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Effect of Tannery Effluent on Agricultural Holdings An Economic Analysis

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Leather industry improves the economic growth by virtue of its export earning potential, also exerts negative externalities on land and water. This paper aims to analyze the impact of tannery pollution on the land utilization and cropping pattern of the study area. The results of the study revealed that the tannery pollution had adversely affected the land utilization pattern and cropping pattern of sample households due to the letting of effluents to the nearby agricultural lands which compelled the farmers to leave their land as fallow and unproductive. Further, the farmers in the pollution zone could not cultivate commercial crops. The farmers had to grow rain-fed fodder sorghum paying little remuneration, which pushed them to subsistence level of farming and also the cost of sorghum was higher (Rs. 16796/ha) in the affected area than non affected area (Rs. 13249/ha). Nearly 40.00 per cent of tanneries were devoid of anti pollution measures. Tannery units must stop to let out untreated water into agricultural lands and farmers in the area must grow the tolerant varieties with suitable soil amendments.

Key words: Tannery pollution, Land utilization pattern, Cropping pattern, Agricultural households.

In Indian economy, agriculture continues to be the dominant sector in the national income. On the other hand, the industrial sector is also playing an important role in the national economy besides providing employment to unemployed and under-employed rural population. The rapid development of industry while improving the economic growth also exerts negative externalities on land, labour and water. Among these, ground water is one of the important sources affected severely due to the industrialization. Among all the industries, the leather industry occupies a pride place in the Indian economy by virtue of its large export earning potential. India is the fifth largest exporter of leather goods and accessories in the world with a lion's share of 24-30 per cent in the country's export. India's export of leather & leather products was US$ 4869 million in 2012-13 (CLE, 2014). Besides, this industry provides employment opportunities to the tune about 2.5 million people. Tamil Nadu is at forefront in leather with an annual production of more than 1.2 billion sq.ft. of finished leather. It is about 60 per cent share in total finished leather production of our country and 45 per cent share in total export from India. There are about 750 tanneries in Tamil Nadu and the raw material processed per day is 500-1000 tons and annual turnover is more than Rs.10,000 crore.

However, the tannery industries are currently affecting the agriculture by way of pollution. In earlier days, the tannery units were traditional and vegetable dye was used for tanning the leather. Nevertheless, in recent times, most of the units turned out to chemical tanning units. Nearly, a month was needed to process one kilogram of leather in the earlier days, but now, due to rapid change of technology, the entire process requires only three to four hours. This shows the rapid development of tannery industries at the cost of polluting the environment by the chemical processes of tanning.

A medium sized tannery unit needs a little more than two hectares of land, 2500 litres of fresh water, and 15 labourers per day. The washed water mostly contains sodium chloride, chromium, which are diverted to the nearby fertile agricultural land or river without adequate treatments and care. The entire agricultural area in the tannery zone is predominantly affected by the effluent. This paper aims to analyze the following objectives: i) to analyze the impact of tannery pollution on the land utilization pattern and cropping pattern of the sample households, and ii) to suggest the policy measures to check further pollution.

Materials and Methods

Design of Study

Dindigul block was selected in Dindigul district as it has more tannery units. The details on the number of tannery units were collected for the block from the record books of the Taluk Statistical Office. The details on characteristics of farms, irrigation particulars, cropping pattern, land utilization pattern

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of the sample farmers were collected from pre-tested questionnaires. The distance between the tanneries was kept as a yardstick for determining the area as affected and unaffected farms. The agricultural lands within and away four kilometre radius of a tannery unit were considered as affected and unaffected areas for the sample area. Five villages from each category and nine farmers from each village were selected to the tune of 90 samples.

Tools of Analysis

Average and percentage analysis was used to examine the nature of cropping pattern and size of the operational holding of the sample farmers. To estimate the cost of production per hectare of agricultural crops, the cost concepts were used.

