

SUBJECT I
HILL AGRICULTURE IN INDIA: PROBLEMS AND
PROSPECTS OF MOUNTAIN AGRICULTURE

**Unlocking the Potential of Agriculture in
North-eastern Hill Region of India**

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I

INTRODUCTION

With rich land, abundant water and a favourable climate, hill agriculture in India's north-eastern region, comprising states like Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura, has considerable potential to grow, and contribute towards improving farm incomes, enhancing food and nutrition security, reducing rural poverty and accelerating the overall economic growth of the region. Unfortunately the growth potential of hill agriculture has remained under-exploited due to lack of system-specific production technologies, poor infrastructure (transport, markets, processing) and underdeveloped institutions (credit, extension, information, insurance), notwithstanding the structural constraints imposed by difficult terrains, inaccessible habitations, diverse socio-cultural and agricultural typologies, and small, scattered and fragmented land holdings.

The agricultural sector, including crops, animal husbandry, fisheries and forestry, contributed 26 per cent to the northeastern region's gross domestic product (GDP) in 2008-09, down by 11 percentage points than in 1993-94. Its importance, however, transcends beyond its economic contribution. From the perspective of rural livelihood, agriculture remains an important economic sector despite its declining share in GDP. About 85 per cent of the region's population is rural, and a majority of it depends on agriculture and allied activities, directly or indirectly - in 2004-05, the agricultural sector engaged 56 per cent of the region's total workforce. The sector is dominated by small landholders - more than three-fourths of the land holdings in the north-eastern region are less than or equal to 2 ha in size (Birthal *et al.*, 2006).

Traditionally, agriculture in the north-eastern states has been looked upon as a subsistence profession generating food for household consumption, ignoring its potential for commercialisation and growth. For instance, high-value crops such as,

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fruits, vegetables, condiments and spices occupy as much as 15 per cent of the region's gross cropped area, but lack of reliable and remunerative markets, and poor infrastructure restrict harnessing their growth potential. The region has considerable scope for enhancing agricultural growth if some of the technological, infrastructural and institutional constraints, which it confronts, are overcome (Chakravarty, 2006).

In view of its potential in spurring economic growth and improving the livelihood of rural population, hill agriculture started receiving increasing attention of the policymakers in recent years (Government of India, 1997, 2008). The North Eastern Region Vision 2020 places considerable emphasis on enhancing agricultural growth through technological change, area expansion and cropping intensity; and value-addition by attracting private investment in agro-processing (Government of India, 2008). However, to unlock the growth potential of agriculture, it is essential to have a better understanding of the past and potential sources of its growth, and target technologies and investment accordingly. In this paper, an attempt has been made to identify and quantify sources of agricultural growth in India's northeastern states. The results can serve as an empirical basis for designing appropriate policies and strategies for accelerated growth and enhanced rural livelihoods. The paper focuses on the crop sector that accounts for close to 70 per cent of the region's gross value of agricultural output.

The paper is organised into five sections. The next section presents data and methodology used to disaggregate agricultural growth by source. Section III provides a brief background on the agricultural economy of northeastern states. The sources of agricultural growth are quantified and discussed in Section IV. Conclusions and policy implications are given in the last section.

II

DATA AND ANALYTICAL APPROACH

Data Sources

In this study we cover the period starting from 1991/92 to 2003/04. The data used in this paper was compiled from various sources. State-level data on area, production and yield of crops were taken from the *Indian Agricultural Statistics, Statistical Abstracts* of the concerned states and *Statistical Abstracts of India*. Producer prices of different commodities for the states were taken from the Central Statistical Organization, which it uses to estimate national income from agriculture. Data on commodity prices were not available for the entire period; hence for the missing years the price series were generated by extrapolating available data using the wholesale price indices of commodities/or commodity groups. The current prices were then converted into real prices using wholesale price index of all commodities (1993/94 base) as a deflator. The value of output of each commodity or commodity group was estimated by multiplying their physical output with real prices.

Method of Decomposition of Growth by Source¹

Agricultural growth is a cumulative and combined effect of changes in the gross cropped area, area under different crops and their yields, land reallocation among crops, and producer prices. These factors may not fully explain the agricultural growth, and the residual can be attributed to the interaction among these variables. Following Minot *et al.* (2003) the growth in agriculture can be decomposed into (i) area effect, (ii) yield effect, (iii) price effect, and (iv) land reallocation or diversification effect.

