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Employment generation potential of watershed development programmes in semi-arid tropics of India

Biswajit Mondal* and N. Loganandhan

Central Soil and Water Conservation Research and Training Institute, Research Centre, Bellary, Karnataka, India.

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This paper examines the employment generation potential of watershed development programmes and identifies the factors that contribute to the shift in labour absorption in farming activities over control situation. Analysis of secondary data collected from the watershed implementing agencies revealed that on an average watershed programmes helped to generate one time employment ranged between 26 and 76 mandays per hectare, for soil conservation, forestry and other works. Primary survey revealed that utilization percentage out of available labour at average households increased due to watershed development programmes. Employment elasticity with respect to various factors of production in crop cultivation worked out and showed negative price elasticity of demand for labour whereas, employment elasticity with respect to all other factors were found to be positive indicating their positive influence on labour demand. A decomposition analysis revealed that about 61% of the employment growth in watersheds over control situation was attributable to technology effect. Labour efficiency was much higher in the watershed than the control villages as evident from higher labour income. The study establishes that the watershed development programme had the potential of creating huge employment opportunities at the farm level in semi-arid tropical region of India.

Key words: Decomposition analysis, employment elasticity, labour demand, profit function, watershed.

INTRODUCTION

Employment generation has come to occupy centre stage in research and development planning as well as implementation in many developing countries. Expanding productive employment was the principal aim of many developmental and relief programmes for sustained poverty reduction, as labour is the main asset for a majority of the poor. Underemployment or disguised unemployment is still a common phenomenon in the Indian agriculture. It results in out-migration of young and healthy rural workforce to sub-urban and urban areas. Thus agriculture is left on physically weaker workers of the village society, which leads to lower marginal productivity of labour and lower wages. Low levels of productivity and low input usage characterize the rainfed agriculture, which constitutes 60% of net sown area of the country. Bulk of the rural poor lives in rainfed regions. So, it is important to accord high priority to sustainable development of these areas through watershed development approach, which are having high potentials in terms of scope of different activities to be carried out as well as surplus labour to engage in such activities. Therefore, generation of gainful employment opportune-ties in the rural areas was aimed through watershed management programme. Singh et al. (2010) reported that integrated watershed development led to increased employment opportunities for the community members

*Corresponding author. E-mail: bisumondal@rediffmail.com. Tel: +918392242164. Fax: +918392242665.

with better wage earnings in construction work during the programme implementation phase and engagement in agricultural fields during the post-implementation periods, but no specific formal mechanisms were developed to enhance the opportunities. Several earlier studies (Dhyani et al., 1997; Arun, 1998; Arya and Yadav, 2006; Kalyan, 2007) also reported that watershed management programme had positive and significant impact in generating employment opportunities at the farm level.

The pre-requisite for proper planning of the available labour force in an area or region is the information about the technical coefficients with regard to labour absorption in various enterprises. An investigation of dynamics of labour employment would provide an increased understanding of the sources of employment growth and this understanding would indicate the directions in which efforts will have to be made for increasing employment opportunities. This research paper provided an account of employment generation potential of watershed development programmes and identified the factors that contributed to the shift in labour absorption in farming activities over control situation. The specific objectives of this paper is to estimate the availability and its utilization of labour for crop and non-crop activities, employment elasticities with respect to various inputs in agricultural production and decompose the employment growth into watershed technology effect and other factors.

MATERIALS AND METHODS

Data source

The study was carried out in semi-arid tropical region of India. A multistage stratified random sampling was employed for the selection of samples for the study. At the first stage, two states namely; Andhra Pradesh and Karnataka were selected purposefully, as major portion of these states comes under hot, semi-arid eco-region. At second stage, two watersheds from each state namely, Upparhalla (Watershed-I) and Kalvi (Watershed-II) from Karnataka state and Mallapuram (Watershed-III) and Chinnahothur (Watershed-IV) from Andhra Pradesh state were selected for detail investigation. One control village contiguous to each selected watershed was also chosen on the ground that such villages did not come under any watershed based activities or progarmmes. Thus, in all, a total of eight villages were selected to carry out the investigation. For selection of ultimate unit of sampling that is, sample households, a complete list of households of the selected villages was prepared. The third stage of sampling involved random selection of 200 households from four watershed villages and 202 households from control villages, in accordance with the probability proportional to number of households in each village for well representation.

