Agricultural Diversification in India with special reference to Haryana

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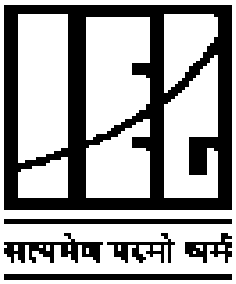

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Abstract

Agricultural diversification as measured by increase in the percent of non-food crops has grown; whereas diversification as measured by the concentration indices has remained unchanged in the recent decade. There have been significant changes in the pattern of agricultural diversification at the regional level. Within a region, smaller sub-regions or pockets of specialization in certain crops and crop-groups have emerged. Farms do not remain diversified and the usual notion of crop diversification as a risk management practice is also belied in the present study. The study also found certain kind of structural changes in all sub-sectors of agriculture: crop, livestock, and fisheries. Concerns over extreme effects of such changes are however, not valid.

The study discusses factors responsible for agricultural diversification at different levels: country (India), state (Haryana) and farms of Kurukshetra district in Haryana. The study regressed alternate measures of diversification namely, the Simpson index and concentration of non-food crops, on several possible factors such as income, land distribution, irrigation intensity, institutional credit, road density, urbanization and market penetration. The regression analysis suggests that increased road density, urbanization encourages commercialization of agriculture and with commercialization, farms in a region are increasingly specialized under certain crops and crop-groups as per the resource, infrastructure and institutions of the region.

I.I Introduction

In relation to agricultural development, "diversification" is probably one of the most frequently used terms in the recent decade. Traditionally, diversification was used more in the context of a subsistence kind of farming, wherein farmers grew many crops on their farm. The household level food security as also risk was an important consideration in diversification. In the recent decade, diversification is increasingly being used to

describe increase in area under high value crops[1]. In this perspective one would like to know what exactly diversification is? Diversification originated from the word "diverge", which means to move or extend in a different direction from a common point. In this sense diversification is the opposite of concentration, therefore, most of the techniques of measuring diversification actually measures concentration in the system. In economics, diversification refers to a situation in which decrease in the dominance of an activity, alternately increase in the share of many activities in a system is depicted. Extending the same notion to agriculture means increase in the share of many commodities in agricultural income may be termed as income diversification in agriculture; whereas increase in the share of withdrawal of a resource by many crops may be termed as resource diversification in agriculture. Diversification is therefore measured with concentration ratios.

The concentration indices however do not explain the alternate definition of agricultural diversification that is, increase in the share of high value crops in agriculture. The notion of 'high value' has emerged after liberalization of trade in agriculture. This largely refers to those commodities for which exports were liberalized during the mid-1990s and differences between domestic and international prices were high at least during the initial period of trade liberalization[2]. The high value range of crops is definitely wider than fruits and vegetables. The present study therefore measures diversification with the changes in the percent of non-food crops at the aggregate level. This will also contribute to the recent debate on food versus non-food crops in the country.

The present paper while examining the pattern of diversification in Indian agriculture also assesses the potential of the so-called high value commodities in augmenting agricultural diversification in the country. The study takes into account alternate definitions of agricultural diversification; first definition is based on a concentration index, whereas second is based on the percent of gross cropped area under non-food crops. Also it takes note of different bases of measuring diversification more

[1] In agriculture the concept of high value crops emerged with trade liberalization in the 1990s; during the initial years of trade liberalization gap between per unit cost of production and export prices was significantly higher in certain commodities. These commodities have been frequently referred as high value crops.

[2] The literature on the high value categorizes basmati rice besides fruits and vegetables as high value commodities (Haque 1995). The present study therefore considers all those commodities as high value crops, exports of which were liberalized in the mid-nineties and difference in the domestic cost of production and export price for which was high

importantly, income-, output-, and resource-based agricultural diversification. While income or output diversification has been studied at the country level as well as state; resource diversification is examined at the level of country, state and district. After studying resource diversification at the country level as also involving states; one of the relatively progressive states, Haryana has been chosen purposively to study diversification at the levels of state involving districts of the state. An average farm is finally, chosen to study diversification at the micro- level. The reference period of the study largely deals with the post 1980s but varies across the analysis depending on the availability of data. The present paper proceeds as follows: Sections II and III study diversification in agricultural income and agricultural production at the aggregate level; subsequently, Sections IV, V and VI study resource diversification at the country, state and farm-level; finally, Section VII concludes the discussion of the study.

I.I.A Agriculture Income Diversification

The Aggregate Agricultural income (agriculture gross domestic product at factor cost, GDP at factor cost) as per the CSO annual series consists of income from crop outputs (field and plantation crops), livestock, fisheries and forestry. Again at the individual sub-sector level, income or GDP at factor cost is available separately for fisheries and the forestry sector; GDP at factor cost is not available separately for the crop and livestock sector. Agricultural GDP at factor cost is available from the combined outputs of crop and livestock. The contribution of agriculture in total GDP as is known widely is decreasing, and the share of industry and the service sector in the economy is increasing. The decline in the share of agricultural GDP has been rapid during the post-liberalization period; in spite of the fact that growth of agricultural income during the 1990s has been marginally higher than the corresponding rate of growth in the 1980s. Growth in agriculture has stagnated towards the end of the 1990s and decelerated thereafter. In this context, the composition of income from agriculture and allied sector of economy has been studied.

The agricultural commodity basket has changed significantly during the reference period. A temporal comparison of the various constituents of agricultural income at 1999-2000 prices is presented in Tables1, 2 and 3. These tables show that after the 1980s livestock has been growing at a rate of around 4 per cent. As a result of high growth, livestock now accounts for around 27 percent of agricultural (crop and plantation) output. The corresponding figure in the initial year of reference was less than 20 percent. GDP from

fisheries has been increasing at an exponential rate of around 2 percent after the 1980s; its share in aggregate agriculture GDP has improved from 2.9 to 4.6 per cent during the reference period. The growth rate of fisheries has however decelerated during the 1990s. Forestry, another sub-sector of agriculture presents a different picture. The rate of growth of GDP forestry was abysmally low during the eighties; the corresponding figure however, improved in the subsequent decades.

Table I.1: Value of Selected Aggregates (at 1999-00 constant price) related to Agriculture and Allied Sectors of the Economy

Period	Crop output	Livestock output	GDP Agriculture	GDP Forestry	GDP Fisheries	GDP from Aggregate Agriculture	Overall Economy
1975/76	192374.2	47543.5	194039.9	17852.2	6317.1	218459.8	537181
1985/86	2542327.6	74488	256858.2	15641.7	8824.9	281324.7	809738.1
1995/96	333573.6	111294.7	344643.1	16592	16008.1	387243	1381011
2003/04	391537.0	146315.3	448619.9	19321.75	22506.25	490447.8	2389235

Source: National Accounts Statistics.

Table I.2: Selected Ratios to depict Structural Changes in Agriculture and Allied Sector

Period	Crop output/ Agriculture	Livestock/ Agriculture	Agriculture/ Aggregate Agriculture	Forestry/ Aggregate Agriculture	Fisheries/ Aggregate Agriculture	Aggregate Agriculture/ Economy
1975/76	80.10	19.82	88.82	8.17	2.89	40.67
1985/86	77.35	22.68	91.30	5.56	3.14	34.74
1995/96	74.98	33.36	88.99	4.28	4.13	28.04
2003/04	72.80	27.20	91.47	3.93	4.59	20.53

Note: Computed from figures as available from National Accounts Statistics.

Table I.3: Annual Compound Growth Rate of Agriculture and Allied Sectors

Period	Crop output	Livestock	Agriculture	Forestry	Fisheries	Aggregate Agriculture	Overall Economy
1975/76	1.8	3.7	1.92	-0.62	2.04	1.72	3.39
1985/86	2.21	4.8	3.04	-0.26	5.51	2.93	5.04
1995/96	2.98	3.72	5.42	0.95	5.22	3.28	5.87
2003/04	2.04	3.5	3.16	1.3	3.27	3.09	7.51

Note: Computed from figures as available from National Accounts Statistics.

