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AGRICULTURAL DIVERSIFICATION IN INDIA AND ROLE OF URBANIZATION

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ABSTRACT

Indian agriculture is diversifying during the last two decades towards High-Value Commodities (HVCs) i.e., fruits, vegetables, milk, meat, and fish products. The pace has been accelerated during the decade of 1990s. HVCs account for a large share in the total value of agricultural production. Supply and demand side factors coupled with infrastructural development and innovative institutions drive these changes. In this paper, the focus is on diversification towards HVCs in the context of urbanization. Group of urban districts (districts with >1.5 million urban population) have a higher share of HVCs compared to the urban-surrounded (near urban districts) and other districts (districts in the hinterland). Among the HVCs, vegetables and meat products have a higher share in urban districts compared to the other two groups. Milk production is more widespread due to excellent network of co-operatives and infrastructure facilities.

Using GIS (geographic Information System) approach it was found that urban-surrounded districts with better road network connection to urban centers have been able to diversify towards HVC's to meet the demand in the urban centers. Model results further confirm these findings. Thus, urbanization is a strong demand side driver promoting HVCs.

Since urban population is growing at more than 3% per annum, demand for HVCs will drive their production. The analysis has also brought out regional variations in HVCs across different districts in the country that has implications on regional development and planning, and consequently on public and private sector investment strategies.

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AGRICULTURAL DIVERSIFICATION IN INDIA AND ROLE OF URBANIZATION[1]

P.Parthasarathy Rao[2], P.S. Birthal[3], P.K. Joshi[4], and D. Kar[5]

1. INTRODUCTION

The concept of diversification at the macro level is a move away from agriculture to secondary and tertiary sectors (industry and service sectors) owing to change in consumers expenditure due to sustained economic growth and rise in per capita incomes. This is reflected in the contribution of different sectors to national income and absorption of labor force. India is no exception as reflected in the declining share of agriculture in the country's GDP. With economic development diversification also occurs with in each sector /sub-sector. For example in agriculture diversification is taking place with in each sub-sector (crops, livestock forestry etc.) and across sub-sectors. At the conceptual plane diversification of agriculture could be classified into the following three categories: 1. Shift of resources from farm to non-farm activities; 2. Shift of resources with in agriculture from less profitable crop or enterprise to more profitable crop or enterprise; 3.Use of resources in diverse but complimentary activities (Vyas 1996; Delgado and Siamwalla 1999).

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[1] An earlier version of this paper was presented at a workshop on Agricultural Diversification in South Asia, Jointly organized by Ministry of agriculture (MoA), Bhutan; National Center for Agricultural Research and Policy (NCAP); and International Food Policy Research Institute (IFPRI), held at Paro, Bhutan, Nov 21-23, 2002.

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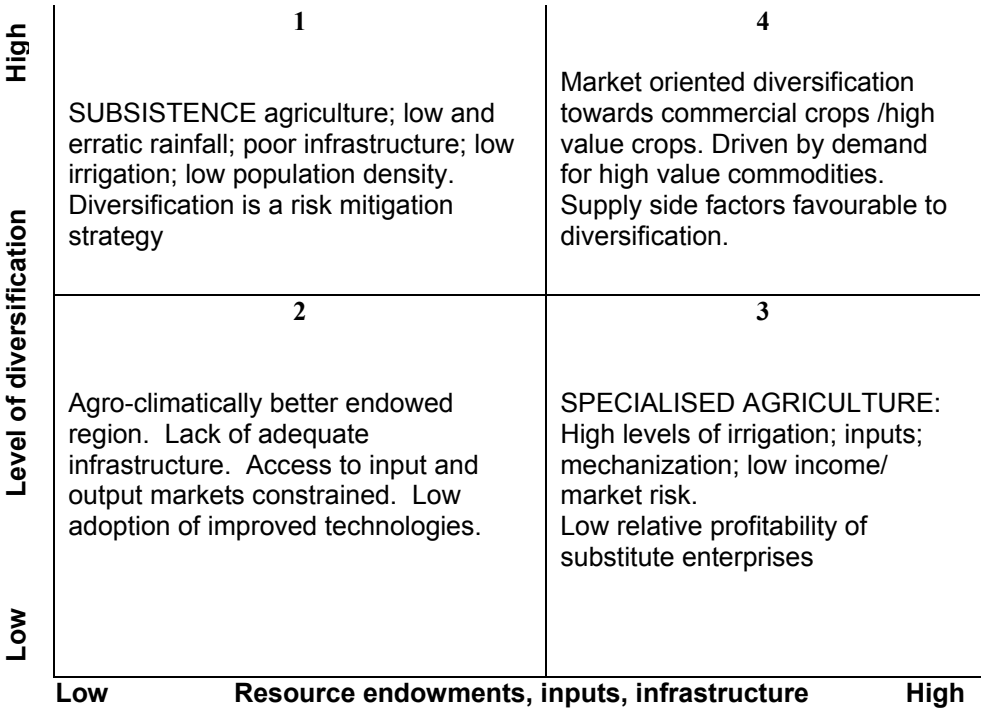
At the farm or micro level in the traditional subsistence agricultural system diversification is a coping mechanism for risk aversion, to act as an insurance against adverse climatic conditions and biotic and abiotic stresses. Here diversification will involve growing more staples. With commercialization of agriculture diversification is a strategy to generate additional income through use of available resources in diverse and complimentary activities. Here, diversification is a move away from traditional crops to high value crops that are more market oriented, leading to progressive substitution out of non-traded inputs in favor of purchased inputs (Pingali and Rosegrant 1995). Thus, although the objective of diversification may vary depending on the level of agricultural development, over all diversification is a strategy for poverty alleviation, employment generation, environmental conservation, and augmentation of farm income through better use of available resources (Satyasai and Vishwanath 1996, Ryan and Spencer 2001).

The relative level of diversification of agriculture across regions within a country will vary, depending on agro-climatic conditions, resource endowments and infrastructure (Figure 1).

In quadrant 1 diversification is high as a risk mitigating strategy against production risks due to harsh and unpredictable agro-climatic conditions. Regions in quadrant 2 are agro-climatically better endowed, but diversification is low due to lack of infrastructure, technology and institutions. Regions in the third quadrant have high levels of irrigation; uses of modern inputs are common and have access to infrastructure and institutions. Here, agriculture is more specialized and market oriented, and diversification as an option for risk reduction or income enhancing strategy is not perceived to be

important. However, there may be sustainability problems associated with over specialization (due to mono cropping) leading to diversification in the long run. Finally, in quadrant 4 we have a situation where commercial diversification is high as an income augmenting strategy to meet the growing demand for high value commodities. Here, diversification gets strengthened with availability of latest technology and required infrastructure. The pace and nature of diversification in a country would thus vary from region to region and over time requiring different strategies.

Figure 1—Diversification of agriculture and resource endowments (Schematic)



The objective of this paper is not to look at the whole gamut of diversification (definitions, scope etc.) but instead, the focus will be on selected high value commodities

that are contributing to diversification of agriculture with particular reference to urbanization as a driver of agricultural diversification towards high value commodities. This is elaborated in more detail in the next section.

1.1 DIVERSIFICATION TOWARDS HIGH VALUE COMMODITIES

The focus of this study is on selected HVCs that contribute to diversification with special reference to the role of urbanization as a driver towards HVCs. The HVCs considered in the present study include, fruits, vegetables, milk, ruminant meat, poultry meat and eggs.

In recent years demand side factors are driving agricultural diversification in India, as also in most South Asian countries. Higher economic growth and consequent income growth in both urban and rural areas are translating into higher demand for high value commodities like fruits, vegetables, and livestock products like milk, meat and fish (Dorjee et al 2002; Pokharel 2003; Wickramasinghe 2003; Joshi et al 2004). This common observation to be attributed not only to changing incomes and prices, but also to structural shifts in demand. Such structural changes can be explained by a number of factors: a wider choice of foods available, exposure to a variety of dietary patterns of foreign cultures, more sedentary occupations, and the move away from food production for household consumption. These trends are highly associated with the general pattern of urban migration (Barghouti et al 2003).

Urban and peri-urban population is rising rapidly in the developing countries. The available estimates reveal that by 2020 the developing countries of Africa, Asia and Latin America will be home to some 75 per cent of all urban dwellers (CGIAR 2003). India is

no exception. The urban population in the country is increasing by more than 3 per cent annually. The forecasts are that by the 2030, the urban population in India will account for 41% of total population (UN 2002). Higher economic growth and consequent rise in incomes, coupled with change in tastes and preferences in both urban and rural areas are translating into higher demand for high-value commodities. Growing urbanization and rising incomes levels are responsible for a different agriculture, which is very distinguished from the traditional agriculture. Such a transformation is leading to changes in production portfolio from cereal-based system to high-value commodities, such as vegetables, fruits, poultry, milk, mushrooms, fish, etc.

In all South Asian countries the income elasticity of demand for fruits, vegetables, milk and meat is high compared to staples like cereals, pulses etc (Paroda and Kumar 2000). During the nineties to meet the growing demand, the livestock sector grew faster than the crop sector in most south Asian countries. This is reflected in an increase in the share of livestock sector in the agricultural sector (Parthasarathy Rao et al 2004; Birthal and Parthasarathy Rao 2002).

Although diversification of agriculture towards HVCs has been occurring for the last several decades, it has assumed greater importance in recent years due to globalization of agriculture under the World Trade Organization. As globalization begins to exert its influence we see the adoption of markedly different diets that no longer confirm to traditional local habits (Pingali 2004). There are also apprehensions that the influx of cheap imports would adversely affect the agricultural sector in South Asian countries. Diversification of agriculture in favor of more competitive and high-value

enterprises is reckoned as an important strategy to overcome the emerging challenges of globalization (Joshi et al. 2002).

During the last several years diversification of agriculture in India towards High Value Commodities (HVCs) has been proceeding at a fast pace. These include fruits, vegetables and livestock products. Between 1982 and 1998 the share of HVCs in total value of agriculture increased from 30% to around 34% (at 1982 constant prices). Owing to preoccupation with food security concerns, and self-reliance the policy makers have not paid much attention to the emerging change in the agricultural sector.