The data for present investigation were collected from both primary as well as secondary sources. The primary data pertaining to socio-economic characteristics of respondents, cropping pattern, productivity and employment generation were collected by personal interview of respondents with the help of pre-tested comprehensive schedule. Information on various aspects of labour availability and utilization was collected using time allocation schedule particularly designed for this study. Secondary data like details of watershed works undertaken and temporary employment generated during programme implementation were collected from Detailed Project Report (DPR) of the selected watersheds.

Analytical methods

To estimate various components of labour availability, initially, effective labour available per household were obtained by considering monthly labour availability and subtracting from it non-availability because of sickness, festivals and various unforeseen. To obtain estimates of labour utilization for crop and non-crop activities, the current magnitudes of labour use for all activities were calculated. These activities include crop production, animal husbandry and various non-farm activities. The returns to per unit of labour input have also been estimated for both watersheds and control villages by using budgeting technique.

For estimating partial employment elasticities with respect to various inputs, production function and labour demand function were fitted. To decompose total change in employment per hectare due to introduction of watershed technology an employment decomposition model based on Unit-output-price (UOP) profit function (Lau and Yotopoulos, 1972) were formulated and used. The UOP profit function formulation enables us to derive labour demand as a function of the normalized wage rate, variable input price and the quantities of fixed inputs. The Cobb-Douglas form of production function with usual neo-classical properties was used for this study with the following specification:

$$Y = AN^{\alpha}F^{\beta 1}K^{\beta 2}L^{\beta 3} \quad (1)$$

where, Y is output, N is the variable labour input and F, K and L are the fixed inputs of fertilizer and manures, flow of capital services and land, respectively. A is constant term of scale parameter, and α, β_1, β_2 and β_3 are the partial output elasticities of labour, fertilizer, capital and land, respectively. The output elasticity of land (β_3) was obtained by the maintained hypothesis of constant returns to scale as:

$$\beta_3 = 1 - (\alpha + \beta_1 + \beta_2).$$

Following Lau and Yotopoulos (1972), a UOP profit function and labour demand function were specified as below:

$$\pi^* = A^{*}W^{\alpha^*}F^{\beta 1^*}K^{\beta 2^*}L^{\beta 3^*} \quad (2)$$

$$N = A^{\Psi}W^{\alpha^*-1}F^{\beta 1^*}K^{\beta 2^*}L^{\beta 3^*} \quad (3)$$

where, $\pi^* = \pi/P_y$ = normalized profit or unit-output-price (UOP) profit, π = profit defined as current revenues less current total variable input cost; $W = P_n/P_y$ = normalized labour wages, P_n = wage rate, and P_y = output price; $A^* = A^{\theta}(1-\alpha)\,\alpha^{\alpha\theta}$, $\theta = (1-\alpha)^{-1}$, $\alpha^* = -\alpha\theta < 0$, $\beta_1^* = \beta_1\theta > 0$, $\beta_2^* = \beta_2\theta > 0$, and $A^{\Psi} = -\alpha^*A$.

Every concave production function has a dual which is a convex profit function; the proposition has been tested from the fact that parameters for profit function that are defined in production function (1) are closely related to the parameters of UOP profit function (2). On the basis of a-priori theoretical considerations, we know that the UOP profit function is decreasing and convex in normalized wage rate (W) and increasing in quantities of fertilizer and capital. It also follows that the function is increasing in the price of output (Bisaliah, 1978). The crucial assumption is that firms behave according to some decision rules which include profit maximization, given the price regime of output and labour, and given the quantities of F and K. In this study, the existence of these systematic decision rules is a maintained hypothesis.

In Equation (3) we have labour demand as a function of W, F and K. In this function, the total change in employment is brought about by shifts in parameters that define the function itself and by changes in W, F and K. It has been argued that ordinary last squares applied to UOP profit function (2) and labour demand function (3) separately are consistent (Lau and Yotopoulos, 1972). However, these estimates are argued to be inefficient because β's appears in both the equations. So, a more efficient approach is to estimate both the equations from production function elasticities imposing the restrictions that β's are equal in both the functions (Zellner, 1962). Our main concern was to decompose the total difference in employment between watershed and control areas farms, hence, the labour demand function in Equation (3) was differentiated totally and converted into per hectare terms as below:

$$dN/N = d\alpha^*/\alpha + dA^*/A^* + (\alpha^*-1)\, dW/W + \beta_1^* dF/F + \beta_2^* dK/K + \log (W) d\alpha^* + \log (F)\, d\beta_1^* + \log (K)\, d\beta_2^* \quad (4)$$

