Impact of Effective Microorganisms (EM) on Crop Yield and Income of the Farmers in India

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Abstract
The use of Effective Microorganisms is expanding in India. Thus many farmers are keen on adopting this technology. Due to the lack of information on the costs and benefits of the technology, studies were initiated to test the economic viability of EM in crop production. The studies reveal that the cost benefit ratio of organic agriculture is enhanced by EM. This was clearly shown with a diverse range of crops such as rice, wheat and potato. The potential using EM in traditional agriculture of India is presented.

Introduction
The use of effective microorganisms (EM) is expanding in India over the last three years, ever since the EM awareness programme and educational campaign was launched. Initially, three blocks viz. Mat, Simbhaoli and Malihabad in the districts of Mathura, Ghaziabad and Lucknow respectively in Uttar Pradesh State were adopted for the purpose of promoting EM awareness and use among farmers for agriculture (as an alternative to chemical fertilizers for crop production), water recycling, sewage treatment, solid waste management and cattle health. The use of EM among farmers in growing different crops for the last three years has given sufficient understanding of efficiency of EM in improving germination, plant health, and yield. Mat Block of Mathura district in Uttar Pradesh state was selected for the study to assess the impact of EM on cost returns and profit of different crops.

Methodology
For the study, a list of EM users in different villages and their size of land holding was prepared. Five villages, having maximum area under EM farms were finally selected for the study and denoted as nucleus villages. Three more villages having considerable area under EM farms and adjacent to the nucleus villages were added to each nucleus village to form a cluster of four villages. This was done to ensure sufficiently large population of EM user farms. Thus, five clusters of villages with each cluster consisting of four villages were finally formed. Corresponding to each sample cluster of villages, six EM users and six non-EM user (conventional) farms were randomly selected. The average size of operational land holding of EM and non-EM farms were found to be 3.20 and 2.65 ha respectively. Thus the study consisted of 5 cluster of villages x 2 category (i.e. EM farm and non-EM farm) x 6 farms, making a total of 60 farms with thirty EM and thirty non-EM.

Primary data were collected by survey method through personal interview of the farmers on pre-tested schedules. This study was done 1994/95.

Cost concepts: Three cost concepts, as defined below, are used in the analysis.

Cost Al : This cost approximates the actual expenditure incurred in cash and kind.

Cost A2 : Cost A1 + rent paid for leased - in land if any.

Cost B : Cost A2 + imputed rental value of owned land (less land revenue paid thereon) + imputed interest on owned fixed capital (excluding land).

Cost C : Cost B + imputed value of family labour.

Profit measures :
1. Family Labour income = Gross returns - Cost B.
2. Farm business income = Gross returns - Cost A l/A2.
3. Net income = Gross returns - Cost C.

Valuation of Inputs and Outputs : Quantities of inputs multiplied by their prices are cost of production and amount of produce multiplied by their prices are the value of production. The inputs purchased and services hired were valued as cost. The inputs and services of the farm family used on the farms were priced at the rate identical to the purchased/hired rate. Land-rent market was not widely prevalent, thus land rent was worked out for the study area as a whole based on the land-rent of few rented out cases. The rent was apportioned between the crops in accordance with the relative period of time involved in crop-raising. Interest rate on working capital was charged at 14 percent per annum for half of the period of time involved in crop-growing.

Result and discussion

The average costs, yields, gross returns and net returns of paddy, wheat, mustard, sugarcane, potato and gram for EM and non-EM farms are presented in Tables 1 to 5. The break-up of per hectare cost into different component of cost for different crops are presented in Table 1 to Table 3.

On an average, per hectare total cost of cultivation (cost C) for paddy, wheat, mustard, sugarcane, potato and gram were as follows: Rs 16292.38, Rs 15676.76, Rs 13935.55, Rs 30244.48, Rs 12791.91, Rs 28593.61, Rs 38154.01 and Rs 11473.13 respectively on EM farms. However on non-EM farms cost C were Rs 16854.79, Rs 16380.56, Rs 13935.55, Rs 30224.48, Rs 41894.05 and Rs 12206.5 respectively. The percentage declines in total cost on EM crops was observed by 3.34, 4.30, 8.21, 5.40, 8.93 and 5.19 percent respectively for paddy, wheat, mustard, sugarcane, potato and gram.