1.2 SCOPE AND OBJECTIVES OF THE STUDY

There are a number of studies that have looked at diversification of agriculture and the factors driving agricultural diversification, but very few have looked at diversification towards HVCs in the context of urbanization. More over, most of the earlier studies on diversification of agriculture were based on national or state level statistics only. This study is at a more disaggregated district level permitting a more in-depth regional analysis.

The main objectives of the study are:

1. Analysis of spatial distribution of agricultural diversification in favor of high value commodities in India by using Geographical Information System (GIS maps).

2. Examine the influence of urbanization in determining composition of value of agricultural production, contribution of each crop to change in value between 1982 and 1998, and speed /growth in diversification towards HVCs.

3. Identify and quantify the factors influencing diversification towards HVCs.

Description of the database and methodology of the study are discussed in the next section. Patterns of diversification are discussed in section II. The role of urbanization in diversification towards HVC's is discussed in section III. Factors influencing diversification towards high value commodities are analyzed in section 4. Finally, conclusions and policy recommendations derived from the study are summarized in the last section.

1.3 DATA AND METHODOLOGY

The district level database for India available with International Crops Research Institute for semi-Arid Tropics (ICRISAT) from 1980 to 1994 was updated to 1998 and expanded to include more variables relevant to this study. While data related to the crop sector, land use, inputs, and infrastructure was readily available from secondary sources, data on livestock outputs at the district level were not available. State level data on value of livestock products by species were collected from Central Statistical Organization (CSO) and the state value was apportioned to the districts with in each state based on proportion of livestock population in each district in a given state. The population census data for 1991 was extrapolated to 1998 using growth rates between 1981 and 1991 census data. The final database thus included more than 200 variables on crops, livestock

population and products, land use, technology, inputs, infrastructure, agro-climatic, socioeconomic and demographic indicators for 492 districts covering 16 states in India.

One problem encountered in using the time-series data for districts is their frequent reorganization. Between 1970 and 1998 182 new districts were created from existing districts. For this, data for newly formed districts are apportioned back to their parent districts and boundaries of newly formed districts adjusted to 1970 base. This provides continuity in the data over time, thus making it possible to study changes over time. The final data set thus consisted of 309 districts that were comparable over time and space[6].

Agricultural diversification in this study is defined as the changing share of high-value commodities in the total value of agricultural output and, urban population was used as a proxy for urbanization. Following steps were adopted to delineate the districts:

1. Districts classified into three diversification zones based on share of HVC's in total value of agricultural output To examine the role of urbanization in the spread of HVC's the districts were subdivided into urban, urban surrounded and other districts.

2. GIS approach (Arc view) was used for spatial analysis of districts based on share of selected and all HVCs in the total value of agricultural production and /or gross

[6] A satisfactory method for dealing with the problem of new districts (created after a certain year) had to be worked through, to accommodate both the need for continuity in the database over the long-term and the need for conducting spatial analysis or operationalisng GIS for which digitized maps with district boundaries for selected years are available.

cropped area; spatial analysis of urbanization and its contribution to spread of HVC's.

3. For each diversification zone and district groups based on urbanization. analysis on composition of value of agricultural production, contribution of HVC's to change in total value of agricultural production between 1982 and 1998, and relative speed /growth in value of HVC between 1982 and 1998.

4. Regression analysis techniques (ordered probit and tobit models) to identify and quantify the factors influencing diversification towards HVCs.

2. PATTERNS AND TRENDS IN DIVERSIFICATION

2.1 DIVERSIFICATION ZONES BASED ON SHARE OF HVCs

At the All-India level HVC's account for 34% of the total value of agricultural production, (fruits and vegetables 15% and livestock products 19%).

There is however, considerable spatial variation in the share of HVC's across the districts in India (Figure 2). Using share of HVC's in total value of agricultural production, districts are divided into three groups: high (>50% share), medium (25-50% share) and low (<25% share) diversification zones (Figure 3). Spatially there is considerable geographical contiguity in the diversification zones. The districts in high diversification zone (Zone 1) are in the coastal and hill regions with a number of exceptions. The districts in medium diversification zone (Zone 2) were found to cover a large part of the irrigated area (north India), eastern India and districts close to the coast

in southern and western India. The districts in low diversification zone (Zone 3) are mainly in the central and northwestern part of the country including large tracts of semi-arid tropics. This observation was contrary to expectation, since diversification, in general is deemed to be high in the semi-arid and arid regions since they grow a large number of crops (cereals, pulses, oilseeds etc). This apparent contradiction is because in this paper diversification is restricted to include only share of HVC's in total value of agricultural production.

Figure 2—Distribution of districts by HVC share: 1998

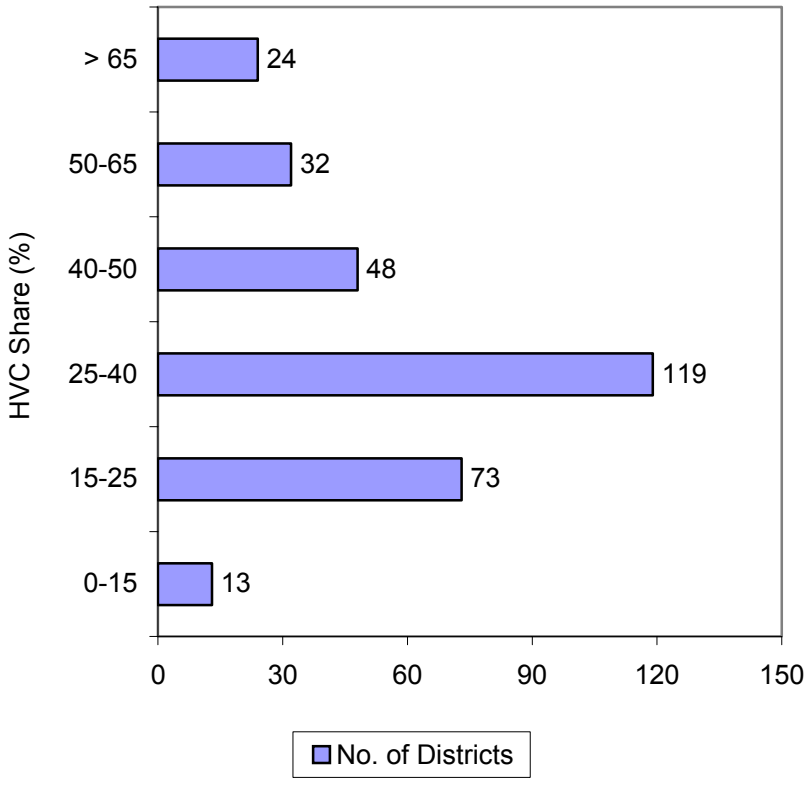
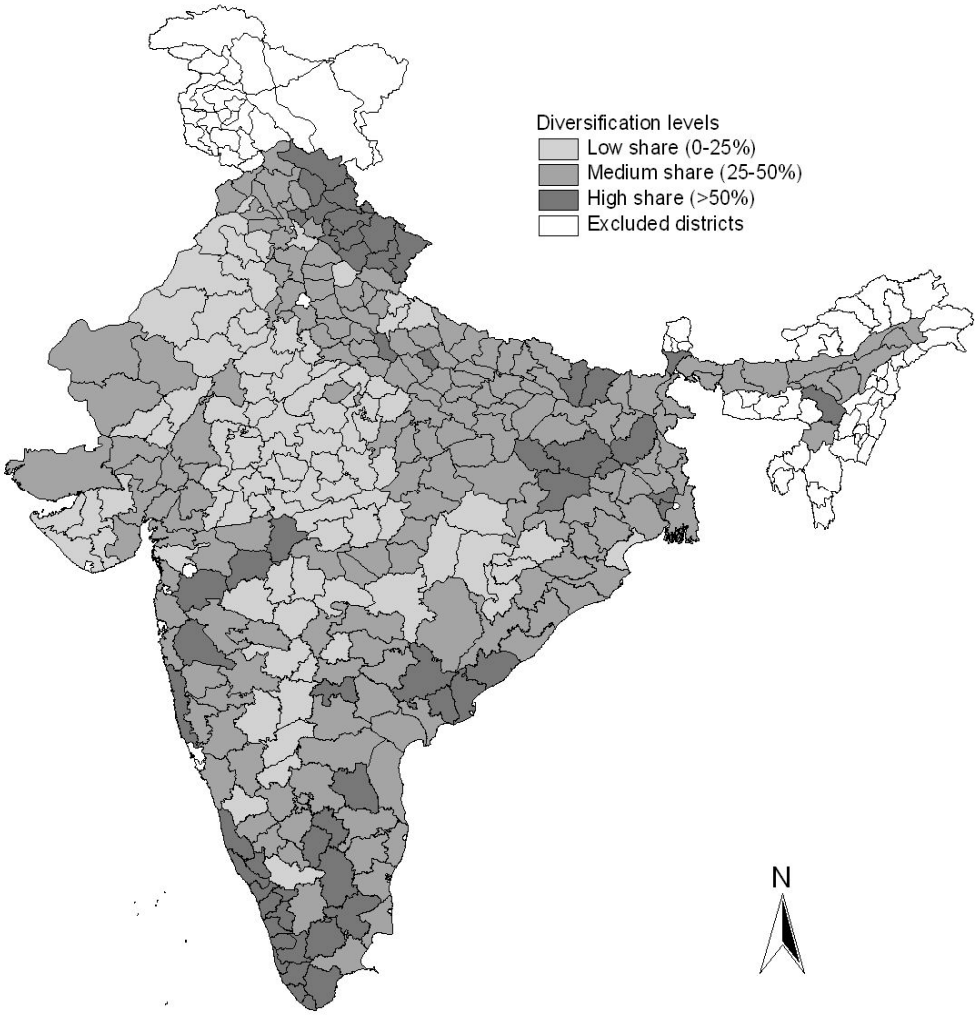


Figure 3—Share of High Value Commodities: India, 1998 (fruits, vegetables, milk and meat)



2.2 CHARACTERIZATION OF DIVERSIFICATION ZONES

The relative importance of the three-diversification zones is shown in Table1. Out of a total of 309 districts more than 50% fall in zone 2 (medium diversification), 30% in zone 3 (low diversification) and 20% in zone 1 (high diversification). The relative share of the three groups in total net cropped area, value of production, population, etc. were in line with their share in number of districts.

