Ind. Jn. of Agri.Econ.
Vol.63, No.3, July-Sept. 2008

SUBJECT II
ENVIRONMENTAL DEGRADATION AND ITS CORRECTIVES IN AGRICULTURE SECTOR

Organic Sugarcane Farming for Enhancing Farmers' Income and Reducing the Degradation of Land and Water Resources in Maharashtra

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I

INTRODUCTION

Maharashtra is the second largest sugarcane growing state in the country. It contributed 0.58 million hectares (13.53 per cent) to total area and 45.78 million tonnes (15.06 per cent) to total production of sugarcane in the country in TE 2002-03. Sugarcane, the second most important cash crop of the state covers less than three per cent of the total cropped area but utilises more than 60 per cent of the total water available for irrigation in the state. This has already exerted considerable strain on the limited water resources of the state. The demand of water for sugarcane irrigation has led to an increase in the number of wells and had resulted into decrease of water table by more than four meters over the past decade in several districts, including the study districts, Jalgaon and Kolhapur (World Bank, 2003). Moreover, the excess use of water combined with higher doses of chemical fertilisers has resulted in enhanced degradation of land and water resources (Pachauri and Sridharan, 1998). This is reflected in the secular decline of sugarcane productivity in recent decades in Maharashtra (Samui *et al.*, 2005).

Organic farming sustains and ameliorates the health of agro-ecosystem encompassing nutrient bio-cycles and soil microbial and bio-chemical activities. It forbids the use of chemo-synthetic fertilisers and pesticides and fosters socially and environmentally beneficial practices such as intercropping, green manuring, and use of organic manures, vermi-compost, bio-fertilisers and bio-pesticides. Recognising the importance of organic farming, the Government of Maharashtra is promoting organic farming in the state since 2003-04 (Government of Maharashtra, 2007). This has helped in increasing the awareness about organic farming, reducing the use of chemicals, and enhancing the area under organic farming in the state.

The findings of several studies have shown that excessive use of chemicals in agriculture results in adverse effects on human health, animals, biodiversity and

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contribute to degradation of land, water and environmental resources (Ghosh, 2004; Maiti, 1999; Pachauri and Sridharan, 1998; Singh *et al.*, 1987). Although the results of these studies are valuable to understand the harmful effects of chemical farming, a keen perusal of these studies indicates that there is dearth of studies which probe into the impact of organic farming on economics and conservation of land and water resources in sugarcane cultivation in Maharashtra. Therefore, the present study is designed to assess the input use, costs, yields, returns and conservation of land and water resources on organic sugarcane (OS) vis-à-vis inorganic sugarcane (IS) farms in the state. The paper also explores the emerging issues and outlines the task ahead for advancing organic farming in Maharashtra.

II

DATA AND METHODOLOGY

Organic sugarcane is an important crop grown in the state. The two most important OS growing districts of Maharashtra, Jalgaon and Kolhapur, were selected for this study. The Jalgaon district is the only district in the state that has the largest number of "certified" OS growing farmers. The Kolhapur district has the highest area under sugarcane among all the districts of Maharashtra. It has sizeable area under OS crop also. The OS is being cultivated by few farmers in selected villages. Therefore, purposive sampling technique was applied for the selection of OS farmers. In Jalgaon district the sample included 72 farmers, 38 OS growing farmers and 34 IS growing farmers, while from Kolhapur district 70 farmers, 34 OS growing farmers and 36 IS growing farmers were selected. Thus, in all 142 sugarcane-growing sample farmers consisting of 72 OS and 70 IS farmers were selected for the study.

The study is based on primary data collected through personal interviews from the OS and IS farmers with the help of a specially designed questionnaire. It covered information on household resource base, cropping pattern, input use pattern, cost of cultivation, productivity, and farmers perceptions on OS and IS cultivation. The data pertains to the agricultural year 2004-05.

