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AGRICULTURE AND SUSTAINABLE DEVELOPMENT
A Case Study of Assam

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North-Eastern Region with natural endowment of forests, orchards and wide ranging field crops and other flora, offers immense potentialities for the growth and development of agriculture. The region is characterised by diverse geological, physiographic and agro-climatic features which makes the region unique. The North-Eastern Region (NER) occupies a geographical area of 2.74 lakh square kilometres. Physiographically, the region is divided into four units, namely: Eastern Himalayas; Eastern Mountains; Meghalaya—Mikir tablelands; and the Brahmaputra valley.

This in turn has given rise to six agro-climatic zones which form the primary basis for development of agriculture in the region. The broad parameters governing the mosaic pattern of agro climates comprise rainfall—ranging between 2200 mm to 4500 mm, temperature between 10-35 degree Celsius, relative humidity 45-95% per cent, *p*H 5.5 to 7.00, varying altitude, longitude, etc. The region characterised by a wide spectrum of agro climates ranging from tropical humid to alpine temperature and rich in bio genetic resources, is congenial for multifarious agricultural development. The entire agricultural development revolves around this chequered pattern. North-East India sustains two-third of the country's forests. Also two-thirds of its area is under cultivation. But surprising enough the region is not self-sufficient in foodgrains. While it produces in excess of other type of cash crops like tea, ginger and potatoes. In

1998-99, the production of potato was 9,97,000 tonnes grown in 114.5 thousand hectares of land compared to the all India production rate of 2,24,95,000 tonnes. The total share was 4.34 per cent of the national production. The yield per hectare is 85,33,000 kg against the all India total of 1,75,74,000 kg per hectare. The yield from Tripura alone is 1,76,00,000 kg per hectare. The region produced 1,07,000 tonnes of ginger in 18,000 hectares of land. The yield on ginger is 5,944.00 kg per hectare. In terms of horticulture production, the region stands out in terms of bananas and pineapples. In the year 1998-99, the area under banana was 60,000 hectares and production was 7,36,000 tonnes. The yield stood at 12,267.00 kg per hectare. The region produced 4,86,000 tonnes of pineapple against all India figures of 10,71,000 tonnes.

The North-East has nearly about 30 per cent of the total national water resources. The region has ground water potential of 25,320 M Cubic metre. This apart, existence of a large number of rivers (19,198 km), reservoirs (8.123 ha), streams, natural lakes/beels (14,37,000 ha), ponds, and tanks (41,624 ha) other estuaries open up opportunities for extensive agricultural development. Stretched over 1.54 lakh square km, the region covers nearly 55 per cent of the geographical area with forest resources consisting of 650 valuable forest species. It has low land paddy fields of 94,80,800 ha. While rest of the country utilises 90 per cent of the water in agriculture sector, the use of water for agriculture and allied activities in NER are negligible. A major reason for the non-utilisation of water is the frequent flood in the region. Four North-Eastern States witness flood every year, Assam being the most acute where 8,000 hectares of fertile land along the Brahmaputra river are eroded every year. Since 1954, nearly 4 lakh hectares of fertile agricultural land accounting for seven per cent of the plains in Assam covering 18 districts have been eroded.

However the region is heavily dependent on State like Andhra Pradesh, Uttar Pradesh and Punjab for its supply of wheat and rice. The region does not produce sufficient foodgrains for its consumption. The region spends over a thousand crore of rupees in importing cereals. Assam alone accounts for 9.56 lakh MT annual deficit of rice production.

Emerging Agricultural Scenario in Assam

Topographical Features

Assam comprises an area of 78,523 square kilometres with 25 districts. Except for the districts of Karbianglong and North Cachar hills, Assam is generally composed of plains and river valleys. It is divided into three principal geographical regions; the Brahmaputra valley in the north; the Barak valley in the south; and the Mikir (Karbi Anglong) and Cachar hills that divide the two regions. The elongated valley of the mighty river Brahmaputra wholly occupies the northern part of Assam. Most of Assam's population live in this valley. The foothills of the Himalayas bound the Brahmaputra valley to the north and another lower range hills and mountains to the south. In the centre part of Assam, to the south of the hills is the Barak valley, which is contiguous with Bangladesh. The Brahmaputra valley is the dominant physical feature of Assam. The Brahmaputra enters Assam near Sadiya at the extreme north-east corner and runs westward for nearly 450 miles before turning south to enter the plains of Bangladesh. The river valley, rarely more than 50 miles wide, is studded with numerous low, isolated hills and ridges that abruptly rise from the plain. The valley is surrounded on all sides, except the west, by mountains and is intersected by many streams and rivulets that flow from the neighbouring hills to empty into the Brahmaputra. Assam lies in the low productivity-high potential zone, where the productivity is low despite abundant water availability and good soil.