The value of HVC's/ha is highest in Zone 1 followed by zones 2 and 3 (Table 2). The value of total agricultural production /ha is also highest in Zone 1, mainly due to the high share in HVCs. In contrast, the lowest share of HVCs has low overall productivity /ha. Thus HVCs are contributing to higher productivity /ha (in value terms).

The indicators for demographic factors (urban population, population density and rural literacy), socioeconomic factors (per capita income) and infrastructure factors (roads, markets) are generally high in zone 1 and lowest in zone 3. In contrast, the variables on technology adoption (irrigation, tractor density, adoption of high yielding varieties) are the lowest in zone 1 and highest in zone 2[7]. Zone 1 has the highest average rainfall and it is lowest in zone 3. Thus zone 3 is the drier region and has a lower share of HVCs in total value of agricultural production. For the agrarian structure, Zone 1 has low average size of land holding coupled with larger number of small holders. In summary, the share of HVCs is high in zone 1 that has high rainfall, low irrigation and input use, high population density, larger urban population and low average size of holdings.

[7] By definition, Zone 2 with assured irrigation should be less diversified and more specialized in few crops. However, livestock is an integral component of crop production and hence on an average districts in this zone fall in the medium diversification zone.

Table 1—Relative importance of district groups by level of diversification: 1998

Indicators	HVCs based diversification zones		
	High (Zone1)	Medium (Zone2)	Low (Zone3)
No. of districts	56	167	86
No. of districts (%)[1]	18.1	54.0	27.8
Share in net cropped area[2] (%)	11.3	53.0	35.6
Share in value of crops and livestock (%)	14.0	57.9	28.1
Share in population (%)	19.7	60.3	20.0
Share in urban population (%)	24.9	54.1	20.9

[1] Percent to all districts total; 2. Arable land.

Table 2—Selected indicators of district groups by level of diversification: 1998

Indicators	HVCs based diversification zones		
	High (Zone 1)	Medium (Zone 2)	Low (Zone 3)
Demographic			
Population density (No./Sq. Km)	426	370	227
Urban population (%)	31.5	22.3	26.0
Literate rural female (%)	41.9	29.4	25.4
Agrarian structure/farm size			
Average size of land holding (ha)	0.9	1.5	2.6
Number of Small land-holders (%)	88.3	80.3	60.6
Technological			
Irrigated area (% to gross cropped area[1])	29.1	40.7	35.7
Area under high yielding varieties (%)	27.7	43.8	26.7
Fertilizer (kg/ha of gross cropped area)	98.1	88.4	62.4
Tractor density (per 000 ha of gross cropped area)	4.4	9.6	8.8
Agro-climatic			
Average normal rainfall (mm)	1660	1195	952
Infrastructure			
Market density (markets/10,000 sq.km of geographic area)	27.1	22.0	21.6
Road density (km/sq.km of geographical area)	0.7	0.5	0.4
Socio-economic			
All crop and livestock (Rs. / ha of gross cropped area)	6159	5253	3798
High value commodities (Rs. / ha of gross cropped area)	3719	1842	731
High value commodities (Rs. / capita (rural))	619	428	360

[1] Includes arable land plus land cropped more than once.

2.3 COMPOSITION OF THE VALUE OF AGRICULTURAL PRODUCTION, AND SPEED OF DIVERSIFICATION

In 1998 on an average, HVC's accounted for 61% of the total value of agricultural production in Zone 1, 35% in Zone 2 and 20% in Zone 3(Table 3 and Figure 4). Among the HVCs fruits and vegetables had the largest share in Zone 1 followed by milk and meat. Fruits and vegetables and milk have almost equal shares in Zone 2, but in Zone 3 livestock products particularly milk dominates with 14% share. . The share of staples like cereals (particularly wheat and coarse cereals), pulses, and commercial crops (oilseeds, sugarcane and cotton) are highest in Zone 3.

The change in total value of production between 1982 and 1998 (at 1982 constant prices) was calculated and apportioned to different commodities contributing to the change.

HVCs in Zone 1 account for the 79% of the change in total value of agricultural production between 1982 and 1998 (at 1980-82 constant prices). Among the HVCs fruits and vegetables contributed 43% and livestock products 36% to the change (Table 4). In Zone 2 HVCs account for 42% of the change with livestock products contributing a larger share. In contrast, in Zone 3 HVCs account for only 18% of the change in total value, mainly driven by changes in the livestock sector particularly milk. Cereals, oilseeds, and commercial crops account for bulk of the change in this zone.

Table 3—Composition of the value of agricultural production by level of diversification: value shares 1998, (constant prices: 1980-82)

Commodities	HVCs based diversification zones		
	High	Medium	Low
	(Zone 1)	(Zone 2)	(Zone 3)
Cereals	**26.7**	**44.0**	**40.7**
Rice	17.6	23.9	11.9
Wheat	3.8	14.4	20.3
Coarse cereals	5.3	5.7	8.5
Pulses	**2.3**	**3.8**	**9.0**
Oilseeds	**4.5**	**6.6**	**19.1**
Commercial crops	**6.1**	**10.0**	**11.3**
Sugarcane	4.8	8.3	6.2
Cotton	1.3	1.7	5.1
Fruits & vegetables	**36.3**	**15.1**	**5.0**
Fruits	24.4	7.3	2.1
Vegetables	11.9	7.8	2.9
Total crops	**75.9**	**79.5**	**85.1**
Milk	**17.3**	**16.3**	**13.4**
Meat & eggs	**7.4**	**4.2**	**1.4**
Bovine and ovine meat	2.5	1.8	0.6
Pig, poultry meat and eggs	4.9	2.5	0.8
Total livestock	**24.7**	**20.5**	**14.9**
Grand total	100	100	100
High value commodities	**61.0**	**35.7**	**19.9**

Figure 4—Share of commodity group by level of diversification: 1998

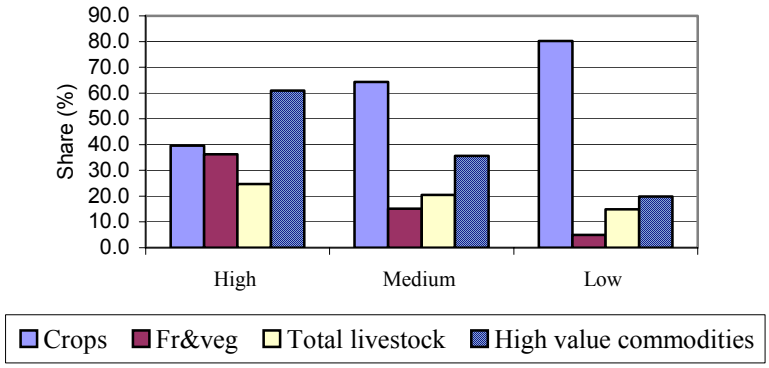


Table 4—Sources of change in value of production by district groups: 1982-1998, (1980-82, constant prices)

Commodities	HVCs based diversification zones		
	High	Medium	Low
	(Zone 1)	(Zone 2)	(Zone 3)
Cereals	**9.0**	**38.3**	**34.8**
Rice	5.2	22.6	10.9
Wheat	2.7	13.6	21.1
Coarse cereals	1.2	2.0	2.8
Pulses	**1.4**	**1.6**	**6.2**
Oilseeds	**5.3**	**9.0**	**29.9**
Commercial crops	**5.0**	**9.1**	**11.3**
Sugarcane	3.1	7.3	6.5
Cotton	1.9	1.8	4.8
Fruits & vegetables	**43.5**	**14.9**	**3.7**
Fruits	33.8	9.0	2.3
Vegetables	9.8	5.9	1.4
Total crops	**64.2**	**72.8**	**85.9**
Milk	**25.2**	**20.6**	**12.6**
Meat & eggs	**10.6**	**6.7**	**1.5**
Bovine and ovine meat	3.1	2.6	0.5
Pig, poultry meat and eggs	7.9	3.63.9	0.91.0
Total livestock	**35.8**	**27.3**	**14.1**
Total	100	100	100
High value commodities	**79.3**	**42.1**	**17.8**

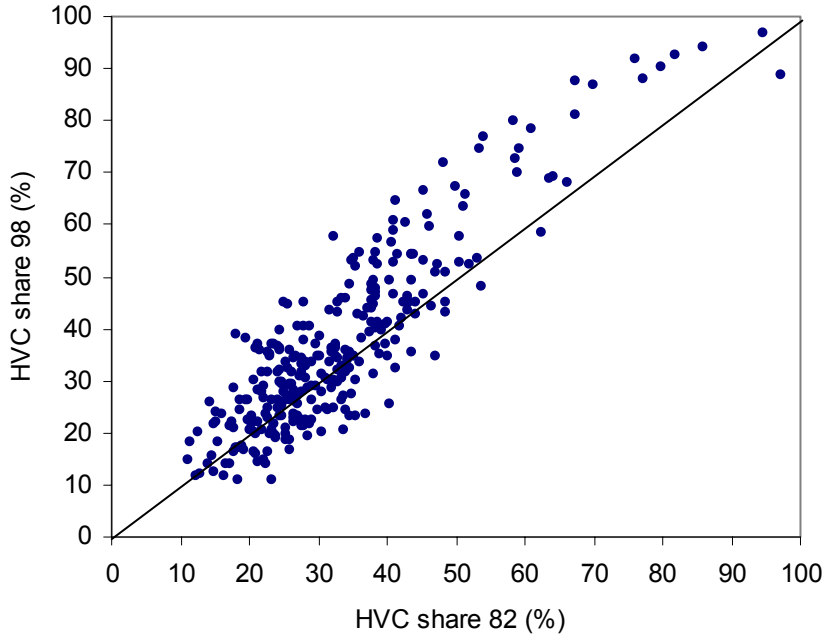
The speed of diversification towards HVCs between 1982 and 1998 is measured as compound growth rates in value of crop and livestock products (Table 5). In zones 1 and 2 HVCs are growing at more than 4% per annum and the growth rates are generally higher than for all other commodities (except oilseeds in Zone 2). Among the HVCs the growth in livestock products (milk and meat) is faster than the growth for fruits and vegetables. In Zone 3 although oilseeds have the highest growth rate (8.3%) followed by commercial crops (3.9), HVCs are growing faster (3.4%) compared to cereals and pulses (3.2 and 2.4 respectively). Within the HVC' s milk (3.6%), meat and eggs (4.2) and fruits (4.4) have high growth rates although from a lower base. The common pattern emerging from all the zones is the high growth in livestock products (milk and meat, particularly poultry meat).