III

CHARACTERISTICS OF OS AND IS FARMERS

The heads of OS households are younger and better educated than their counterparts from IS households. The average size of land holding of OS farmers was found to be 4.48 ha compared to 3.72 ha for IS farmers (Table 1). Most of the sample farmers used well irrigation for their sugarcane crop. The OS farmers owned more number of livestock than IS farmers. The better livestock position of OS farmers may be attributed to their higher demand for manures and other livestock products for cultivation of organic crops. Sugarcane and cotton, the most important cash crops of the state also prevailed over the cropping pattern on sample farms. Importantly, OS crop occupied the largest coverage at 20.32 per cent of gross cropped area (GCA) on

sample farms in the study district. The per cent area under high value fruit and vegetable crops and low water intensive chickpea crop was substantially higher on OS farms.

TABLE 1. CHARACTERISTICS OF SAMPLE FARMERS

Characteristics (1)	Organic Sugarcane growing farmers (2)	Inorganic Sugarcane growing farmers (3)
Age of family head (years)	43.12	46.00
Education of family head (Edu. years)	10.59	9.49
Average size of land holding (ha)	4.48	3.72
Average net irrigated area (ha)	3.61	3.13
Per cent of well irrigated area	86.32	83.43
Livestock (No./household)	8.94	6.78
Major crops grown (per cent to GCA)		
• Organic sugarcane	20.32	0.00
• Inorganic sugarcane	0.00	20.99
• Cotton	14.55	23.09
• Fruit and vegetable crops	14.44	7.81
• Chickpea	7.82	2.37

Source: Field survey.

IV

ECONOMICS OF OS AND IS CULTIVATION

The sugarcane cultivation, especially the OS cultivation, needs large number of human labour days. On an average, the per ha human labour use was found to be 251.08 days on OS farms and 214.79 days on IS farms, showing 16.90 per cent higher use on OS farms (Table 2). This is mainly attributed to increased labour use for operations such as preparatory tillage, manuring, green manuring and managing the weeds, pests and diseases on OS farms. Furthermore, the intercropping typically found on OS farms, with crops having various planting and harvesting schedules, may distribute the labour demand more evenly which could help stabilise the employment (Mathur, 1963). This implies that OS farming provides an opportunity to rural masses of sustained farm employment throughout the year.

TABLE 2. INPUT USE PATTERN ON OS AND IS FARMS

(*units per ha*)

Input (1)	Organic Sugarcane (2)	Inorganic Sugarcane (3)	Per cent over Inorganic (4)
Human Labour (days)	251.08	214.79	16.90
Seed (tonnes)	2.94	3.31	-11.44
Organic manures (tonnes)	11.76	6.68	75.99
Bio-fertilisers (kg)	201.46	-	-
Chemical fertilisers (kg)			
● Nitrogen (N)	-	355.86	-
● Phosphate (P)	-	127.54	-
● Potash (K)	-	80.87	-
Insecticide/ Pesticide (kg)	2.08	2.56	-18.65
Irrigation (Number)	21.31	25.81	-17.45

Source: Field survey.

The use of sugarcane seed was 11.44 per cent less on OS farms mainly due to use of 2-bud setts and use of strip method of planting. The use of organic manures is quite high on OS farms. This is obvious considering the dependence of OS farmers on organic manures for augmenting and sustaining the soil resources. The IS farmers used 355.86 kg N, 127.54 kg P, and 80.87 kg K per ha for sugarcane crop. This is quite high when compared with the levels of 110.10 kg N, 44.70 kg P and 30.10 kg K per ha for irrigated sugarcane crop in the country (Government of India, 2000). The higher use of inorganic fertilisers is showing deficiencies of several micronutrients resulting in degradation of land resources, reduced productivity and pollution of natural resources (Ghosh, 2004; Pachauri and Sridharan, 1998; Singh and Swarup, 2000). In terms of the use of bio-pesticides for OS crop and chemical pesticides for IS crop, IS farmers used 18.65 per cent more quantity compared to OS farmers. This is mainly because, along with bio-pesticides, OS farmers also used other practices for management of pests and diseases.