Resources and the Sectoral Contribution

Assam is a State rich in natural resource like oil and natural gas, coal, rubber, tea and some mineral like granite, limestone, and kaolin. The present State is much smaller than what it was forty years ago. It is still the largest economy of NER. It is like the gateway of other North-Eastern States with an infrastructure index (according to CMIE in 1992-93) of 93, quite close to the average of 100. Although it is more industrially developed than the other North-Eastern States, it is primarily an agrarian economy with 74 per cent of its population engaged in agriculture and allied activities. The State is known for its large industries in the petroleum sectors. In

Table 15.1: NSD Product at Factor Cost by Industry of Origin at Constant (1993-94) Prices

(Rs. in lakhs)

Industry	1993-94	1997-98	1998-99	1999-2000	2000-01 (*Q*)	CARG (%)
Agriculture	5,02,168	5,47,705	5,19,522	5,49,722	5,64,894	1.70
Sub Total						
Primary Sector	6,47,448	7,03,174	6,74,218	7,04,383	7,23,595	1.60
Total NSDP	13,47,683	14,70,357	14,57,444	15,58,037	16,23,618	2.70
India	6,85,91,200	8,90,71,200	9,48,98,200	10,11,22,400	—	6.68

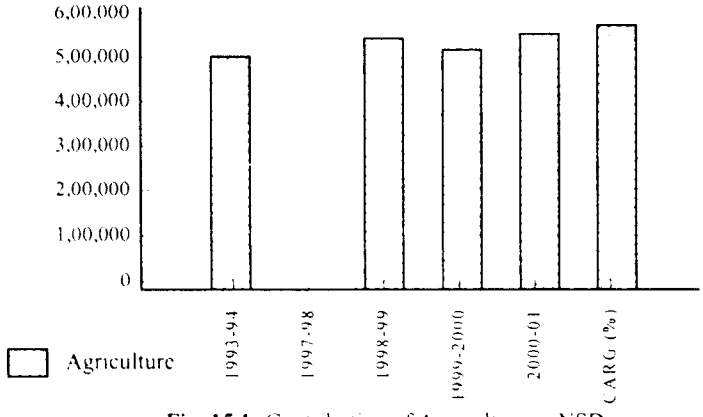

Fig. 15.1: Contribution of Agriculture to NSD

Source: Directorate of Economics and Statistics, Government of Assam, 2002.

1999-2000, the contribution of the tertiary sector to the State Domestic Product (SDP) is the highest (39.46). Over the years, there has been a shift in the sectoral contribution from primary to the tertiary sector while the secondary sector indicates a fluctuating contribution to the SDP. Assam's Net State Domestic Product at constant (1993-94) prices was Rs. 16,23,618 lakh in 2000-01. During 1993-94 to 2000-01 the NSDP at constant price grew by an average rate of 2.70 per cent per annum. The growth rate was lower than the all India rate during the same period. During the period 1993-94 to 2000-01, the compounded annual average rate of growth of the primary sector was 1.60 per cent; the secondary sector was 4.58 per cent while the tertiary sector grew at 3.32 per cent. The growth rate achieved was much lower than the national average.

Agricultural Scenario

Agriculture occupies an important place in the economy of the State. Till date it is a traditional agriculture based economy and forms the major occupation of the people of the State. It is relatively non-mechanised and hence requires manual labour during various stages of production like ploughing, weeding, harvesting and threshing, etc. The people of the State depend heavily on agriculture sector for their livelihood. In Assam, more than 70 per cent of the population are engaged in agriculture as farmers, or as agricultural labourers, which generates Rs. 423 per capita income from the sector (1990). Seventy-four per cent of its total agricultural area is devoted to rice cultivation. The average size of land holding per household was only 1.30 hectares during 1990-91. The fragmentation of land is attributed to the law of inheritance and the government land reform measures which set the ceiling for land holdings per family to 50 *bighas* or 16.6 acres. The growth of agriculture is miserably low at 1.87 per cent per annum. The total values of agricultural crops are growing at the rate of 2.14 per cent per annum. The total foodgrain production in 1999-2000 was 4.04 million tonnes and it occupies about 70 per cent of the gross cropped area in the State. Main cash crops are jute, tea, cotton, oilseeds, sugarcane, fruits and potatoes. Wheat production in 1999-2000 was 0.1 million tonnes, rice was 3.9 million tonnes and pulses were 64.688 tonnes. Although rice is the major crop of Assam, its productivity over the years has not increased while the other crops have slightly increased in both productivity and land

acreage. For example, while rice yield per hectare in 1970-71 was 1,022 kgs per hectare, it was 1,261 kgs in 1990-91. The yield of wheat was 583 kgs in 1970-71 and it increased to three-fold from 583 kgs per hectare to 1,455 kgs in 1990-91. A similar increase was observed in jute, sugarcane, potato, and mustard.