The production function analysis would show the relationship between output and factors of production. In the present study, it was hypothesized that the pollution has affected the basic production relationship leading to inefficiency in resource use in agricultural lands. To test the hypothesis and verify whether there exists inefficiency in handling of the resources on the polluted farm, a production function analysis was carried out. After examining, the dependent and independent variables a linear production of the following form was proposed.

$$Y = A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + U$$

Where,

Y= Yield (kg/ha)

X_1=Human labour (man-days/ha)

X_2= Expenditure on manure and chemical fertilizer (Rs /ha)

X_3=Expenditure on plant protection chemicals (Rs /ha)

X_4=Bullock labour (bullock pair days/ha)

X_5=Distance from tannery units (km)

X_6=Dummy variable (1 if affected farm, 0 if unaffected farm)

A=constant term, B_1…. B_7 = coefficient of variables

U=Disturbance term

Description of Variables

Human Labour (X_1)

All hired labour was considered alike and valued at the existing wage rate of casual labour. Wages earned by male and female labour formed the basis for standardization into man-day units. Based on wage rates, two women were equated to one man and one adult male labour work of eight hours was taken as one man- day unit. Apriori assumption was that the use of more human labour would increase the yield of sorghum.

Expenditure on Fertilizer and Manure (X_2)

The manures and fertilizers were valued at purchase cost. The farm produce manure was valued at prevailing market rates. The plant protection chemicals were valued at the price at which they were brought the actual expenditure incurred in the valuation of the inputs. Apriori assumption was that more use of fertilizer and manure would increase the yield of sorghum.

Expenditure on Plant Protection Chemicals (X_3)

It included both insecticides and fungicides used for sorghum cultivation. The plant protection cost was collected from farmers at actual price paid in the market. Apriori assumption was that more use of plant protection chemical would increase the yield of sorghum

Bullock Labour (X_4)

Owned and hired labour was changed at the prevailing rates of hire charges in the locality. Apriori assumption was that more use of bullock lobour would increase the yield of sorghum.

Distance from the Tannery Units (X5)

Apriori assumption was that the longer distance from tannery units would have a positive effect on the yield of sorghum crop.

Results and Discussion

Characteristics of the sample farms

Size of the farms

Size of farm holdings is the structural parameter influencing the level and pattern of farm production. The size of the sample farms is presented in Table 1.

Table 1. Distribution of operational holdings of sample farms

Size group (ha)	Affected farms			Unaffected farms		
	Frequency	Total area (ha)	Average area (ha)	Frequency	Total area (ha)	Average area (ha)
Marginal (< 1.0)	25 (55.55)	18.50	0.74	18 (40.00)	13.50	0.75
Small (1.01-2.0)	11 (24.45)	16.50	1.50	13 (28.89)	33.50	2.57
Medium (2.01-4.0)	9 (20.00)	24.00	2.66	10 (22.22)	32.50	3.20
Large (>4.0)	-	-	-	4 (8.89)	28.00	7.00
Total	45 (100.00)	59.00	1.31	45 (100.00)	107.50	2.38

Among the total sample in each category, marginal farms were found to be predominant (55.55 per cent) in the affected farms. It could also be seen that the average size of holdings of affected farms was 1.31 ha, which was less than half of the average size of holdings of unaffected farms which accounted for 2.38 ha. In all the size groups, the unaffected farms had larger size than affected farms. These two observations *viz.,* more number of marginal farmers and smaller size of holdings among the affected farms expressed apathy among the pollution-affected farmers by shrinking their productive lands.

Table 2. The irrigation intensity of the sample farms

Details	Affected farms	Unaffected farms
Gross irrigated (ha)	-	19.50
Net irrigated (ha)	-	15.75
Irrigation intensity (%)	-	123.81

Irrigation intensity

Availability of irrigation helps to achieve higher productivity in farms. The irrigation intensity of the sample farms is presented in Table 2.

The affected farms were not at all irrigated by any source of irrigation and had to depend on rainwater only. In the affected farms, though wells were available, it could not be utilized because of ground water pollution caused by the tanneries. In the unaffected farms, the irrigation intensity was 123.81 per cent. It indicated that the higher efficiency of water use was found in the unaffected farms.

Cropping intensity

The cropping intensity would reveal the degree of land utilization in crop production. The cropping intensity of the sample farms as a whole is presented in Table 3.

Table 3. Cropping Intensity of the sample farms

Details	Affected farms	Unaffected farms
Net sown area (ha)	26.50	107.00
Gross cropped area (ha)	24.15	120.00
Cropping intensity (%)	91.13	112.14

A close examination of the table reveals that the cropping intensity of unaffected farms was 112.14 per cent, whereas it was 91.13 per cent of affected farms. This higher cropping intensity of unaffected farms indicated the effective land utilization over the affected farms. The lower cropping intensity of affected farms might be due to absence of irrigated facilities, thus, lesser crop productivity. The part of the agricultural land was diverted to use for tannery purpose. This lead to the land unfit for cultivation. Nevertheless, the unaffected farms were far away from the tannery units.