Following Bisaliah (1978) the decomposition equation was expressed in terms of elasticities of production and re-arranged as below:

$$dN/N = [\theta.dA/A] + [\theta.d\alpha/\alpha + \theta^2(\log A + \log\alpha)d\alpha - \theta^2(\log W)d\alpha + \theta^2\{(1-\alpha)d\beta_1 + \beta_1 d\alpha\}\log F + \theta^2\{(1-\alpha)d\beta_2 + \beta_2 d\alpha\}\log K] - [(\theta\alpha +1)\, dW/W] + [\theta\beta_1(dF/F) + \theta\, \beta_2(dK/K)] \quad (5)$$

Equation (5) allowed us to decompose per hectare change in employment (dN/N) into following three components:

(i) Technology effect: This includes the effects of shifts in scale parameter (A) and slope parameters (output elasticities) in production function (1), given W, F and K as under control. This effect was captured by adding the values of first and second bracketed expression of employment decomposition Equation (5).
(ii) Normalized wage rate effect: This effect was denoted by the third bracketed expression of Equation (5) which captured the effect of difference in normalized wage rates (Ws) confronting watershed and control areas farms, given the output elasticity of labour (α) in watershed areas.
(iii) Complementary inputs effect: This effect (further bracketed expressions) includes the employment effects of differences in quantities of fertilizers and capital, given the output elasticities of these inputs in watershed areas.

For the purpose of decomposition analysis, derivatives in Equation (5) were expressed in discrete form as below:

$$\Delta N/N = [\theta.\Delta A/A] + [\theta.\Delta\alpha/\alpha + \theta^2(\log A + \log\alpha)\, \Delta\alpha - \theta^2\, (\log W)\, \Delta\alpha + \theta^2\{(1- \alpha)\Delta\alpha + \beta_1\Delta\alpha\}\log F + \theta^2\{(1-\alpha)\Delta\beta_2 + \beta_2\Delta\alpha\}\log K] - [(\theta\alpha+1)\Delta W/W] + [\theta\beta_1(\Delta F/F) + \theta\beta_2(\Delta K/K)] \quad (6)$$

where, ΔN = (N) Watershed technology - (N) Control. Likewise, ΔA, ΔF, ΔK and coefficients were computed and the base values of N, A, F, K were the values pertaining to control.

RESULTS AND DISCUSSION

Description of the study region and watershed development programmes

Despite the significant increase in irrigated area in India during planned development of over four decades, about 60% of net sown area in the country is still rainfed (Bhatia, 2005). Amongst different rainfed areas, the most vulnerable are semi-arid tropical regions. About 53.4% of India's land area comprises arid and semi-arid regions (GoI, 2004) characterized by low and erratic rainfall, periodic droughts and different associations of vegetative cover and soils. The states which are falling under semi-arid tropics (SAT) includes Andhra Pradesh (Prabhakar et al., 2011), Gujarat, Karnataka, Madhya Pradesh, including Chhattisgarh, Maharashtra, Rajasthan and Tamil Nadu. The share of rainfed agriculture in SAT states is about 73% of which the two selected states (Karnataka and Andhra Pradesh) contributes around 40% and the percentage of rainfed area to net area sown in these two states are 77 and 60%, respectively (Bhatia, 2005). Major crops grown in this region include coarse cereals like jowar, bajra and ragi; pulses like bengal gram and horse gram and oilseed crop like groundnut and sun-flower. Not only the yields per hectare are low in rainfed land in semi-arid region, the variability in both area and yield for most of the crops in semi-arid states is much higher than the all-India average. The semi-arid areas have been subject to large scale degradation of natural resources caused by the depletion of forests, soil erosion, declining common pool resources, etc. (Jodha, 1990) and around 300 million people depend for their sustenance on dryland agriculture, of which 30 to 40% can be classified as poor as per latest available Census (Ryan and Spencer, 2001). Seasonal migration could be seen as a form of spatial diversification, which is at the root of food and livelihood security strategies by the marginal and small farmers in the region (Mondal et al., 2012).