Population and Agriculture

While the economy of the State is ailing for all these years, the population growth is exceptionally high in the State. While the population of the country during the 1961-91 decade grew by 92 per cent, it has grown by 107.4 per cent in Assam during the same period. Population density in Assam was 286 per square kilometre as against the national average of 267 per square kilometre in 1991. As per 2001 census, the population of the State is staggering 2,24,14,322 with a growth rate of 24.2 per cent and by 2025, it would reach around 4 crore which would put tremendous pressure on land, infrastructure and its people. The population density stands at 340 people per square kilometre as per 2001 census.

As seen from Table 15.2, there was an increase in the number of cultivators from 35,59,117 in 1991 to 37,41,912 in 2001, i.e., an increase of 0.05 per cent. The number of males engaged as cultivators declined by 7.2 per cent whereas the female cultivators increased by 56 per cent during the decade under reference. As regards agricultural labourers, the total increase percentage hovered around 47 per cent with 24.44 per cent males and 189 per cent for females during the decade from 1991-2001.

As seen the shifting of the trend is towards females as agricultural labourers and cultivators. It is also evident that the males have diverted from the primary sector to secondary or the tertiary sector for their livelihood and sustenance.

Land Pattern in Assam

Figure 15.2 reveals that the net area for cultivation increased by only 0.7 per cent while the agricultural land increased by only 0.64 per cent from 1996-99. The figure also indicates that there was a steady growth of uncultivable land to the extent of 10,852 hectares during the period of reference. The area sown more than once showed a decline trend to the tune of 4,886 hectares from 1996-99. The net

Table 15.2: Decadal Population engaged in Agriculture

	Population			Cultivators			Agriculture labourers		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
1991	2,24,14,322	1,16,57,989	1,07,56,333	35,59,117	28,70,583	6,88,534	8,44,964	6,82,573	1,52,391
2001	2,66,38,407	1,37,87,799	1,28,50,608	37,41,912	26,61,619	10,80,293	12,89,902	8,49,434	4,40,468

Source: Census Report, 2001.

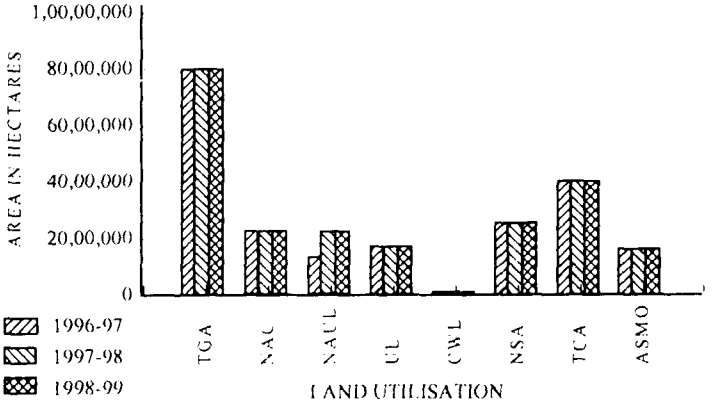

Fig. 15.2: Classification of Area in Assam

Source: Directorate of Economics and Statistics, Government of Assam 2002.

sown area was 68.54 per cent to that of the total cropped area as of data available in 1998-99. Assam accounted for 5.72 lakh gross irrigated area in 1971-72 and there has been no addition of a single hectare till 1991-92. The irrigated area as proportion to cropped area in 1971-72 was 19.8 per cent, in 1981-82 was 16.5 per cent and in 1991-92 was 14.8 per cent thus showing a decline trend over the decades. The gross irrigated area in 1991-92 accounted to 5,72,000 hectares.

Cropping Area

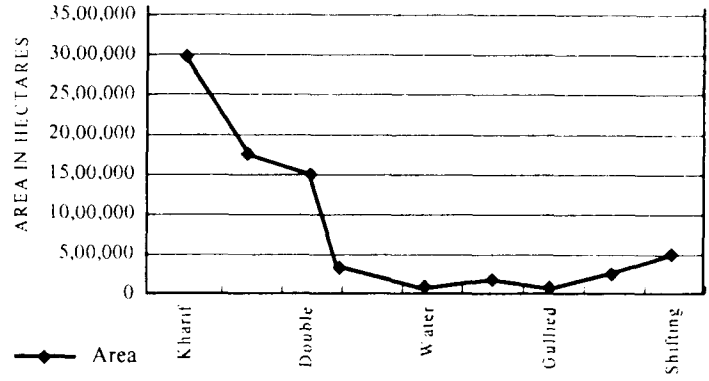

Fig. 15.3: Land Utilisation Pattern of Different Crops in Assam

Source: Directorate of Economics and Statistics, Government of Assam, 2002.