The CSO income output series presents relatively detailed statistics for crops and the livestock sector. These sectors also account for the bulk of employment in agriculture. The structural changes in the value of agricultural output at the specific disaggregate level during last three decades is presented in Table 4. A perusal of these figures suggests significant changes in the structure of agricultural output since the nineties. The share of cereals and pulses has declined; while the share of fruits, vegetables, condiments and spices has increased significantly. Fibres are essentially aggregates of cotton, jute

and mesta, their share is fluctuating during the reference period. Some commodities for which the share in value of output remained almost stagnant are sugar, fibres, drugs and narcotics. Tea, coffee and tobacco together constitute drug and narcotics group. If we collate these trends in commodity aggregates with the agricultural -export -import basket (see Table 1 in appendix), it is evident that the share of exportable commodities like fruits, vegetables, spices and condiments in the value of agricultural output increased. While shares of importable commodities like pulses and oilseeds have decreased after the nineties, the share of commodities in which India has been a traditional exporter, for example, fibres, drugs and narcotics remained stagnant during the reference period.

Table I.4: Structural Changes within Crop output

Items	1975/76	1985/86	1995/96	2003/04
Fine Cereals	27.25	29.17	30.52	27.74
Coarse Cereals	8.26	6.70	5.35	4.68
Pulses	7.44	6.35	5.39	4.54
Oilseeds	7.23	7.37	9.08	7.89
Sugar	4.64	4.38	4.92	5.83
Fibres	3.91	3.62	3.97	3.64
Drags & Narcotis	2.39	2.32	2.43	2.47
Fruits & Vegetables	18.02	18.69	20.49	23.87
Condiment & Spices	2.97	3.27	3.76	4.68
Others	17.89	18.12	14.08	14.65

Note: The above values are in per cent, the percent values are computed from the figures of National Accounts Statistics.

With trade liberalization, the relative prices of exportable commodities have increased and that of importable commodities have decreased. In the short run (3-4 years), a continuous increase in the relative price of a commodity increases its production more often by substituting it for importable commodities without any significant effect on the cropped area. As a result, the shares of exportable commodities have increased in the total value of agricultural output.[3]

As is evident from Table 5, there is a general decline in the share of cereals in the value of agricultural output in states, barring Haryana, Punjab and Karnataka. In these states, the cropping pattern appears to be oriented towards cereals especially, wheat and rice. The share of pulses in the value of agriculture has increased in the states of Karnataka and Madhya Pradesh. In Karnataka, the area under pigeonpea and moong increased

[3] An increase in the share of horticultural products and spices in agricultural output during recent years are examples in this context.

during the reference year. While Madhya Pradesh (MP) is the major pulse producing state of the country, pigeonpea and chickpea are important pulses produced in most states. These pulses account for more than 60 per cent of area under pulses in the country. Increase in the production of soyabean in MP and rapeseed and mustard in Rajasthan is also reflected in the increased share of oilseeds in the value of agriculture in these states. In most of the other states, the share of oilseeds in agricultural output has declined.

The share of sugar did not change significantly during the reference periods; though a significant reorientation in the structure of production of sugar is evident from states. In Maharashtra, the share of sugar in the recent decade is only one-half the share of the previous decade. Tamilnadu and UP improved their shares in the sugarcane production of the country. The share of fibres in total value of agricultural output has increased considerably in Andhra Pradesh and Gujarat, primarily due to increase in the area under cotton in these states. One of the important commodity groups, which have registered an increase of its share in the agricultural commodity basket in most of the states, is fruits and vegetables. The share of fruits and vegetables has increased considerably in Himachal Pradesh, Bihar, and West Bengal, Tamilnadu, Andhra Pradesh and most of the North Eastern states. Fruits and vegetables are increasingly being considered as engine of agricultural growth in the country. There are also doubts about this potential and this concern is examined here.

Table I.5: Structural Changes in the Value of Agriculture for Different States

States	Cereals		Pulses		Oilseeds		Sugars		Fibers		Indigo & dyes	
	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06
Andhra Pradesh	36.25	30.63	4.24	5.54	19.37	10.85	4.49	4.60	5.51	6.32	0.00	0.00
Arunachal Pradesh	20.34	33.11	1.00	2.61	5.75	8.09	0.00	0.52	0.00	0.00	0.00	0.00
Assam	35.22	30.05	1.15	0.99	4.92	3.48	2.02	1.38	1.73	0.94	0.00	0.00
Bihar	45.07	34.10	5.92	3.96	1.48	1.11	3.53	2.80	1.17	1.21	0.00	0.00
Goa	30.05	18.43	2.19	2.04	22.90	12.31	1.54	0.64	0.00	0.00	0.00	0.00
Gujarat	19.13	13.22	6.04	2.77	27.13	24.67	6.68	7.46	10.32	18.52	0.00	0.00
Haryana	49.63	52.09	4.46	1.09	9.94	7.83	5.09	5.36	11.07	9.32	0.00	0.01
Himachal Pradesh	44.86	27.92	1.30	0.73	1.10	0.72	0.14	0.39	0.04	0.11	0.06	0.05
Jammu & Kashmir	36.90	26.41	1.43	0.76	2.97	2.04	0.05	0.02	0.02	0.00	0.01	0.00
Karnataka	21.13	24.37	3.31	4.19	15.91	10.63	9.83	6.87	3.77	1.63	0.00	0.00
Kerala	10.74	4.28	0.16	0.04	28.49	22.69	0.58	0.37	0.22	0.03	0.00	0.00
Madhya Pradesh	36.69	26.42	15.34	16.75	18.99	26.99	0.46	0.63	1.48	2.67	0.00	0.00
Maharashtra	26.45	11.78	7.03	5.40	11.09	7.75	10.45	5.20	5.87	5.64	0.00	0.00
Manipur	64.38	48.69	0.29	0.69	0.65	0.19	1.45	0.41	0.00	0.00	0.00	0.00
Meghalaya	34.82	24.09	1.20	0.79	1.35	0.85	0.11	0.01	2.50	1.34	0.00	0.00
Mizoram	47.23	46.23	5.64	2.93	5.62	3.43	0.94	0.72	0.98	0.42	0.00	0.00
Nagaland	42.40	32.26	5.61	10.03	6.63	14.45	3.65	3.43	0.05	0.36	0.00	0.00
Orissa	35.11	31.49	8.07	3.44	9.22	3.03	1.72	0.68	0.75	1.02	0.00	0.00
Punjab	64.95	67.80	0.75	0.27	2.21	0.66	3.13	2.39	12.31	7.50	0.00	0.00
Rajasthan	30.26	29.06	9.63	8.41	24.44	30.27	0.69	0.16	4.74	2.90	0.05	0.24
Sikkim	35.89	19.89	6.61	4.01	7.32	6.21	0.00	0.00	0.00	0.00	0.50	0.00
Tamil Nadu	32.52	20.56	2.50	1.75	22.70	15.84	9.80	14.00	2.19	0.79	0.00	0.00
Tripura	53.06	35.49	1.34	0.59	3.00	0.89	1.20	0.63	0.81	0.31	0.00	0.00
Uttar Pradesh	43.92	40.60	7.72	5.74	4.93	2.62	18.08	19.35	0.05	0.02	0.00	0.00
West Bengal	43.59	30.72	1.21	0.88	4.22	3.06	0.36	0.42	4.06	2.94	0.00	0.00
Jharkhand	NA	29.95	NA	5.02	NA	1.45	NA	0.26	NA	0.02	NA	0.00
Chattisgarh	NA	53.26	NA	7.29	NA	2.71	NA	0.02	NA	0.02	NA	0.00
Uttaranchal	NA	30.73	NA	1.54	NA	1.37	NA	18.08	NA	0.00	NA	0.00
All India	36.53	30.31	5.73	4.60	12.56	10.05	6.50	6.02	3.90	3.92	0.00	0.01

Note: In the above table abbreviation NA stands for Not Available

(Contd.)