If A_i is the area under crop i , Y_i is its yield, and P_i is its price, then gross value of output (R) from n crops can be obtained as:

$$R = \sum_{i=1}^n A_i Y_i P_i \quad \dots(1)$$

To measure the effect of land reallocation among crops we express A_i as the share of crop i in total cropped area, that is $a_i = A_i / \sum_i A_i$ and re-write equation (1) as:

$$R = \left(\sum_{i=1}^n a_i Y_i P_i \right) \sum_{i=1}^n A_i \quad \dots(2)$$

Taking total derivative of equation (2) provides change in gross value of output due to area, yield, price and land reallocation/diversification.

$$dR \cong \left(\sum_{i=1}^n a_i Y_i P_i \right) d \left(\sum_{i=1}^n A_i \right) + \left(\sum_{i=1}^n A_i \right) d \left(\sum_{i=1}^n a_i Y_i P_i \right) \quad \dots(3)$$

Equation (3) provides an approximation of the changes in the value of crop output explained by area, yield price and land reallocation as it excludes interaction effect of these variables. The second term on the right-hand side of equation (3) can be further decomposed from a change in sums to the sum of changes as:

$$dR \cong \left(\sum_{i=1}^n a_i Y_i P_i \right) d \left(\sum_{i=1}^n A_i \right) + \sum_{i=1}^n A_i \sum_{i=1}^n d(a_i Y_i P_i) \quad \dots(4)$$

Further expansion of the term $\sum_{i=1}^n A_i \sum_{i=1}^n d(a_i Y_i P_i)$ in equation (4) yields following expression:

$$dR \cong \left(\sum_{i=1}^n a_i Y_i P_i \right) d \left(\sum_{i=1}^n A_i \right) + \sum_{i=1}^n A_i \sum_{i=1}^n a_i Y_i dP_i + \sum_{i=1}^n A_i \sum_{i=1}^n (a_i P_i dY_i) + \sum_{i=1}^n A_i \sum_{i=1}^n (Y_i P_i da_i) \quad \dots(5)$$

Equation (5) provides disaggregation of growth due to cropped area, crop yields, prices and diversification. The first term on the right hand side represents a change in the gross value of output due to a change in total cropped area. The second term estimates the contribution of prices to the growth in gross value of output, and the third term captures a change in the value of output due to a change in the crop yields or technology. The fourth term measures the contribution of land reallocation or diversification to the change in the gross value of output. Note that, these sources do not fully explain the change in the gross value of output, and there is another term called 'interaction' that is defined as the difference between the actual and explained change in the gross value of output. Dividing both sides of equation (5) by the overall change in the gross value of output (dR) gives the relative share of each source in overall growth.

The method can disaggregate growth using data at two points of time (starting and end year data) and also using continuous data series. In this paper, we have decomposed agricultural growth taking year-to-year difference in the de-trended data series² rather taking the difference between the starting and ending year values.

Each growth source has its implications for the agricultural development policy. If a lower share of growth is associated with area expansion, it reflects that there is a limited scope to expand area under cultivation. If the contribution of prices to growth is low, it may reflect adverse terms of trade for agriculture or lack of markets or higher transportation and transaction costs. In either case, the implication is that in the long-run, growth must result from yield-enhancing technologies and diversification of agriculture from lower- to higher-value crops. Policy implications of yield increases and diversification are not as obvious (Minot, 2003; Joshi *et al.* 2006a). Does a lower share of these sources in agricultural growth imply that there is under-investment in agricultural research and infrastructure or economic conditions do not favour that type of growth? Drawing implications from these sources requires additional information regarding investment in agricultural research, development of infrastructure, income level, income growth, etc.

III

OVERVIEW OF AGRICULTURE IN THE NORTHEAST REGION

This section provides a general background of the agricultural economies of the north-eastern states as to provide a context that could be useful in interpreting growth sources and drawing policy implications.

The northeastern region, comprising states such as Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura account for 8 per cent of the country's geographical area and 4 per cent of the population. Geographically, Arunachal Pradesh is the largest state in the region, but is sparsely populated (Table 1). Assam is the second largest state in area and houses about 70 per cent of the region's population. The region, in general, is characterised by uneven landscape, limited arable land, low population density, low urbanisation, poor infrastructure, low

level of irrigation, high rainfall, low fertiliser use and low cropping intensity. There is, however, considerable diversity in these characteristics within the region.