Figure 15.3 shows the land utilisation pattern of different crops in Assam. The four measure areas of utilisation are confined to *Kharif*, *Rabi*, double cropping and shifting cultivation. The area utilised are to the extent of 2,95,824 hectares for *Kharif*, 17,44,511 hectares for *Rabi*, 14,87,041 hectares for double crop and 4,82,571 hectares for shifting cultivation. As seen from the figure the other left out land are waterlogged, swampy, gullied and also covered by grass.

Water Resources

Brahmaputra and Barak rivers alone constitute 32 per cent of the country's water resources and there is very less utilisation of Brahmaputra's water in the region. It is well known that Brahmaputra has surplus water between May and October. The inadequacy of an irrigation network has been a major impediment in improving the

output of the region. Owing to paucity of funds, the non-tapping of ground water resources is inexplicable. Assam has appreciable ground water reserves, which have not been fully utilised. The abundance of rains ensures regeneration of this resource as yet its utilisation has remained at a very low level.

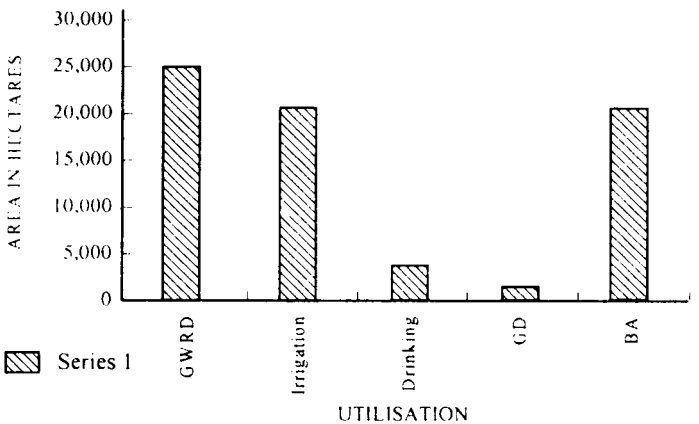

Fig. 15.4: Ground Water Resource and Utilisation

Source: Directorate of Economics and Statistics, Government of Assam 2002.

Assam accounted for 5.72 lakh gross irrigated area in 1971-72 and there has been no addition of a single hectare till 1991-92. The irrigated area as proportion to cropped area in 1971-72 was 19.8 per cent, in 1981-82 was 16.5 per cent, and in 1991-92 was 14.8 per cent thus showing a decline trend over the decades. The gross irrigated area in 1991-92 accounted to 5,72,000 hectares. The figures shows the ground water resources available in the State. If utilised and harnessed properly, it can bring a new revolution in the agricultural sector.

Foodgrain Production in Assam

Rice is the major crop claiming the lion's share in the area, water and budgetary allocations, besides being the dominant staple in the dietary habits of the people. This is evident from the fact that rice, as a major crop is grown thrice a year. However the production pattern shows no subsistence increase from 1993 to 2000. Next to rice other cereals

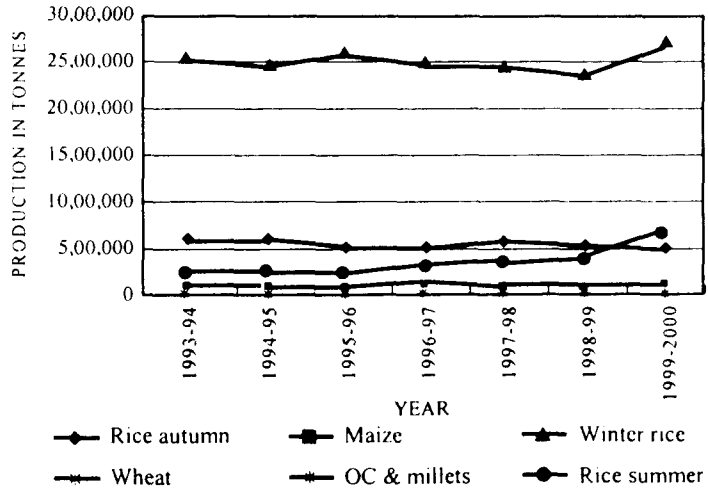

Fig. 15.5: Production of Crops

Source: Directorate of Economics and Statistics, Government of Assam, 2002.

and millets are grown which only showed a substantial increase in the year 1995-96 after which the production stagnated and was around 5,400 tonnes up to the year 1999-2000. In case of maize the production showed a marginal increase over the period from 1993-1998 after which the production declined in the year 1998-2000. The slow growth of crops can be attributed to inadequate production technology, price variability, production risk and low level of irrigation that lead to stagnation yield of these crops.