Table I.5: Structural Changes in the Value of Agriculture for Different States

States	Drugs & Narcotics		Spices & Condiments		Fruits & Vegetables		Kitchen Garden		By Product		Other Crops	
	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06	1990-93	2003-06
Andhra Pradesh	4.39	4.19	8.18	10.38	11.03	21.14	0.30	1.29	4.04	2.86	2.72	3.06
Arunachal Pradesh	0.00	0.57	2.62	13.70	66.03	33.62	0.03	0.46	3.99	6.33	0.51	1.30
Assam	17.30	19.67	8.87	11.15	27.16	28.58	0.25	1.60	1.72	2.04	0.79	1.19
Bihar	0.35	1.67	0.35	0.17	31.96	47.01	0.83	1.93	7.72	5.95	1.63	1.37
Goa	0.00	0.31	2.37	2.12	35.34	60.97	0.11	0.43	2.86	1.51	2.83	1.54
Gujarat	2.54	1.21	5.33	3.47	12.50	15.43	0.84	1.82	5.22	4.57	4.99	8.07
Haryana	0.00	0.03	0.52	0.86	4.21	9.47	0.37	0.87	9.73	6.98	5.02	6.67
Himachal Pradesh	0.13	0.16	0.68	3.45	42.44	59.68	0.14	0.87	7.33	4.80	1.88	1.70
Jammu & Kashmir	0.75	0.20	0.17	0.41	48.88	55.04	0.04	0.91	5.01	3.89	3.74	10.94
Karnataka	5.45	6.63	7.50	7.67	26.80	29.86	0.67	2.22	3.91	4.68	2.75	2.73
Kerala	3.07	6.90	11.55	11.45	32.69	27.70	0.11	0.57	2.10	0.84	10.44	25.51
Madhya Pradesh	0.08	0.36	1.96	3.14	8.32	10.08	1.83	4.59	11.14	6.78	3.81	4.66
Maharashtra	0.25	0.08	1.80	0.72	25.10	28.37	2.22	1.82	7.20	5.20	2.76	29.27
Manipur	0.00	0.00	3.54	4.77	23.44	40.81	0.18	0.87	5.94	3.85	0.28	0.29
Meghalaya	0.52	1.04	17.48	10.74	33.04	54.08	0.04	1.14	5.69	2.97	4.05	3.71
Mizoram	7.04	2.13	8.29	14.16	15.55	22.71	0.05	0.63	6.18	4.40	4.51	2.66
Nagaland	0.00	0.35	7.21	10.83	25.12	20.19	0.74	1.59	7.91	6.40	2.28	1.17
Orissa	0.38	0.13	4.29	3.92	30.47	47.58	0.28	1.40	9.41	7.76	0.55	0.47
Punjab	0.01	0.01	0.26	0.23	6.16	7.04	0.49	0.95	7.02	4.04	2.74	9.75
Rajasthan	0.90	1.35	7.81	4.46	1.86	2.17	1.20	1.57	13.88	11.79	5.41	8.67
Sikkim	0.00	0.00	23.42	29.97	17.16	34.73	0.24	0.48	7.21	4.07	2.32	0.96
Tamil Nadu	2.51	2.85	2.79	3.24	20.51	32.97	0.36	1.54	3.33	5.40	1.33	2.10
Tripura	1.24	1.97	4.01	5.38	30.04	48.60	0.14	0.89	5.21	2.83	0.31	3.02
Uttar Pradesh	0.40	2.22	0.88	0.72	11.23	16.94	0.39	1.48	10.61	6.77	1.88	4.54
West Bengal	3.11	7.49	2.11	2.06	31.03	45.99	0.35	1.36	9.91	5.80	0.20	0.18
Jharkhand	NA	0.00	NA	0.07	NA	51.59	NA	3.23	NA	4.50	NA	6.06
Chattisgarh	NA	0.01	NA	0.49	NA	25.35	NA	4.51	NA	6.03	NA	3.31
Uttaranchal	NA	0.14	NA	2.07	NA	34.17	NA	0.86	NA	6.90	NA	4.72
All India	1.97	2.68	3.64	3.37	18.26	24.93	0.75	1.74	7.66	5.60	2.84	7.93

I.I.B Potential of Horticulture- based Agricultural Diversification

There have been studies (Joshi et al. 2007) eulogizing the role of fruits, vegetables and similar exportable crops often termed as 'high value' crops in the ongoing diversification-led growth of Indian agriculture. The potential of fruits and vegetables as the new source of growth can be examined in terms of supply and demand side factors. The demand-side pull for fruits and vegetables was further strengthened with the opening up of the economy and increase in per capita income. The prices of fruits and vegetables have increased consistently. The wholesale prices of fruits and vegetables during 1994-2008 have grown at an annual compound growth rate of 3.8 and 6.7 percent. This growth in price was even sharper during certain sub-periods[4]. Considering the high income elasticity for fruits and vegetables demand for these commodities would remain firm and this will be reflected in the relatively higher prices for fruits and vegetables.

The higher price has led to an increase in the area under fruits and vegetables, subsequently, production and value of output from horticulture has also increased. This is evident from Tables 4 and 5. The future potential for increasing the growth of fruits and vegetables in the states would depend on their existing levels in the respective states and therefore a distribution of states on the basis of share of fruits and vegetables is important. The distribution of states on the basis of the share of horticulture (fruits and vegetables) to agricultural output is presented in Table 6.

Table I.6: Distribution of States on the Basis of Share of Fruits and Vegetables in Agricultural Output

Share of fruits & veg'les in agri. output	States with percent share in parentheses
High (>21%)	Goa(39), Tripura(37), HP(36), Orissa(35), Meghalaya(35), Jharkhand(34), Delhi(33), J&K(31), West Bengal(29), Sikkim(28), Bihar(27), Manipur(26), Arunachal Pradesh(22), Uttarakhand(22), Karnataka(22), Maharashtra(22).
Medium (14-21%)	Assam (20), Tamil Nadu(20), Kerela(18), Dadra & Nagar Haveli(16), Puducherry(16), Chattisgarh(15).
Low (<14%)	Mizoram(13), A & N Islands (13), UP(12), Andhra Pradesh(12), Gujarat(11), Nagaland(11), MP(7), Haryana(6), Punjab(5), Chandigarh(5), Daman & Diu(3), Lakshadweep(2), Rajasthan(1).

As is evident from Table 6, states have different levels of shares in their fruits and vegetables produce in total agricultural output. The share of fruits and vegetables is high in most of the eastern and north-eastern states. Among north-eastern states, Tripura has a

[4] The prices of vegetables were fluctuating during the reference period (1994-07), increase in these prices being very significant after 2004. Prices of fruits as compared to vegetables have been increasing consistently; increase in prices of fruits has been particularly sharp after 2001.

share of 37 percent followed by Meghalaya with 35 percent. Most of the northern and western states have a very low share in the produce of fruits and vegetables with Rajasthan registering a share as low as 1 percent. In the northern region, Himachal Pradesh is an exception; fruits and vegetables account for as high as 36 percent of agricultural output. In the southern states, the share of fruits and vegetables are around the national average of 17 percent. The corresponding figures for Kerala and Tamilnadu are 18 and 20 percent, respectively.

These figures clearly show that in many states of India, the share of fruits and vegetables in total agricultural output has been less than the national average. The area under fruits and vegetables may increase in these states. These states however, present a different kind of resource endowment which is often not suitable for horticulture. Again institutional arrangements that encourage production of horticulture, wherein gain to producers is high are negligible for many commodities in these states. In certain states like Himachal Pradesh (HP), the share of fruits and vegetables in agricultural output is very high which suggests exhaustion of the potential area under fruits and vegetables in HP under the existing circumstances.

Land utilization statistics are also used to assess the potential of horticulture-led diversification. The percent of gross cropped area under fruits and vegetables is presented in Table 14 which shows that in most of the states of India barring Haryana, and Punjab the percent of GCA under fruits and vegetables has increased. Though the percent increase has differed across states; at the aggregate level increase in the percent of gross cropped area has been around one only. Such small increase has however raised several questions related to its implications for food security and also the long-term fruits and vegetable-led growth in agriculture.