The mean population density in the region is 148 persons per sq. km. of geographical area, ranging from 13 in Arunachal Pradesh to 340 in Assam (Table 1). In most states, urbanisation is low (11-24 per cent), except Nagaland where close to half of the total population lives in urban areas. A majority of rural population in the region depends on agriculture and allied activities for its livelihood. Agriculture engages 56 per cent of the total work force. Dependence on agriculture is higher in Nagaland (68 per cent) than in any other state. The average size of land holding is less than 1.5 ha, except in Arunachal Pradesh and Nagaland.

The arable land is limited to only 18 per cent of the total land reported for use. This figure is as low as less than 5 per cent for Arunachal Pradesh and Mizoram. Only in Assam and Tripura, 30-35 per cent of the reported area is utilised for cultivation. The cropping intensity in most states, except Assam and Arunachal Pradesh is low, 104 to 120 per cent. Cultivation in the post-rainy season is restricted due to lack of under-developed irrigation infrastructure.

Agriculture in the northeastern region is mainly rainfed. Yet, the climate is favourable for cultivation of a wide variety of crops especially horticulture crops. The average annual rainfall in the region is 2300 millimeters, ranging from 1400 to 5500 millimeters across states. Most of it however is received during June-September. The normal temperature varies between 18⁰C to 32⁰C during summers and from 0⁰C to 22⁰C during winters. Land is fertile and water resources are abundant. The developed irrigated area is only 41 per cent of the ultimate potential. The hydropower potential is around 66,000 megawatts (which is about 40 per cent of the national potential) but the operating hydropower projects and projects under construction together constitute 6 per cent of the region's potential (World Bank, 2007).

Adoption of improved agricultural technology is poor. An indication of this is the low intensity of fertiliser use. The average fertiliser consumption in the region is 41kg/ha. It is as low as 5kg/ha or less in Arunachal Pradesh, Nagaland and Sikkim, and does not exceed 60kg/ha in any other state in the region. The availability of institutional credit to the agricultural sector is estimated, as the amount of loan outstanding, is about Rs. 5400 per ha of net sown area. Road density varies widely across states; from 21 to 155 km/100sq.km. of the geographical area.

Agriculture and allied activities account for over a quarter of region's GDP, and their share has been declining (Table 2). Among the states the share of agriculture in GDP is the lowest in Mizoram (14 per cent) and highest in Nagaland (29 per cent), except in Nagaland where it has declined considerably since the early 1990s. The performance of agricultural sector in the region had been quite impressive during the past one decade or so (Table 2). At the regional level, the sector grew at an annual rate of 3.1 per cent, slightly higher than the national level of 2.8 per cent. In Manipur, Meghalaya, Nagaland and Tripura its performance was better than the national average.

TABLE 1. KEY ECONOMIC INDICATORS OF DEVELOPMENT OF NORTHEASTERN REGION

Indicators (1)	Unit (2)	Arunachal										North-east (11)
		Pradesh (3)	Assam (4)	Manipur (5)	Meghalaya (6)	Mizoram (7)	Nagaland (8)	Sikkim (9)	Tripura (10)			
Geographical area, 2004-05 ^a	Sq.km.	83743	78500	22327	22429	21087	16579	7096	10492	262253		
Reported area for land use, 2004-05 ^a	000 ha	5547	7850	1945	2227	2085	1583	726	1049	23012		
Net sown area, 2004-05 ^a	per cent	3.6	35.3	11.2	10.2	4.5	19.3	15.0	26.7	18.3		
Population, 2001 ^b	lakh	11	267	24	23	5	20	5	32	387		
Population density, 2001 ^b	Persons/ sq.km.	13.1	340.0	107.0	103.3	42.0	119.9	76.2	304.9	147.6		
Rural population, 2001 ^b	per cent	79.6	87.3	76.1	80.4	50.4	82.3	88.9	83.0	84.9		
Agricultural workers, 2001 ^b	per cent	62.3	52.7	57.4	65.9	59.8	68.0	56.3	50.9	55.6		
Literacy rate, 2001 ^b	per cent	54.7	64.3	70.5	63.3	88.5	67.1	69.7	73.7	65.6		
Average size of land holding, 2003 ^c	ha	3.8	1.1	1.2	1.4	1.3	7.4	1.5	0.6	1.3		
Cropping intensity, 2004-05 ^a	per cent	129.4	142.7	108.3	119.8	110.9	119.7	110.9	103.9	133.3		
Gross cropped area irrigated, 2004-05 ^a	per cent	17.2	4.1	23.0	27.2	18.6	28.5	18.7	35.7	10.4		
Fertiliser use, 2005-06 ^d	Kg/ha	2.9	49.3	59.8	18.0	25.5	1.5	2.8	39.2	41.0		
Road density, 2005-06 ^a	km./100 sq.km.	21.9	114.0	51.2	42.6	24.0	126.8	28.5	155.3	66.1		
Amount of loan outstanding (direct and indirect), 2007-08 ^e	(Rs./ha)	5149	4848	6419	6170	11331	4412	3682	8897	5366		
Per capita income, 2007-08 ^f	Rs.	33302	23993	21082	33674	29576	20892	37553	28806	25373		

