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A Comprehensive Impact Assessment Study of Assam Rural Infrastructure Agricultural Services Project

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I

INTRODUCTION

Socio-economically Assam is one of the most prominent states of the north-eastern states of India. For rural communities of this state agriculture and tea cultivation are the two main economic pillars of livelihood support system. About 69 per cent of the total work force of the state is engaged in agriculture and allied activities. Geographically, Assam covers an area of about 78,000 sq. km, of which 34,000 sq. km. (44 per cent) are cultivable land. It accounts for about 2.4 per cent of the total geographical area of India. Agro-economically, the state could be divided into three main regions, i.e., lower Assam, upper Assam and hilly tracts. These regions stretch from the Himalayan foothills in the northeast to Bangladesh in the southwest. The Northern and Eastern part of the state is largely under tea cultivation, whereas lower and upper Assam which comprises two famous Brahmaputra and Barak valleys constitute the main agricultural production areas of the state. Hilly tracts are located in the southern part of the state, bordering the states of Meghalaya and Nagaland.

Though the area is rich in natural resources such as water and land but due to infrastructural limitations such as irrigation, the natural resource utilisation is not very impressive in the state. Poor quality of input supply, inadequacy of ground water harvesting infrastructure, poor rural road connectivity, problem of severe floods and failure to adopt and generate agricultural research and technology suitable to the local conditions are some of the critical factors affecting agricultural growth of the state.

To address these problems a comprehensive World Bank funded agricultural development project named "Assam Rural Infrastructure and Agricultural Services Project (ARIASP)" was launched in the state in the year 1994. The project was implemented during August 31, 1995 to December 31, 2003.

The project aimed to facilitate economic upliftment of poor section of the rural population in the state by creating better income enhancement opportunities to poorer farmers. To achieve this objective the project had initiated a number of agriculture

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and allied sector developmental activities. These project interventions covered areas such as extension services, horticulture, fisheries and livestock developmental activities. The project efforts aimed at increasing productivity of these sectors. Besides supporting department of agriculture and its allied departments, it also attempted to strengthen the institutional support for technology generation, education and training, seed multiplication and land administration and planning. The development of rural infrastructure such as rural roads and small-scale irrigation systems were the other key components of the ARIASP project taken up to support overall growth of agricultural sector.

As ARIASP was a major multi sector developmental intervention aimed at improving living standard of economically weaker farmers of the state, it is very important to know the overall impact of this mega agricultural developmental initiatives on farming communities of the state. Though World Bank carried out several impact assessment studies as part of in house project monitoring by the World Bank, but these studies were of very limited use as they evaluated the performance of ARIASP only on preconceived project objectives using a rigid Logframe technique and lacked a holistic system perspective project evaluation. Moreover, the results of such in-house studies has a very limited circulation therefore, even these partial project results were not in the common knowledge domain. Therefore the present study was carried out to fill this void in the literature and provide critical input to policy planners for future planning. Although the project covered poor farming communities in the entire state (23 districts), the intensity of activities in each district varies on the basis of the existing production potential.

II

METHODOLOGY

To assess the impact of the project research, methodology was designed in such a way so that it can capture the impact of the project on a broad range of socio-economic parameters. The following are some of the key features of the project.

2.1 Study Period

Primary data collection for this study was initiated in September 2003 and was completed in December 2003**.**

2.2 Sampling Framework

To get reliable and reflective results, it is necessary to have adequate representation of all the regions and all the activities. Hence a *Multi-Phase Stratified Random Sampling* frame was developed for this study. A broad structure of this sampling framework is given below. Figure 1 below reflect the generic view of sampling design used in the impact assessment study.