Increase the production potential depends on the sources of growth in the production of fruits and vegetables. The area, production and productivity-related figures for fruits suggest that in fruits most of the increase in production during 1987-2007 is accounted for by the increase in area under fruits since productivity increase during the period has been negative. At the commodity level, positive growth in the productivity of fruits is registered in fruits such as apple, banana, grapes, guava, pineapple, coconut, and litchi. Traditional fruits like mango, citrus have registered a negative growth during the reference period.

The land utilization statistics as available from National Horticulture Board shows that production of vegetables at the all-India level during the period, 1987-2007 has increased by around 4.6 per cent; increase in productivity has been very significant at 1.7 percent. Growth in the productivity of vegetables has been positive for cabbage, cauliflower, brinjal, lady finger, tomato; while traditional vegetables like potato, and onion registered a negative growth during the above period. Vegetables also hold a greater promise for agricultural development on account of its labour-intensive nature. The requirement of labour in vegetable cultivation is less skewed; in such cases family labour, specifically female labour is utilized efficiently.

The above discussion highlights an increase in the share of fruits and vegetables in the gross cropped area and the values of agriculture in states. Horticulture especially fruits require a new set of investments in infrastructure. Favourable institutions that increase the share of the producer in the consumer's rupee are extremely important for both fruits and vegetables. Vegetables as compared to fruits show greater promise as productivity increase has been very significant. The labour requirement in vegetables also suits small farms dominated by family labour.

I.I.C Potential of Livestock-led Diversification

Livestock output in India, is growing faster than any other agricultural sub-sector. Livestock accounted for less than one-fifth of agricultural output in the early seventies; the corresponding figure has increased to 40 percent in the recent years (after 2000s). This is often considered as a new source of agricultural growth in the country. CSO also presents information related to livestock output separately for milk, meat, egg and wool. The share of each sub group of livestock product is presented in Table 7. This table indicates that the share of eggs, milk, and meat group in total livestock output is increasing while that of wool, hair, dung, and silkworm has decreased during the reference period.

Table I.7: Structural Changes within Livestock output

Items	1970s	1980s	1990s	2000s
Milk Group	59.05	64.23	67.14	69.13
Meat Group	18.14	17.05	17.99	17.83
Eggs	2.21	3.01	3.44	3.68
Wool & heir	0.62	0.27	0.22	0.20
Dung	18.93	14.23	9.98	8.14
Silkworm	1.04	1.21	1.23	1.02

Note: All values are in per cent.; figures are the average of particular decade like 1970s is the average of 1970-71 to 1979-80, while 2000s is average of years 2000-01 to 2007-08. (Source: National Accounts Statistics)

There has been supply as well as demand side impetus for growth of dairy in the livestock sector in India. Livestock products have become increasingly significant in the food basket of consumers. Income elasticity of demand for livestock products is more than one suggesting an increase in demand for livestock products (milk and milk products) as per capita income increases[5]. India has also been exporting a considerable amount of milk products to neighbouring and Middle-East Asian countries. Demand for milk and milk products would therefore remain robust. Constraints would probably be on account of supply of milk products.

Livestock-based rural livelihoods have emerged as important in India with the increased fragmentation of land and increased number of small and marginal farmers. The expectation from livestock often appears high on the following accounts. In India, mixed farming has been a way of life and in such a system, agriculture and livestock have a complementary relationship. This suggests that livestock alone cannot continue to grow for long. This complementary relationship that thrives with the use of inputs from one sub-system to another is weakening with the onslaught of commercialization. There are evidences from northwest India to show that a complementary relationship is giving way to competitive relations. The competitive relationship is on account of labour on a large farm. Field visits to Kurukshetra district of Haryana show that large farmers frequently depend on attached labour as family labour is not sufficient for animal husbandry-related operations on their farm. Milk production with hired labour is not very profitable in India[6]. Constraints on account of family labour therefore limit the intensity of livestock on the large farms of the region.

The competitive relationship is apparent on account of land on a small farm. Though secondary information on the area under fodder is not available, in a state like Haryana where dairy is highly developed, around 10 percent of the cropped area appears to be allocated to fodder crops at the state level. The corresponding figure varies across districts and also across size of farms. The author's own estimate based on farms in the Kurukshetra district shows that around 15 percent of cropped area is under fodder. The

[5] Income elasticity of demand for milk is 1.15 and 0.99, respectively in rural and urban part of the country, the corresponding estimate for most of the agricultural commodities is substantially lower than one (Radhakrishna and Ravi 1980).

[6] Though India is an efficient producer of milk; productivity of cattle in a large part of the country has been so low that milk production is profitable in these regions only with the efficient utilization of family labour. There are several studies in the library of the National Dairy Research Institute, Karnal that report a negative return from milk production in the above regions once imputed value of family labour is incorporated.

corresponding figure is even higher on small farms. The possibility of competition for scarce land has increased with the deterioration of common resources in the country. The pressure on availability of fodder is also on account of deterioration in the quality of crop residue with the increased application of pesticides for crops.

Some of the livestock–related development has however, reduced competition between food and fodder. The livestock population has been decreasing in the recent period. There have been structural changes in the bovine population as well. The structural changes are in the form of increased population of buffalo and replacement of *desi* cow with cross-bred cow (Jha 2004).

The future growth of a sector also depends on how well spread or broad the base of a sector is? Distribution of states on the basis of share of livestock to agriculture output is presented in Table 8 which shows that the share of livestock has varied across states. The ratio of livestock to agricultural output is more than 30 percent in Rajasthan, Bihar, Chattishgarh, Punjab, and Haryana. The ratio of livestock to agricultural output was low in Karnataka, Kerala, Maharashtra, West Bengal and some northeastern states. Most of the northeastern states, West Bengal, Kerala are humid and not suitable for rearing cattle. The scope of furthering the growth of livestock/dairy based development is therefore limited in the newer states while the older states where climate is suitable for dairy husbandry are showing constraints in further increasing intensity.

Table I.8: Distribution of States on the Basis of Livestock to Agricultural Output

share of Livestock to Agricultural Output	Name of States with percent share in parentheses
High (>28%)	Chandigarh(84), Delhi(56), J&K(35), Rajasthan(34), Bihar(33), Chattisgarh(33), Punjab(32), Haryana(31), Nagaland(30), A&N Islands(29), Andhra Pradesh(29).
Medium (22-28%)	Meghalaya(28), Tamil Nadu(28), Puducherry(28), HP(28), Uttarakhand(27), Mizoram(26), UP(26), Arunachal Pradesh(25), Manipur(25), Dadra & Nagar Haveli(23), Jharkhand(23), MP(23), Gujarat(22).
Low (<22%)	Karnataka(19), Maharashtra(19), West Bengal(19), Kerela(19), Assam(18), Sikkim(18), Lakshadweep(15), Tripura(13), Orissa(13), Goa(10), Daman & Diu(7).

The above discussion on agriculture and livestock output suggests that the share of horticulture has increased in the crop sector; whereas in the livestock population the share of crossbred-cattle and buffalo has increased in the country. These trends are significantly clear at the aggregate level; India is however too diverse a country to generalize. In fact, trends often in the opposite direction are also evident from the different states of India. The trend in income growth at the country level has therefore been extended to the levels of states. Trend growth also includes the allied sector of the

economy. The income here is gross domestic product (GDP) in agriculture (including livestock), fisheries and forestry and also aggregate income as reflected with the Gross State Domestic Product (GSDP) in the states. The prospects of growth of these sectors in the states would depend on the existing levels of these sectors in that particular state. The per cent shares of these sectors in state GDP is therefore presented in Table 9.