Table 1: Comparison on Production Costs (%) of EM-farms and Conventional Farms in Mathura District of Uttar Pradesh India 1994-95.

Particulars	Paddy		Wheat		Mustard	
	EM farm	Conven. Farm	EM farm	Conven. Farm	EM farm	Conven. Farm
Family labour	16.9	16.98	11.56	11.51	13.39	13.98
Hired labour	15.17	15.7	9.85	11.01	14.23	15.09
Tractor-Machinery and draft animal power cost	7.8	7.08	8.41	8.03	8.79	9.61
Seed	2.03	2.03	4.36	4.41	0.82	0.72
Manures	9.97	4.45	10.18	5.51	12.88	6.45
Fertilizers	3.52	13.25	9.77	18.03	2.71	12.97
Plant protection cost	1.43	3.11		2.75	1.19	2.34
EM	5.89		6.12		5	
Irrigation	9.53	9.79	10.11	10.14	6.1	6.39
Interest on working capital	3.88	3.88	4.12	4.19	3.62	3.75
Rental value of land	24.55	23.73	25.52	24.42	31.27	28.7
Total (%)	100	100	100	100	100	100
Total cost/ha (Rp)	16292.38	16854.79	15676.76	16380.56	12791.19	13935.55

Source: C.D.S./INFRC/EM Project survey of Farms

Note: For each crop , Thirty EM and Thirty Conventional farms studied

Per hectare cost B (total cost minus family labour cost) for paddy, wheat, mustard, sugarcane, potato and gram were Rs 13654.54, Rs 13864.72, Rs 11079.16, Rs 23784.08, Rs 35413.53 and Rs 1029.40 respectively on EM farms and Rs 13992.04, Rs 14495.14, Rs 11987.55, Rs 25449.13, Rs 39691.88 and Rs 10743.96 respectively on non-EM farms.

Per hectare cost A1 for paddy, wheat, mustard, sugarcane, potato and gram were Rs 9654.54, Rs 9864.72, Rs 7987.55, Rs 15784.80, Rs 31413.53 and Rs 6209.43 respectively on EM farms and Rs 9992.04, Rs 10495.14, Rs 7987.55, Rs 17499.13 and Rs 34691.88 respectively on non-EM farms.

Table 2: Comparison on Production Costs (%) of EM-farms and Conventional Farms in Mathura District of Uttar Pradesh India 1994-95.

Particulars	Sugarcane		Potato		Gram	
	EM farm	Conven. Farm	EM farm	Conven. Farm	EM farm	Conven. Farm
Family labour	16.82	15.8	8.18	7.64	11.78	11.98
Hired labour	8.87	10.09	10.61	10.13	9.89	11.52
Tractor-Machinery and draft animal power cost	6.83	5.73	3.59	3.25	8.89	8.07
Seed	11.71	11.51	37.55	33.27	10.48	10.36
Manures	5.45	3.45	7.72	5.16	7.8	4.82
Fertilizers	4.33	11.03	11.92	21.71	2.7	9.74
Plant protection cost	0.72	1.4	0.71	1.55	1.19	3.34
EM	3.36		2.52		5.62	
Irrigation	7.15	7.43	2.33	2.32	3.78	3.79
Interest on working capital	6.78	7.09	5.39	5.42	3.51	3.67
Rental value of land	27.98	26.47	10.48	9.55	34.56	32.78
Total (%)	100	100	100	100	100	100
Total cost/ha (Rp)	28594	30224	138154	41894	11573	12207

Source: C.D.S./INFRC/EM Project survey of Farms

Note: For each crop , Thirty EM and Thirty Conventional farms studied

Table 3 : Per Hectare Cost, Gross Returns and Net Profit Over Different Cost Concepts of Selected Crops on EM and Non-EM Farms 1994-95.