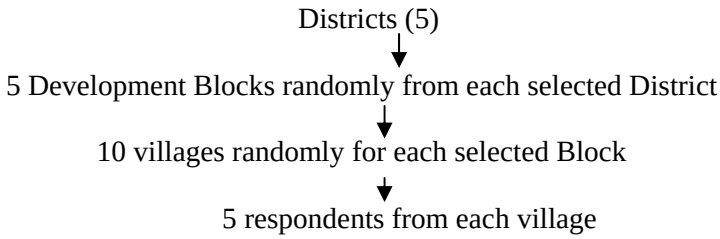

Figure 1. Sampling Design

2.3 Conceptual and Analytical Framework

Considering the multi-sector nature of the project a comprehensive multivariate analytical approach has been used in the present study. The advantage of using such an approach is that it allows to capture the impact of the project on several developmental parameters on a single methodological platform. The study attempted to compare the overall socio-economic improvement of the beneficiary farmers with those non-beneficiaries (who have not been benefited from the project) by using discriminant analysis technique. The study also identified and compared the factors influencing crop and livestock productivity in both before and after project scenario. A brief explanation of these concepts have been presented in the following sections.

2.3.1 Stepwise Regression Analysis

In order to identify the critical factors affecting crop and livestock productivity and to estimate their relative importance on productivity, stepwise regression analysis was carried out on before and after set of data. The regression analysis was performed by directly taking productivity as the dependent variable and regressed on the characters seemed to be affecting these dependent variables. Before regression analysis, zero order correlation analysis was done to examine the existence of the problem of multi-collinearity. If any, the problem of multi-collinearity was resolved through dropping of one or more multi-collinear variables or through specification of the variables in alternative form. A correlation coefficient of above 0.70 was considered as an indicator of the existence of multi-collinearity. In all, the variables were examined for their correlation with family income and employment. The following form of linear regression function was estimated for each enterprise using stepwise regression method.

$$Y = a + b_1 X_1 + b_2 x_2 + ... \quad ...b_k x_k$$

where,

Y = Yield per animal per day or yield/hectare/year

(To be one at a time and keeping other variables constant)

a = intercept,
b_i = regression coefficient of the variable,
X_i = i-th explanatory variables.

In stepwise regression method, the program performs a series of multiple regression, starting with most influential variable and adding one step at a time, one new variable which makes the greatest improvement in the goodness of fit. Under this method not only the significance of the variables added through each step in the model is tested for its significance at some specific level but also the variables which have entered in the previous steps. This procedure terminates when the specific level of significance is achieved (10 per cent probability level in the present study) or regression coefficient of the last variable added fails to reach or all programmed variables gets included in the model.

When the regression analysis was done for the purpose of prediction with several of the X variables, perhaps most of them may contribute little or nothing accurately predicting the dependent variable. Instead a suitable choice of few of them might give the best prediction. Through stepwise regression this problem could be solved very effectively. Stepwise regression results were used to identify the factors which are affecting crop and livestock productivity to know if there is a change in the types of factors which affect crop and livestock productivity and to examine if there is any change in their relative productivity influencing power.

2.3.2 Discriminant Analysis

In order to examine the overall impact of developmental intervention through ARIASP discriminant analysis technique was used. The discriminant method seeks to obtain a set of coefficient (Li) such that the squared difference between the mean score of one group (Non-ARIAS Project area) and the mean score of the other group (ARIAS Project area) is as large as possible in relation to the variation of discriminant score (Z) within the groups. With the discriminant function, it is possible to measure the net effect of a variable by holding the other variable constant and the relative importance of variables in regard to their power of discrimination between the two groups of the data, i.e., area which received developmental intervention and the area which was not covered under the project.