Table I.9: Share of Agriculture, Fisheries and Forestry GDP to State GDP

	Agriculture in SGDP			Fisheries in SGDP			Forestry in SGDP		
States	1980-83	1990-93	**2000-03**	**1980-83**	**1990-93**	**2000-03**	**1980-83**	**1990-93**	**2000-03**
A&N Islands	41.71	30.60	24.47	1.85	9.91	8.58	12.27	12.19	1.60
Andhra Pradesh	39.94	31.76	23.89	1.14	1.31	3.38	1.01	0.90	1.10
Arunacha Pradesh	33.38	30.97	28.56	0.08	1.03	0.88	13.06	10.36	4.16
Assam	36.02	35.08	30.75	2.00	1.70	1.82	2.03	2.30	1.50
Bihar	38.90	36.54	34.84	0.87	1.40	2.00	2.06	1.44	1.90
Delhi	3.96	3.90	1.15	0.07	0.08	0.02	0.00	0.00	0.00
Goa	12.97	12.14	6.90	2.72	1.55	2.23	1.94	0.95	0.16
Gujarat	33.83	24.86	13.68	0.79	1.46	1.14	1.89	1.19	0.28
Haryana	50.24	44.20	28.13	0.07	0.15	0.13	0.46	0.25	0.21
Himachal Pradesh	33.23	27.11	21.11	0.20	0.38	0.21	12.80	7.64	4.28
J&K	34.24	29.37	NA	0.44	0.54	NA	7.56	5.30	NA
Karnataka	39.07	32.66	22.04	0.54	0.37	0.54	2.47	2.57	1.62
Kerala	30.54	29.05	28.15	1.80	3.05	4.06	2.47	0.69	3.74
Maharashtra	22.76	18.78	13.17	0.52	0.53	0.37	2.38	1.79	1.15
Manipur	42.46	32.77	25.16	1.28	2.54	2.89	2.30	1.51	1.88
Meghalaya	32.32	22.99	21.88	0.34	0.81	0.69	1.90	1.25	0.96
Mizoram	19.89	25.78	23.07	3.98	2.88	1.18	4.15	3.33	0.92
MP	39.30	34.15	25.45	0.10	0.26	0.24	7.45	3.04	2.43
Nagaland	24.95	23.21	NA	0.07	0.48	NA	6.71	4.13	NA
Orissa	44.30	30.44	26.73	1.45	1.93	2.29	4.74	4.33	2.73
Pondicherry	11.56	8.90	3.55	5.76	9.75	1.91	NA	NA	0.33
Punjab	47.37	45.04	39.03	0.04	0.13	0.31	0.98	0.27	0.35
Rajasthan	47.97	41.77	23.91	0.24	0.08	0.07	0.71	1.65	1.40
Sikkim	48.38	39.03	21.84	0.07	0.13	0.08	0.73	0.81	1.69
Tamil Nadu	22.48	18.96	13.14	0.71	0.61	1.33	0.25	0.64	0.48
Tripura	41.35	35.83	23.47	2.12	3.82	3.11	8.47	3.17	1.37
UP	46.07	39.69	32.92	0.19	0.35	0.41	1.80	0.34	1.00
West Bengal	25.55	28.17	23.78	2.72	3.57	3.79	1.28	1.07	0.69

The share of agriculture in aggregate GDP has been decreasing continuously over the decades in almost all states. Mizoram and West Bengal are exceptions. The share of agriculture has not been decreasing continuously in these states; there was a sharp increase in the share of agriculture during the eighties, the same declined in the nineties. The states witnessing of a maximum decline in the share of AGDP include Sikkim, Rajasthan, Haryana and Gujarat. The states registering a minimum decline in the share of agriculture during the entire period of reference are West Bengal, Kerala, Bihar and Arunachal Pradesh. The reasons for significant variation in the share of agriculture over

the reference period appear to be different for different states. In states like West Bengal, the particular trend has implications for performance of agriculture; while, the above trend in states like Gujarat and Rajasthan indicates a relatively better performance of sectors other than the agriculture. Although a declining share of agricultural GDP in overall GDP is a sign of development, a similar structural transformation has not happened in employment and in this context any land-saving activity like dairy and fisheries has become important for rural livelihood. The GDP in fisheries and forestry has been studied to assess the performance of these sectors.

Figures reveal that the share of GDP from forestry in the total SGDP has also declined in most of the states over the decades. Changes in forestry-related regulations have important implications in this context. The decline has been particularly sharp in states like Arunachal Pradesh wherein the share declined from 13 to 4 percent and in Himachal Pradesh wherein the share declined from 14 to 4 percent. India is one of major fish producing countries of the world occupying a third position in fisheries and a second in aquaculture. A comparison of fish GDP to GSDP over states shows that the share of fishery in GSDP has increased in most of the states; the increase was however more pronounced in the eighties. Particular trends in agriculture and different sub-sectors of agriculture would be clear, once we collate the percent changes in these sectors with the trend growth in the sector.

A comparative account of growth in agriculture, forestry, fisheries and state GDP during the eighties (between 1980-81 and 1989-90), nineties (between 1990-91 and 1999-00) and 2000s (between 2000-01 and 22005-06) is presented in Table 10. As is apparent from the table, growth in agriculture has decelerated in many states. This deceleration was particularly sharp in Maharashtra, Madhya Pradesh (MP), Tamilnadu, Rajasthan, Haryana and Bihar. In some of these states, growth during the eighties was higher and growth at the same rate could not be maintained thereafter. There are also exceptions to the above trend; the growth in agriculture accelerated in Himachal Pradesh (HP), Jammu and Kashmir (J&K), Meghalaya and Nagaland. Interestingly, these are states with a high proportion of fruits and vegetable cultivation; these crops were favoured during the years of trade liberalization; therefore the share of agriculture has also increased in these states.

Growth in forestry was considerably high in Uttar Pradesh (UP), Punjab, Kerala, Delhi, Haryana and some northeastern states like Sikkim, Tripura and Manipur. Many of these states have experienced poor growth of forestry in the eighties; in few of the above states

the share of forestry in state GDP has been extremely low suggesting lower levels of forestry in these states. In fisheries, Andhra Pradesh, Goa, Karnataka, Jammu and Kashmir (J&K), Rajasthan and Tamil Nadu improved their rate of growth during the reference period. Tamil Nadu, AP and Goa have long coastlines highlighting the importance of marine fisheries in the state GDP; whereas, Rajasthan, J&K have more of inland fisheries. The pattern of fish production in India indicates a surge in inland fish production in the recent past; this can be attributed to increased performance of inland aquaculture in the country[7] (Jha 2006). The scope of expanding marine fisheries beyond the shallow sea zone remains important for the country.

The above discussion highlights the decreasing role of agriculture in the aggregate economy. Though the above structural changes in the economy are common for developing economies; some Indian states like WB, Kerala, and Bihar lag behind other states in the above change. The share of horticulture in crop, cross-bred in bovine, bovine in livestock, inland in total fisheries and fisheries in allied sectors has increased thereby suggesting significant changes in the structure of agriculture and allied economies. The role of trade in the above structural changes in agriculture and allied activities is also evident.

I.II Agriculture Output Diversification

The previous section discusses agricultural diversification with the help of the CSO Income Series. The findings illustrate the kind of diversification in the country's agricultural economy with income data. Income data has however, several limitations. The present section therefore discusses diversification with agricultural production data. Earlier the extent of agricultural diversification across sub-sectors and again in the crop sector across crops was examined. The present section discusses the extent of diversification of the production basket for an individual crop. Diversification here is across states.

Diversification is an analogy for concentration; if production of a commodity is concentrated in a few states, the present study presumes that the production of that commodity is less diversified across states. The percent share of a commodity during the reference period is based on the share of states in the aggregate production of a

[7] The CSO National Accounts Statistics income series at the 1993-94 prices shows that the inland fisheries has registered a growth of around 6 percent while marine fisheries grew by around 2 percent during 1994-2002.

commodity. Since there have been fluctuations in production of a commodity, the states share is obtained from production data of two consecutive years; for instance, the year 1982-84 is an average of production in the year 1982-83 and 1983-84.

The share of states in the production of selected commodities is presented in Tables11 and 12. Table 11 shows an average share of states in the production of commodities like paddy, wheat, cotton, sugarcane. These commodities are cultivated in a large number of states, therefore changes in the share of states during the reference period is presented in Table 11. There are some other agricultural commodities that are cultivated in selected states only; and production of such commodities is further concentrated in certain states. Examples of such commodities are jowar, bajra, maize, barley, gram, tur, groundnut, rape-mustard, sunflower and soyabean. For these commodities, the five important states which have been growing the respective commodity are presented in Table 12.