Production of rice is almost hovering around 1,324 to 1,548 kg per hectare with an annual growth rate of 2.24 per cent in the period between 1993-2000. The cause is attributed to the constraints like cultivation on rain fed, marginal and sub-marginal lands, high susceptibility to insects, pests and diseases, weather aberrations (including flood) and lack of genetic breakthrough. Consequently OC and millets, which was 4,534 tonnes during 1993 registered a growth rate of 32.37 per cent in 1995-96 and from 1995-96 showed a stagnated production around 5,429 tonnes in average up to the year 1999-2000.

As evident from Fig. 15.5, increase in production were small and future increases are expected to be less than moderate because

of a shift of occupation from primary sector to secondary or tertiary sector until and unless a technological and infrastructure revolution is ushered in.

Yield of Different Crops

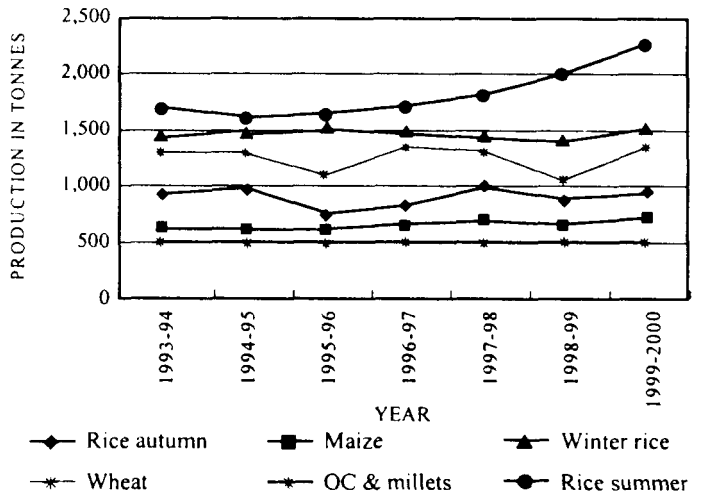

Fig. 15.6: Average Yield of Crops

Source: Directorate of Economics and Statistics, Government of Assam, 2002.

The average yield of rice (autumn) was not substantial as in the case of summer rice. Rice (summer) showed an increase of 4.63 per cent yield over a period of seven years from 1993-2000, whereas in case of winter rice there was no substantial increase of yield and it almost stagnated at 1,415 kg per hectare. There was a very meagre impact of technology on production levels of these crops due to marginalisation factors. Other crops like maize and autumn rice showed no absolute increase in production over the reference period from 1993-2000.

Area of Different Crops

The area under rice recorded a poor growth rate of only 0.60 per cent during the period between 1993-2000. The trend also shows diversification of land to summer cultivation from wheat. The area

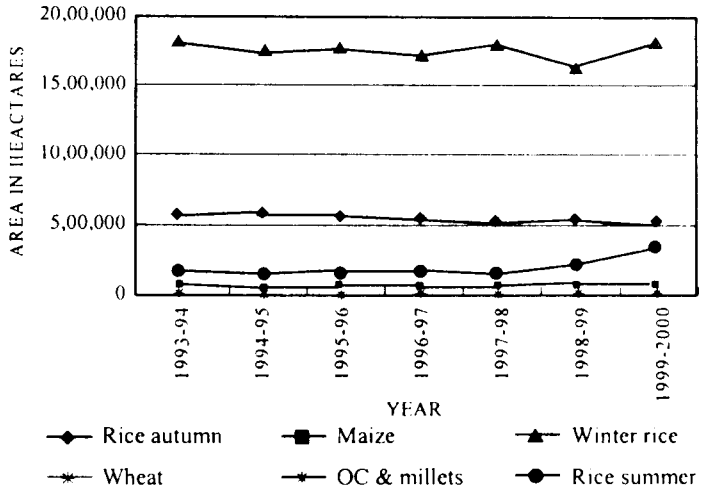

Fig. 15.7: Production Area of Crops

Source: Directorate of Economics and Statistics, Government of Assam, 2002.

under rice, declined from 6,46,586 hectares during the period from 1994-95 to 1999-2000 witnessing –13.82 per cent growth rate. With reduction in area there is decrease in production from 6,19,126 tonnes to 5,14,156 tonnes during the reference period. During 1993-95 production however increased from 5,86,620 tonnes to 6,19,126 tonnes showing a growth rate of 5.54 per cent. After 1995, there was a reduction in the production level till the year 2000 as compared to 1994-95. Summer rice in terms of area exhibited a growth rate of 129.86 per cent from 1993-2000 whereas winter rice witnessed –0.21 per cent growth rate during the same period.