The general form of discriminant function applied on the combined set of data from the sampled population is given below:

$$Z = \sum_{i=1}^{k} + Li * Xi$$

Where,

Z = Total discriminant score,
L_i = Discriminant coefficient associated with variable Xi,

X_i = i-th independent variable which may discriminate the population in two distinct groups (i = 1,2,……..….k)

The Mahalnobis D^2 statistics was used to measure the distance between the two groups (ARIASP area and Non ARIASP area). D^2 statistics was then transformed into 'F' statistics, which was then used to see if the two groups were different from each other. The percentage contribution of each individual characteristic (X_i) in the total distance measured (D^2 value) between the two groups was computed as follows:

The difference between the two groups in respect of each variable X_1, X_2, ….. X_k and called d_1, d_2, …… d_k respectively were obtained by unidimensional substractions of mean score of farmers of the project area from mean score of farmers of non-project areas. The coefficients of discriminant function were then multiplied by the difference of the means of the respective variables. The values so obtained in respect of different variables were expressed as the percentage of D^2 value (total distance measured between the two groups).

In the discriminant function analysis finally only those variables were retained whose percentage contribution in D^2 was found to be positive and more than or equal to one per cent. This was done to screen out those variables, which had very low discriminating power. At the preliminary stage, several variables with alternative specifications of some of them were programmed in search of extent of socio-economic heterogeneity/inequality of farmers of project and non-project areas

IV

FINDINGS OF THE STUDY

4.1 Impact on Cropping Pattern

The Impact of the ARIASP project is quite visible through changes observed in the cropping pattern of the project area. The pattern of change in cropping system has been observed to be different for different regions of the state, i.e., Brahmaputra valley, Barak valley and mountainous region. In Brahmaputra valley, which represents low-lying area with alluvial soil, shift in cropping pattern is more sharp which may be attributed mainly to assured irrigation factor. However, in general, across the region people have shifted to more cash generating crops as reflected from the findings presented in following table.

TABLE 1. IMPACT ON CROPPING PATTERN

	Percentage of Gross Cropped Area	
Crop	Before ARIASP	After ARIASP
(1)	(2)	(3)
1. Food grain	78.2	72
2. Pulses	2.16	2.5
3. Oilseed	8.06	8.5
4. Fibre	1.86	2.0
5. Fruits and vegetables	3.76	4.4
6. Others	6.00	10.6

Source: *Statistical Handbooks of Assam.*

4.2 Impact on Farming System

The farming community of Assam in general follow integrated farming system, i.e., crop farming with livestock, poultry, fisheries along with other farm enterprises. Adoption of this integrated farming system generates strong presence of backward and forward linkages of crop farming with other agricultural allied enterprises. Due to presence of these strong linkages, any change in agriculture influences the performance of other allied farm enterprises. Therefore, in the present study an attempt has been made to examine the impact of changes in cropping pattern, triggered on by the project activities by looking into crop sequencing. This approach was based on the assumption that adoption of particular crop rotation is indicative of farming pattern of that region. This also helps in examining the resource usage pattern of that region. The results of the study has been presented in Table 2.

TABLE 2. IMPACT OF ARIASP ON CROP ROTATION

Crop rotation (1)	Percentage of farmers adopting	
	Before ARIASP (2)	After ARIASP (3)
Direct seeded Ahu rice /Jute followed by *Rabi* pulses/wheat/Mustard/winter vegetables	35	28
Ahu rice/Jute/ Summer vegetables followed by Wheat/Pulse/Rape and mustard/potato winter vegetables	40	32
Summer mung/Soyabean followed by winter vegetables/Wheat/*Rabi* pulses/Oilseeds	21	25
Summer vegetables followed by Wheat/Pulses/Oilseeds/Winter vegetables	12	23
Kharif maize/Soyabean followed by rapeseed and Mustard/Lentil winter vegetables/Potato	14	17

A close look at the data presented in Table 2 indicates that after improvement in irrigation infrastructure, the farmers are shifting towards more cash generating crops, which has resulted in improved cash flow in the family on continuous basis. This improved cash flow in turn has a very positive impact on health, education, nutritional intake and purchasing capacity of the people of the region (71 per cent beneficiaries).