As is evident from Table 11, the production of paddy is relatively better distributed across states. In the recent year 2002-04, West Bengal accounted for the highest proportion (18.2 percent) of paddy production in the country, the corresponding share was only 11.9 percent in the earlier period of the reference in which span Andhra Pradesh was the highest paddy producer of the country. As regards the implications of the production of paddy on natural resources especially water; the above changes in the share of states in the production basket of paddy appear desirable since paddy is a water intensive crop and West Bengal receives more rainfall than Andhra Pradesh (AP). In this perspective, decline in the share of Orissa in the aggregate production of paddy is important. There could be state-specific constraints for decline in the share of states in paddy[8]. Examples of other paddy-producing states, which account for more than the 5 percent of the area under paddy, are Uttar Pradesh, Punjab, Haryana, and Tamilnadu. In the production of paddy, the percent share of Tamilnadu (TN) has decreased over the years. It may be noted that a large part of TN falls under the semi-arid region of the country and decline of area under paddy is encouraging; in this context increase in the share of states located in the northwest part of the country is baffling. This highlights the effect of policy-distortions on the production of paddy in the semi-arid region of the country.

[8] For example in Orissa, it is reported that a large tract of paddy-cultivating area has became uncultivable (saline) due to rearing of shrimp in the coastal belt of AP. (Source: Das 2009)

As compared to paddy, production of wheat is relatively concentrated in Uttar Pradesh, Punjab and Haryana. These states together account for around 70 percent of wheat production in the country. The pattern of wheat production has not changed significantly during the reference period (Table 11).

Jowar (sorghum), bajra, maize and barley are major coarse cereals produced in the country. At the aggregate level, the production of jowar and barley has decreased during the reference period whereas the production of bajra and maize has increased during the same period (Table 12). Increase in the production of maize has been very significant. The production structure of maize has also changed significantly for example; Andhra Pradesh, Rajasthan and Karnataka have emerged as important maize producing states in the recent period. The share of these states in the earlier year of reference (1982-84) was very low. Maize is increasingly being used as poultry feed in the country and a high growth of the poultry sector is creating a demand for these commodities.[9] This has given an impetus to the production of other coarse cereals as well since many of the coarse grains are used alongwith maize in the preparation of poultry feeds. On the supply side, popularization of *rabi* maize has also contributed to an increase in the production of maize in the country. The production structure of coarse cereals other than maize has not changed significantly. In jowar, Maharashtra accounts for more than 50 percent of the aggregate production of the country. In barley, another relatively neglected coarse cereal, Uttar Pradesh and Rajasthan together account for more than 70 percent of production at the all-India level. Production of bajra is relatively distributed among the leading states; five major bajra-producing states such as Rajasthan, Gujarat, Maharashtra, Uttar Pradesh and Haryana together account for around 90 percent of the production of bajra at the all-India level.

Though the production of pulses has increased at the all-India level; production of gram and pigeonpea has stagnated during the reference period suggesting an increase in the production of pulses other than the above (Table 11). Gram and pigeonpea together account for around 60 percent of the total production of pulses in the country. A total gram production of 6.33 lakh tonnes is distributed among the states of Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, and Andhra Pradesh. A temporal comparison of

[9] Eggs exclusively obtained from poultry have increased their share in livestock output from 2.2 percent in the 1970s to 3.8 percent in 2000s. This growth in percent is in addition to the growth of poultry meat, one of the important constituents of meat (a commodity group) in livestock output as provided by the CSO Income series.

the state-wise production structure of gram during the reference period shows that Andhra Pradesh has emerged as an important pulse-growing state replacing Haryana. The important pigeonpea producing states are Maharashtra, Uttar Pradesh, Gujarat, Karnataka and MP. Table 11 shows that five major gram and pigeonpea producing states together account for 87.4 and 77.7 percent of total gram and pigeonpea production in the country.

The major oilseeds-growing states of the country are MP, Gujarat, Maharashtra, Rajasthan and AP. Four major oilseeds namely, groundnut, rape-mustard, soyabean and sunflower, together account for more than 90 percent of aggregate oilseeds production of the country. Interestingly, Gujarat, Rajasthan and Karnataka account for around 40 per cent of aggregate production of groundnut, rape-mustard and sunflower, respectively whereas Madhya Pradesh accounts for as high as 58 percent of the domestic production of soyabean. Among oilseeds, the production of rape-mustard has increased significantly during the reference period; production of rape-mustard has further concentrated during the reference period. As is evident from Table 5, major edible oil producing states have accounted for around 80 percent of the aggregate production in the year 1982-84; while in the year 2002-04, these states together account for around 87 percent of the aggregate production in the country. This clearly suggests an increase in the concentration of production of oilseeds in the country. Soyabean and sunflower are relatively new crops; the production structure of these commodities is therefore not available for the earlier reference period (1982-84).

In India, cotton and sugarcane are important commercial crops. The state of Maharashtra, Gujarat, Andhra Pradesh, Haryana, Punjab, Karnataka, Madhya Pradesh and Rajasthan are important cotton producers. Amongst these states, Maharashtra and Gujarat together account for more than 50 per cent of the domestic production of cotton in the year 2002-04; while during the earlier period of reference (1982-84) the share of these states was 40 per cent. This shows an increase in the concentration of production of cotton in the country. In cotton production, the share of Andhra Pradesh, Madhya Pradesh and Haryana has increased; while the share of Punjab, Karnataka, and Rajasthan has declined during the reference period. In sugarcane, Uttar Pradesh accounts for around 44 percent of the aggregate production in the country. Other important sugarcane producing states are Maharashtra, Tamilnadu, Karnataka, Gujarat, and Andhra Pradesh. The percent share

of these states in the aggregate production of sugarcane has changed marginally during the reference period.

Sugarcane is water intensive crop. Eastern states like Bihar now accounts for a very small proportion of sugarcane production in the country though historically this has been important producers of sugarcane in the country and world. The regional skewness in the production of sugarcane without any regard for natural resource endowment is rooted in the differential incentives for sugar manufacture in different states of the country. The sugar mills are concentrated in certain states on account of favorable industrial environment. The existence of these mills has affected the allocation of land and production of sugarcane in its surroundings irrespective of the natural resource status of the region. A high concentration of sugar mills in West UP, Maharashtra, Tamilnadu and Gujarat are a few examples of such distorted policies.

The above discussion shows that for most of the crops, the percent share of the leading producing states has increased during the reference period (1983, 2003, 2006-07). This suggests an increasing trend towards specialization of agricultural production in the country. This specialization is not necessarily in accordance with the natural resource endowment of the region; favourable institutions and incentive structures have induced the above specialization.

Table I.10. Annual Compound Growth in Agriculture, Forestry and Fisheries in the Selected States during 1980-2005

