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Economics of Energy Use in Cotton Production on Small Farms in District Sahiwal, Punjab, Pakistan

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ABSTRACT

Energy is a necessity of life for human beings all over the world due to its function in strengthening the security and contentment of the people. The study was focused on economics of energy use on small farms in cotton production in Punjab province of Pakistan. The study was focused on all types of energy (fossil fuels, chemicals, animate, animal dung, wood, etc.). The study was primarily based on the primary data. Sample of 90 farmers was taken as study respondents at random. Energy use rates/patterns and production patterns were studied. The minimum, maximum and average energy use in cotton production was 18940.83, 32451.19 and 26561.02, respectively. The impact of various energy inputs on output was studied. The share of various energy types in total cost of production was estimated. The highest share in total energy was of commercial energy (52.95) and lowest one was of animal energy (nil).

Key Words: Energy; Cotton production; Sahiwal; Punjab

INTRODUCTION

Energy is a foundation stone of the modern economy. Energy provides an essential ingredient for almost all human activities. Average annual per capita energy consumption for the world, OECD countries and the developing countries has been estimated at 1.6,5 and 1 TOE/Capita respectively (UNDP, 1997; UNDP/EC, 1999; World Bank, 2000). Around two billion people have no access to electricity and rely on traditional fuels, such as dung, crop residues and wood fuel. Another two billion have per capita consumption that is barely one-fifth of the average consumer in OECD countries (UNDP/EC, 1999).

Pakistan is bestowed with substantial energy resources in the country (natural gas, coal & oil). It has a large hydro-electricity base, which contributes towards meeting the energy requirements of a large segment of our population. Yet with all these endowments, the energy requirement of the population and different sectors of the economy, namely industry, agriculture, transport etc., is so great that the government has no other choice but to import energy (Mustafa, 1988).

Agriculture practices in many developing countries continue to be based to a large extent on animal and human energy. As energy is regarded as a factor of production, its restricted availability affects the economy adversely. Energy input accounts for a major proportion of total cultivation costs. Increasing energy costs would adversely affect Pakistan's competitiveness especially in the event of the implementation of WTO agreements (Anonymous, 1991).

Cotton is the main cash crop of Pakistan. It accounts for 11.7% of value added in agriculture and about 2.9% of GDP. It also earns over 60% of the foreign exchange for the country (GOP, 2003). Pakistan is the fourth largest producer of cotton in the world, its yield per hectare ranks 13th in the world, with an average annual production of 1610,000 million tonnes (MT). On average, Pakistan annually imports 92,000 MT and exports 98,000 MT. Most of the cotton produced in Pakistan is grown in a belt along the eastern border of the nation. The province of Punjab accounts for most of the national production (85% of Pakistan's total cotton), while the province of Sind produces the other 15% of Pakistan's cotton. It is a labour-intensive crop and provides labour to the rural poor, especially to women for its 3 - 5 pickings (USDA Economic & Statistics System, 2003).

Un-fortunately, in Pakistan agricultural farming is identified with the big farmer, who is influential enough to have his way in any case. A review of the Pakistani farming community reveals that 81% farmers in the country operate farms smaller than 12.5 acres; where as 64% of total farmers have a farm size less than 7.5 acres (GOP, 2001). The share of small farms (less than 5 hectares) accounts for 68% of total farms in Pakistan during 1972. However, the figure increased to 81% in 1990 (Adil *et al.,* 1992). Most of small farmers are believed to be handicapped in resource availability (financial, technical, etc.). Increasing energy prices may affect their productivity very seriously. Therefore in view of above-mentioned facts, the current research study has been planned with special focus on small farmers of cotton zone of Pakistan.

The study was focused on the energy use (rates/pattern) on small farms and their impact on crop yields in the cotton zone of irrigated Punjab and Estimation of the share of various energy inputs in total cost of production.

METHODOLOGY

The study was mainly based on primary data. The information was collected through a field survey, in the Sahiwal districts. All small farms were categorized into three groups, very small (0 - 5 Acres), small (5.1 - 8 Acre) and very small (8.1 - 45 Acres). A sample of 90 respondents was selected in total. Total cropped area of the three villages under consideration was 653 acres, which was represented by very small, medium small and small farmers as 32.22, 31.11 and 36.67%, respectively. A comprehensively designed and pre-tested questionnaire was used for acquiring the necessary information.

Data thus obtained was in a non-comparable and non-additive form e.g., man-days, bags of fertilizers, liters of diesel etc. To overcome this problem, different conversion factors were available. For instant, (a) NCAER, India (1981), (b) Helsel (1987) and (c) Panesar and Bhatnagar (1987). Chemical energy had been estimated merely on nitrogen content basis. Phosphorous, Potash as well as insecticides/weedicides etc., were ignored. Conversion factor given by Helsel (1987) represented the American condition, that were much advanced and highly energy intensive as compared to Pakistan. Farming conditions and technological atmosphere in Pakistan were quite similar to India. Therefore conversion factor giving by Panesar and Bhatnagar (1987) was used for converting the energy from various sources into Mega Joules (MJ). Then the analysis of energy use was carried out.

In order to estimate the contribution of various energy types, regression analysis for the cotton was carried out. The proposed production function was as under.

$$Y = f(X_1, X_2, X_3, X_4)$$

Where

Y = Yield of crop under consideration.

X_1 = Man power.

X_2 = Animal power.

X_3 = Chemical (Fertilizer + Insecticides).

X_4 = Commercial (Diesel, Electricity).

Regression was run by employing the various functional forms, keeping in view the sign/magnitude of the co-efficients, value of R^2, t-values, etc. Cobb-Douglas type of production function was selected.