Sources: (a) *Statistical Abstract of India, 2007* (www.mospi.gov.in); (b) *Census of India, 2001* (www.censusindia.gov.in); (c) *Agricultural Census* (<http://agcensus.nic.in>); (d) *Agricultural Statistics at a Glance, 2008* (<http://daenet.nic.in>); (e) *Basic Statistical Returns* (<http://www.rbi.org.in>); (f) *National Accounts Statistics* (www.mospi.gov.in).

TABLE 2. GROWTH OF AGRICULTURAL SECTOR OF NORTH-EASTERN STATES

(1)	Share of agriculture in GDP		Annual growth rate, 1993/94 to 2008/09 (per cent)	
	1993/94	2008/09	Agricultural GDP	GDP
	(2)	(3)	(4)	(5)
Arunachal Pradesh	43.4	25.8	1.25	5.34
Assam	39.4	27.9	2.48	6.29
Manipur	35.5	23.6	3.30	5.80
Meghalaya	25.3	19.5	4.82	7.35
Mizoram	29.6	13.9	0.58	6.19
Nagaland	24.4	28.5	9.21	6.43
Sikkim	34.3	17.0	2.63	7.78
Tripura	35.3	22.4	4.84	8.67
Northeast	36.8	25.9	3.12	6.55

Source: Estimated using data from National Accounts Statistics (www.mospi.gov.in).

With a share of 69 per cent in the gross value of output of the agricultural sector, crops comprise the most important segment. The share of crops, however, vary considerably within the region; 55-60 per cent in Manipur, Mizoram and Nagaland, 65-70 per cent in Arunachal Pradesh, Assam, Meghalaya, and Tripura, and 85 per cent in Sikkim.

The cropping pattern in the region³ is dominated by cereals (Table 3). Rice occupies more than two-thirds of the gross cropped area in Assam, Manipur and Tripura, and one-third to one-half in other states. Maize is also an important crop in Nagaland, Arunachal Pradesh, Mizoram and Meghalaya. The share of oilseeds is higher in Nagaland, Assam and Arunachal Pradesh than in other states. Pulses occupy around 3 per cent of the gross cropped area in most states except Nagaland (9 per cent) and Meghalaya (1.5 per cent).

TABLE 3. SHARE OF CROPS IN GROSS CROPPED AREA, 2004-05

(1)	(per cent)							
	Arunachal Pradesh (2)	Assam (3)	Meghalaya (4)	Manipur (5)	Mizoram (6)	Nagaland (7)	Tripura (8)	North-east (9)
Rice	42.8	65.9	35.0	69.5	52.1	42.2	70.1	61.5
Maize	13.6	0.5	5.5	1.9	7.7	11.4	0.6	2.4
Cereals	65.3	68.5	42.6	71.4	59.7	58.4	71.1	66.2
Pulses	2.6	3.0	1.5	3.2	3.8	9.0	2.5	3.3
Oilseeds	8.7	8.1	3.1	0.6	4.6	15.3	3.3	7.7
Vegetables	7.2	4.6	13.6	7.0	5.4	6.9	9.2	5.8
Fruits	13.7	2.9	8.3	11.9	16.8	7.5	8.3	5.1
Condiments and spices	2.5	3.4	7.8	5.2	8.8	2.2	2.5	3.7
Tea	0.0	7.0	19.5	0.4	0.0	0.0	1.9	6.1
Other crops	0.0	2.4	3.5	0.3	1.1	0.7	1.2	2.1
All crops	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Estimated using data from *Statistical Abstract of India, 2007* (www.mospi.gov.in).