Commercialization index

The share of cash crops in the gross cropped area measures the commercialization of the farm business. The commercialization of the sample farms is presented in Table 4.

Table 4. Commercialization index of the sample farms

Details	Affected farms	Unaffected farms
Gross cropped area (ha)	24.15	120.00
Cash crop area (ha)	0.00	33.15
Commercialization index (%)	0.00	27.63

The unaffected farms had 27.63 per cent of the commercialization index. The zero commercialization index in affected farms showed the subsistence nature of farms in the pollution zone.

Impact of tannery effluents

Land utilization pattern

To understand the impact of tannery effluents on the sample farms, land utilization pattern in both affected and unaffected farms is presented in Table 5.

Table 5. Land-utilization pattern of the sample farms

Details	Affected farms	Unaffected farms
Owned land (ha)	59.00	83.00
Leased in land (ha)	-	6.25
Leased out land (ha)	5.75	-
Total operational holdings (ha)	53.25	89.25
Net area cultivated (ha)	24.15	60.50
	(45.35)	(67.78)
Current fallow (ha)	29.10	28.75
	(54.65)	(32.22)

(Figures in the parentheses indicate percentage to total)

The table indicated that the farmers in the affected area leased out their lands to the tannery owners who used it for releasing effluents. The total operational holdings were found higher in the unaffected farms. The net area cultivated was found to be higher (67.78 per cent) in the unaffected farms, while the current fallow was found to be higher (54.65 per cent of the total operational holdings) in the affected farms which might be due to the fact that the cultivation of crops were adversely affected by the release of tannery effluents. Because of the adverse impact of the tannery effluents on the cropping pattern and productivity, the value of land, rent paid for leased in land and rent received for leased out land were found to be lower in the affected farms when compared to the unaffected farms.

Cropping pattern

Cropping pattern adopted by the sample farms is presented in Table 6.

Table 6. Cropping pattern in the sample farms

Crop	Affected farms		Unaffected farms	
	Total area (ha)	% to GCA	Total area (ha)	% to GCA
Sorghum	24.15	100.00	13.00	14.56
Groundnut	-	-	20.50	22.97
Cotton	-	-	28.00	30.26
Sunflower	-	-	27.75	32.21
Total	**24.15**	**100.00**	**89.25**	**100.00**

(GCA-Gross Cropped Area)

A moderate degree of diversification and higher proportion of area under cash crops were the characteristics of cropping pattern in the unaffected farms. The major crops cultivated in the unaffected farms were sorghum, groundnut, cotton and sunflower accounting for 89.25 ha, out of which 85.44 per cent was devoted to cash crops which were value adding in these farms.In affected farms, sorghum was the only crop. The reason for raising the food crop sorghum only in the affected farms was to meet the consumption needs of the farmers and for minimizing the risk in the farm income because of the high cost of raising cash crops.

Thus, the tannery pollution had an adverse effect on the cropping pattern in the affected area. In the affected areas, the farmers have to grow tolerant sorghum varieties like CO 7. Though, sorghum was only considered as a possible crop in the affected farms, the cost of production of sorghum was found to be higher than the net return.

Functional analysis

The influence of selected variables on the yield of sorghum crop was estimated through functional analysis. The results are presented in Table 7.

Table 7. Estimated yield function for sorghum in the study area

Variable	Regression coefficient	't' value
Constant (A)	-47.369**	2.287
Human labour (X_1)	0.701*	1.921
Expenditure on fertilizers and manure (X_2)	1.034*	1.661
Expenditure on plant protection (X_3)	-0.307	1.307
Bullock labour (X_4)	-0.144	0.287
Distance from the tannery units (X_5)	62.913***	6.346
Dummy variable (X_6)	-70.337***	4.172
R^2 = 0.8291; F = 40.19***	N = 90	

(Note: ***-significant at 1% level; ** - significant at 5% level; *-significant at 10% level)

The results clearly indicated that 82.91 per cent of variation in the yield of sorghum per farm in the study area was explained by the specified variable included in the functions and estimated function, as a whole was significant at one per cent probability level. The signs of regression coefficients of distance from tannery units and human labours were in confirmation with apriori expectation.