Watershed development programmes are being implemented in the region with the twin objectives of natural resource conservation and enhancing the livelihoods of the rural poor through enhancement of production levels. A total of 4.3 and 6.2 million hectare of land have been covered under the various projects (by different departments under Ministry of Rural Development, Ministry of Agriculture and Ministry of Environment and Forests, Government of India) in the State of Karnataka and Andhra Pradesh, respectively (Sharda et al., 2008). Different types of treatment activities that generally carried out in the watersheds includes soil and moisture conservation measures in agricultural lands (contour/ field bunding and summer ploughing), drainage line treatment measures (loose boulder check dam, minor check dam, major check dam, and retaining walls), water resource development/ management (percolation pond, farm pond, and drip and sprinkler irrigation), crop demonstration, horticulture plantation and afforestation. The aim of all these were to ensure the availability of drinking water, fuel wood and fodder and raise income and employment for farmers and landless labourers through improvement in agricultural production and productivity (Prabhakar, 2012).

Temporary employment generated by watershed programmes

In all the selected watersheds, soil and water

Table 1. Temporary employment generated at the study watersheds (in hundred mandays).

Components	Karnataka state		Andhra Pradesh state	
	Watershed-I	Watershed-II	Watershed-III	Watershed-IV
Soil and moisture conservation works	922.4	120.6	217.1	283.8
Forestry/horticulture	98.6	42.9	170.2	9.21
Total	1021.0	163.5	387.3	293.0
Average (per hectare)	0.74	0.33	0.45	0.26
Non-land-based activities	26	6.4	5.9	1.5

Table 2. Availability and utilization of labour in study villages.

Particulars	Watersheds	Control villages
Monthly labour available per household (mandays)	78	69
Monthly labour utilization per household (mandays)	53	38
Labour utilization percentage	67.95	55.07
Employment gap	32.05	44.93

Table 3. Labour absorption in farm and non-farm activities in the study domain (mandays per year per household).

Activities	Watersheds	Control villages	Difference
1. Crop enterprises	351 (55.10)	288 (62.34)	63***
2. Animal husbandry	142 (22.29)	120 (25.97)	22**
3. Non-farm employment	144 (22.61)	54 (11.69)	90***
Total	637 (100.00)	462 (100.00)	181***

Figures in parentheses indicate % of total; *** and **indicates difference between two areas were significant at 1 and 5% level.

conservation as well as planting programmes were carried out by manual labour only. Analysis of secondary data reveals that the watershed programmes generated one time employment ranged between 26 and 74 mandays per hectare for soil conservation, forestry and other works (Table 1). The differences between the watersheds were mostly due to variations in the number and size of erosion control structures and in case of forestry and horticulture it was due to difference in intensity of programme. Further, the programme also created assets for livelihoods of poor and provided employment to the extent of 150 to 2600 mandays in different watersheds. The magnitude of employment is not in-significant; further these activities now providing recurring employment as the fruit trees are yielding as reported by the respondents.

Household availability and utilization of labour

The specific aspects covered in this objective are availability of family labour per household per month, contribution of labour for crop, livestock and non-farm activities under different land holding categories (Tables 2 and 3). On an average, 78 and 69 mandays of effective labour per household per month, respectively in watershed and control areas were available. Farm households in watershed could utilize only 68% of available labour and the utilization in control areas was only 55%. Employment gap was more in control areas to the extent of 13%.

Introduction of watershed technologies increased the cropping intensity, production levels and shifts the farming activities from less labour intensive (low value) to more labour intensive (high value) crops, livestock and other enterprises which in turn shift the labour absorption per hectare of cultivated area over control areas. Therefore, human labour use in farming as well as non-farm activities in both watershed as well as control areas were also analysed and the results are presented in Table 3. The regular labour employment in agriculture in watersheds (351 mandays per household per year) was significantly higher than the control villages (288 mandays per household per year). The results also indicated that the average number of days employed in animal husbandry activities were significantly higher in the watershed villages. Thus, it can be concluded that watershed management programme had positive and

Table 4. Input-output levels in crop production in study region (per farm per year).