4.3 Impact on Crop Productivity

Paddy is a very important crop in Assam. It is a staple food for majority of the people of Assam. It accounts for more than 67 per cent of the gross cropped area of the state. A review of secondary crop productivity data (Government of Assam, 1995; 2001; 2002) reveals that as a result of ARIASP intervention the overall average productivity of paddy has increased more than 16 per cent in Assam. In the state, production of paddy has gone up from 3362 thousand tonnes in 1993-1994 to 3999 thousand tonnes in the year 2000-01 showing more than 18 per cent increase in total

production. This increase in productivity and production has ushered in the green revolution in the state which is essentially due to multidirectional efforts of ARIASP. This is a remarkable achievement specially if we consider a very short effective project period of 4 years.

A close look of secondary data reveals that the project has resulted in increase in the crop productivity in the range of 4 per cent to 21 per cent, depending on the nature of the crop. This improvement in crop productivity appears mainly due to development of irrigation through ARIASP, as during project implementation irrigation development was the only major intervention in the project area.

4.5 Impact on Cropping Intensity

Improvement of irrigation facilities has facilitated more intensive land utilisation in the project area, which is self evident from the estimates presented in Table 3.

TABLE 3. IMPACT OF ARIASP ON CROPPING INTENSITY

Cropping intensity range	Percentage of farmers adopted		
	Before ARIASP	After ARIASP	Net change
(1)	(2)	(3)	(4)
More than 200 per cent	11	24	+13
150-200 per cent	22	38	+16
100-150 per cent	67	38	-29
Weighted average = 195	100	100	

The results presented in Table 3 indicate that although 38 per cent farmers are still operating in 100-150 per cent cropping intensity range, but a large number of farmers have started more intensive use of their land as they have moved up in 150-200 per cent cropping intensity range and in few cases even to more intensive cropping intensity range. This shift in cropping pattern has further pushed the average cropping intensity in the project area upto 195 per cent.

Impact on Farm Diversification

One very positive outcome of ARIASP intervention has been that farmers are now adopting more integrated farming practices and diversifying sources of their income. The impact assessment study attempted to capture it and these findings have been presented in Table 4.

TABLE 4. IMPACT OF ARIASP ON FARMING SYSTEM

(per cent)

Allied activities	No of farmers adopting		
	Before ARIASP	After ARIASP	Change
(1)	(2)	(3)	(4)
Dairying	70	78	+8
Fisheries*	9	10	+1
Poultry	71	74	+3
Honey bee keeping	62	63	+1
Sericulture	27	31	+4
Others	11	14	+3

* In Assam around 10 per cent farmers have their own fish ponds. However majority of the farmers are engaged in some fish catching activities in common fisheries sources, i.e. river, village ponds, open water fisheries, etc.

A review of the data presented in Table 4 above indicates that slowly farmers are diversifying their source of income which is a very healthy sign as it may insulate them from various type of risks associated with the crop farming.

4.6 Impact on Nutritional Intake

In Assam milk and fish has been traditionally a very important source of protein in the human diet. However poor genetic herd and low yield had created a situation of milk starvation in the state. This situation is reflected from the fact that at the time of ARIAS Project inception, per capita milk consumption was as low as 80.40 grams/day/capita, which has gone up to 150 gram/day/capita (87.5 per cent increase). After the ARIASP statistically this increase was observed highly significant (at 5 per cent level of significance). One natural outcome of improved fish production through activities such as promotion and rehabilitation of farmers' pond and community tanks was improved per capita fish consumption in the project area. Fish being an excellent source of protein, has helped improve the overall health of the beneficiaries significantly. As a result of improved fish productivity per capita fish consumption has gone up from 6.5 kg/capita to 14 kg/capita per year, which was observed to be statistically highly significant ('Z' test).

