



Intensity and extent of adopting watershed activities in Nagaland

MUKESH KUMAR YADAV^{1*}, AMOD SHARMA² and PARMINDER SINGH³

Nagaland University SASRD Medziphema Campus, Dimapur, Nagaland 797 106, India

Received: 26 February 2020; Accepted: 03 September 2020

ABSTRACT

In India, agriculture is important occupation of which 52.00% of the people depend for their livelihood. For the present study a multistage random sampling technique is adopted with a total of 320 respondents selected from the Kohima and Dimapur district of Nagaland state, among that 160 farmers are beneficiaries and 160 are non-beneficiaries both drawn from the watershed villages as check farmers for assessing the impact of watershed on sustainability of the agriculture during the agricultural year 2018–20. The Regression analysis results reveal that the farmer's enrollment as member in watershed programme increases about 1.65 % in the agricultural income, while the regression coefficient of education level for the medium farmers was found to be 0.76 implying that 1.00% increases in the educational level yields with 0.76% on their agricultural income. However, it is non-significant for small and large farmers; the results reveal that family size of the respondents positively influence the adoption of livestock, soil and water conservation and compost and agro-forestry at 5.00% level of significance. The tetra correlations results showed that watershed management practices are positively correlated and practices the activities in jointly or complementary to each other. All the positive impacts of watershed development programme are expected to improve standard of living at the household level, establishing financial framework for sustainable functioning of watershed projects and participatory planning for upliftment of the people and conserving the biodiversity which is another prerequisite for ensuring the sustainability of the watershed project.

Key words: Beneficiaries, Impact, Linear, Non-beneficiaries, Watershed

Out of the 142 million ha of cultivated land in India; 105 million ha is under rainfed agriculture, which contributes 44.00% of total food basket and support 40.00% of the production (Yadav and Sharma 2019a). The state of Nagaland characterized by undulating, highly erodible and degrading tracts, having more than 85.00% of rainfed area; watershed approach constitutes most suitable approach of development for such hill areas (Yadav and Sharma 2019b). The approach is holistic, multidisciplinary and integrated involving close coordination of different activities departments. In the past, planning based on administrative units has failed to take into account the peculiar problems, resulting from the historical process of over-exploitation of various natural resources in each locality. The Government of Nagaland has launched many watershed projects financed by national and international donor agencies with a view to rehabilitate the degraded environment and improve the economy of the state. Integrated Watershed Development Project is an integrated multi-sectoral Watershed Development Project. The project becomes operative in 11 districts in mid-hill

regions of the state from October 2008 (Govinda and Sathish 2011). The state is mostly comprised hilly terrain, with plain areas limited to only Dimapur. Kohima, the capital of Nagaland has an elevation of 1444 m. It has eleven districts and a collection of 16 tribes residing in this hilly state (Chishi and Sharma 2019). Kohima is a hilly district sharing its borders with Dimapur in the west, Phek in the east, Peren in the South and Wokha in the north. It has a humid subtropical climate, with an elevation of 1444 m and covers an area of 1463 sq km. Dimapur district is the centre for many commercial activities. It is bounded by Kohima district on the south and east, Karbi Anglong on the west, Golaghat district of Assam in the north. A large area of the district is in the plains with an average elevation of 260 m above sea level with an area of 927 sq km (Walling and Sharma 2018).

MATERIALS AND METHODS

The IWMP was launched in 2008–09 in all districts of Nagaland, viz. Dimapur, Kohima, Kiphrie, Longleng, Mokochung, Mon, Phek, Peren, Tuensang, Wokha and Zunhebuto. Kohima and Dimapur districts were purposively chosen to conduct this study. In the second stage of sampling, two blocks, viz Medziphema and Chumukedima were selected from Dimapur district and Kohima and Tsemnyu blocks from Kohima district were selected. Although the

*Corresponding author e-mail: mukeshyadav101990@gmail.com

Watershed areas depend upon the catchment area however 4 villages from each block were selected to proposed 16 villages in total, with 8 minimum villages from each district by random method. Then a sample of 20 numbers of cases of watershed management programme was selected; out of that 10 were from beneficiaries and 10 will be from non-beneficiaries; which will be drawn by following the purposively random sampling method. The sampled respondents are furthermore post stratified into small (1-2 ha), medium (>2 ha) and large farmers (>10 ha) based on the total land holding accordingly among the beneficiaries 55, 74, 31 farmers were belonging to small, medium and large farmers respectively. Similarly, in case of non-beneficiaries 75, 62 and 23 farmers were belonging to small, medium and large farmers respectively. Thus, in total 320 farmers in that 160 farmers are beneficiaries and 160 are non-beneficiaries was drawn from the watershed villages as check farmers for assessing the impact of the watershed on sustainability of the agriculture. The secondary data was collected from secondary sources, viz office of the Project Director, Integrated watershed management programme Kohima and Dimapur and various published materials from the Directorate of Land Resource, Directorate of Agriculture, Government of Nagaland and Internet sources.