Cobb douglas production function. This type of production function was expressed in the form of equation as under:

$$Y = a\,(X_1)^{b1}\,(X_2)^{b2}\,(X_3)^{b3}\,(X_4)$$

Where

Y = stands for output per acre.

a = stands for Y-Intercept (Constant).

X, X_1, X_2, X_3 and X_4 = stand for level per acre from different sources.

b, b_1, b_2, b_3 and b_4 = stand for elasticities of production function of respective inputs.

Both sides of function could be transformed to logarithms in base 10:

$$\log\ Y = (\log a + b_1)(\log X_1 + b_2)(\log X_2 + b_3)(\log X_3 + b_4)(\log X_4 + e).$$

RESULTS AND DISCUSSIONS

Source of power. Table I shows all the target farmers were using tractors for traction power. Bullocks were not used for this purpose, because of their low efficiency. Hence 100% farmers were using tractors as a source of traction power. Among theses 41.12% have their own tractors and remaining 58.88% hire tractor services.

Size bases categories. In table II the respondent farmers were categorized into three classes on the basis of Land acreage. All three categories contribute 16.46, 28.79 and 54.75% area under research, respectively.

Energy consumption in cotton production. Table III shows Minimum, maximum and average consumption of energy of cotton was, 18940.83, 32451.19 and 26561.02, respectively.

Total energy consumption in agriculture by energy source and categories of farmers. It was obvious from Table IV that the contribution of animal energy was nil. No contribution of animate source of energy at small farms was due to higher degree of mechanization at farms. The contribution of animate source had been envisaged to decrease more with the introduction of combine harvesters and automatic planters for rice plantation, which would lead to increase the share of commercial energy.

The highest share in total energy was of commercial energy and lowest one was of human energy. The difference in the contribution of chemical source of energy at very small, medium small and small was due to the reason that the chemical source of energy was neutral to scale.

Production function analysis. In order to determine the relative contribution of different sources of energy input to output, the data was subjected to production function analysis. For this purpose, gross value of output in mounds was considered as a function of human energy (x_1), bullock energy (x_2), chemical energy(x_3) and commercial energy(x_4) in Mega Joule, respectively. Linear, Quadratic and Cobb-Douglas types of production functions were tried for cotton, which covered highest acreage. However Cobb-Douglas type of production function gave better results as indicated by the highest R square values, t values, positive correlation, significance of coefficients in almost all the cases. So for further analysis I made use of the empirical estimates of different coefficients as given by this function.

Analysis showed that output Y of cotton was significantly affected by human energy (x_1), chemical energy (x_3) and commercial energy (X_4). It was obvious that one % change in energy from different sources i.e., human, chemical, commercial contributed toward the yield of cotton to the extent of 1.013, 0.228 and 0.560%, respectively.

SUGGESTIONS

1. As the output (yield) of different crops is positively

Table I. Source of power

Tractor				Total	
Owned		Hired			
No.	%	No.	%	No.	%
37	41.12	53	58.88	90	100

Table II. Size based categories

Very Small (0-5.5 Acres)				Mod. Small (5.6-8 Acres)				Small (8.1-15 Acres)			
No.	%	Area	%	No.	%	Area	%	No.	%	Area	%
29	32.22	107.5	16.46	28	31.11	188	28.79	33	36.67	357.5	54.75

Table III. Energy consumption in cotton production

Name of Crop	Minimum Energy (MJ/Acre)	Maximum Energy (MJ/Acre)	Average Energy (MJ/Acre)
Cotton	18940.83	32451.19	26561.02

Table IV. Total energy consumption in agriculture by energy source and categories of farmers

Energy Source	Very Small (0-5.5 Acres)	% Share	Mod. Small (5.6-8 Acres)	% Share	Small (8.1-15 Acres)	% Share	Total	% Share
Manual	876.173	1.324	826.043	1.334	960.589	1.353	2662.805	1.338
Chemical	29300.48	44.299	28751.26	46.462	32900.48	46.368	90952.22	45.710
Commercial	35964.89	54.375	32303.2	52.202	37093.41	52.277	105361.3	52.951
Total	66141.54	100	61880.50	100	70954.48	100	198976.33	100

dependent on the level of human, chemical and commercial energy applied, therefore more cultural practices and high levels of chemical and commercial sources of energy should be applied.

2. No doubt, crop yield potential depends primarily on genetic factors, but its level of exploitation is significantly influenced by the level and packages of the input of energy applied. A proper level as well as economically advisable combinations of different energy types should be maintained.

3. Commercial energy has played a key role in raising the level of energy application. Anyhow, credit facility for the purchase of small tractor is not sufficient to raise the level of commercial energy. Lack of repair facilities and non-availability of the spare parts had been the main factors responsible for the non-adoption of mechanical technology especially at the small farms. Therefore, along with credit facility, emphasis should be laid on the provision of repair work and spare parts at the door steps of the farmers. Moreover, certain arrangements for the supply of the agriculture, Machinery and other allied equipments by the government authorities on rental basis would significantly enhance the level of energy applications.

4. Chemical source of energy i.e., fertilizes, pesticides and herbicides are highly energy intensive inputs, but considerable quantity of this energy source is wasted. Therefore, proper measures should be adopted for the minimization of energy losses in the form of nutrient losses in agriculture. Optimum use of irrigation water can prevent leaching and as well as other fertilizers nutrient losses. Organic matter should be used to improve the soil fertility. The crop rotation should be followed with a legume crops for enriching the soil with nitrogen. Further, credit facility should be provided to the small farmers on easy terms and conditions.

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