To better understand changes in diversification in the different districts / zones, HVC shares in 1998 for each district are plotted as a function HVC shares in 1982 (Figure 5). Distance above the diagonal line would represent increasing HVC shares and vice versa. A close examination of the graph indicates that the growth in HVC share is widespread in all districts but also declining in some districts. Districts with high-HVC shares and districts with above average shares in the medium diversification zone are increasing their shares more than those with low-HVC shares. 65% of the districts in the high diversification zones increased their share of HVCs by more than 5% between 1982 and 1988, compared to 46% in the medium diversification zone and only 41% in the low diversification zone. A number of districts in the low HVC share districts are showing a reduction in HVC share, presumably switching back to traditional crops.

Table 5—Annual compound growth rates in value of production by district groups: 1982-1998, (constant prices)

Commodities	HVCs based diversification zones		
	High	Medium	Low
	(Zone 1)	(Zone 2)	(Zone 3)
Cereals	**0.89**	**2.67**	**3.17**
Rice	0.75	2.98	3.48
Wheat	2.37	2.98	4.15
Coarse cereals	0.54	0.93	1.04
Pulses	**1.62**	**1.13**	**2.38**
Oilseeds	**3.87**	**4.99**	**8.30**
Commercial crops	**2.39**	**2.81**	**3.91**
Sugarcane	1.75	2.71	4.17
Cotton	5.63	3.36	3.60
Fruits & vegetables	**3.92**	**3.10**	**2.65**
Fruits	4.83	4.18	4.37
Vegetables	2.39	2.24	1.62
Total crops	**2.50**	**2.85**	**3.99**
Milk	**5.23**	**4.44**	**3.60**
Meat & eggs	**5.08**	**6.36**	**4.17**
Bovine meat	4.49	5.32	3.14
Ovine meat	4.14	6.68	3.62
Pig meat	2.47	6.44	9.39
Poultry meat and eggs	5.74	6.31	4.50
Total livestock	**5.18**	**4.79**	**3.65**
All commodities	3.06	3.20	3.93
High value commodities	**4.40**	**4.02**	**3.38**

Figure 5—District wise share of high value crops (HVC) to total value; 1982 and 1998



Supply side factors like access to technology and infrastructure would be constraining growth of HVCs in the low-HVC share districts. In contrast, the high diversification districts are able to increase their share due to growing demand close to the growing areas.

Although it is not the objective of this paper to do a state level analysis of diversification towards HVCs, spatial pattern of distribution of districts by diversification zones across states and share of HVCs 's across diversification zones in each state in India is shown in appendix 1. Share of fruits, vegetables, and livestock products in total value of HVCs by state and diversification zone are shown in appendix II.

3. ROLE OF URBANIZATION IN DRIVING HVCS

One of the objectives of this paper is to test the hypothesis that urbanization is an important driving force towards HVC's i.e., as we move closer to urban centers, agriculture is diversified towards HVCs. On the contrary, as we move away from the urban centers, food grains dominate. To get a better handle on the role of urbanization, districts are divided into (i) urban districts (>1.5 million urban population), (ii) urban surrounded districts and (iii) other districts. The concept of including a group of urban surrounded districts was that these districts also have access to the growing urban markets.

3.1 CHARACTERIZATION OF URBAN AND OTHER DISTRICT GROUPS

The urban group accounts for 10% of the total districts, urban-surrounded 30% and the group of other districts 60% (Table 6). The urban group despite a lower share in the total population (20%), had a higher share of urban population (41%), compared to 22% in urban-surrounded and 37% in other district group.

Table 6—Relative importance of urban and other district groups: 1998

Indicators	District groups		
	Urban	Urban Surrounded	Others
No. of districts	31	91	187
No. of districts (%)[1]	10.0	29.4	60.5
Share in net cropped area[2] (%)	10.3	31.4	58.3
Share in total value of cop and livestock (%)	14.6	33.0	52.5
Share in total population (%)	20.1	30.2	49.7
Share in urban population (%)	41.2	21.7	37.2

[1] Percent to all districts total.
[2] Arable land

Characterization of the district group for select indicators (Table 7) revealed that the urban districts group had smaller holding size, higher population density, higher percentage of urban population, and higher rural literacy compared to the other two district groups. The urban group of districts also had a higher density of roads and markets. Adoption of technology (HYVs, tractors, irrigation, fertilizer-use) was also marginally higher in urban districts group than in other two district groups.

The value of high-value commodities/ha is highest in urban group of districts and consequently the value of total agricultural production /ha is also highest in this group. The value of HVC / capita (rural population) was significantly higher in the urban group of districts and was found to decline on moving towards urban-surrounded and other group of districts.

3.2 SPATIAL ANALYSIS OF HIGH VALUE COMMODITIES AND URBANIZATION

As a first step, spatial analysis is carried out by superimposing urban districts and urban surrounded districts on the delineated diversification zones

3.2.1 Diversification Zones and Urbanization

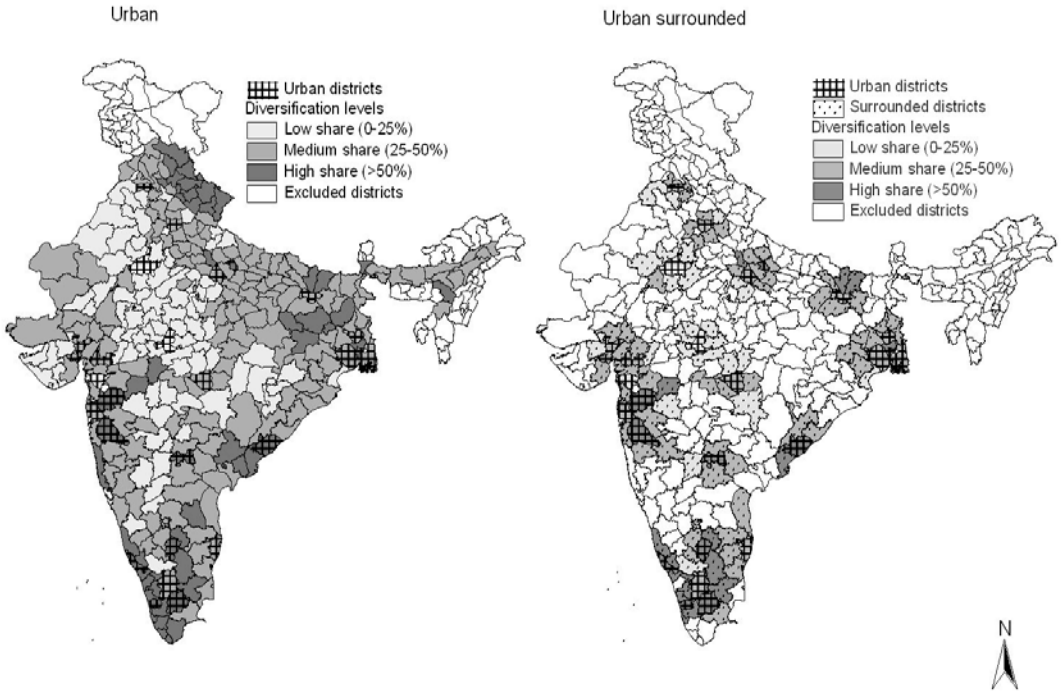
Urban districts were superimposed over the diversification zones to test the hypothesis that HVCs are more concentrated around urban centers (Figure 6). It is found that a majority of the districts in the urban group were in the high and medium diversification zones. Out of 31 urban districts, 11 (35%) were in the high diversification zone, and 17 (55%) in the medium diversification zone. Out of a total of 91 districts in the urban-surrounded group, 16 (18%) fell in the high diversification zone, 50 (55%) in

the medium diversification zone. For the other districts group, only 29 (15%) out of 187 districts were in the high diversification zone. Obviously, the cost advantage in transportation of HVCs and their quick disposal are the principal reasons that make farmers close to urban centers more competitive than the far-off farmers.

Table 7—Selected indicators for urban and other districts group: 1998

Indicators	Districts group		
	Urban	**Urban Surrounded**	**Others**
Demographic			
Population density (No./Sq. Km)	725.0	350.3	278.6
Urban population (%)	55.9	19.6	20.4
Literate rural female (%)	45.4	30.7	27.4
Organisational			
Average size of land holding (ha)	1.4	1.6	1.8
Number of small land-holders (%)	80.9	75.8	75.0
Technological			
Irrigation (% to gross cropped area)	46.2	40.0	36.2
Area under high yielding varieties (%)	37.5	37.7	36.4
Fertilizer (kg/ha of gross cropped area)	110.7	83.1	73.2
Tractor density (per 000 ha)	11.5	8.7	8.3
Agro-climatic			
Average normal rainfall (mm)	1253	1162	1229
Infrastructure			
Market density (markets/10,000 sq.km of geographic area)	30.0	24.9	18.6
Road density (km/sq.km of geographical area)	0.7	0.6	0.4
Socio-economic			
All crop and livestock (Rs. /ha of gross cropped area)	5122	3730	2866
High value commodities (Rs. / ha of gross cropped area)	2901	1792	1357
High value commodities (Rs. / capita (rural))	671	462	403

Figure 6—Share of high value commodities in agricultural value: 1998 (with urban and urban surrounded districts superimposed)



On the basis of the spatial analysis, we could infer that urbanization was an important factor in the adoption of HVCs. Its impact, though limited, was gradually spreading in the surrounding-districts also. With the development of roads and other infrastructure facilities the districts surrounding urban centers also start supplying the HVCs to the urban districts. As stated earlier, the demand for HVCs is rising in the urban districts much faster than other areas due to rising per capita income and changes in tastes and preferences. To meet the demand for HVCs in the urban areas, the agriculture is transforming from food grain based system to high-value agriculture. Kumar and Mathur (1996) have found that structural shifts (urbanization) had a positive impact on demand

for vegetables, fruits, meat, fish and eggs. Structural shifts were found to be as important as income changes in explaining shifts in the demand patterns towards high-value commodities. It is expected that as urbanization increases it would further fuel the demand for HVCs.