Discriminant function: The discriminant analysis model is a linear combination of the farmers' characteristics. The coefficients are estimated so that the groups differ as much as possible on the values of the discriminate function. This occurs when the ratio between group sums of squares to within group sum of squares for the discriminant scores is at a maximum. The above function 'Z' is used to discriminate the farmers who are members of the WUCS and non-members of the WUCS. Discriminant function coefficients (un-standardized) are the multipliers of variables, when the variables are in the original units of measurements. The un-standardized coefficients are multiplied by the values of the variables. These products are summed and added to the constant term to obtain the discriminate scores. For each

discriminant function, the Eigen value is the ratio of between groups to within-group sum of squares. Large Eigen value implies superior function. The grouping variable is a set of dummy variables that define group membership. Predictor variables are a set of independent variables, which helps to discriminate the groups (Tilekar *et al.* 2009).

Production function analysis: In order to assess the impact of watershed on agricultural and livestock income by employing the Cobb-douglas production function. The significance of this model permits quantifying of marginal contribution of each input to the total income. One can examine the impact of farmers' membership of watershed programme on agricultural income and livestock income by holding all other parameters intact (Battese 1992).

Adoption of watershed management practices by Multivariate model: The adoption of various watershed management practices examined on single or joint analysis methods. Single adoption techniques usually analyze the decision to adopt a single technology by employing univariate models without considering complementary technologies. In principle, farmers usually consider a portfolio of watershed management practices and thus the watershed management practices is multivariate. In this context, the theoretical structure is based on farmers likely to adopt the technologies in combination of watershed management practices concurrently to contract with multidimensional nature of environmental and land degradation consequences that affects the agricultural and livestock productivity and livelihood of the farmers. Here we employed multivariate probit model which simultaneously estimating interrelated of multiple management activities. This model comprises of six binary choice equations, viz. livestock farming (Dairy, piggery, integrated farming); soil erosion control measures (contour bunding, soil bund, and grass strip); soil fertility (application of compost), agroforestry. Among the livestock farming and soil erosion measure if the farmer adopted any one the practice mentioned treated as one otherwise zero (Sudhishri and Dass 2012, Vishandas *et al.* 2014).

Table 1 Linear discriminate function between beneficiaries and non-beneficiaries

Independent variable	Standardized coefficients	Beneficiaries	Non- beneficiaries	F-value
Total cultivated area (ha)	0.236	5.66	4.98	3.56
Proportion of Irrigated area to the total cultivated area	0.39**	72.57	65.83	16.52
Distance of farm from the irrigation structure (m)	0.45**	580.00	2550.00	18.63
Gross cropped income (₹)	0.15*	322916.32	144255.86	10.56
Livestock income (₹)	0.23**	318525.00	94941.28	24.78
Fisheries income (₹)	0.145	25919.00	17180.00	2.89
Education level (Illiterate = 0, literate = 1)	0.36	0.95	0.7	1.98
Percentage of fallow land to total cultivated land (%)	0.124**	-	-	19.56
Chi-square value	78.56	-	-	2.63
Eigen value			0.74	
Canonical correlation			0.714	

(** Significance at 1 and 5 %; Dependent variable Beneficiaries = 1; Non-beneficiaries = 0; Number of sample (n) = 320)

The latent nature of estimation is based on observable binary variables shows that whether farmers adopted a particular technology or not. The error terms = 1, 2, ... 5 are distributed multivariate normal each with mean 0 and variance-covariance matrix V, where V has 1 on the leading diagonal, and non-zero correlation $j_k = k_j$ as off diagonal elements. In this model, the sign and significance of the correlation coefficient provide evidence on the nature of the relationship between adoptions equations. A positive correlation is interpreted as a complementary relationship, while a negative correlation is interpreted as being substitutes (Amale *et al.* 2011, Varat 2013).