Agriculture in most states is quite diversified towards high-value crops, that is fruits, vegetables, condiments and spices. These three crop groups together occupy about 15 per cent of the gross cropped area in the region. Their share is 25-30 per cent in Arunachal Pradesh, Manipur, Meghalaya and Mizoram, and 10-20 per cent in other states. Tea plantation is also important in Meghalaya and Assam.

IV

SOURCES OF GROWTH

In this section, we provide estimates of the (i) contribution of different crops to the overall growth of the crop sector, and (ii) relative contribution of area, yield, prices and land reallocation or diversification to overall growth.

First, we examine the composition and growth of the crop sector. At the regional level, rice contributes one-third of the total value of crop sector output, which is about half of its share in the gross cropped area (Table 4). Fruits, vegetables and condiments and spices together account for more than half of the total value of output of crops. In most states the share of these high-value crops is close to the regional average, except in Nagaland and Tripura where it is around 60 per cent. From a comparison of the value shares with area shares of these crops it is revealed that these generate larger returns to land as compared to cereals, pulses and oilseeds. Their relative profitability, however, varies across states due to differences in yields, prices and transport costs.

Table 4 also presents growth rates in the value of output of different crops. As a whole, the crop sector grew at an annual rate of 3.6 per cent during 1991-92 to 2003-04. The rate of growth was higher for condiments and spices (7.3 per cent), fruits (5.5 per cent) and vegetables (4.5 per cent). The performance varies across states. Growth of crop sector was higher than regional average growth in Nagaland (15 per cent), Arunachal Pradesh (4.7 per cent) and Tripura (4.4 per cent). The condiments and spices grew faster compared to other crops in most states, except Assam and Arunachal Pradesh. Fruits were the second fastest growing crop group, except in Assam and Meghalaya. Rice too exhibited a very high growth in Meghalaya, Nagaland and Tripura.

The purpose of this exercise is to identify crops or crop groups that have potential to contribute towards accelerating agricultural growth. The thumb rule for this is: promote crops whose share in the overall crop sector growth is higher than its share in the total value of output. Accordingly, fruits, vegetables and condiments and spices have emerged as the main drivers of crop sector growth. At the regional level, fruits contributed 40 per cent to the overall growth of the crop sector. Rice, vegetables, and condiments and spices each accounted for about one-fifth of the overall growth. Together, high-value crops accounted for 70-80 per cent of the crop sector growth in most states, except Meghalaya (61 per cent) and Assam (93 per cent). At the state level too, fruits remained an important driver of growth, except in