3.2.2 Fruits and Vegetables and Urbanization

The absolute area under fruits (Figure 7) is mainly concentrated in the eastern and western coastal districts, and northwest and northeastern districts. It may be mentioned here that fruits have specific niches based on agro-climatic or soil characteristics. However, fruit cultivation is also spreading to non-traditional areas due to availability of improved varieties and increasing demand due to urbanization. By superimposing urban districts on the area under fruits we find that the area under fruits was high in a majority of the urban districts; 23 out of 31 urban districts (75%) had high-to-medium density of area under fruits. For the urban-surrounded districts it was 60% and for other districts group it was 50%.

For vegetables (Figure 7), the spatial distribution was found to be different from that of fruits. North, northeastern and eastern districts were found to have the highest area under vegetables. Like fruits, the northwestern districts had the lowest area under vegetables. Most of the districts in the northwest region are specializing in rice-wheat systems due to policy distortions in favor of rice and wheat. However, in other areas it is clear that urbanization is an important driving force as a majority of the urban districts (28 out of 31: 90%) fell in the high or medium category of vegetable density. For urban-surrounded districts, the value was 70% and for other districts, 60%.

3.2.3 Milk, and Urbanization

The spatial distribution of the shares of milk value 1982 (prices) in the total agricultural production is shown in Figure 8. Milk production was found to be high mainly in the north, western and a few pockets in southwest India. Although urbanization is an important factor driving milk production, it is less important compared to fruits and vegetables. Only 9 out of 31 urban districts (29%) were found to fall in the high milk production category. About 30% of districts in the other districts group had a high share in milk production compared to 15% for the urban-surrounded group. This implies that milk production is not concentrated in urban centers or urban-surrounded districts alone and a significant contribution to the total value of milk comes from the interior (away from urban centers) districts. The reason for such a variation in production of milk compared to fruits and vegetable around urban centers is due to expansion of effective cooperative network in the dairy sector and transport infrastructure. The promotion of 'Operation Flood' to boost milk production and augment income of rural small holders uniformly promoted dairy sector irrespective of their proximity to the urban center (NDDB 2002; Parthasarathy 2002).

Figure 7—Area under fruits and vegetables: 1998 (with urban districts super imposed)

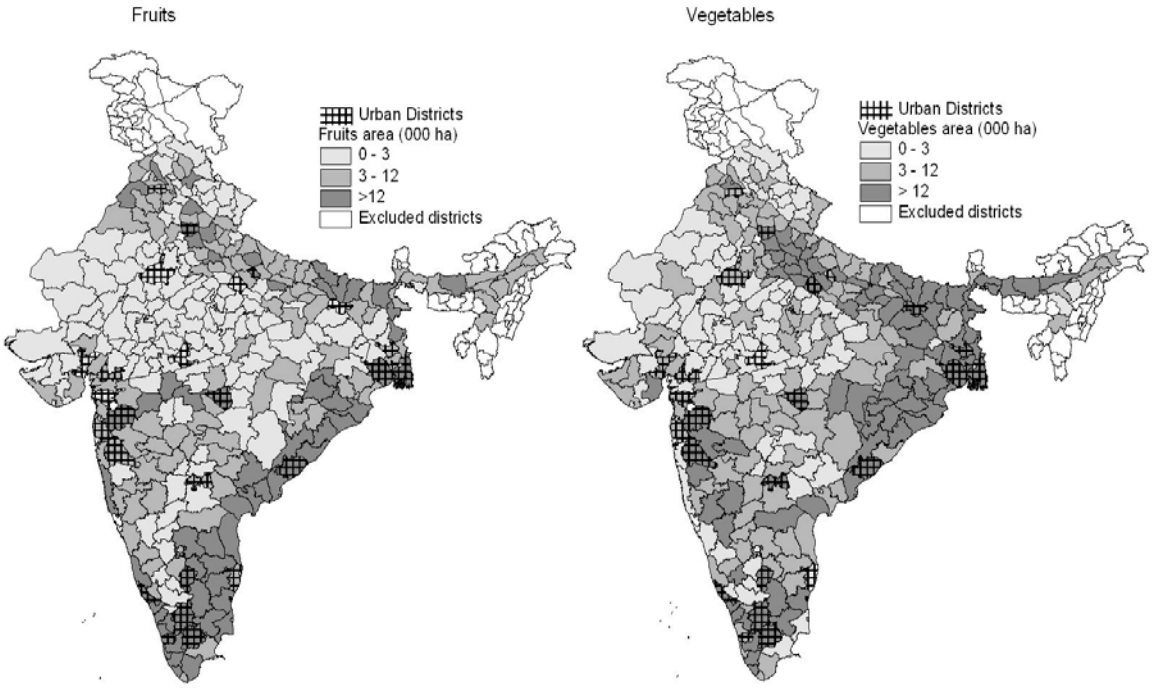
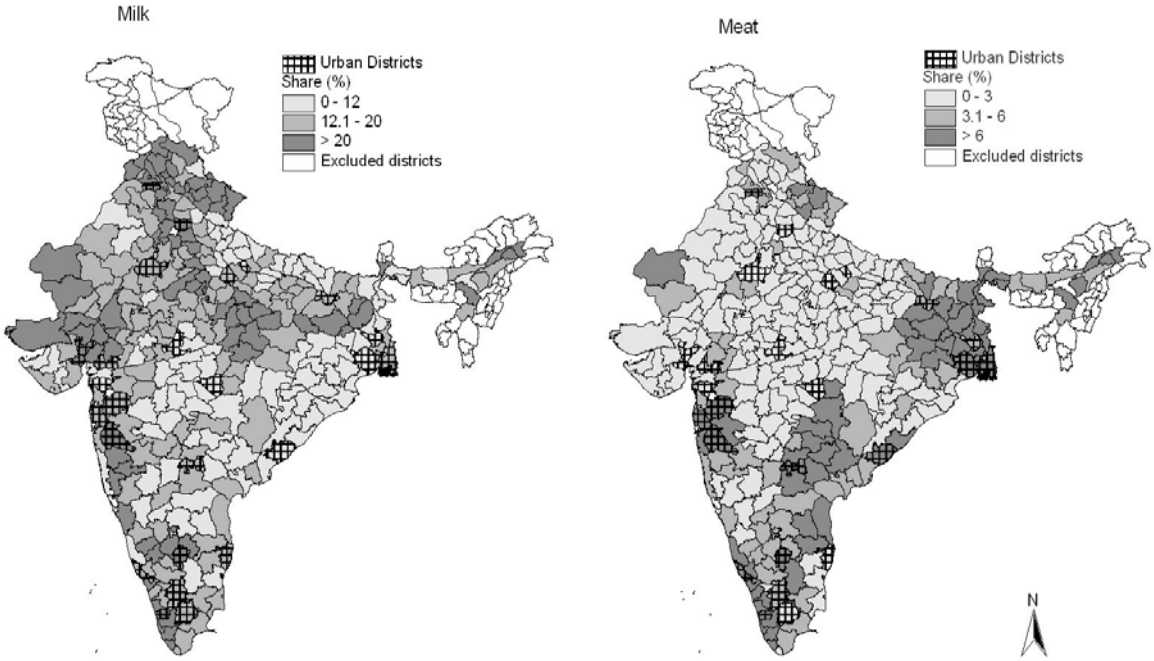


Figure 8—Share of milk and meat to agricultural value: 1998 (with urban districts superimposed)



3.2.4 Meat and Urbanization

Meat production is relatively higher in the eastern and southern India, the Deccan Plateau, and a few districts in the western India close to urban cities like Mumbai and Pune. Unlike milk, meat production was found to be high in a large number of urban districts. The urban-surrounded districts too contributed significantly to meat production. Demand for poultry meat and eggs in several urban districts and small ruminant meat in urban districts of eastern India is driving the increased production of meat. Thus, unlike milk, in the other districts group a majority of districts (65%) had low shares in meat production. There were, however, a few urban districts in central, and northwestern India where the share of meat production was low, perhaps due to a large number of vegetarian population.

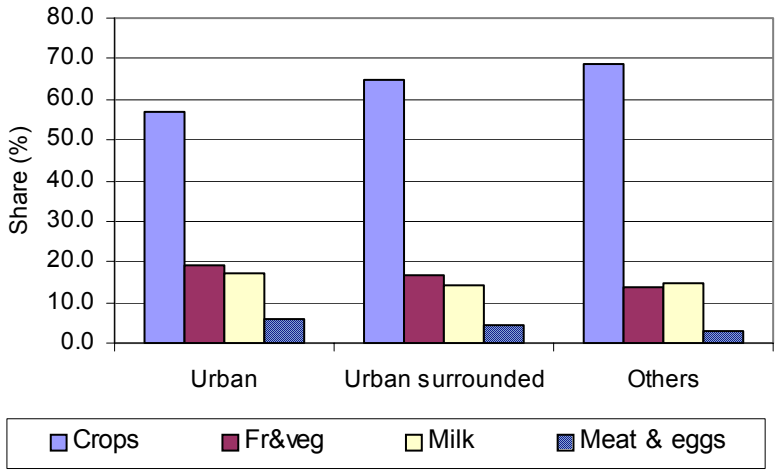
3.3 COMPOSITION OF THE VALUE OF AGRICULTURAL PRODUCTION AND SPEED OF DIVERSIFICATION

High value commodities account for 43% of the total value of production in the urban group, compared to 35% in urban surrounding and 32% in the other district group (Table 8 and Figure 9). In the case of meat and particularly poultry meat the share of urban districts is almost two times larger than in the other two groups. Fruits and vegetables, and milk have marginally higher shares in the urban districts compared to other two groups.