The cost of cultivation refers to cost A_2 plus family labour which includes all actual expenses in cash and kind incurred in production by the owner plus rent paid for leased-in land plus imputed value of family labour as has been defined by the Commission for Agricultural Costs and Prices, Government of India (2005). The results presented in Table 3 indicate that average cost of cultivation of OS crop was Rs. 37,017.38 per ha as against Rs. 43,163.81 per ha for IS crop, reflecting 14.24 per cent lower cost on OS farms. The lower cost of cultivation on OS farms is because of non-use of chemical fertilisers and less cost incurred on irrigation, seed and plant protection. The increased cost of cultivation due to increased input prices has also increased the requirement of credit for agriculture. However, several studies have concluded that the inability to payback the credit is one of the important reasons for creating distress among farmers (Mishra, 2006; TISS, 2005). The foregoing results indicate that OS farming reduces the cost of cultivation of a crop implying reduced requirement of credit for crop production.

TABLE 3. COSTS, YIELD, VALUE OF PRODUCTION AND PROFITS

Particulars (1)	Organic sugarcane (2)	Inorganic sugarcane (3)	Per cent over inorganic (4)
Total Cost of Cultivation (Rs./ha)[a]	37,017.38	43,163.81	-14.24
Sugarcane Yield (tonnes/ha)	96.63	103.56	-6.79
CV of Sugarcane Yield (per cent)	28.11	40.72	-12.61
Cost of Production (Rs./tonne)	383.50	416.96	-8.02
Gross Value of Production (Rs./ha)	1,16,711.38	1,12,087.84	4.12
Gross Profit (Rs./ha)	79,694.00	68,924.04	15.63
CV of Gross Profit (per cent)	39.76	45.68	-5.92
GVP/GCC	3.15	2.60	21.41

a: This does not include the cost of harvesting, transport and marketing.

Some studies have noted that the change from conventional intensive farming to organic farming reduces yield, at least during the initial years (IFAD, 2005; Rajendran *et al*., 2000). This study also found that the average yield of OS crop was 6.79 per cent lower than IS crop. However, the OS farmers were confident and it has also been reported by some scholars that in subsequent years organic farming is able to reduce this yield gap (Rajendran *et al*., 2000) and sometimes had also given higher yields than conventional methods (Thakur and Sharma, 2005). A stable yield is an important feature of sustainability. The yield stability measured by coefficient of variation (CV) indicates that the CV of yields was substantially lower at 28.11 per cent in OS crop as against the 40.72 per cent in IS crop suggesting that yields were more stable under OS farming than the IS farming (Table 3). Thus, lower yields on OS farms were more than compensated by the price premium fetched by organic sugarcane and the sugarcane yield stability observed on OS farms.

The increase in price of inputs in conventional agriculture had inflated the cost of cultivation and had reduced the profitability (Sen and Bhatia, 2004). Therefore, the issue of profitability is intimately related to the economic well-being and livelihood security of the farmers. In this context, the examination of Table 3 shows that the gross value of production (GVP) and profits were higher on OS farms than the IS farms. The GVP from OS farm amounted to Rs. 116711.38 per ha as against Rs. 112087.84 per ha from IS farm. This has resulted in higher profits by 15.63 per cent from OS crop thereby enhancing farmers' income. This is mainly due to lower cost of cultivation on OS farms and relatively higher price fetched by organic sugarcane. Moreover, the CV of gross profits was also lower on OS farms denoting greater stability of profits on OS farms than IS farms. Thus, OS farming not only enhances the farmers' income but also provides greater stability to farm income. Higher output-input (GVP/GCC) ratio is another feature of OS farming which is the reflection of higher input use efficiency observed on OS farms. These features of OS farming are critical for ensuring the economic well-being and livelihood security of the farmers.