STATE	1980-2005				1980-1990				19902000				2000-2005			
	Agri-culture	**Forestry**	**Fishing**	**GSDP**	**Agri-culture**	**Forestry**	**Fishing**	**GSDP**	**Agri-culture**	**Forestry**	**Fishing**	**GSDP**	**Agri-culture**	**Forestry**	**Fishing**	**GSDP**
A&N Islands	12.69	5.73	26.11	16.72	10.78	11.58	32.66	13.66	14.84	6.78	19.75	21.57	28.83	-59.18	4.25	8.88
Andhra Pradesh	12.9	17.6	21.01	15.55	10.64	10.61	17.13	13.8	13.35	21.7	25.46	16	-3.44	1.36	22.31	7.62
Arunacha Pradesh	13.21	7.99	27.49	14.44	16.14	12.35	59.01	15.82	12.27	2.17	11.77	13.4	0.32	3.07	6.12	4.9
Assam	12.39	11.6	13.02	12.7	12.34	12.42	12.5	14.23	12.05	5.76	14.22	11.8	3.6	9.09	8.59	7.75
Bihar	8.28	8.7	12.5	8.49	12.45	9.84	20.63	13.4	5	8.51	6.54	4.61	6.14	4.08	16.84	7.33
Delhi	8.93	27.72	11.86	17.36	15.34	18.58	23.67	15.56	1.39	44.66	10.33	18.5	-0.02	2.51	-28.1	9.2
Goa	11.95	3.36	17.41	16.39	10.95	-0.25	1.9	11.89	11.23	0.4	27.55	20.8	-7.9	21.9	-14	5.54
Gujarat	10.69	4.1	17.05	15.03	7.8	11.23	18.71	13.09	13.27	0.9	14.55	17.6	8.9	47.05	16.28	14
Haryana	12.47	11.4	18.82	15.35	10.53	8.49	28.97	13.74	11.26	14.63	17.52	15.6	1.85	6.65	5.26	9.95
Himachal Pradesh	13.05	9.43	17.29	15.82	9.35	6.02	16.16	12.8	14.45	8.72	12.05	17.9	8.17	13.63	3.83	8.76
J&K	12.22	8.27	16.19	13.44	8.81	8.4	12.76	11.9	15.26	8.12	17.13	16.1				
Karnataka	11.98	12.31	16.93	15.39	10.69	16.42	8.74	13.69	13.77	11.49	28.06	16.8	-8.6	2.14	6.33	7.16
Kerala	11.91	17.34	17.61	-20.2	10.63	-3.42	13.75	12.33	13.73	34.73	14.58	-43.2	-1.24	-22.85	1.26	6.67
Maharashtra	12.39	9.86	14.03	15.33	12.29	10.68	9.72	13.71	12.66	6.46	13.94	16.1	4.66	6.6	9.58	11.3
Manipur	10.68	14.26	19.42	13.88	11.24	8.49	20.31	14.42	11.43	23.38	13.99	14.45	5.45	4.06	9.43	12.23
Meghalaya	13.8	14.24	22.37	15.95	10.88	11.45	14.04	15.37	15.88	14.7	14.38	15.8	4.33	-1.62	-5.89	7.91
Mizoram	18.04	8.72	9.4	17.39	25.94	19.65	15.13	20.82	14.84	0.64	3.79	16.3	1.23	10.15	20.7	11.4
MP	10.3	6.78	15.15	12.25	11.76	2.36	27.82	13.44	9.94	6.76	9.3	11.1	3.87	6.72	0.14	5.8
Nagaland	18.25	13.55	28.4	18.55	15.633	17.23	51.1	17.88	16.86	14.18	26.34	17				
Orissa	10.37	9.43	15.3	12.88	8.72	12.73	14.83	12.42	15.64	8.02	15.15	14.9	8.21	-5.27	11.13	7.03
Puducherry	11.03		9.17	16.51	6.6		19.51	12.77	11.56		1.39	22.6	-3.65	0.97	1.86	8.22
Punjab	12.53	6.12	27.07	13.49	12.69	4.21	26	13.75	12.15	14.68	25.24	13.7	0.34	10.34	14.75	4.35
Rajasthan	11.85	20.6	9.51	15.42	10.89	21.91	-2.97	13.91	12.85	12.03	16.61	17.2	-4.34	8.22	7.98	3.75
Sikkim	10.56	22.22	15.99	15.39	16.29	4.44	24.81	17.5	9.76	27.96	9.97	16.4	2.52	6.07	26.38	13.2
Tamil Nadu	11.73	19.44	20.65	15.07	11.63	32.04	6.49	14.24	14.63	18.55	35.46	17.4	-10.21	8.17	0.68	4.84
Tripura	12.43	5.68	18.18	15.74	10.98	5.3	21.23	13.51	14.04	8.7	19.17	18.6	18.05	11.34	0.91	11.9
UP	11.35	10.11	17.16	13.18	10.49	-5.34	23.11	12.94	11.01	26.3	13.52	13.4	4.75	-2.78	10.98	6.28
West Bengal	13.9	10.81	15.63	14	13.6	9.46	16.76	12.87	16.56	13.45	16.08	16	2.09	-1.25	10.04	8.94

Table I.11: The Changes in States' Share in Total Production of Important Commodity and Commodity Groups at All India level

	Rice			Wheat			Total Cereals			Pulses		
States	**2006/07**	**2002/04**	**1982/84**	**2006/07**	**2002/04**	**1982/84**	**2006/07**	**2002/04**	**1982/84**	**2006/07**	**2002/04**	**1982/84**
Andhra Pradesh	12.71	10.02	15.31		0.02	0.03	7.32	6.02	8.45	9.51	8.94	4.57
Assam	3.13	4.77	4.87	0.09	0.11	0.28	1.47	2.18	2.12		0.48	0.42
Bihar	5.34	6.48	7.42	5.16	5.79	5.88	5.25	5.63	6.02	3.10	4.91	5.74
Jharkhand	3.18	2.80	_	0.17	0.16	_	1.68	1.48	_	1.83	1.10	_
Gujarat	1.49	1.13	1.15	3.96	2.07	3.38	2.91	2.51	3.53	4.15	3.55	4.20
Haryana	3.61	3.28	2.46	13.27	13.39	10.04	7.18	7.05	5.05	0.99	0.86	2.75
Himachal Pradesh		0.13	0.17	0.66	0.73	0.79	0.61	0.69	0.77		0.14	0.09
Jammu & Kashmir		0.58	1.09	0.65	0.43	0.51	0.49	0.70	0.92		0.16	0.25
Karnataka	3.70	2.96	4.07	0.28	0.20	0.44	4.29	3.38	4.78	6.27	5.46	4.54
Kerala	0.67	0.84	2.43		0.00	0.00	0.31	0.37	1.22		0.06	0.17
Madhya Pradesh	1.47	1.57	7.63	9.67	8.31	8.97	5.19	5.41	8.79	22.54	21.89	21.61
Chhatisgarh	5.40	4.82	0.00		0.15	0.00	2.56	2.31	0.00	3.45	3.14	0.00
Maharashtra	2.75	2.88	4.12	2.15	1.37	2.20	5.09	4.93	7.00	16.20	15.97	9.03
Orissa	7.31	6.08	7.40		0.01	0.28	3.42	2.78	3.63	2.46	1.83	8.04
Punjab	10.86	11.58	8.20	19.26	20.93	21.13	12.45	13.41	11.23		0.28	1.05
Rajasthan		0.14	0.27	9.31	7.82	8.25	6.16	6.13	5.89	10.42	9.80	13.17
Tamilnadu	7.08	5.75	7.44		0.00	0.00	3.92	3.12	4.11	2.04	1.90	1.89
Uttar Pradesh	11.91	12.95	11.67	33.02	35.86	32.32	19.24	21.04	19.83	13.94	17.26	20.52
Uttaranchal		0.65	0.00	1.06	1.09	0.00	0.56	0.90	0.00		0.24	0.00
West Bengal	15.80	18.21	11.89	1.06	1.37	1.65	7.76	8.68	5.61	1.06	1.46	1.80
All-India	100	100.00	100.00	100	100.00	100.00	100	100.00	100.00	100	100.00	100.00
All-India Prod'n (in lakh tones)	930.36	804.69	534.42	750.81	686.02	439.71	2030.9	1807.80	1282.75	140.20	130.41	122.56

Contd. ……

	Oilseeds			Cotton			Sugarcane		
States	**2006/07**	**2002/04**	**1982/84**	**2006/07**	**2002/04**	**1982/84**	**2006/07**	**2002/04**	**1982/84**
Andhra Pradesh	1.36	7.36	13.36	9.63	13.04	11.50	6.10	5.91	6.06
Assam	0.13	0.80	1.27		0.01	0.03	0.30	0.37	1.16
Bihar	0.15	0.61	1.04		0.00	0.01	1.68	1.71	2.27
Jharkhand		0.09	_		0.00	_		0.05	_
Gujarat	2.57	16.79	18.58	38.84	24.18	21.24	4.40	5.17	3.95
Haryana	0.83	4.31	1.23	8.00	11.02	9.94	2.69	3.39	3.13
Himachal Pradesh		0.04	0.05		0.00	0.01		0.03	0.02
J & K		0.41	0.46		0.00	0.02		0.00	0.01
Karnataka	1.13	5.75	7.91	2.70	3.26	7.70	8.06	9.10	7.72
Kerala		0.01	0.11		0.05	0.13		0.11	0.45
Madhya Pradesh	5.81	20.99	8.89	3.67	4.55	3.81	0.79	0.83	0.99
Chhatisgarh		0.57	0.00		0.00	0.00		0.01	0.00
Maharashtra	3.72	13.56	10.99	20.42	26.00	19.61	22.10	12.26	15.77
Orissa	0.18	0.69	5.63		0.59	0.04	0.36	0.31	1.64
Punjab	0.08	0.51	1.11	11.84	11.54	13.45	1.69	3.04	3.14
Rajasthan	5.17	13.72	6.84	3.31	4.00	8.07		0.14	0.80
Tamilnadu	1.08	5.37	9.08	0.97	1.53	3.92	11.57	9.53	8.11
Uttar Pradesh	1.03	4.73	11.54		0.05	0.34	37.68	44.41	43.78
Uttaranchal		0.14	0.00		0.00	0.00	1.72	2.98	0.00
West Bengal	0.65	2.87	1.61		0.01	0.00	0.36	0.49	0.71
All-India	100	100.00	100.00	100	100.00	100.00	100	100.00	100.00
All-India Prod'n (in lakh tonnes)	240.29	201.74	114.05	220.63	112.91	70.58	3550.52	2594.41	1832.63