Particulars	Paddy		Wheat		Mustard	
	EM farm	Conven. Farm	EM farm	Conven. Farm	EM farm	Conven. Farm
Cost A1	9654.54	9992.04	9864.72	10495.14	7079.16	7987.55
Cost B	13654.54	13992.04	13864.72	14495.14	11079.16	11987.55
Cost C	16292.38	16854.79	15676.76	16380.56	12791.19	13935.55
Gross returns	22980.5	19577.8	21522	19078	25156.5	21904.5
Net returns over						
Cost A1	13325.96	9585.76	11657.28	8582.86	18077.34	13916.95
Cost B	9325.96	5586.76	7657.28	4582.86	12422.34	9916.95
Cost C	6688.12	2723	5845.24	2697.44	12364.69	7968.95

Particulars	Sugarcane		Potato		Gram	
	EM farm	Conven. Farm	EM farm	Conven. Farm	EM farm	Conven. Farm
Cost A1	15784.08	17449.13	31413.53	34691.88	6209.43	6743.96
Cost B	23784.08	25449.13	35413.53	39691.86	10209.43	10743.9
Cost C	28593.61	30224.48	38154.01	41894.05	11573.13	12206.5
Gross returns	82405.68	69497.58	71462.9	54153.6	18269.5	13373.1
Net returns over						
Cost A1	66621.6	52048.45	36049.37	19461.72	12087.07	6629.14
Cost B	58621.6	44048.45	32049.37	15461.72	80870.74	2629.14
Cost C	41556.66	39273.1	29308.89	12259.55	6723.37	1166.6

Source: C.D.S./INFRC/EM Project survey of Farms

Note: For each crop , Thirty EM and Thirty Conventional farms studied

Inter-component cost comparison revealed that expenditure on manures was more on EM crops as compared to fertilizer, plant protection and irrigation charges which were found to be less on EM treated crop as compared to non-EM crops. The expense on fertilizer for paddy, wheat, mustard, sugarcane, potato and gram were 3.52, 9.77, 2.71, 4.33, 11.92 and 2.70 percent of total cost respectively on EM farms and 13.25, 18.03, 12.97, 11.03, 21.71 and 9.74 percent respectively on non-EM farms. The expenditure on plant protection measures for paddy, mustard, sugarcane, potato and gram were 1.43, l.19, 0.72, 0.71 and 1.19 percent of total cost respectively on EM farms and 3.11, 2.34, 1.40, 1.55 and 3.34 percent on conventional farms. However on the EM wheat farm there was no use of plant protection measures for the control of phalaris minor weed. Thus, this study revealed that EM application reduces the human labour cost, fertilizer, plant protection measures and irrigation cost on farms.

Yield of selected crops on EM and non-EM farms are displayed in Table 4. Yield of paddy,

wheat, mustard, sugarcane, potato and gram were 63.95, 48.45, 23.38, 1201.98, 420.37 and 21.55 quintails respectively on EM farms, where as on non-EM farms the were 53.92, 41.55, 20.24, 1004.13, 338.46 and 15.57 quintails respectively. This study showed that percent increase in yield of main product on EM farms were 18.60, 16.60, 15.51, 19.70, 24.20 and 38.40 % respectively. However, decline in by product of EM crops were 0.60, 0.97, 6.90, 4.65 and 8.89 respectively in paddy, wheat, mustard, sugarcane and gram. Thus, study revealed that yield was more on EM farms as compared to non-EM farms.

Table 4: Per Hectare Cost Gross Returns and Net Profit and Cost-benefit Ratio of Selected Crops on EM and Non-EM Farms 1994-95

Crops	Gross Returns (In Rs.)		% Increase	Total Cost (In Rs.)		% Decrease	Net Profit (In Rs.)		% Increase	Cost Benefit Ratio	
	EM Farm	Non EM Farm		EM Farm	Non EM Farm		EM Farm	Non EM Farm		EM Farm	Non EM Farm
Paddy	29980	19578	17.4	16292	16855	3.34	6688	2723	146	1.41	1.16
Wheat	21522	19078	12.8	15677	16381	4.30	5845	2697	117	1.37	1.16
Mustard	25157	21904	14.9	12791	13936	8.21	1235	7969	55	1.97	1.57
Sugarcane	82406	69498	18.6	28594	30224	5.40	53812	39273	37	2.88	2.30
Potato	71463	54154	32.0	38154	41894	8.93	29309	12259	139	1.87	1.29
Gram	18297	13374	36.9	11573	12207	5.19	6723	1167	476	1.58	1.10

Source: C.D.S./INFRC/EM Project survey of Farms

Note: For each crop, Thirty EM and Thirty Conventional farms studied

Gross returns of different crops are shown in Table 5. Gross returns of paddy, wheat, mustard, sugarcane, potato and gram came to Rs 22980.50, Rs 21522.CO, Rs 25156.50, Rs 82405.68, Rs 71462.90, and Rs 18296.50 respectively on EM farms and Rs 19577.80, Rs 19078.00, Rs 21904.50, Rs 69497.58, Rs 54153.60 and Rs 13373.60 respectively on non-EM farms. The percentage increase in gross returns on EM farms compared to non-EM for paddy, wheat, mustard, sugarcane, potato and gram were 17.38, 12:81, 14.85, 18.57, 31.96 and 86.82 percent respectively.