Tetrachoric correlations coefficient: Tetrachoric correlation is a special type of the polychoric correlation could be used when both observed variables are dichotomous. The tetrachoric correlation coefficients of watershed management practices if correlation coefficient is positive implies that technologies are complementarily in nature and on other hand negative shows that correlation coefficient indicates technologies or management practices are mutually exclusiveness (Battese and Corra 1977).

Analysis of variance: The analysis of variance was

performed to see whether there is difference in the net returns of the farmers between Active and Control watershed. The F-value of ANOVA explains whether there is significant difference among the watershed. Student t-test was used to know which watershed is significantly different from the others, i.e. Testing two means with respect to net returns per acre per annum) (Singh *et al.* 2017). The data were encoded and analyzed by employing STATA software.

RESULTS AND DISCUSSION

Data (Table 1) reveals the discriminate function analysis to examine the difference in attributes of the beneficiaries and non-beneficiaries and the dependent variable assigned a dummy variable of value one to beneficiaries and zero to non-beneficiaries of watershed. Among the explanatory variables Proportion of Irrigated area to the total cultivated area Distance of farm from the Irrigation structure, gross cropped area, livestock income and per cent of fallow land to total cultivated land are major factors influencing the discriminating power of the function, as compared with other predictors which had smaller coefficients. The equivalents of irrigated area to total cultivated area of the

Table 2 Multivariate probit model for different activities of watershed programme

Particular	Livestock activity		Soil and water observation		Compost application		Agro forestry		Groundwater recharge	
	Coefficient	T Value	Coefficient	t value	Coefficient	t value	Coefficient	t value	Coefficient	t value
Age of the household head	0.032 (0.23)	0.139	0.012 (0.056)	0.214	0.032 (0.15)	0.214	0.015 (0.23)	0.066	0.014 (0.36)	0.039
Education of the household head	0.089 (0.45)	0.197	0.025 (0.45)	0.056	0.021 (0.047)	0.447	0.456 (0.045)	10.134	0.045 (0.014)	3.215
Family size	0.056 (0.013)	4.552	0.034 (0.013)	2.765	0.35 (0.01)	35	0.032 (0.013)	2.602	0.036 (0.052)	0.693
Total cultivated land	0.036 (0.56)	0.064	0.065 (0.56)	0.117	0.03 (0.2)	0.15	0.012 (0.001)	12	0.028 (0.063)	0.445
Livestock position	0.35 (0.056)	6.25	0.047 (0.056)	0.84	0.065 (0.014)	4.643	0.0152 (0.025)	0.608	0.045 (0.074)	0.609
Non-farm activities	0.056 (0.005)	12.444	0.065 (0.096)	0.683	0.056 (0.09)	0.623	0.056 (0.005)	12.445	0.213 (0.056)	3.804
Extension services	0.089 (0.012)	7.416	0.014 (0.002)	7	0.045 (0.078)	0.577	0.089 (0.012)	7.417	0.045 (0.015)	3
Training services	0.013 (0.004)	3.25	0.085 (0.016)	5.449	0.014 (0.056)	0.25	0.013 (0.062)	0.21	0.096 (0.022)	4.466
Member of the WAs	0.09 (0.005)	20	0.063 (0.005)	14	0.31 (0.065)	4.77	0.056 (0.078)	0.718	0.045 (0.033)	1.402
Farm distance from watershed irrigation structure (in km)	0.0125 (0.006)	2.45	0.036 (0.036)	1.026	0.056 (0.006)	10	0.023 (0.009)	2.585	0.012 (0.002)	9.6
No of observation	320									
Wald statistics χ^2	235.23									
Prob> χ^2	0.0023									
Log like hood ratio	-245.36									

Table 3 The Extent of farmers adopting the watershed programme management practices across farm categories