TABLE 4. SHARE OF DIFFERENT CROPS IN THE GROSS VALUE OF OUTPUT AND GROWTH

<i>(per cent)</i>								
(1)	Arunachal Pradesh (2)	Assam (3)	Meghalaya (4)	Manipur (5)	Mizoram (6)	Nagaland (7)	Tripura (8)	North-east (9)
Share in gross value of output, 2002-04								
Rice	27.2	33.6	20.2	51.2	38.9	17.9	37.4	32.5
Maize	6.6	0.1	1.6	0.6	3.4	4.4	0.1	0.8
Cereals	37.0	34.3	22.1	51.7	42.3	23.7	37.5	34.0
Pulses	2.7	1.3	0.7	0.9	4.0	6.5	0.9	1.7
Oilseeds	8.9	3.1	0.4	0.2	2.1	7.2	0.7	3.0
Vegetables	9.2	15.9	17.0	7.2	8.9	15.2	10.5	14.7
Fruits	31.9	20.1	25.5	32.1	28.6	31.1	42.3	24.5
Condiments and spices	10.6	13.1	11.7	7.6	12.8	15.6	6.5	12.2
Tea	0.0	10.4	21.9	0.0	0.0	0.0	0.5	8.5
Other crops	0.0	1.9	0.6	0.3	1.3	0.7	0.9	1.5
All crops	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Annual growth in the value of output, 1991-92 to 2003-04								
Rice	1.8	2.6	6.8	1.3	3.2	4.2	5.0	3.0
Maize	1.7	1.2	1.8	-0.3	1.0	8.6	0.0	3.6
Cereals	1.4	2.6	6.2	1.3	3.0	5.2	4.9	2.9
Pulses	5.0	3.0	7.0	2.9	-5.7	14.4	-1.3	4.3
Oilseeds	-0.8	-1.2	-0.7	-6.3	-7.3	14.6	-11.0	-0.3
Vegetables	2.6	4.5	2.7	3.8	3.0	15.6	0.0	4.5
Fruits	11.7	4.2	0.7	5.1	5.5	25.5	5.9	5.5
Condiments and spices	8.9	2.0	10.3	15.1	9.9	31.1	9.5	7.3
Tea	NA	-0.4	0.9	-9.4	NA	NA	-5.1	-0.2
Other crops	NA	-3.3	-0.6	-7.4	4.1	-10.6	-6.0	3.4
All crops	4.7	2.8	3.7	2.5	3.3	15.0	4.4	3.6
Share in crop sector growth, 1991-92 to 2003-04								
Rice	13.1	26.1	40.7	30.5	36.2	7.3	28.8	23.0
Maize	3.0	0.0	0.9	-0.2	2.3	3.5	0.0	1.0
Cereals	15.6	25.7	41.0	30.3	38.5	12.1	28.1	23.9
Pulses	3.3	1.8	1.3	1.0	-8.4	6.5	-0.1	2.3
Oilseeds	-0.2	-3.0	0.0	-0.9	-6.4	7.4	-5.3	-0.7
Vegetables	5.0	31.8	27.0	9.5	7.0	15.7	5.1	22.3
Fruits	58.1	37.4	2.9	49.7	42.6	39.2	61.0	39.9
Condiments and spices	18.2	24.4	31.5	11.9	25.0	19.9	12.4	21.7
Tea	0.0	-16.4	-4.2	0.0	0.0	0.0	-0.4	-8.5
Other crops	0.0	-1.6	0.3	-1.5	1.7	-0.7	-0.9	-1.0
All crops	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Estimated by the author.

Meghalaya. Rice was the main driver of growth in Meghalaya, and the second largest in Manipur, Mizoram and Tripura. Likewise, vegetables too was an important source of growth in Assam and Meghalaya but not in other states.

Another way to decompose growth is by its source that is, due to area, yield, price and diversification. Table 5 presents decomposition of growth by these sources. Yield improvements were the main source of increase in the value of output of rice, maize, vegetables, condiments and spices. The effect of prices on growth was

negative in the case of cereals, oilseeds, condiments and spices and tea, and these explained about half of the growth in case of fruits and more than 30 per cent in case of pulses.

The diversification column in Table 5 provides a change in the value of crop sector output due to land reallocation towards or away from that crop, holding other sources constant. Condiments and spices, fruits, maize, tea and pulses gained from land reallocation, while rice, oilseeds and other crops lost. Figures in the area expansion column show that almost every crop gained from the additional area brought under cultivation.

The last row of Table 5 shows composition of the growth of the crop sector as a whole. More than two-thirds of agricultural growth in the region was due to improvements in crop yields. The contribution of prices to growth was negative. Nearly 22 per cent of the growth came from land reallocation from lower- to higher-value crops, and another 19 per cent from increase in the gross cropped area. This shows that there is a considerable scope to accelerate agricultural growth through diversification and also area expansion. Regarding growth through area expansion, it may be noted that at present most states in the region utilise only a fraction of the reported area for land use for cultivation, and only a small proportion of it is cultivated twice in a year.

TABLE 5. SOURCES OF CROP SECTOR GROWTH BY CROP IN NORTH-EASTERN REGION

Crop (1)	Area expansion (2)	Yield increase (3)	Price increase (4)	Diversification (5)	Interaction (6)	Per cent annual growth (7)
Per cent share in growth						
Rice	25.4	91.8	-5.2	-15.0	3.0	3.0
Maize	13.0	68.2	-22.1	40.9	-0.1	3.6
Cereals	25.5	90.1	-4.9	-13.3	2.5	2.9
Pulses	13.2	28.5	26.7	30.6	1.0	4.3
Oilseeds	-84.7	-417.0	578.5	16.1	7.1	-0.3
Vegetables	13.0	94.4	0.8	-10.3	2.2	4.5
Fruits	9.0	20.3	33.8	36.4	0.5	5.5
Condiments and spices	11.0	78.8	-29.0	37.4	1.7	7.3
Tea	-28.0	44.8	164.9	-79.5	-2.1	-0.2
Other crops	-34.6	1.5	-126.5	247.8	11.8	-3.4
All crops	18.6	67.5	-9.8	21.9	1.7	3.6

Source: Estimated by the author.