Table 8—Composition of the value of agricultural production by district groups: value shares 1998, (constant prices: 1980-82)

Commodities	District groups		
	Urban	Urban Surrounded	Others
Cereals	**39**	**39**	**42**
Rice	24	19	19
Wheat	11	13	16
Coarse cereals	5	7	7
Pulses	**3**	**5**	**6**
Oilseeds	**6**	**10**	**11**
Commercial crops	**9**	**11**	**9**
Sugar	8	8	6
Cotton	1	3	3
Fruits & vegetables	**19**	**16**	**14**
Fruits	9	10	7
Vegetables	10	7	6
Total crops	**76**	**81**	**82**
Milk	**17**	**14**	**15**
Meat & eggs	**6**	**4**	**3**
Bovine and ovine meat	1.8	1.7	1.4
Pig, poultry meat & eggs	4.3	2.6	1.7
Total livestock	**24**	**19**	**18**
High value commodities	**43**	**35**	**32**
Total crop and livestock value (Million Rs.)	131188	296469	471487

Figure 9—Share of Commodity in Urban, urban surrounded and other district groups, 1998



3.3.1 Sources of change and growth in share of HVCs

HVCs accounted for almost 50% of the change in the total value of output in the urban districts compared to 41% in the urban-surrounded districts and 35% in other districts (Table 9). The higher contribution of livestock products to the change in urban districts mainly accounted for this difference (milk and meat products). Thus although milk production is more widespread across all district groups, it has grown marginally faster in the urban group of districts during the last 20 years.

To further supplement the above findings annual compound growth rates of HVCs were computed to assess the speed of agricultural diversification towards HVCs for the three district groups. No significant difference was observed between the three groups of districts in the growth rates for all high-value commodities (Table 10 and

Figure 10). With in the HVCs livestock products, particularly, meat and eggs had the largest growth in urban districts (7.2 % per annum), compared to 5.6% in the urban-surrounded districts and 5.2% in other districts group. The growth of milk too was marginally higher in urban districts group. In contrast, fruits and vegetables had a higher growth rate in the urban-surrounded (3.7%) and other districts group (3.3%), compared to urban districts group (2.7%). Early adoption of fruits and vegetables (mainly vegetables) around the urban centers and gradual move towards near urban center is the main reason for relatively higher growth rates in urban-surrounded districts. However, the spread of meat and poultry production is still expanding rapidly in the urban centers.

Table 9—Sources of change in value of production by district groups: 1982-1998, (constant prices)

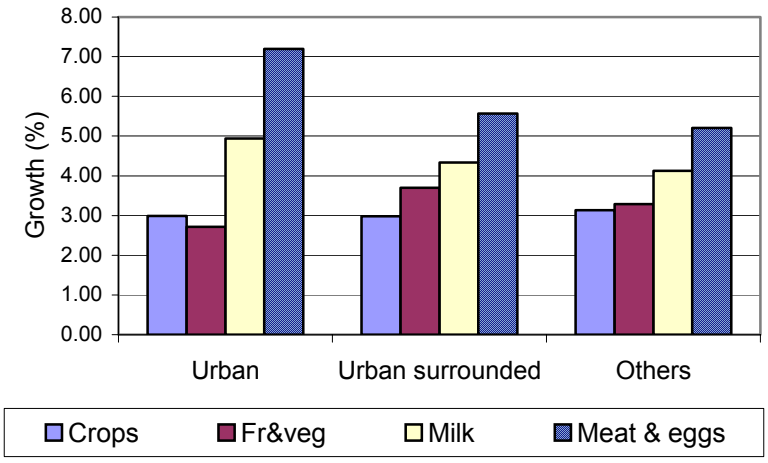
Commodities	District groups		
	Urban	Urban surrounded	Others
Cereals	**34.1**	**30.6**	**35.4**
Rice	24.5	16.4	14.9
Wheat	9.2	12.2	17.8
Coarse cereals	0.4	2.0	2.7
Pulses	**1.3**	**3.7**	**3.0**
Oilseeds	**8.7**	**14.4**	**17.5**
Commercial crops	**7.5**	**10.3**	**9.2**
Sugar	7.3	7.7	5.6
Cotton	0.2	2.7	3.5
Fruits & vegetables	**16.2**	**17.6**	**13.4**
Fruits	11.0	11.6	9.0
Vegetables	5.2	6.0	4.4
Total crops	**67.7**	**76.6**	**78.5**
Milk	22.5	17.3	17.3
Meat & eggs	**9.8**	**6.1**	**4.2**
Bovine and ovine meat	2.7	2.2	2.0
Pig, poultry meat & eggs	7.0	3.9	2.2
Total livestock	**32.3**	**23.4**	**21.5**
All commodities	100	100	100
High value commodities	**48.5**	**40.9**	**34.9**

Although a mixed picture emerges from the above analysis, the urbanization, by and large, has been an important factor in driving the production of HVCs, as these had a higher share in the total value of production in the urban group of districts compared to the other two groups. For urban-surrounded and other districts group the difference with respect to share of HVCs and contribution of HVCs to change etc., is marginal. The urban-surrounded districts as a group clearly were not driving HVCs production, but individually a few districts were contributing a larger share.

Table 10—Annual compound growth rates in value of production by district groups 1982-1998, (constant prices)

Commodities	District groups		
	Urban	Urban surrounded	Others
Cereals	**2.83**	**2.46**	**2.66**
Rice	3.56	2.78	2.43
Wheat	2.69	2.97	3.78
Coarse cereals	0.21	0.84	1.12
Pulses	**1.48**	**2.23**	**1.54**
Oilseeds	**6.32**	**6.31**	**6.60**
Commercial crops	**2.57**	**3.08**	**3.28**
Sugar	2.85	2.94	2.94
Cotton	0.57	3.60	4.02
Fruits & vegetables	**2.72**	**3.67**	**3.31**
Fruits	4.20	4.44	4.57
Vegetables	1.56	2.76	2.12
Total crops	**2.92**	**3.12**	**3.16**
Milk	**4.94**	**4.33**	**4.12**
Meat & eggs	**7.20**	**5.57**	**5.20**
Bovine meat	5.74	4.65	4.50
Ovine meat	6.98	4.75	6.13
Pig meat	6.79	5.95	4.85
Poultry meat & eggs	7.47	6.21	4.75
Total livestock	**5.45**	**4.59**	**4.30**
High value commodities	**4.06**	**4.14**	**3.85**
All commodities	3.42	3.37	3.35

Figure 10—Annual growth in value of production by district groups: 1982-1998 (constant prices).



To find why only some urban-surrounded districts had higher share of HVCs, we superimposed the National Highways network passing through urban centers to the surrounded districts (Figure 11). Urban-surrounded districts were then grouped into three categories, based on the number of highway passing through them, i.e., 0, 1, and 2 or more highways. These district groups were then characterized for the share of HVCs in the total agricultural value (Table 11). It is found that no national highway passed through 25 districts, only one through 45 districts and 2 or more highways were passing through 21 districts in the urban-surrounded districts. HVCs had a higher share in the total value of production (38%) in the district groups through which national highways were passing (1 or 2 and more). Thus, urban-surrounded districts with greater passes of national highways and better road network were more diversified towards HVCs to meet the demand for HVCs in urban centers. This suggests the importance of roads in

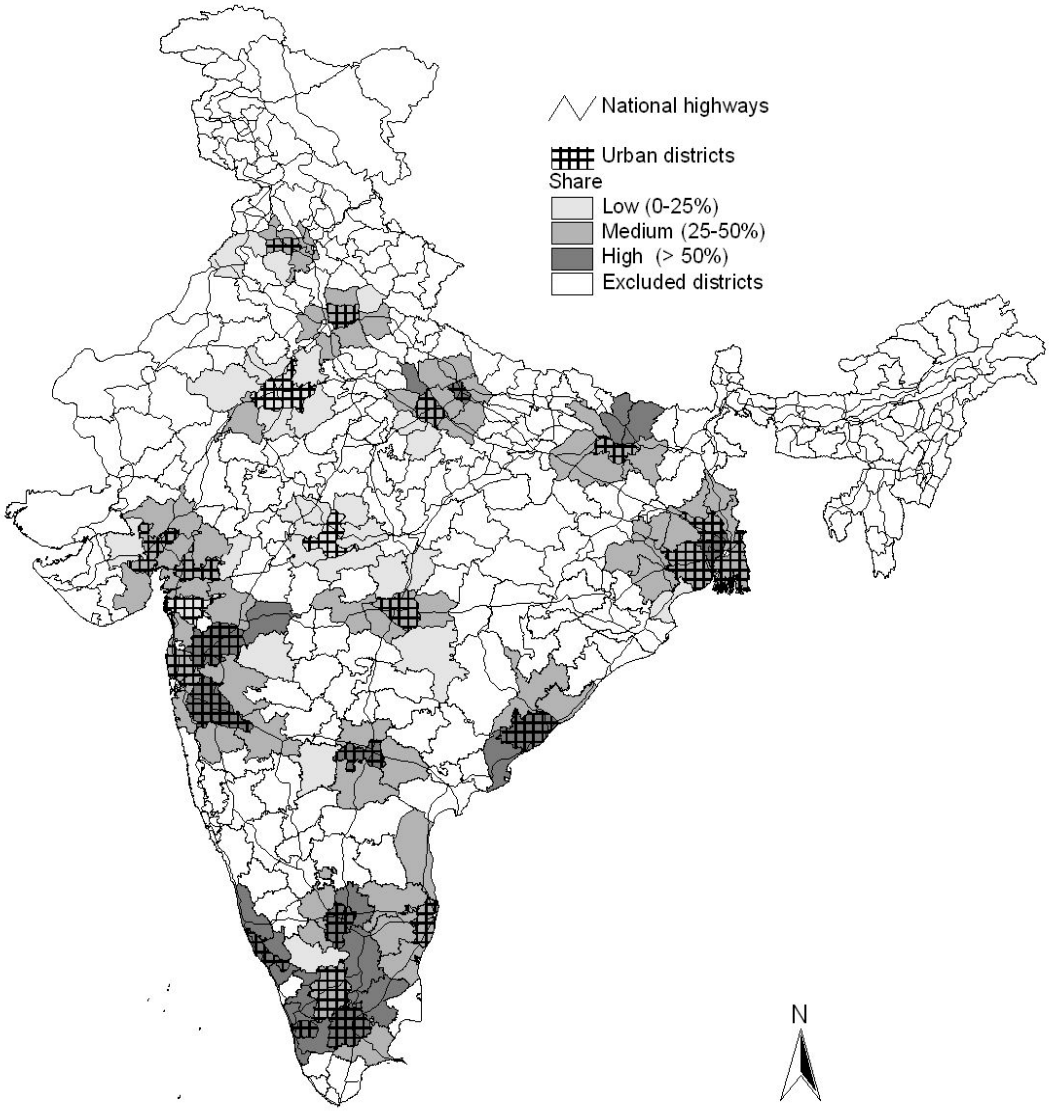
promoting agricultural diversification towards perishable and HVCs. Therefore, higher investment in roads would boost production of HVCs to meet the demand of urban population.

