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Impact of Shelterbelts on Net Returns from Agricultural Production in Arid Western Rajasthan

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Abstract

This paper has documented the impact of shelterbelt on agricultural returns by collecting primary data from 80 farmers each in shelterbelt and non-shelterbelt areas. To decompose the total change in net returns, separate production functions have been estimated for shelterbelt and non-shelterbelt farms. The study has revealed an increase of 430.8 per cent in net returns due to shelterbelt plantation, in which shelterbelt technology has contributed 399.4 per cent and increase in use of complementary inputs, 31.4 per cent. In the change of 399.4 per cent, shelterbelt has accounted for 305.6 per cent, i.e. shifting from non- shelterbelt to shelterbelt and remaining 93.8 per cent has been due to inputs used by non-shelterbelt, which might be due to improvement in soil health.

Introduction

The arid zone covers around 12 per cent of the total geographical area of India and is spread over Rajasthan, Gujarat, Punjab, Haryana, Andhra Pradesh, Karnataka and Maharashtra. Rajasthan alone accounts for about 61.9 per cent of the total arid area of the country, spread over 12 districts, namely Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali and Sikar in the western Rajasthan. The hot arid region of western Rajasthan, a part of the Thar desert, is highly prone to wind erosion and represents a fragile ecosystem which has resulted from a continued effect of various natural processes such as low and erratic rainfall, intense heat, high evaporation, low relative humidity, poor edaphic conditions, high biotic pressure, high wind speed, etc. The agricultural productivity in the region remains limited due to un-conducive environment, limited choice of crops and aberrant weather conditions. The sweep of strong winds across sandy desert is a big hindrance in the sustenance of agricultural and allied activities (Mertia *et al.,* 2006).

The advent of Indira Gandhi Nahar Pariyojana (IGNP) and development of tube-wells covering 50,000 ha area in the Lathi series have prospected to provide assured irrigation facility, and consequently, the agricultural activities have increased manifold in the western Rajasthan. However, open canal and irrigation channels often get choked with the deposition of wind-blown sand, interrupting the regular water supply and ultimately affecting the crop productivity. To minimize the erosion hazards of speedy winds and optimize agricultural production, various efforts have been made in the past by adopting different soil and water conservation measures. Adoption of shelterbelts on farm in the arid region of western Rajasthan is considered as one of the most important technological intervention for minimizing the

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harmful effects of strong winds on one hand and increasing the farm productivity on the other hand through moderation of micro-environment at field level. The shelterbelt technology involves raising of porous vegetative barriers comprising strips of trees, shrubs and bushes planted across the prevailing wind direction. These vegetative barriers provide first line defence against wind erosion, breakage of branches and shedding of fruits and moderates the effects of extreme weather events like cold and heat waves.

During the past five decades, after independence, massive afforestation through shelterbelt plantation has been done in the Indian Thar Desert, particularly in above-mentioned twelve districts of western Rajasthan. Major thrust has been on shelterbelt plantation along roads, canals and boundaries of agricultural fields and grasslands. In the Jaisalmer district alone, about 1,300 running kilometres along roads and 27,800 running kilometres along canal sides, tree-belts have been raised. Volumes of data have been generated on the designs, composition, suitable tree species, planting technique, etc. of shelterbelts (Mertia, 1986). But on the effect of shelterbelts on wind speed, soil loss, crop yield, microclimatic environment, etc. only some patchy information is available and no systematic study seems to have been carried out on the impact of shelterbelts at the field level for which these were conceived, designed and planted in the arid ecosystem. The present study was aimed to assess the extent to which the shelterbelt technology could fulfil its prime objective of minimizing hazardous effects of strong winds and increasing farm productivity and returns.

Methodology

To assess the impact of shelterbelt plantations on agricultural production, 80 farmers each from the shelterbelt and non-shelterbelt areas were selected randomly from tube-well command lathi series and canal command area of IGNP Phase –II in the Mohangarh tehsil of Jaisalmer district. All these farmers were surveyed and primary information was collected through a pre-designed schedule. During survey, discussions were held with the farmers in a participatory mode and efforts were made to involve maximum members of a farm household, including farm women and children, for seeking information. The data on such aspects as cost of inputs used for crop production, returns from crops, etc. were also recorded. To find the contribution of shelterbelt to net farm returns, Bisaliah (1977) decomposition model was used.