Items	Watersheds (173)	Control villages (171)	Difference
Output (kg)	5795.69	3238.68	2557.01***
Labour input (mandays)	563.23	357.93	205.30***
Fertilizer input (INR)	10143.60	6460.09	3683.51***
Capital input (INR)	31780.02	20645.68	11134.34***
Farm size (cultivated land in hectare)	2.816	2.537	0.279NS

Figures in brackets indicate number of farms in each area; INR: Indian National Rupees, *** indicates the significant difference between two areas at 1% level; NS: Not significant.

Table 5. Estimates of production function, UOP profit function and labour demand function.

Variables	Watersheds			Control villages		
	Production function (R^2=0.932)	UOP profit function	Labour demand function	Production function (R^2=0.899)	UOP profit function	Labour demand function
Constant	1.865(0.285)	1.132	2.969	1.342 (0.364)	0.347	0.821
Labour input	0.724*** (0.080)	-	-	0.703*** (0.103)	-	-
Labour wage (Normalized)	-	-2.623	-3.623	-	-2.367	-3.367
Fertilizer input	0.144*** (0.063)	0.522	0.522	0.146** (0.066)	0.492	0.492
Capital input	0.212*** (0.061)	0.768	0.768	0.243*** (0.078)	0.818	0.818
Land	-0.08	-0.290	-0.290	-0.092	-0.310	-0.310

Figures in parentheses indicate standard errors; *** and ** indicates coefficients are significant at 1 and 5% level, respectively.

significant impact on generating employment opportunities at the farm level.

Input-output level in crop enterprises

Table 4 presents the pattern of input use and output level during a calendar year under predominantly groundnut growing farms at both watershed and control villages. It indicates that the level of output and labour usages was much higher in the watersheds which can be attributable directly to the watershed development programmes. Higher usages of other inputs also indicate the level of intensiveness in cultivation at watershed villages compared to control villages.

Elasticities of production function, UOP profit function and labour demand function

Table 5 presents the production function estimates as well as estimates of UOP profit function and labour demand function separately for watersheds and control areas. In production function estimation, the dependent variable (Y) considered was the output measured in kg per year per farm whereas the independent variable included were labour input measured in mandays per year (N), expenditure on fertilizer and manures measured in INR per year (F) and expenses on capital inputs covering expenditure on bullock labour, value of seed, expenditure on irrigation, value of plant protection chemicals, expenditure on machinery use, land revenue, apportioned amount of interest and depreciation on fixed capital assets used in production, etc. measured in INR per year (K). It may be noted from Table 5 that about 93 and 90% of the total variation in the output, respectively at watershed and control areas were explained by the included variables which justify the use of production function coefficients for estimating profit function and labour demand function. The regression coefficients associated with all the independent variables were positive and statistically significant except farm size, indicating thereby their positive influence on the level of output at both the areas. Negative output elasticities of land emerged from the fact that small farms might received better attention and management and results more output.

The UOP profit function and labour demand function given in Table 5 were estimated using production function estimates. As expected, the profit function is decreasing in prices of labour and increases in fertilizer and fixed capital inputs. Employment elasticities with respect to different factors as envisaged in labour demand function to be different under watershed technology and control.

Table 6. Decomposition analysis of total change in employment (per hectare per year).

No.	Estimated sources of change in employment	Percentage attributable
A.	Technology effect	
	(i) Neutral technology effect	131.22
	(ii) Non-neutral technology effect	-70.70
Sub-total		60.52
B.	Normalized wage rate effect	-3.32
C.	Complementary inputs effect	
	(i) Effect of fertilizer and agro-chemicals	24.94
	(ii) Effect of capital inputs	21.81
Sub-total		46.75
D.	Total estimated change due to all effects	110.59

This implies that employment response to a given change in these key variables will be different on these two locations. Negative price elasticity of demand for labour implying withdrawal of a section of labour force consequent upon a rise in wage rate which indicated the presence of disguised unemployment in the production enterprises. Negative elasticities of demand for labour with respect to land might be due to mechanization of farm operations at larger sized farms. Employment elasticities with respect to all other factors viz. fertilizer and capital input are positive implying positive influence of these factors on labour demand.

Decomposition of employment growth

The aim of this objective was to decompose the total change in employment into watershed technology, wage rate and complementary inputs component for providing an empirical perspective on the sources of employment growth. For empirical implementation of this objective, an employment decomposition model based on the UOP profit function and labour demand function has been formulated. The decomposition analysis, assuming Hicks-non-neutral technical change between watershed and control areas yielded the following results (Table 6).