The expenditure on plant protection and bullock labour were expected to have a positive influence on the yield of sorghum, but the regression results showed negative signs. However, they did not significantly influence the yield of sorghum. The human labour had a positive and significant influence at ten per cent level. The co-efficient of it was 0.701. This indicated that, if the human labour is increased by one man day over the mean value, *ceteris paribus*, the yield of sorghum will be increased by 0.701kg. The co-efficient of the distance from the tannery units was positively significant at one per cent level with the co-efficient values of 62.91. If the distance from the tannery is increased by one kilometre over the mean level, *ceteris paribus*, the yield of sorghum would be increased by 62.91kg. In addition, obviously the dummy variable used to represent affected farms is significantly affecting the yield of sorghum at one per cent level.

Anti pollution measures

The anti pollution measures are essential to check further pollution which are attempted by establishing Effluent Treatment Plants by each and every units or where ever possible, or a Common Effluent Treatment Plant (CETP) jointly for several industries. The existing antipollution measures in the tanneries are presented in Table 8.

Table 8. Anti pollution measures in the sample area

Anti pollution measures	Number of tannery units
Tanneries using anti pollution measures	60 (60.00)
a) Common Effluent Treatment plant (CETP)	30 (50.00)
b) Effluent Treatment Plant at individual tannery units	10 (16.67)
c) Recycling of water	8 (13.33)
d) Disposal of solid waste by burning	12(20.00)
Tannery not using anti pollution measures.	40(40.00)
Total 100(100.00)	

(Figures in the parentheses indicate percentage to total)

It could be observed from the table that only 60.00 percentages of total tanneries were using anti pollution measures. Out of 60 tanneries, only 50 per cent of tanneries had the Common Effluent Treatment Plant that was established jointly by government of Tamil Nadu, and the central government. About 16.67 per cent of the tannery units were having the individual Effluent Treatment Plants. The recycling of water is the other control measure in the tannery industrial area of Dindigul block, which was practiced by 13.33 per cent of total number of tannery units. It was found to be involving more cost to recycle the effluent water; most of the tanners were reluctant to adopt it. The disposal of solid waste by burning under fire was practices by 20.00 per cent of tannery units. After burning they were used as manures for the cultivable land.

Overall, 40.00 per cent of the tannery units had not adopted any antipollution measures. The situation revealed that the antipollution measures were not taken intensively and even in the case of the units following such measures, the results were not satisfactory. It is amazing to note that why the anti-pollution measures, besides all the environmental protection and control of pollution orders are not deserved the required importance.

Conclusion

Most of the farmers in the affected areas were marginal and rain-fed condition. The area within four kilometres from the tannery unit was severely affected. The farmers were unable to utilize the ground water due to tannery pollution. The cropping intensity, irrigation intensity and commercialization index for affected farms were lower than unaffected farms. Most of the farmers in the affected area had just leased out their lands to tannery owners at higher rates. The current and permanent fallow was also higher in the affected area. Only rain-fed fodder sorghum was the probable crop in the affected. The cost of production of sorghum was also higher in the affected area than unaffected area. Nearly 40.00 per cent of tanneries were devoid of anti pollution measures. Tannery units were causing water, air pollution in their locality.

The above results conclusively showed that the land use pattern has been changed; land kept fallow is bulging in size year after year. This should be seriously viewed and steps might be initiated to stop

letting down of untreated water into agricultural lands.

Tannery effluents have shifted the cropping pattern of the affected farms from commercial cash crops to rained crops. So, farmers have to grow the tolerant varieties, new hybrids and also agricultural department and agricultural universities to selectively spread the developed technologies to end this hazard.

Input subsidies may be given by the government to the affected farmers for the purchase of chemicals for as soil amendments to encounter the tannery problems. The standards should be properly reoriented for letting out of the tannery effluents and also should have strict monitoring and enforcement mechanism Recycling and reuse of water with less concentration of chromium content has to be done by all tannery units.By enforcing the above all conditions alone, farmers in the tannery pollution area can survive in the future.The longer time will be taken to recover the affected farms. In order to compensate the loss in income, the opportunity cost of the land may be given as compensation in the short run, adequate reclamation support at heavily subsidized rates may also be given in the long run to reduce the ill effect of tannery pollution on agricultural holdings in the affected area.

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