Note: For crops, whose rate of growth is negative, the signs associated with growth sources will be opposite to what appear against these because of the negative growth; hence, their contributions should be interpreted accordingly. In some crops, the contribution of some sources to their growth is exceptionally high. This happens when the positive contribution of one source of growth is counteracted by the negative contribution of another and the resultant overall growth is small and/or negative.

The sources of growth at state level, however, are in stark contrast with growth sources at the regional level (Table 6). While the overall growth of crop sector in Assam and Tripura was driven by yield increases, their contribution to growth in Arunachal Pradesh, Meghalaya and Nagaland hardly exceeded 15 per cent. The contribution of yield increases to agricultural growth in Manipur and Mizoram was 25-30 per cent. Note that, in states where yield increases were an important source of growth, rice had a larger share of the cropped area and fertiliser use intensity was also higher there.

TABLE 6. RELATIVE SHARES OF DIFFERENT SOURCES IN CROP SECTOR GROWTH IN NORTH-EASTERN STATES

State (1)	Area expansion (2)	Yield increase (3)	Price increase (4)	Diversification (5)	Interaction (6)
<i>Arunachal Pradesh</i>	53.4	5.5	2.6	40.3	-1.8
Assam	-0.4	95.4	-13.3	18.5	-0.3
Meghalaya	76.1	10.2	-13.3	18.6	8.4
Manipur	26.1	31.5	15.8	30.7	-4.1
Mizoram	31.5	25.1	14.6	33.0	-4.2
Nagaland	49.6	15.7	-4.2	34.6	4.3
Tripura	-3.7	120.0	18.6	-25.7	-9.3
North-east	18.6	67.6	-9.8	21.8	1.8

Source: Estimated by the author.

The growth in states like Meghalaya, Arunachal Pradesh and Nagaland was driven by area expansion that is, increase in the gross cropped area. In these states, the gross cropped area expanded at a much faster rate (1.4-5.6 per cent a year) than in the other states and accounted for about one-half to three-fourths of growth. In contrast, area expansion has ceased to be a source of growth in Assam and Tripura.

Diversification from lower- to higher-value crops accounted for 30-40 per cent of growth in Arunachal Pradesh, Manipur, Mizoram and Nagaland. In these states a higher share of diversification to agricultural growth is probably due to higher urbanisation, particularly in Mizoram (50 per cent) and Manipur (24 per cent). It is worth mentioning here that the demand for high-value food commodities has been found to be positively related to urbanisation (Parthasarathy Rao *et al.*, 2006). The contribution of diversification to agricultural growth was around one-fifth in Assam and Meghalaya. In these states mainly Assam and Tripura, population density is much higher than in other states, and enhancing foodgrain security appears to be the main focus of agricultural research and development. Urbanisation is also low in these states.

Prices had a mixed effect on agricultural growth. In Manipur, Mizoram and Tripura prices contributed 16-19 per cent to agricultural growth, while their share was marginally negative in Assam, Meghalaya and Nagaland. The lower contribution of prices to agricultural growth indicates under-developed markets, poor infrastructure

and a lack of agricultural price policy. Note that, market imperfections result in higher marketing and transaction costs, which are important barriers to the transformation of agriculture.

The inter-state variation in agricultural growth and its sources may be attributed to differences in the availability of arable land and its productive capacity, climatic conditions, cropping pattern, adoption of technologies, input use, irrigation, infrastructure (transport, markets, processing) and institutions (credit, extension). Nonetheless the decomposition of growth by crop and source provides an important input in setting agricultural research and development priorities in the region.

VI

CONCLUSIONS AND IMPLICATIONS

Agriculture in the north-eastern region of India has considerable potential to grow and contribute to the overall economic growth and livelihood of the rural population. The climate is favourable to grow a wide variety of crops, particularly fruits, vegetables and spices. Lack of system-specific technologies, poor infrastructure and underdeveloped markets, however, restrict the realisation of true potential of agriculture.