Table 11—Impact of national highways passes on diversification within urban-surrounded districts group

	No. of National Highway passes / No. of districts					
	Zero (0.39)[1]		One (0.57)		≥Two (0.83)	
	25[2]		45		21	
Share of high-value commodities in total agricultural value (%)	Years		Years		Years	
	1982	1998	1982	1998	1982	1998
Fruits	4.4	4.9	10.3	11.2	7.6	10.9
Vegetables	6.9	6.1	8.7	7.4	5.9	6.7
Bovine milk	13.4	14.8	11.9	14.1	12.7	15.5
Meat	0.9	1.2	1.3	2.0	1.8	1.7
Poultry, pig meat and eggs	1.2	1.5	1.6	2.9	2.4	3.2
Total HVCs	26.8	28.4	33.9	37.6	30.3	37.8

[1] Figures in parentheses represent road density, km / sq km in 1998
[2] Number of districts.

Figure 11—National highways and share of HVC: 1998 (urban and urban surrounded districts)



4. FACTORS INFLUENCING DIVERSIFICATION TOWARDS HIGH VALUE COMMODITIES

4.1 MODEL SELECTION

The spatial and tabular analyses have provided sufficient clue that urbanization is an important factor influencing adoption of HVCs. However, it has not been possible to pin point specific factors based on the above analysis nor could we know anything about their significance levels. Therefore, factors influencing agricultural diversification towards HVCs were analyzed with the help of cross section models with each district as a unit of observation.

The models tried included the ordered probit model and modified version of tobit model for truncated dependent variable. The modified version of tobit model is best suited to deal with truncated dependent variable that is bound between a given maximum and minimum values (Gujarati 1995). In our model the dependent variable is shares of HVCs in the total value of agricultural production, and vary between 0 and 1.

It is also possible to consider the values of the dependent variable as count-type data arising from categorization of continuous data. The shares are thus polychotomous-dependent variables that have a natural order. By coding these as 0, 1, 2, (by taking appropriate cut off points), one might regard these as ordinal rankings that could be modeled using 'ordered probit model'. Here, the OLS is not appropriate since coding of the data only reflects ranking, and the difference between rank 1 and 2 cannot be treated as equivalent to the difference between rank 2 and 3 (Kennedy 1998). The obvious

drawback of this method is loss of continuous data and was run merely to corroborate the findings from the tobit model.

4.2 DESCRIPTION OF VARIABLES

The dependent variables were defined in three different ways to capture the role of different factors in promoting/retarding agricultural diversification towards HVCs. These included: (i) share of high-value commodities (HVCs) in the total value of agricultural production; (ii). Share of fruits and vegetables in the total value of agricultural production; and (iii) share of poultry meat and eggs in the total value of agricultural production

For the ordered probit model the data for the above dependent variables were ordered as 0, 1, and 2, from low to high shares in the total value of agricultural production by taking suitable cut off points.

The explanatory variables considered in the models included agro-climatic, technological, agrarian structure, socio-economic and infrastructure variables, that determine share of HVCs from the supply and demand side. A list of variables with their units and description are given in Table 12.

Table 12—Expected impact of the determinants of the high-value commodities

Explanatory Variables	Units	Description	Dependant variables (share to total agricultural value)		
			All HVCs	Fruits and vegetables	Livestock products
Demand side factors					
URBPER	Percentage to total population	Urban population	+	+	+
POPDEN	No. / sq. km of geog. Area	Human population density	+	+	+
VOPR	Rs. / person	Per capita value of agricultural production	+	+	+
Supply side factors					
CBCAT	Percentage	Cross-bred cattle	+	n.a[1]	+
IMPPOU	Percentage	Improved poultry	+	n.a	+
VETY	No. / 000'00 livestock units	Density of veterinary institutes	+	n.a	+
AI	No. / 000' livestock units	Density of AI centers	n.a	n.a	+
CPRGA	Percentage	CPR'S to geog area	+	n.a	+
RAIN	00 mm	Normal rainfall	+	+	+
CVRAIN	Coefficient of variation	Seasonal rainfall distribution	-	-	-
LGP	Days	Length of growing period	+	+	n.a
FERT	kg / ha	Consumption of NPK per ha cropped area	+	+	n.a
MSFPER	Percentage	Marginal & small land holdings	+	+	+
FSIZE	ha	Size of land holding	-	+ / -	-
ROAD	km / 00' sq km of geog. Area	Road density	+	+	+
MARKET	No. / 10,000 sq km of geog. Area	Agricultural commodity market density	+	+	+
TRACT	No. / 000' ha of NCA	Denstiy of tractors	-	-	n.a
IRRI	Percentage	GCA irrigated	-	-	-
HYVs	Percentage	Area under high yielding varieties	-	-	n.a

[1] Not applicable

For the demand side variables like urban population, per capita rural and urban income, we expect a positive relationship with share of HVCs. Studies have indicated that the income elasticity of demand for HVCs was high not only in urban areas but also in rural areas (Kumar et al 2003). Urbanization is another driving force on the demand side that would influence agricultural diversification towards HVC. Due to structural changes, urbanization has been occurring at a fast pace and expected to fuel larger demand for HVCs. Urbanization is accompanied by the changes in life styles, tastes and preferences and also larger disposable income that increase demand for HVCs. For this analysis since data on per capita income at the district level were not readily available, only urbanization was included in the models.

Among the supply side factors, all infrastructure variables, like roads, markets, veterinary institutions, Artificial Insemination (AI) centers for livestock would have a positive impact on HVCs. Roads and markets provide a direct link to the producer with the consumer cutting down on transport and transaction costs. Veterinary institutions and AI centers would help in the faster adoption of improved livestock technologies. Variables like irrigation, tractor density, area under HYVs would either have a negative influence on HVCs or remain insignificant. In regions with high input agriculture and access to irrigation, the farmers tend to specialize in a few crops or enterprises. Agriculture is less risky and also there is a good market for the specialized products.

Adoption of crossbred technologies in the livestock sector would have a positive impact on HVCs, particularly on milk and meat production. Districts with higher rainfall

and longer Length of Growing Period (LGP) are expected to have a positive impact on adoption of HVCs due to longer cropping season and scope for double cropping.

4.3 MODEL RESULTS

4.3.1 All HVCs

Owing to problems of multicoliniarity only a few of the variables listed above could be included in the model. For example, the irrigation variable was correlated with adoption of high yielding varieties, tractor density and fertilizer use; farm size variable was correlated with percent of small and marginal farmers; rainfall and LGP are correlated. Hence, only one variable from each of the above categories were included in the model. To address the problem of endogenous variables two models were tried, the first model included all the relevant variables and in the second model endogenous variables if any were excluded. This is because endogenous variables not only influence the dependent variable but are also determined by the dependent variable.

All variables in the model, explaining share of HVCs in the total value of production have the expected signs with varying significance levels (Table 13). For ease of reporting, only results from the modified tobit model are discussed here. For the demand side variables, urban population as expected had a positive impact on HVCs and was significant at 1% probability level. Thus confirming our earlier findings based on tabular and spatial analysis.

Table 13—Factors determining diversification: All HVCs, 1997-98, model results[1].

Explanatory variables	Estimated coefficients					
	Modified Tobit		Modified Tobit[2]		Ordered probit	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
URBPER	0.235	5.00	0.281	5.68	0.016	2.78
MSFPER	0.383	10.26	0.354	8.97	0.040	9.82
ROAD	0.006	0.31	0.065	3.48	0.005	1.72
CBCAT	0.284	6.46			0.015	2.28
VETY	0.187	6.20	0.267	9.09	0.044	3.59
TRACT	-0.359	-5.86	-0.172	-2.99	-0.031	-3.80
RAIN	0.405	3.47	0.662	5.67	0.017	1.31
Constant	-5.339	-1.80	-9.510	-3.09	-3.341	-10.78
Sigma	10.895	24.86	11.607	24.86		
R^2	0.60		0.55		--	
Adjusted R^2	0.59		0.54		--	

[1] Estimates based on district level data, N=309.
[2] Excluding endogenous variable, CBCAT.

Share of HVCs was positively related to the number of smallholders, indicating that smallholders tended to diversify their production portfolio i.e. crop and livestock activities, more as a strategy to earn additional income by fully employing their labor resources. The man-hours requirements per ha of HVCs (fruits and vegetables) are almost 2-3 times higher compared to traditional crops (Joshi et al 2004). Small farmers were willing to diversify towards fruits and vegetables after meeting their food security needs provided suitable technology and marketing outlets at remunerative prices for HVCs were readily available (Shanmughasundaram 2003). However, there are some apprehensions about the sustainability of small farmers producing HVCs, due to small and scattered production, price risk associated with HVC's and need to maintain stiff quality standards as the size of processing units increases to reap economies of scale (Pingali et al 2004). One option is that with proactive government support small farmers

could become increasingly commercialized and integrated into the market Alternatively, to address these concerns several novel arrangements like contract farming, horizontal integration of farmers, and access to institutional credit are some of the measures suggested (Deshingkar et al 2003; Ravendran et al 2004, Pingali 2004).

On the supply side, several variables were tried and after some experimentation, a few had to be dropped due to problem of multicolinearity as discussed earlier. Among the variables included infrastructure variable related to the livestock sector (veterinary institutions) had the expected impacts and was significant at 1% probability levels. Roads were however, insignificant in the first model. In the second model after excluding the endogenous variable (improved cattle)[8] roads density was positive and significant at 1% probability level.

As expected, normal rainfall significantly influenced share of HVCs. This finding goes against the earlier findings that diversification declines as we move to high rainfall areas. Here, the positive association is between rainfall and HVCs, (not all commercial crops) and HVCs seem to have niches in high rainfall areas also. Tractor density, a proxy for irrigation and intensive agriculture negatively influenced share of HVCs. Owing to specialization, diversification had taken a back seat in districts with high irrigation.