4.7 Creation of Additional Employment

In ARIAS project area, improvement in cropping intensity is the most visible impact of ARIASP propelled by installation of more than 63,800 shallow tubewells (STWs), out of which, 53134 STWs are already operational. The study estimated that on an average these STWs are serving 2.2 hectare area. Therefore, additional net cultivated area brought under assured irrigation through STW is 116894.8 hectare. As the current cropping intensity in the project area is 195 per cent, therefore, with this cropping intensity level, net addition in gross cropped area can be worked out as 74812.67 hectares. This addition in gross cropped area is the main source of

increment in employment in agriculture. Similarly on the basis of current crop mix and existing technology, per hectare labour absorption rate has been estimated to be 93 man-days. Since, ARIASP had contributed 64 per cent increase in the cropping intensity which has added some 74812.67 hectares crop land through increase in gross cropped area. We can work out additional employment created through ARIASP as 69.585 lakhs man-days/year or 131 man-days/farmer/year. For marginal, small, medium and large farmers this incremental employment was 28, 78, 128 and 288 man-days/farmer/year respectively. Increased requirement of labour across the farmers categories in general and large farmers in particular pushed up the average nominal wage rate in project area by 10-15 per cent.

4.8 Impact on Magnitude and Composition of Family Income

The cumulative impact of ARIASP has improved the average family income of the farmers of the project area from Rs. 14,631.7/family/year to Rs.20,888.5/ family/year showing a net increase of 42.76 per cent, which is a very impressive achievement for any project to be achieved within a short period of 4-5 years. Before and after ARIASP income composition of the farmers of the project area has been presented in Table 5 below.

TABLE 5. BEFORE AND AFTER COMPOSITION OF FAMILY INCOME

Source of income	Before the ARIASP Rs./family/year	After the ARIASP Rs./family/year	Percentage change	'Z' value
(1)	(2)	(3)	(4)	(5)
Agriculture	7,232	9,813	35.69	3.985*
Livestock	897	1,656	84.62	5.004*
Fisheries	993	1,672	68.38	5.134*
Others (Wage labour, services etc.)	5,509.7	7,747.5	40.62	5.071*
Total	14,631.7	20,888.5	42.76	

** and * Significant at 10 and 5 per cent level of significance, respectively.

The above findings reveal that in general all major project activities have yielded the desired results. This positive gain has improved the project income from agriculture, livestock and fishery activities significantly. Increased productivity of crop, livestock and fisheries is the main source of this improvement in income, which was further reinforced by the better price realisation due to road rehabilitation. This is despite the general depression in prices of agricultural produces due to increased production and non availability of marketing support to absorb this additional marketable surplus generated as a result of project interventions.

4.9 Factors Affecting Crop and Livestock Productivity

As explained in the Methodology section, to assess the relative importance of various factors, which determine crop and livestock productivity, stepwise regression methods, was used.

4.10 Factors Affecting Crop Productivity

The following variables were attempted in regression analysis.

1. Timeliness (Deviation in days from stipulated date of agronomic practices)
2. Quality of input (10 point scale)
3. Managerial skill (10 point scale)
4. Human labour (Hour/hectare)
5. Capital investment (Rs./ha.)
6. Educational level of head of the family/Decision maker
7. Size of the farm (ha.)
8. Number of training attended by the farmer
9. Exposure visits (Nos.)
10. Use of chemical/ insecticides (Rs./ha.)
11. Seed (Kg/ha.)
12. Fertiliser (kg/ha.)
13. Manure (Kg/ha.)

The final run of stepwise regression analysis for before and after ARIASP set of data yielded the following results:

TABLE 6. FACTORS AFFECTING CROP PRODUCTIVITY

	Timeliness		Managerial skill		Training		Capital investment	
	b1		b3		b5		b7	
Types of farmers (1)	Before ARIASP (2)	After ARIASP (3)	Before ARIASP (4)	After ARIASP (5)	Before ARIASP (6)	After ARIASP (7)	Before ARIASP (8)	After ARIASP (9)
1. Large	0.33*	0.42*	0.45*	0.46*	0.21**	0.35*	0.42*	0.45*
2. Medium	0.39*	0.49*	0.56*	0.59*	0.27**	0.39*	0.54*	0.57*
3. Small	0.44*	0.50*	0.62*	0.67*	0.32**	0.42*	0.62*	0.65*
4. Marginal	0.49*	0.51*	0.68*	0.71*	0.39*	0.48*	0.64*	0.70*
Overall	0.40*	0.48*	0.61*	0.65*	0.32**	0.40*	0.58*	0.64*