Problems of Agricultural Development

Size of Operational Holdings

The size of operational holdings less than two hectares is uneconomical and falls in the category of small and tiny holdings. In Assam the average size of operational holding during the period from 1970-71 to 1990-91 has come down from 1.47 hectares to 1.31 hectares. Small and marginal holdings account for 80 to 90 per cent of the total holdings. In the year 1971-72, 27.12 per cent of the

household were landless and 99.22 per cent household had less than 6.07 hectares. With increase in population and fragmentation of land holdings, it is imperative that a new thought has to be given for the land reforms. Such small size of agricultural plots is uneconomical and less suitable for scientific cultivation. It leads to wastage of labour, time and other inputs like biomass and fertilisers. This also leads to low yield rate.

Irrigation

The inadequacy of an irrigation network has been a major impediment in improving the output of the region. Owing to paucity of funds, the non-tapping of ground water resources is inexplicable. Assam has appreciable ground water reserves, which have not been fully utilised. The abundance of rains ensures regeneration of this resource as yet its utilisation has remained at a very low level. The farmers are yet to adopt large-scale drip irrigation and sprinkle irrigation. Improved irrigation facilities by harnessing the ground water resources particularly for minor irrigation can increase the gross area irrigated to cover at least 50 per cent of the GCA which is yet to be realised by the irrigation technocrats.

Flood Damage and Flood Control Measures

Floods over the years have affected the people in terms of damage to property, crop, cattle, and loss of human lives besides shattering the socio-economic fabric of the State. The total area affected in 1969 was 8,607 square kilometres, which was further, increased to 8,607 square kilometres in 1970 and to 3.06 lakh hectare in 1978. The total damage was estimated at 427.02 lakh of rupees in 1978.

Of the 25 districts in the State, 22 districts experienced the worst flood in 50 years in Assam last year. As estimated 48 lakh people are affected by floods, which brought untold damage to the agricultural production (*The Telegraph* 25th July, 2002). Estimated loss is of 2.4 per cent of SDP due to flood damage. In the year 1987-88, 10.49 lakh hectares of crop area was affected by flood and the total damage was estimated to be 386.59 crores of rupees. (Basic statistics of the NER-1989, NEC). Agricultural lands located in the low and flat alluvial plains, where malfunctions of water retention and

retardation are caused by rapid progress of urbanisation, have increased the vulnerability to flood damages topographically.

Micro Credit

Agricultural credit is a crucial input to the farmers living in the remote, hilly, backward and tribal areas. It helps in raising the capabilities of small peasants and promoting sustainable agricultural systems. Because of smaller fragment of land, lack of proper collateral guarantee, most of the commercial banks refuse to give loan to the farmers. Most of the farmers depend upon unscrupulous moneylenders for meeting their requirements of harvesting the crops. Even the government scheme like IRDP failed to provide loans to the farmers to improve their agricultural production and other allied agricultural activities. Without improving the micro credit system, it is not possible to improve the agricultural scenario in Assam as most of the farmers belong to the marginalised category.

Marketing

In Assam no proper marketing facilities exists for farmers either in the form of linkages with markets nor there is any substantial improvement in rural marketing structures. Markets for agricultural products in Assam are underdeveloped. Geographically Assam is in a better position to market its products than other North-Eastern States. But for this there is a requirement to have a better transportation system, communication system and marketing infrastructure, and market intelligence system. Proper marketing system can also act as a source of revenue in the form of tax from the daily and weekly markets and check gates. Brokers and buyers have no access to timely market reports about the price of products on daily basis and in this regard the farmers are far away. Farmers are forced to sell their products immediately after the harvest at a lower rate.

Non-Economic Factors

Lack of proper education to the farmers, disturbed law and order situations, political and administrative instabilities, growth of population, lack of skilled manpower, lack of entrepreneurial skill specially among the youth and the vision of the people to invest in

agriculture are some of the principal reasons to contribute adversely for the growth of agriculture in Assam. Along with these the potentiality of Assam in agro-food industries still remains unexplored.

Conservation of Land, Water and Biological Resources

There is no optimal use of land, water and genetic resources in a sustainable manner in Assam. Efforts are needed for the use of marginal, wasteland and community lands for agro forestry, which can substantially, improve the economy of the people. The government should initiate pilot projects on dry land for agriculture. The land reform measures are far behind the other States, which is a must for helping the poor by way of distributing land to the landless and also for agricultural growth.

Consumption of Fertilisers

The fertiliser consumption per hectare of gross cropped area in 1994-95 was 9.5 kg in Assam as against 175 kg in Punjab, 136 kg in Tamil Nadu, 126 kg in Haryana and 75.7 kg on an average in the country as a whole. The pesticide consumption was 0.8 per cent while the other NER consumed 1.2 per cent of the country's total pesticide consumption.