Particular	Beneficiaries				Non beneficiaries			
	Small	Medium	Large	Total	Small	Medium	Large	Total
Dairy farming	13 (23.64)	35 (47.3)	21 (67.75)	69 (43.13)	14 (18.67)	25 (40.33)	17 (73.92)	56 (35)
Piggery farming	8 (14.55)	20 (27.03)	8 (25.81)	36 (22.5)	10 (13.34)	7 (11.3)	5 (21.74)	22 (13.75)
Integrated farming (Dairy + piggery)	12 (21.82)	27 (36.49)	8 (25.81)	47 (29.38)	0 (0)	12 (19.36)	4 (17.4)	16 (10)
Dairy + Fish farming	7 (12.73)	8 (10.82)	12 (38.71)	27 (16.88)	0 (0)	3 (4.84)	5 (21.74)	8 (5)
Fish farming	20 (36.37)	18 (24.33)	10 (32.26)	48 (30)	0 (0)	9 (14.52)	6 (26.09)	15 (9.38)
Contour bunding	22 (40)	25 (33.79)	15 (48.39)	72 (45)	12 (16)	10 (16.13)	11 (47.83)	33 (20.63)
Soil bunding	10 (18.19)	9 (12.17)	8 (25.81)	43 (26.88)	5 (6.67)	8 (12.91)	10 (43.48)	23 (14.38)
Grassstrip soil bund	18 (32.73)	30 (40.55)	8 (25.81)	53 (33.13)	13 (17.34)	18 (29.04)	15 (65.22)	29 (18.13)
Rain water harvesting (RWH)	30 (54.55)	18 (24.33)	10 (32.26)	58 (36.25)	0 (0)	11 (17.75)	10 (43.48)	21 (13.13)
Compost (COM)	20 (36.37)	8 (10.82)	12 (38.71)	40 (25)	10 (13.34)	11 (17.75)	14 (60.87)	35 (21.88)
Agroforestry (AGFOR)	34 (61.82)	29 (39.19)	12 (38.71)	75 (46.88)	10 (13.34)	17 (27.42)	12 (52.18)	39 (24.38)
Groundwater recharge methods	10 (18.19)	18 (24.33)	10 (32.26)	38 (23.75)	2 (2.67)	9 (14.52)	5 (21.74)	16 (10)

beneficiaries and non-beneficiaries was tested for equality of two means and F value is significant at 1% implies that there is function, as compared with other predictors which had smaller coefficients. The equivalents of irrigated area to total cultivated area of the beneficiaries and non-beneficiaries was tested for equality of two means and F value is significant at 1 % implies that there is significant difference between the two variances in the irrigated area. Similarly, Distance of farm from the irrigation structure was found to next best estimator and with F value of 18.63 at 1% of significant level (Borah and Sharma 2015).

Results obtained from multivariate probit model indicated the result of likelihood ratio test of the null hypothesis implies that covariance of the error terms are not correlated hence rejected 245.36 ($\text{prob} > \chi^2 = 0.00$) indicating the multivariate probit model is suitable than univariate model (Table 2). The Wald statistics indicates that 235.26 $\text{prob} > \chi^2 = 0.00$ the model fit to the data very well. Implying that regression coefficient are jointly rejecting the null hypothesis. The results of the study indicate that family size of the respondents positively endorsing the adoption of livestock, soil and water conservation and compost and agro-forestry at 5% of significance. The total cultivated land is positively significant in influencing in the practice of agro-forestry at 1% significant level implying that because of larger land holding the farmers may practise

the agro-forestry activities to augment the income as well to recharge the groundwater level (Singh and Sharma 2020). The education of the farmers plays a greater role in practices of the watershed management activities in fact, its influences on practices of compost applications, agro-forestry and groundwater recharge at 5% of level of significance. The higher chi-square value of 78.56 and lower F-value indicates that the standardized coefficients have the discriminating power at 1% significance. The Eigen value of 0.74, which is the proportion of the between group sum of squares to the within group sum of squares, indicates that the linear discriminant function is superior in discriminating the two groups (Chishi and Sharma 2018). The canonical correlation (0.714) indicates the strong measure of association between the discriminant scores and the groups (beneficiaries and non-beneficiaries). Extent of farmers adopting the watershed programme management practices across farm categories reveals that 43.00% of the beneficiary farmers are practising dairy farming as against the 35.00% of the non-beneficiaries (Table 3). The contour bunding 40.00% in case of beneficiaries and only 16.00% of the farmers practising contour bunding in case of non-beneficiaries. The rainwater harvesting about 30.00% of the farmers in case of beneficiaries and 13.00 % in case of non-beneficiaries in the study area. The findings clearly indicated that small farmers adopted less percentage of watershed management

practices as compared to large farmers in the region mainly because of impediments such as socioeconomic, institutional and environmental factors (Sharma 2012).