V

CONSERVATION OF LAND RESOURCES

The indiscriminate use of inorganic fertilisers and pesticides are burning the vital soil micro-organisms, spoiling its structure and increasing the micro-nutrients deficiencies leading to degradation of land resources and reducing crop yield and income of the farmers. Thus, degradation of land poses a serious threat for the sustainability of agriculture. However, the evidence from the preceding section indicates that OS farmers successfully substituted chemical fertilisers and pesticides with soil conservation enhancing the socially and environmentally sensitive practices such as intercropping, organic manures, green manuring, bio-fertilisers, vermi-compost, and bio-pesticides.

As seen from Table 4, 52.05 per cent OS farmers practiced intercropping in sugarcane as compared to 34.78 per cent of the IS farmers. The major advantages of intercropping are in making the optimum use of soil and environmental resources (Willey *et al.*, 1981). For instance, the intercropping of deep and shallow rooted crops makes the optimum use of soil resources as they do not compete for nutrients from the same soil stratum. The legume and non-legume crops are intercropped to fulfill the fertility and rotational requirements of the soil. The legume crop in intercropping fixes the atmospheric nitrogen, increases organic matter content of the soil, and improves the structure of the soil (Kumar and Tripathi, 1990). This in turn enhances the internal aeration and drainage, increases the soil microbial activities, improves the storage of soil moisture and nutrients, thus favouring plant root growth and limiting soil erosion and degradation (Sarkar *et. al.*, 2003).

TABLE 4. IMPORTANT CULTIVATION PRACTICES FOLLOWED BY OS FARMERS

(per cent of farmers)

Farming practices (1)	Organic sugarcane (2)	Inorganic sugarcane (3)
Intercropping	52.05	34.78
Organic manures	100.00	100.00
Animal penning	28.77	14.49
Green manuring	39.73	2.90
Bio-fertilisers	72.60	0.00
Vermi-compost	26.03	0.00

Source: Field survey.

Although all farmers used organic manures, OS farmers used almost 76 per cent higher manure for their sugarcane crop as compared to IS farmers (Table 2). It is well recognised that the use of organic manures improves soil tilth and aeration, increases the moisture holding capacity of the soil and stimulates the activities of soil micro-organisms. Similar to organic manures, the benefits of animal penning are also incontrovertible. Green manuring helps in enhancing the organic matter in the soil, protecting the soil against seasonal erosion and leaching (Maiti, 1999).

The bio-fertilisers and vermi-composts are found to be exclusively used by OS farmers. These inputs are important in enhancing the overall health of crop-soil-microbial ecosystem and promoting soil organic matter enzymes leading to safeguarding and improving the nutrient content of the soil. They also help in maintaining the fertility of soil over a longer period which is a key to enhancing the productivity and sustainability of soil resources (Maiti, 1999). Thus, organic farming practices followed by OS farmers are found to be the best practices for not only arresting the unabashed land degradation but also for the sustainable sugarcane cultivation in the state.

VI

CONSERVATION OF WATER RESOURCES

Water is a key to development of agriculture. About 80 per cent of the water is utilised for agriculture in Maharashtra (World Bank, 2003) and more than 60 per cent of it is utilised for sugarcane crop alone. The farmers are virtually mining water from deep aquifers for sugarcane crop (World Bank, 2003). The issue of equity is also not less important as the resource rich farmers are found to be exploiting this resource rampantly. The higher use of chemical fertilisers is also polluting the groundwater resources (Singh *et al*., 1987). It is a cause of great concern and demands its conservation and judicious use as it has endangered the stability and sustainability of water resources.

To study the conservation and saving of water resources under OS and IS farming, one may need actual measured data on the use of water on both OS and IS farms. However, we concede that we do not have such an irrigation water measured data. In the absence of actual measured data, the saving and conservation of water resources can be best indicated by other measures of water use efficiency (WUE). The field survey data is used to work out the various WUE indicators presented in Table 5.