The Success Areas

The Shallow Tube Well Irrigation Scheme implemented in the State under *Samridha Krishak Yojana* (SKY) by the State Agricultural Department is a success in terms of its physical achievements—added irrigation, increased farm output, and higher income for farmers besides efficiency in financial utilisation. The scheme was launched in October 1999 with an outlay of Rs. 230 crore meant to cover 18 districts with the installation of one lakh shallow Tube Wells by March 2001. The primary objective of the scheme was to boost agricultural production, especially during the *Rabi* (winter) season and thereby creating additional employment opportunities and promoting income generation in the agricultural sector. The impact of the scheme can be seen in terms of production of rice, which increased from 32.54 lakh MT to 38.61 lakh MT to 39.98 lakh MT to 40 lakh MT, from 1998-2002 showing an increase trend in rice

production in successive years. The production could have been higher, but many farmers shifted to multiple cropping patterns as they were assured of regular irrigation. A boost in farm output and increase in job opportunities were the two direct benefits the farmers derived from the scheme. While the technical rationale was to increase irrigation resources to enhance production, the method was popular participation through cost sharing between the State and the beneficiaries on 2 : 1 ratio. Since irrigation facilities in the pre-project situation were grossly inadequate, STWs turned out to be appropriate and cost effective methods of minor irrigation in the region, which has relatively high ground water levels. From November 1999 to January 2001, the physical achievement of the project was 82,666 against a targeted one lakh STWs in less than 14 months, indicating an achievement of 82.67 per cent.

The percentage of area under irrigation from STWs was 3.34 lakh hectares, which was 20.45 per cent of the total gross area (under crops) of 16.32 lakh hectares. And increase in gross production due to irrigation from STWs was 3.35 lakh hectares, which was approximately 9.61 per cent of the production level. The cropping intensity achievement was 144.09 per cent, though short of the project target of 200 per cent for flood affected and 300 per cent for flood free areas. Additional area under irrigation contributed by STWs rose more than 20 per cent and the estimated additional production towards paddy, *Rabi* crops, and all crops was 4.23 lakh MT, 3.81 lakh MT, and 8.03 lakh MT respectively.

Developmental Strategy

Resource Flow

Assam needs special attention in the area of flow of resources and higher level of subsidies for exploiting the tremendous regional potential. The region has the potential to improve in the agricultural sector. The constraint areas lie in lack of skilled manpower, infrastructure development, resources/credit flow and high transportation cost, etc. needs to be addressed to. Extension services through demonstration and training to the tribal growers assume considerable importance. A substantial portion of investment is needed on—Far Water management for increasing production and

for increasing consumption of fertilisers. The multi-agency network consisting of co-operatives, commercial banks and regional rural banks should play a dominant role in agricultural credit disbursement.

Watershed Management and Integrated Management of Reservoirs

In the rain fed areas, watershed management is important factor in improving the agricultural production. Integrated farming systems should be practised in Assam through self-help groups in the micro-watersheds to institutionalise people's participation. The agricultural production strategy should focus on flood control, drainage management, improve irrigation facilities particularly minor irrigation and a better input delivery system supported by extension. The fertiliser consumption will have to be substantially steeped up an the gross irrigated area in this region to be increased to cover at least 50 per cent of the GCA of the districts. Along with the chemical fertilisers, the use of organic manures and bio-fertilisers should be also promoted for better soil health. Minor irrigation holds the key in this region and there is considerable ground water potential. Specially drip irrigation and sprinkler irrigation should be promoted in this zone. As already stated Million well schemes can also make useful contribution. The emphasis should be on raising the capability of small peasants.

There is a need to support integrated management of reservoirs and sediments by developing economical and safe technologies and by effective environmental assessment tools to ensure sustainable water resources. This also can help in land-use planning, and water-shed management with farmer's participation of NGO's as facilitators. The farmers also are to be trained in drainage management.

Flood Control Measures

The flood control measures in Assam has to be a joint effort as the catchments area of river Brahmaputra is located at Arunachal Pradesh and the river Barak in south Assam lies in Manipur.

This calls for preparation for integrated flood control measures for controlling the frequency of the floods and development of water resources. At present there is no integrated flood catchments area treatment plan for flood mitigation in the various catchments area

including provision for flood cushions. Therefore, the government and other related institutions should adopt well-organised structural and non-structural measures to alleviate flood damages and prepare operational frameworks for the risk management. Hydrosolidarity should be the basis for wise water governance and hence should provide a background for balancing upstream against downstream water use. This requires an understanding of the water circulation through the catchments.

Due to natural and anthropogenic causes, the climatic pattern in future would be at extremes, causing frequent flash floods in some areas and drought in others. Any model on climate will not be able to predict the daily or weekly amount of rainfall over a given area. Under these circumstances, the only key issue is to stabilise and protect the farmer against the vagaries of climate, through watershed management or watershed development. Watershed and micro watershed must be promoted not only for providing employment, minimising soil erosion, controlling the peak hydrograph, but also enhancing ground water recharge from rainfall.