The Regression analysis results reveal that the farmer's enrollment as member in watershed programme increases about 1.65% increases in the agricultural income. The regression coefficient of education level for the medium farmers found to be 0.76 implying that 1% increase in the educational level yields 0.76% of the agricultural income for the medium farmers however, it is non-significant for small and large farmers. The distance of irrigation structure from the farm found to be positively significant for all the size groups it is evident from the fact the mean distance between the farm and irrigation structure is 580 m. The Multivariate model subjected to assess factors influencing the practices in watershed management activities. The results reveal that family size of the respondents positively influencing the adoption of livestock, soil and water conservation and compost and agro-forestry at 5% level of significance. The total cultivated land is positively significant in influencing in the practice of agro-forestry at 1% significant level implying that because of larger land holding the farmers may practice the agro-forestry activities to augment the income as well to recharge the groundwater (Paney and Sharma 2018).

REFERENCES

- Amale A J, Kalhapure S P and Yadav D B. 2011. Impact of watershed development project on farm economy: a case study. *Agricultural Situation in India* **68**(3): 137–44.
- Battese G. 1992. Frontier production functions and technical efficiency: a survey of empirical applications in agricultural economics. *Agricultural Economics* **7**(1): 185–208.
- Battese G E and Corra G S. 1977. Estimation of a production frontier model: with application to the pastoral zone of Eastern Australia. *Australian Journal of Agricultural Economics* **21**(3): 169–79.
- Borah Mrinali Gogoi and Sharma Amod. 2015. Impact of women labour and its utilization under different agro-climatic zones with reference to different farm size groups in state of Assam. *Economic Affair* **60**(2): June: 237–41.
- Chishi S Kanitoli and Sharma Amod. 2018. A sustainable impact assessment approach of integrated watershed development programme in Nagaland. *International Journal of Current Microbiology and Applied Sciences* **7**(11): 1661–68.
- Chishi S Kanitoli and Sharma Amod. 2019. Resource use efficiency on different farm size groups of Integrated Watershed Development Programmes beneficiaries in Nagaland. *International Journal of Current Microbiology and Applied Sciences* **8**(6): 2135–44.
- Govinda G V and Sathish A. 2011. Socio-economic and natural resources impact of Sujala watershed project in Karnataka. *International Journal of Science and Nature* **2**(1): 31–37.
- Paney Yani and Sharma Amod. 2018. Prioritization strategies for the resources of traditional paddy-cum-fish culture in lower Subansiri district of Arunachal Pradesh. *International Journal of Current Microbiology and Applied Sciences* **7**(5): 1112–1124.
- Sharma Amod. 2012. Inter-state disparities in socio-economic development in North East Region of India. *Journal of Agricultural Science* **4**(9): 236–43.
- Singh M, Gupta B, Babu S, Avasthe R K and Das S K. 2017. Fodder, fuelwood consumption pattern and energy dynamics along elevation gradient in Giri Catchment, Himachal Pradesh, India. *Indian Journal of Agricultural Sciences* **87**(2): 261–65.
- Singh Motilal and Sharma Amod. 2020. Resource-use-efficiency analysis for the selected major horticultural crops in the state of Nagaland and Manipur. *Plant Archives* **20**(2): 9113–19.
- Sudhishri S and Dass A. 2012. Study on the impact and adoption of soil and water conservation technologies in Eastern Ghats of India. *Journal of Agricultural Engineering* **49**(1): 51–59.
- Tilekar S N, Hange D S, Shendge P N, Kalhapure S P and Amale A J. 2009. Economic evaluation of Bahirwadi watershed in Ahmednagar district of Maharashtra: a case study for replication in potential areas. *Agricultural Economics Research Review* **22**: 415–22.
- Varat T M. 2013. An assessment of watershed development programme: a study of Mandhwan village, district Ahmednagar. *Indian Streams Research Journal* **3**(1): 2230–50.
- Vishandass A K, Singh Jaspal and Sharma Amod. 2014. Inefficiency of maize cultivation in different Agro-Climatic Zones of Uttar Pradesh. *International Journal of Agricultural and Statistics Sciences* **10**(Supplement 1): 131–38.
- Walling Imti and Sharma Amod. 2018. Impact of agricultural technology management agency on different enterprises for the enhancement of production and income to the rural economy of Nagaland. *Economic Affair* **63**(2) June: 331–35.
- Yadav Mukesh Kumar and Sharma Amod. 2019a. Livestock rearing contribution towards the beneficiary and non-beneficiary on Watershed Development Programme in Nagaland. *International Journal of Current Microbiology and Applied Sciences* **8**(9): 1566–75.
- Yadav Mukesh, Kumar and Sharma Amod. 2019b. Assured Income and Employment of beneficiary and non-beneficiary through different activities Implemented under watershed programme in Nagaland. *International Journal of Current Microbiology and Applied Sciences* **8**(9): 1576–83.