TABLE 5. WATER USE EFFICIENCY ON OS AND IS FARMS

Indicator of water use efficiency (1)	Organic sugarcane (2)	Inorganic sugarcane (3)	Per cent over Inorganic (4)
Irrigation cost (Rs./ha)	6030.43	7397.93	-18.48
Irrigation cost (Rs./tonne)	62.41	71.44	-12.64
Number of irrigations applied	21.31	25.81	-17.45
Productivity per irrigation (tonnes/ha)	4.54	4.01	13.22
GVP per irrigation (Rs./ha)	5476.84	4342.81	26.11
Profit per irrigation (Rs./ha)	3739.75	2670.44	40.04

Source: Field survey.

The irrigation cost is considerably lower on OS farms. On an average, OS farmers spent Rs. 1,367.50 per ha less on irrigation as compared to IS farmers. Another aspect to be noted from Table 5 is the lower irrigation cost per unit of cane production on OS farms. The irrigation cost per tonne of cane production on OS farms was 12.64 per cent less than IS farms. This indicates higher sugarcane productivity per unit of irrigation expenditure on OS farms in comparison with IS farms. It follows from this analysis that the irrigation costs incurred on per unit of area as well as per unit of cane production were lower on OS farms implying less use of water, saving of water by OS farmers in the cultivation of sugarcane crop.

Another result that comes out clearly from Table 5 is the number of irrigations given to OS crop were quite lower. The OS crop was given 21.31 irrigations while

the IS crop was given 25.81 irrigations. This indicates that OS needs 17.45 per cent lower number of irrigations than the IS crop. Moreover, the water use efficiency expressed as the productivity of sugarcane per irrigation was found to be 13.22 per cent higher on OS farms. Furthermore, the GVP per irrigation was 26.11 per cent higher on OS farm. Yet another measure, the profit per irrigation was also substantially higher at 40.04 per cent on OS farm than the IS farm.

The foregoing results revealed that the various water use efficiency indicators performed better under OS farming as compared to IS farming. This suggests that OS farming is very effective and superior in the conservation of water resources as compared to conventional farming. This is mainly attributed to the fact that incorporation of organic matter to soil improves its structure and enhances its micro-porosity leading to improved infiltration of rain water and increased soil moisture retention capacity (Kumar and Tripathi, 1990; Sarkar *et al*., 2003). Thus, OS farming has substantial potential in enhancing the sugarcane productivity and profit per unit of water use and saving the scarce water thereby providing an opportunity for its conservation and sustainable use. No doubt, this is crucial for a relatively water scarce state like Maharashtra.

VII

EMERGING ISSUES AND FUTURE OPPORTUNITIES

Some of the key issues reported by the sample farmers are discussed below for policy interventions and future research.

(1) The farmers reported that the period involved in conversion from conventional farming to organic farming is the most difficult one. Therefore, it is recommended that the beginners should receive training and support in organic production methods, certification and marketing during this period.

(2) The use of organic inputs was found to be higher on OS farms compared to IS farms. The demand for these inputs is likely to increase with the expansion of area under organic farming. Therefore, the involvement of self-help groups of landless households for production of certified inputs would be most useful. This may help in smooth supply of quality organic inputs at a reasonable price to organic farmers and also help in providing gainful employment opportunities to the landless rural people in their own area.

(3) The sugarcane yield on OS farms was observed to be 6.20 per cent lower than the IS farms. It is thus necessary to resolve the yield limiting issues in OS farming on priority basis.

(4) Although, certification is essential for receiving premium prices to organic products in the market, farmers reported that it is both complicated and expensive. However, the farmer associations facilitated the certification of organic produce and

post-harvest operations for its member farmers. This emphasises the need of such associations. Therefore, public and private agencies and NGOs may encourage farmers to form their own associations.

(5) The organic farming does have social benefits in terms of conservation of land and water resources and benefits to human health and environment. Therefore, it is suggested that the social benefits as well as the social costs of OS farming may be properly measured and quantified to get an idea about the extent of incentives that could be justified for promotion of OS farming in the state.

No doubt, addressing and resolving these issues would go a long way in enhancing the economic well-being and livelihood security of the farmers and reducing the degradation of land and water resources in Maharashtra.

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