Table 5: Yield (per ha) of Selected Crops on EM and Conventional Farms 1994-95

Crops	Main product yield in Qtls		Percent increase	By product yield in Qtls		Percent decrease on by products on EM farm
	EM farm	Conventional farm		EM farm	Conventional farm	
Paddy	63.95	53.92	18.6	82.5	83	0.6
Wheat	48.45	41.55	16.6	51	51.5	0.97
Mustard	23.38	20.24	15.51	20.52	21.75	6.9
Sugarcane	1201.98	1004.13	19.7	205	215	4.65
Potato	420.37	338.46	24.2	-	-	-
Gram	21.55	15.57	38.4	10.25	11.25	8.89

Source: C.D.S./INFRC/EM Project survey of Farms

Note: For each crop , Thirty EM and Thirty Conventional farms studied

Net returns (gross returns - total cost i.e. cost C) of paddy, wheat, mustard, sugarcane, potato and gram were Rs 6688.12, Rs 5845.24, Rs 12364.69, Rs 53812.07, Rs 29308.89 and Rs 6723.37 respectively on EM farms and Rs 2732.00, Rs 2697.44, Rs 7968.95, Rs 39273.10, Rs 12259.55 and Rs 1166.00 respectively on non-EM farms. Percent increase in net profit on EM farms as compared to non-EM farms came to 145.61, 116.70, 55.16, 37.02, 139.07 and 476.32 percent respectively.

A study of inter crop comparison revealed that on EM farms percent increase in yield was maximum in gram followed by potato, sugarcane, paddy, wheat and mustard. However, percent increase in gross returns on EM farm was more on gram followed by potato, sugarcane, paddy, mustard and wheat. Thus, the study revealed that EM application was most profitable in gram followed by potato, sugarcane and paddy crops.

Cost-benefit analysis: Cost benefit analysis for paddy, wheat, mustard, sugarcane, potato and gram crops are given in Table 4. The cost benefit ratio (value of output divided by value of input) for paddy, wheat, mustard, sugarcane, potato and gram came to 1.37, 1.34, 1.97, 2.90, 1.87 and 1.58 respectively on EM farms and l.13, 1.14, 1.57, 2.32, 1.29 and 1.10 respectively on non-EM farms. The cost benefit ratio had direct relationship with the EM farms. The cost benefit ratio on EM farms were distinctly favourable when compared to non-EM crops. This convincingly established the efficacy of EM in reduction of cost inputs of farms and producing lucrative yields, thus maximizing economic benefits to the farmers.

Conclusion

From the analysis, following results were observed:

1. The yield of paddy, wheat, mustard, sugarcane, potato and gram increased on EM farms as compared to non-EM farms by 18.60, 16.60, 13.35, 19.70, 24.20 and 38.40 percent respectively.
2. Gross returns on gram was maximum followed by potato, sugarcane, paddy, mustard and

wheat that was 36.82, 31.96, 18.57, 17.38, 14.85 and 12.81 percent respectively on EM farms as compared to non-EM farms.

3. The risk of paddy, wheat, mustard, sugarcane, potato and gram decreased up to 3.34, 4.30, 8.21, 5.40, 8.93 and 5.19 percent respectively on EM farms as compared to non-EM farms.
4. The cost benefit ratio (value of output divided by value of input) for paddy, wheat, mustard, sugarcane, potato and gram were 1.37, 1.34, 1.97, 2.90, 1.87 and 1.58 respectively on EM farms and 1.13, 1.14, 1.57, 2.32, 12.9 and 1.10 respectively on non-EM farms. The cost benefit ratio on EM crops showed a distinct beneficial aspect when compared to non-EM crops.