Net Returns Decomposition Model

Separate crop production functions were estimated for modern (shelterbelt) and traditional (non-shelterbelt) technologies to decompose the total change in output (Bisaliah, 1977; Thakur and Kumar, 1984; Hussain and Young, 1985; and Kiresur *et al*., 1995). A farm unit consisted of 5 ha in this study. The specification of production functions used in the decomposition analysis was as follows:

$$\ln Y_t = \ln A_t + a_1 \ln FERT_t + a_2 \ln HL_t + a_3 \ln OE_t + U_1 \quad \ldots(1)$$

$$\ln Y_m = \ln A_m + b_1 \ln FERT_m + b_2 \ln HL_m + b_3 \ln OE_m + U_2 \quad \ldots(2)$$

where,

Y = Net returns (Rs/ farm)

FERT = Expenses on fertilizers and manure (Rs/ farm)

HL = Human labour (humandays/farm), and

OE = Other expenses, including cost of seeds, irrigation, pesticides and hiring charges of farm machinery, etc. (Rs/ farm)

'A' is a constant (intercept term), U's are error-terms and 'a_is and 'b_is' are regression coefficients of respective inputs. Subscripts 't' and 'm' indicate traditional (non–shelterbelt) and modern (shelterbelt) technology systems, respectively. Besides fitting crop production functions for traditional and modern technologies, a pooled function was also fitted using a dummy variable for the shelterbelt. Following model was used to decompose the total change in crop output:

$$\ln Y_m - \ln Y_t = (\ln A_m - \ln A_t) + [(b_1 - a_1) \ln FERT_t + (b_2 - a_2) \ln HL_t + (b_3 - a_3) \ln OE_t] + [(b_1 (\ln FERT_m - \ln FERT_t) + b_2 . (\ln HL_m - \ln HL_t) + b_3 (\ln OE_m - \ln OE_t)] + (U_2 - U_1) \quad \ldots(3)$$

The decomposition Equation (3) measures the percentage change in output with the introduction of modern technology. The expression on the right hand side of Equation (3) is a measure of percentage change in output due to shift in scale parameter (A) of the production function (first bracket), and the effect of change in slope parameters (second bracket) of Equation (3), and these two terms sum-up to the total effect of modern technology. The third bracketed-term of Equation (3) provides the contribution of change in input-use. The difference between the resources required to achieve the modern technology level of net return by traditional technology and actually used with modern technology indicates the value of input saved.

Results and Discussion

Net Return Functions of Shelterbelt and Non-shelterbelt Farms

For the decomposition of net return per farm, regression equations were estimated separately for shelterbelt and non-shelterbelt farms using ordinary least square method (OLS) and results have been presented in Table 1. The explanatory variables included in the regression model explained adequate variations for shelterbelt and non-shelterbelt farms. Further, the 'F'- test showed that the value of coefficient of multiple determinations (R^2) was significant at 1 per cent level, indicating that the explanatory variables included in the model were adequate for forecasting. A perusal of the production functions estimated for shelterbelt and non–shelterbelt farms showed that the coefficients of farmyard manure and fertilizers (X_1), labour (X_2) and other expenses (X_3) were positive and significant at varying levels of significance. The regression coefficients estimated in the production function were equivalent to the production elasticities and the production elasticities of all the variables were relatively higher in the shelterbelt than non–shelterbelt farms.

Structural Break and Nature of Technological Change

The existence of structural break was examined by conducting tests for the equality of regression coefficients. Chow's test (1960), applied to find the equality of regression coefficients, was found significant at 5 per cent level. This indicated that shift in net return due to shelterbelt caused the structural break. The nature of technological change was examined by testing the homogeneity of regression coefficients under study, while the constant terms (intercepts) in the two production functions were allowed to differ (Kiresure, 1995). The computed F-ratio was found insignificant, implying that the shift in production function was due to dummy variable, i.e. shelterbelt. The significance of dummy variable indicated that the shift in net return was due to shelterbelt plantation.

