higher methane emission compared to rain-fed flood-prone (0.70 Tg). Thus, externality cost was reduced upto `283 (206+77) in A-WUCS as compared to P-WUCS in head reach region. Net economic and externality gain of `3177 is realised under A-WUCS as compared to P-WUCS in head reach region.

Economic and externality cost of paddy cultivation in Active and Passive WUCS in tail reach region

The details of economic and externality cost of paddy cultivation under A-WUCS and P-WUCS in tail reach region are depicted in Table IV. The findings indicated that farmer can save upto `131 which is mainly due to optimum application of inputs (fertilizer and plant protection chemicals). The cultivation of paddy in A-WUCS has reduced the subsidy burden on government by `175 (113+62), which is mainly due to judicious usage of nitrogenous fertilizer and recovery of water cess.

TABLE IV

Economic and externality cost of paddy cultivation in active and passive WUCS in tail reach region in study area

(Rs./acre)

Particulars	Paddy crop	Cost (in Rs)	Added cost	Reduced cost
1. Farmer cost	ATP	24555		131
	PTP	24686		
2. Government cost				
2.1 Subsidy burden	ATP	965		113
on fertilizer	PTP	1078		
2.2 Subsidy burden	ATP	492		
on irrigation	PTP	554		62
3 Environmental cost				
3.1 EDC due to	ATP	750		
nitrogenous fertilizer	PTP	837		87
3.2 GHG Emission cost	ATP	79		
	PTP	84		5
4. Net returns			Reduced returns	Added returns
	ATP	8400		5074
	PTP	3326		
Total (1+2+3+4)				5472
Net economic and externality gain				**5472**

Note: 1. ATP: Active Tail Reach Paddy,
2. PTP: Passive Tail Reach Paddy.
2. Externality cost: Government and Environmental cost

The externality cost was reduced to `267 (175+92) in A-WUCS as compared to P-WUCS in tail reach region. It may be due to reduction in greenhouse gas ($CH_4$) emission cost followed by four to five times aeration and lower application of nitrogenous fertilizer in A-WUCS as compared to P-WUCS. Net economic and externality gain of `5472 is realized under A-WUCS as compared to P-WUCS in tail reach region.

The study indicated that returns per rupee of expenditure realized was highest in A-WUCS (1.27) as compared to P-WUCS (1.22) in head reach region. Net economic and externality gain of `3177 was realised in A-WUCS as compared to P-WUCS in head reach region whereas, it is `5472 in A-WUCS as compared to P-WUCS in tail reach region.

Therefore, proper education and training may be imparted to motivate farmers in P-WUCS to enroll them as members in order to realize net economic and externality gain as that of A-WUCS. Creating awareness among the farmers to adopt direct seeded rice and system of rice intensification under aerobic condition will reduce methane emission and also water requirement. WUCS should implement the existing by-laws effectively to facilitate equitable distribution of water among head and tail reach farmers.

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