Micro Credit

The Rural Infrastructure Development Fund (RIDF) which was envisaged in the Ninth Plan should be used to promote projects which encourage organisations of small farmers, artisans and landless labourers for skill upgradation, processing of agricultural products, transport infrastructure, and quality improvement in the agricultural products.

Potentialities in Agro Areas

The potentiality of Assam in agro-food industries still remains unexplored. There is a need for infrastructure facilities like cold storage and processing facilities close to the production centres in rural areas. The government should encourage agro processing and agro industries in the region through a suitable industrial policy.

Sustainability in Agricultural Growth

It is clear that there is little scope for further expansion of the net sown area and that land scarcity will become an acute feature of the

rural economy in Assam. Water is a precious asset and there are severe concerns regarding proper utilisation of water resources. Therefore, a judicious use of land and water resources will have to a central concern for sustainability of agricultural growth. There has been a growing concern in recent years about the deteriorating conditions of soil health and water resources due to improper management. The deterioration in land and water resources has been in the form of land degradation and waterlogging. There is a greater need to have an integrated approach in the management of agricultural nutrients, chemicals and in taking effective measures to deal with the problems.

Sustainable Development and Agriculture

The concept of sustainable development emphasises on a symbiotic relationship between consumer human race and producer natural resources. The goal of sustainability is for equity and social justice, economic efficiency, ecological harmony and endogenous choices. The strategy of sustainability includes improving the quality of human life while living within the carrying capacity of the supporting ecosystem. Sustainability is compatibility between ecology and economics. Sustainable development must meet the needs of the present generation without compromising the ability of the future generations with reference to their aspirations and needs. Therefore, the exploitation of resources, the direction of investments and institutional changes are to be consistent with future as well as present needs. Sustainable development in agriculture is promotion of ecological sound agriculture with reference to land, water, energy, nutrient supply, genetic diversity, pest management, post-harvest systems and location specific research and development.

The deterioration in the agricultural base in Assam in spatio-temporal terms, and the irrational management of land have damaging repercussions and are reflective of unsustainable policy frame and planning strategies, which are evident from the observable signs as listed:

(a) Extensive deforestation and *Jhum* farming.
(b) Recurring floods and resultant soil erosion.

(c) Growing land degradation reflected through wastelands and waterlogging areas.
(d) Exponential growth of unemployment in rural areas.
(e) Feminisation of agriculture.
(f) Population growth outstripping available resource base of crop lands.
(g) Adverse land labour ratio.
(h) Mono cropping.
(i) Irrigation practices without proper arrangement of drainage, which would further give rise to alkaline or saline soil through waterlogging.

The unsuitable activities in agriculture includes:

1. Intensive cultivation of land without taking adequate care of soil fertility and soil structure.
2. Indiscriminate application of variety of pesticides, fungicides, herbicides, etc.
3. Indefensible and excessive trapping of underground water.
4. Incurable and rapid replacement of the indigenously adopted varieties with high yielding hybrid strains.

Fortunately for Assam, the advantage of foreseeing a green revolution and sustainable agricultural development lies in the absence of the above-mentioned four points. It only requires a holistic approach for achieving ecologically friendly sustainable development by maintaining the fragile balance between productivity functions on one hand and conservation activities and practices by the concerned farmers through monitoring and identification of problem areas on the other. It requires application of alternate agricultural practices, crop rotation, crop diversification, use of appropriate amount of fertilisers, energy efficient farming methods and reclamation of underutilised or wastelands. For achieving such a self-reliant status or sustainable development in agriculture, the wholistic approach on every resource sector needs to be concentrated at all local and regional levels.

Research and Development

For empowerment of farmers and sustainable agriculture the following areas may be looked into:

- Promote organic farming among the interested farmers through proper technology and guidance.
- Create awareness programme on bio-fertilisers, vermin-compost and organic manure to maintain crop production and also maintain soil fertility.
- Establish agricultural technology information centre with video conferencing facility.
- Provide information technology and all kinds of advisory service to farmers through the single window clearance system.
- The extension centres at each district should have laboratories and the scientists should test any plant with disease.
- The farmers should have direct access to the resources at the centre in terms of technology and advice with a provision of a system for feedback.
- Make provision for sales counter for seeds, fertilisers at the resource centre.
- Make provision for audio-visual presentations and video conferencing with agricultural organisations, scientists, or farmers from any part of the State.
- Make provision for input testing laboratories in all the district headquarters.
- Make provision for training-*cum*-demonstration centres on different agricultural products at the resource centres.
- Establish seed farms for cereals, pulses, oilseeds, cotton, etc.
- Demonstrate water-harvesting technology to the farmers and initiate their participation on irrigation management.
- Providing regional facility for training on ecological conservation and scientific use of land and water resources.
- Provide adequate support to agricultural research in the areas of biotechnology, microbiology, genetic improvement of crops including hybrid technology, genetic upgradation and post-harvest technology.

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