Table 1. Coefficients of parameters of production function

Parameters/ farm type	Shelterbelt	Non- Shelterbelt	Pooled analysis
FYM and fertilizers (Rs)	0.2103**	0.1691**	0.3056*
	(0.0817)	(0.0611)	(0.0994)
Labour (humandays)	0.2859**	0.1989**	0.3957*
	(0.1013)	(0.0817)	(0.1083)
Other expenses (Rs)	0.0719**	0.0483*	0.1579*
	(0.0302)	(0.0231)	(0.0759)
Intercept	6.2517	3.1994	2.0715
Dummy variable			0.9579**
			(0.1759)
R^2	0.8856	0.7719	0.9217
No. of observations	80	80	160

Notes: Figures within the parentheses indicate the standard errors.

*, ** denote significance at 5 per cent and 1 per cent levels, respectively.

Table 2. Geometrical means of inputs-used per farm

Particulars	Shelterbelt	Non-Shelterbelt
FYM and fertilizers (Rs)	15057.56	10571.33
Labour (humandays)	386.61	181.87
Other expenses (Rs)	22581.97	17083.11

Sources of Net Return Difference between Shelterbelt and Non-shelterbelt Farms

The contribution of technological change and other complementary inputs was worked out with the help of regression coefficients and geometrical mean level of inputs used (Table 2). The observed change in net returns per farm was of 435 per cent (Table 3). The technological changes were because of shelterbelt response of inputs used in non-shelterbelt farms. The contribution due to shelterbelt was of 305.6 per cent, i.e. simply switching from non-shelterbelt to shelterbelt technology. The contributions of higher efficiency of inputs like FYM and fertilizers (X_1), total labour used (X_2) and other expenses (X_3) were about 32 per cent, 39 per cent and 23 per cent, respectively (Table 3). The significant contribution of shelterbelt technology in the total change in net farm returns apparently embodied positive effects of shelterbelts resulting from the protection of crops from desiccating winds, improved soil and other favourable conditions created in the sheltered area in leeward side of the shelterbelt (Mertia, 1992). A recent study by Mertia *et al*. (2006) has revealed that the presence of shelterbelt could reduce wind speed (up to 36 per cent at 02 m height), daily air temperature (by 3-4 °C) and increased organic carbon of surface soil (from 0.12% to 0.28%) on leeward side of the shelterbelt. The reduction in temperature decreased the water loss from the soil through evaporation. Maan and Muthana (1984) had reported that the evapo-transpiration (PE) is largely influenced by the wind in arid region and shelterbelt could reduce pan evaporation by 5-14 per cent on the leeward side of shelterbelt. The microclimatic variations within shelterbelts and their modifications with respect to seasons have indicated significant impact on the associated agricultural crops. The cumulative favourable effect of the shelterbelt had probably increased the crop production and thus, the net farm income.

The contribution of complementary inputs, viz. FYM and fertilizers (X_1), total labour used (X_2) and other expenses (X_3) was 7.7 per cent, 21.6 per cent and 2.1 per cent, respectively. This indicated that farmers' net returns further increased by 31.4 per cent due to increased inputs. The total change estimated due to shelterbelt was of 430.8 per cent (99 % of the observed change). The minor difference between observed change and estimated change might be due to random error- term, which among others accounted for the variables that could not be included in the model.

Table 3. Decomposition analysis of change in net returns from shelterbelt and non- shelterbelt farms

Sl No.	Particulars	Change, %
1.	Observed change in net return	435.0
2.	Sources of change	
	(A) Technological change (shelterbelt)	399.4
	i) Shelterbelt plantations	305.6
	ii) FYM and fertilizers	32.0
	iii) Labour	38.8
	iv) Other expenses	23.0
	(B) Due to difference in input-use	31.4
	i) FYM and fertilizers	7.7
	ii) Labour	21.6
	iii) Other expenses	2.1
3.	Total estimated change in net returns due to shelterbelt plantation	430.8

Conclusions

The **s**helterbelt plantation has been found to be an important technology to minimize erosion hazards and increasing farm productivity through moderation of micro-environment at the field level, especially in the hot arid region of western Rajasthan, which is highly prone to wind erosion, causing a big hindrance to the sustenance of agricultural and allied activities. Study conducted in the Jaisalmer district has revealed an increase of 430.8 per cent in the net returns due to shelterbelt plantation, in which shelterbelt technology has contributed about 399 per cent. Hence, the government should further encourage the shelterbelt plantation on the boundaries of agricultural fields to minimize the harmful effects of strong winds and increase the farm returns.

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