First, 131% of the increased employment is attributable to technology effect; we call it as watershed technology. A brief explanation on why technical change given rise to positive employment effect in the decomposition model based on the UOP profit function framework is in order. As every concave production function has a dual which is a convex profit function and vice-versa, technical change that shifts production function upwards, also shifts profit function upwards. This upward shift in profit function, other things being equal, shifts the demand for labour. The effect of non-neutral component of technical change on employment was negative to the extent of 71%. The negative effect was due to the normalized wage rate differentials which were slightly higher at control areas than the watershed areas which, however, could not offset the total technology effect that was still positive to the extent of 61%.

Second, the employment effect of the difference in normalized wage rate is estimated to be -3%. This follows from the fact that the daily normalized wage rate in watersheds are slightly lower than one paid at control areas. Even though the money wage rate at watershed is higher than the control areas, lower normalized wage rate confronting watershed areas follows from the higher average output price which might be due to better quality of produce and/or higher market linkages. This result seems to indicate the importance of output price, given the money wage rate, in generating employment opportunities at the farm level. Several earlier studies (Mellor, 1976; Rao, 1977; Vyas and Mathai, 1978) also indicated that the output level and price to be closely linked to employment as evidenced from high employment elasticities.

Third, the complementary inputs effect on employment is estimated to be 25% with fertilizer and 22% with other capital expenses. This positive employment effect follows from the condition that an increase in quantities of these inputs shifts the marginal product curves of labour to the right. As a result, the profit maximizing farm tends to employ more labour in watersheds at a given wage rate. This result very well support the strategy of physical planning for the production and distribution of complementary inputs in any employment generation programme.

Rate of return per unit of labour

The returns to per unit of labour have been estimated for crop production at both watershed and control areas and presented in Table 7. The results showed that the labour rate was almost similar between watershed and control areas but due to higher gross return per hectare, corresponding difference in labour income was around

Table 7. Differences in rate of return per labour input between watersheds and control villages.

Particulars	Watersheds	Control villages	Difference
Gross return (INR in thousand per hectare per year)	32.99	19.75	13.24
Labour income (INR in thousand per hectare per year)	15.09	0.67	14.42
Labour unit used (number per hectare per year)	200	141	59
Labour income (INR per unit)	75.46	4.74	70.72
Cost of labour (INR per unit)	32.82	31.86	0.96
Net labour income (INR per unit)	42.64	(-) 27.12	69.76

INR 71 and net labour income in the control areas was negative to the extent of INR 27. It indicates that labour efficiency increased due to implementation of watershed development programmes in the study region.

CONCLUSION AND RECOMMENDATION

It is evident from above analysis that watershed development programmes have helped to create employment opportunities on temporary as well as permanent basis. If maintenance programmes are taken up as envisaged in the technical plan of the watershed development programme, it is possible to further improve the employment opportunities, which will help to stabilize annual incomes of the landless in particular and farming community in general. On the basis of various estimates of labour availability and utilization, the employment potentials of rural semi-arid region can be further boosted with the following specific points.

(i) Execution of watershed development programme should be done involving both land based and non-land based activities for creation of employment for the rural masses. Inclusion of horticulture/plantation works generates huge temporary as well as regular employment in the watershed programme.
(ii) Labour utilization per household was found to be higher in the watershed villages than the control villages, which might be due to higher cropping intensity and introduction of labour intensive remunerative crops.
(iii) Labour wages, product price and all the complementary inputs are important determinants of employment. Estimated employment elasticity and the labour demand model can be used to derive the output price adjustments and the use of complementary inputs to reach specific employment goals.
(iv) Positive technology effect in the decomposition analysis follows from the condition that technical change shifts profit function upwards. This upward shift in profit function, other things being equal, shifts the demand curve for labour to the right. As the output price is very important to bring the wage rate negative so that total effect increased, more emphasis should be given to high value crops. Various complementary inputs also shift the marginal product curves of labour to the right. As a result, the profit maximizing farm tends to employ more labour in the watershed at a given wage rate. This result very well support the strategy of physical planning for the production and distribution of complementary inputs in any employment generation programme.
(v) Higher net return per labour input in watershed indicates higher labour efficiency in the watershed. Hence, implementation of watershed development programme needs to be continued and extended to other villages for higher labour income and well being of the farmers by improving the productivity of land in the region.

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