In this paper, we have identified and quantified the sources of agricultural growth in the north-eastern states, which if strengthened and supported by appropriate technologies, infrastructure and policies can revolutionise agriculture which has just started taking off in most northeastern states. On the whole, agriculture in the region grew at an annual rate of 3.6 per cent during the last one-and-half decade; and about two-thirds of this growth came from yield improvements. Its performance and sources thereof, however, vary widely within the region. Yield increases were the main source of agricultural growth in Assam and Tripura, while growth in Arunachal Pradesh, Meghalaya and Nagaland was driven by area expansion. Diversification towards high-value crops was also an important source of growth in Arunachal Pradesh, Manipur, Mizoram and Nagaland.

Each of the growth sources has its implications for the agricultural research and development policy. However, sometimes the implications of these sources may not be as obvious, and require additional assumptions and information to derive policies and strategies. Keeping this in view we suggest the following strategies to harness the growth potential of hill agriculture in the north-eastern region.

First, enhancing foodgrain security of the region remains an important research and policy challenge. Yield levels of most crops including fruits and vegetables have lagged behind their corresponding national averages. For example, rice yield in most states in the region, except Manipur and Tripura, where it is close to the national average, is 25 to 50 per cent below the national average. Likewise yields of most fruits and vegetable crops are 25-75 per cent lower than the national average (Rai *et al.*, 2008). Low yields are due to lack of availability and adoption of improved

varieties, inputs and cultivation practices (Chakravarty 2006; Rai *et al.*, 2008). This implies that (i) agricultural research in the region is either underinvested or lacks efficiency, and (ii) research-extension linkages are weak. In either case, the need is to revisit the research and development agenda and set priorities to tap the true potential of agriculture through technological change and enhanced research-extension linkages.

Second, our results suggest that there is ample scope to enhance agricultural growth through area expansion, and improving cropping intensity at least in the short-run. If the policy were to strengthen area-led growth then the priority should be to increase investment in land and water management aiming at double cropping on the existing arable land. We are aware that the difficult terrain and uneven landscape do not allow cultivation of all types of crops in the region. However, appropriate land use planning together with agronomic research focusing on evolving terrain-specific cropping pattern and cultivation practices can help bring additional area under cultivation. Note that, in the long-run land frontiers will close down and area expansion cannot remain an important source of growth unless technologies render multiple cropping possible on the same piece of land.

Third, the diversification from lower- to higher-value crops offers an opportunity to accelerate agricultural growth, enhance farm income and generate rural employment. There is evidence that high-value crops generate three to seven times more returns to land and are labour-intensive compared to foodgrains (Sharma, 2005; Joshi *et al.*, 2006b), and have a larger concentration among small landholders (BIRTHAL *et al.*, 2006; BIRTHAL *et al.*, 2007). Note that small landholders have sufficient family labour and higher-value agriculture is a perfect opportunity for them to utilise their surplus family labour and enhance farm income.

Favourable climatic conditions are an added advantage for most states to promote production and exports of high-value crops like pineapple, banana, citrus, ginger, passion fruits and orchids. Domestic and export demand for high-value food products have been growing fast. This potential, however, has not been tapped because the existing marketing and processing infrastructure and institutions are inadequate to support diversification beyond a certain limit (BIRTHAL *et al.*, 2006). In this era of market liberalisation and globalisation, the returns to diversification towards higher-value crops are conditional to investment in post-harvest technologies for processing, quality and food safety (Pingali, 2006). Therefore, there is a need to support the process of diversification through investment in markets, infrastructure, cold storages and food processing, besides providing technological and institutional support (credit, extension, insurance) to farmers and processors.

Finally, we did not find any significant effect of output prices on agricultural growth. Does it mean that agriculture has ceased to be price-responsive or markets are imperfect and are not giving appropriate signals to producers? Given the low crop yields, it appears that local markets for agricultural commodities are thin and transfer of produce to urban centres raise transportation and transaction costs, which could be

very high for small marketable surpluses. In a study of marketing of fruits and vegetables in Nagaland, Nakro and Khiki (2006) estimated transportation costs alone account for 18-28 per cent of the total cost of their production. The corollary to this is that for harnessing the growth potential of hill agriculture, policy should emphasise linking producers to markets so as to provide them a reliable outlet and remunerative prices for their produce.

NOTES

1. This section has been drawn heavily from Minot *et al.* (2003) and Birthal *et al.* (2008).
2. The data was detrended using three year moving average method.
3. Sikkim was not included in the subsequent analysis due to incomplete data and data anomalies. Also the average situation of the northeast discussed from hereon does not include Sikkim.

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