[8] Among the variables selected in the models only crossbred cattle (included in the model on all HVCs) and improved poultry (included in the model on share of poultry and eggs) are endogenous variables. Hence these were excluded in model 2. Tractor density was considered exogenous variable since it is a fixed asset and cannot be used in divisible units.

4.3.2 Fruits and vegetables

Urban population and higher % of small farmers had positive and significant influence on the share of fruits and vegetables (Table 14). Tractor density had a significant and negative effect on diversification towards fruits and vegetables. Tractor density is a proxy for intensive agriculture in irrigated areas. Rainfall had positive and significant influence on the share of fruits and vegetables. This clearly shows that rainfed areas are emerging important niche for fruits and vegetable cultivation. Since irrigated areas are specializing towards rice and wheat, the rainfed areas are diversifying into fruits and vegetables, as these require less water for their cultivation. Road density is positive and significant at the 1% probability level.

Table 14—Factors determining diversification: fruits and vegetables, 1997-98, model results.[1]

Explanatory variables	Estimated coefficients			
	Modified Tobit		Ordered probit	
	Coeff.	t-ratio	Coeff.	t-ratio
URBPER	0.137	2.96	0.016	3.27
MSFPER	0.290	7.83	0.049	8.85
ROAD	0.061	3.48	0.004	1.87
TRACT	-0.145	-2.70	-0.022	-2.35
RAIN	0.444	4.05	0.041	3.23
Constant	-16.048	-5.57	-4.231	-9.86
Sigma	10.899	24.86		
R^2	0.38		--	
Adjusted R^2	0.37		--	

[1] Estimates based on district level data, N=309

4.3.3 Meat (monogastrics only) and eggs

Urban population, roads, smallholders, and normal rainfall positively influenced poultry production, and all the variables were significant. (Table 15). In the first model the share of improved poultry in total poultry population had a positive effect on poultry production. In the second model this variable was excluded since it is endogenous to the system. Only irrigation was negatively related to poultry production, implying that in highly irrigated districts poultry activity was less important.

In short, we can say that technological, socio-economic, agro-climatic and infrastructure factors play a role in determining diversification towards high-value commodities. Although urbanization is an important factor driving diversification towards HVCs, it is not the only factor influencing diversification. Several factors on the supply side influence adoption of HVC's at the farm level.

Table 15—Factors determining diversification: monogastrics meat and eggs, 1997-98, model results[1]

Explanatory variables	Estimated coefficients					
	Modified Tobit		Modified Tobit[2]		Ordered probit	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
URBPER	0.064	4.86	0.073	5.85	0.016	2.98
MSFPER	0.039	3.71	0.038	3.56	0.013	2.56
ROAD	0.009	1.95	0.011	2.32	0.008	5.01
IMPPOU	0.017	2.28			0.008	2.43
IRRI	-0.029	-3.89	-0.022	-3.22	-0.010	-3.07
RAIN	0.110	3.53	0.115	3.67	0.067	4.71
Constant	-3.009	-3.81	-3.025	-3.80	-2.333	-5.34
Sigma	2.954	24.86	2.979	24.86		
R^2	0.28		0.26		--	
Adjusted R^2	0.26		0.25		--	

[1] Estimates based on district level data, N=309.
[2] Model excluding endogenous variable, IMPPOU

5. SUMMARY AND CONCLUSIONS

A clear distinction is to be made between diversification as a risk mitigating strategy and as an income enhancing strategy. In the latter, a large element of risk is associated with diversification towards commercial crops related to technology and market prices. The risk is doubly more in the case HVCs due to their perishable nature.

High-value commodities account for a large share of the total value of agricultural production in a number of districts in India. Based on the share of HVCs, districts have been delineated into low, medium and high diversification zones. HVCs on an average account for 60% share in the high diversification zone compared to 20% in the low diversification zone. However, the speed of diversification towards HVCs is high in all the zones compared to other crop groups like cereals, pulses, oilseeds etc., with a few exceptions. Amongst the HVCs, livestock products like milk and particularly poultry meat and eggs, have been growing the fastest.

Districts with high and medium (above average) share of HVCs in 1982 further increased their share, while a number of districts with low HVC share in 1982 either increased their share marginally or saw their shares declining over time. Owing to favourable factors, diversification towards HVCs is gaining strength in districts favoring HVCs. In districts with low diversification towards HVCs, lack of access to technology, adequate infrastructure and policy support is slowing down diversification towards HVCs.

Urban districts group have a higher share of HVCs compared to the urban-surrounded and other districts group. Among the HVCs, vegetables and meat products

have a higher share in urban districts compared to the other two groups. Milk production is more widespread due to excellent network of co-operatives and infrastructure. Urban-surrounded districts with better road network have been able to diversify faster since they are able to meet the demand for HVCs in the urban centers.

Besides urbanization, technological, agro-climatic, agrarian structure, and infrastructure variables have significantly influenced diversification towards HVCs. Since urban population is growing at more than 3% per annum, demand for HVCs will drive their production. Even in rural areas, demand for HVCs will grow as incomes rise. However, supply side constraints will have to be addressed at a rapid pace to keep pace with demand.

Density of small farms is positively influencing HVCs. Small farmers would be the major beneficiaries of higher production of HVCs. It provides them an opportunity to diversify their income sources by participating in the markets for HVCs. There are however, apprehensions that as processing is undertaken on a large-scale to reap economies of scale small farmers will be affected due to scattered production and stiff quality standards. Novel institutional arrangements and appropriate policies need to be formulated to help small farmers sustain production of HVCs.

Infrastructure variables like roads, markets and veterinary facilities significantly influence adoption of HVCs. On the other hand, irrigation, adoption of high-yielding varieties, or high input agriculture in the better-endowed regions have a negative influence on HVCs. Rainfall also plays important role in diversification towards HVCs. Rained areas, lagging far behind from the irrigated areas, are emerging important

domains for HVCs to augment employment and income. Promoting rainfed areas through appropriate infrastructure development for agricultural diversification would have far reaching implications on the developmental and poverty alleviation programs.

Although the findings of this study are in line with earlier studies on diversification of agriculture, there are some differences. This is because in this study we have considered only diversification towards HVCs and not the entire array of commercial crops. For instance, earlier studies found that diversification was taking place mainly in low rainfall areas. But HVCs are finding niches in high rainfall areas too. However, both HVCs and other commercial crops were significantly and negatively associated with irrigation and high input use agriculture. Hence diversification of agriculture (both commercial crops and HVCs) is occurring mainly in the rainfed areas. Urbanization is a strong driver of HVCs on the demand side. The driving force of urbanization is lees so for commercial crops. This is again due to the perishable nature of HVCs and hence their production is closer to urban demand centers.

This analysis has brought out regional variations in HVCs across the country. It has implications on regional development as well as planning. Farmers close to cities would stand to gain more from production of HVCs than those farther away. Investment strategies particularly related to infrastructure (roads, markets, cold chains) will have to be matched with the demand drivers and also supply side factors. This would have implications on public and private sector investment strategies.

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Appendix I—State-wise distribution of districts and share of HVC's by level of diversification TE 1998

State	No. of districts			Share of HVCs (%)		
	Low	Medium	High	Low	Medium	High
Andhra Pradesh	1	13	6	20.2	38.2	56.3
Assam	0	9	1	0.0	41.0	62.7
Bihar	0	10	7	0.0	38.4	60.6
Gujarat	6	11	0	15.4	36.0	0.0
Haryana	2	5	0	23.0	30.6	0.0
Himachal Pradesh	0	5	5	0.0	44.5	71.2
Karnataka	7	5	4	21.8	32.1	62.1
Kerala	0	0	10	0.0	0.0	82.9
Madhya Pradesh	28	14	1	18.2	30.7	52.5
Maharashtra	7	14	4	21.2	30.5	56.0
Orissa	4	9	0	22.7	31.5	0.0
Punjab	4	7	0	22.4	37.0	0.0
Rajasthan	20	6	0	18.7	29.6	0.0
Tamil Nadu	0	6	6	0.0	34.1	55.5
Uttar Pradesh	7	38	9	20.7	36.4	61.9
West Bengal	0	12	3	0.0	35.7	54.4

Appendix II—Share of fruits, vegetables and livestock products in total value of HVCs by states and level of diversification, TE 1998

States	Low diversification			Medium diversification			High diversification		
	Fruits	Vegetables	Livestock	Fruits	Vegetables	Livestock	Fruits	Vegetables	Livestock
Andhra Pradesh	6.0	10.9	83.1	37.9	10.0	52.2	55.0	8.5	36.5
Assam	0.0	0.0	0.0	19.8	30.6	49.6	49.5	3.8	46.7
Bihar	0.0	0.0	0.0	18.2	24.3	57.5	20.1	26.1	53.8
Gujarat	8.5	13.8	77.7	14.5	16.1	69.5	0.0	0.0	0.0
Haryana	5.4	7.5	87.1	2.3	6.0	91.8	0.0	0.0	0.0
Himachal Pradesh	0.0	0.0	0.0	8.5	14.7	76.8	37.3	29.1	33.7
Karnataka	7.3	18.1	74.6	6.9	28.7	64.4	34.4	13.5	52.0
Kerala	0.0	0.0	0.0	0.0	0.0	0.0	44.4	10.1	45.5
Madhya Pradesh	10.5	11.6	77.9	13.8	11.5	74.7	68.3	7.0	24.8
Maharashtra	21.1	16.1	62.9	27.0	15.4	57.5	47.4	16.5	36.1
Orissa	10.6	73.9	15.5	18.3	61.7	20.0	0.0	0.0	0.0
Punjab	7.6	5.0	87.4	5.6	5.9	88.5	0.0	0.0	0.0
Rajasthan	6.7	2.4	90.9	2.7	2.6	94.7	0.0	0.0	0.0
Tamil Nadu	0.0	0.0	0.0	34.4	13.2	52.4	42.1	26.6	31.3
Uttar Pradesh	22.7	19.1	58.2	27.3	24.3	48.4	26.3	38.7	35.1
West Bengal	0.0	0.0	0.0	10.3	36.8	52.8	10.3	41.5	48.2

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