** and * Significant at 10 and 5 per cent level of significance, respectively.

The regression results presented in Table 6 above indicate that in the state even after project intervention, crop productivity affecting factors remained the same across various farm categories. It is interesting to note that after project intervention

these factors have become more critical. This can be explained as the natural consequence of shift of traditional cropping system into modern cropping system which is more sensitive to these factors.

4.11 Factors Affecting Animal Productivity

To identify the critical livestock productivity affecting variables and for identifying the relative influence of variables, stepwise regression analysis was carried out. In the initial run the following variables were considered.

(1) Dry fodder (Kg/day/animal).
(2) Green fodder (Kg/day/animal).
(3) Concentrate (Kg/day/animal).
(4) Expenses on veterinary medicines (Rs./month).
(5) Breed type (Dummy variable 0 and 1).
(6) Herd size (No).

The final run of stepwise regression yielded the following results.

TABLE 7. FACTORS AFFECTING ANIMAL PRODUCTIVITY

Types of animal	Dry fodder b1		Green fodder b2		Concentrate b3		Expenses on veterinary b4		Herd size b6	
(1)	Before (2)	After (3)	Before (4)	After (5)	Before (6)	After (7)	Before (8)	After (9)	Before (10)	After (11)
Cross breed	0.045**	0.032**	0.57*	0.78*	0.50*	0.64*	0.68*	0.87*	0.021**	0.020**
Desi breed	0.066**	0.060**	0.28**	0.22*	0.23**	0.29*	0.036**	0.031**	-0.07**	-0.04**

** and * Significant at 5 and 10 per cent level of significance,

From these regression results it is evident that for cross breed animals, the expenses on veterinary medicines, green fodder and supply of concentrates is very critical to realise their full productive potential whereas, for desi breed green fodder turns out to be most critical. These results also indicate that crossbreed animals have more sensitivity towards nutritional and veterinary health support. The results also indicate that after ARIASP project the relative influence of these productivity determining factor has increased.

4. 12 Overall Socio-Economic Impact

Any comprehensive developmental projects like ARIASP have multidimensional socio-economic impact on the beneficiaries. Therefore, to assess the overall impact of ARIASP discriminant analysis techniques have been used to assess if in terms of

various socio-economic developmental parameters, the beneficiary and non-beneficiary groups of farmers differs significantly or not. The results of the discriminant analysis have been presented in Table 8.

TABLE 8. DISCRIMINANT ANALYSIS

Discriminant variable (1)	Percent contribution in total socio-economic disparities (2)
1. Family income	39
2. Infrastructure	22
3. Resource base	18
4. Crop and livestock productivity	21

The results of the discriminant analysis suggests that as a result of developmental intervention of the ARIASP project, project area have better family income, infrastructure, resource base and are better in terms of crop and livestock productivity.

V

CONCLUSION

ARIASP was major multi-sector developmental intervention aimed at improving the standard of living of the economically weaker farmers of the state. The findings of the study reveal that in general all major project activities have yielded the desired result. This positive gain has improved project income from agriculture, livestock and fishery activities significantly. Increased productivity of crop, livestock and fisheries is the main source of this improvement in income, which is further reinforced by the better price realisation due to road rehabilitation. This is despite the general depression in prices of agricultural produces due to increased production and non-availability of marketing support to absorb this additional marketable surplus generated as a result of project interventions.

The study also indicated that even after such multi-sector project intervention crop and livestock productivity affecting factors remained the same across various farm categories. After project intervention these factors have became even more critical. The results of the discriminant analysis suggest that as a result of developmental intervention of the ARIASP project, the project area has better family income, infrastructure, resource base and is better in terms of crop and livestock productivity.

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