Table I.12: Concentration of Production for some Agricultural Commodities

Crops	Year	All-India Prodn. (in lakh tons)	Leading states with % figures in parentheses
Jowar	2002-04	71.17	Mahar(50.51), Karnataka(14.76), MP(11.01), AP(8.88), Rajasthan(4.42).
	1982-84	113.44	Mahar(41.23), Karnataka(15.39), MP(14.73), AP(11.60), Gujarat(4.71)
Bajra	2002-04	83.76	Rajasthan(35.17), Gujarat(16.39), Mahar(16.07), UP(14.31), Haryana(9.11)
	1982-84	63.78	Rajasthan(36.21), Gujarat(22.02), UP(12.84), Mahar(10.29), Haryana(8.55)
Maize	2002-04	126.27	AP(15.49), Karnataka(10.98), MP(13.47), Rajasthan(11.14), UP(8.48)
	1982-84	72.36	UP(13.45), Bihar(13.16), MP(13.14), AP(8.84), Punjab(7.53)
Barley	2002-04	13.56	UP(38.65), Rajasthan(31.55), MP(8.57), Haryana (6.10), Punjab(5.97)
	1982-84	18.27	UP(45.88), Rajasthan(24.63), MP(8.97) , Haryana (6.12) , Punjab(6.0)
Gram	2002-04	49.59	MP(42.67), UP(16.23), Rajasthan(10.23), AP(8.57), Mahar(9.69)
	1982-84	50.22	MP(30.84),UP(25.57), Rajasthan(23.91), Mahar(3.63), Haryana(5.98)
Pigeonpea	2002-04	22.86	Mahar(32.26), UP(15.34), Gujarat(9.92), Karnataka(9.65), MP(9.60)
	1982-84	22.14	UP(28.27), Mahar(20.01), MP(18.14), Gujarat(9.11), Karnataka(7.04)
Groundnut	2002-04	62.73	Gujarat(39.90), Tamilnadu(16.82), Karnataka(9.18), Mahar(7.79), AP(6.03)
	1982-84	62.83	Gujarat(25.50),AP(22.37),Tamilnadu(15.44), Mahar(10.94), Karnataka(10.25)
Rapeseeds & Mustard	2002-04	50.40	Rajasthan(39.11), Haryana(16.76), UP(16.16), WB(7.64), MP(6.96)
	1982-84	23.87	UP(35.05), Rajasthan(22.69), Gujarat(9.38), MP(7.31), Assam(5.63)
Sunflower	2002-04	9.30	Karnataka(42.48), AP(32.76), Mahar(14.11), Bihar(2.16), Tamilnadu(1.08), UP(1.08)
Soyabean	2002-04	62.11	MP(58.20), Mahar(31.40), Rajasthan(6.99), AP(1.14), Karnataka(0.87)

I.II.A Resource Diversification in India

Land is one of the most important resources used in agriculture and continuous data for same is also available for a relatively longer period of time. Resource diversification is discussed with the proportion of individual crop in the gross cropped area (GCA) of the districts, state and country. Resource diversification has been computed with Simpson indices and also with modified-entropy indices, explained in the analytical framework (For details, see Appendix II: Analytical Framework). These indices are worked out for states and country for the years 2003-04, 1993-94 and 1983-84. The land utilization statistics for fruits and vegetables are available since 1991-92. The diversification indices in 1993-94 and 2003-04 have therefore been calculated by incorporating fruits and vegetables in the gross cropped area. Diversification indices with and without fruits and vegetables have been significantly different for those states wherein fruits and vegetables account for a large proportion of GCA. These diversification indices therefore, cannot be substituted for each other and both of these indices are presented in Table 13.

Table 13 shows that diversification indices at the all-India level are quite high. Figures at the aggregate level have been higher than those in most of the states. Karnataka is an exception; the state has diverse resource endowment that has led to cultivation of variety of crops. In other words diversification indices are higher for the state since considerable acreage in the state is under many crops. Similarly diversification indices are relatively higher for larger states as large state generally consists of diverse agro-climatic regions and there is scope for allocating a larger proportion of land to many crops. Though the modified-Entropy indices are based on logarithmic values; the value of this index is similar to the Simpson index for most of the states barring Haryana, and Punjab. The latter states as compared to the other states of the country have information on a fewer number of crops as crops cultivated in less than 500 hectares of area are not reported in land use statistics available in the Statistical Abstract of Haryana or similar other land utilization statistics of these states.

At the all-India level there is no change in either of the diversification indices during the reference period (1983-84 to 2003-04). For many states, changes in diversification indices are only marginal during the reference period. The increase in diversification is significant in the state of Goa, West Bengal, Maharashtra, Andhra Pradesh, and Tamilnadu. These are states that registered a sharp increase in the levels of urbanization during the reference period. Joshi et al. (2007) have found a strong relationship between urbanization and diversification. The states that showed a significant decline in the diversification indices during the reference period are Haryana, Meghalaya and Orissa.

Table I.13: A Temporal and Spatial Comparison of Diversification Indices in India

	Div. Indices without Fruits and Vegetables						Div. Indices with Fruits and Vegetables			
	Simpson Index			Modified Entropy Index			Simpson Index		Mod-Entropy Index	
States	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	2003-04	1993-94
Andhra Pradesh	0.87	0.83	0.83	0.79	0.71	0.72	0.88	0.85	0.81	0.73
Assam	0.42	0.42	0.45	0.43	0.42	0.47	0.5	0.48	0.49	0.48
Arunachal Pradesh	0.1	0.08	0.07	0.17	0.14	0.14	0.44	0.38	0.4	0.35
Bihar & Jharkhand	0.67	0.68	0.7	0.54	0.58	0.62	0.7	0.7	0.58	0.61
Goa	0.46	0	0	0.59	0		0.63	0.41	0.74	0.08
Haryana	0.77	0.79	0.8	0.65	0.71	0.72	0.77	0.8	0.66	0.73
Jammu & Kashmir	0.69	0.69	0.7	0.69	0.69	0.8	0.73	0.72	0.74	0.74
Himachal Pradesh	0.64	0.65	0.67	0.62	0.62	0.69	0.7	0.7	0.68	0.68
Gujarat	0.88	0.88	0.87	0.81	0.82	0.82	0.88	0.88	0.83	0.84
Karnataka	0.92	0.9	0.89	0.85	0.81	0.81	0.92	0.91	0.87	0.83
Kerala	0.68	0.71	0.71	0.7	0.73	0.79	0.76	0.78	0.75	0.78
Maharashtra	0.88	0.86	0.84	0.8	0.77	0.75	0.89	0.86	0.83	0.79
MP & Ch'sgarh	0.86	0.87	0.87	0.76	0.79	0.81	0.86	0.87	0.77	0.8
Meghalaya	0.5	0.58	0.56	0.51	0.69	0.85	0.45	0.53	0.45	0.61
Orissa	0.41	0.5	0.66	0.36	0.41	0.54	0.54	0.6	0.44	0.49
Punjab	0.61	0.63	0.64	0.51	0.55	0.61	0.63	0.64	0.54	0.56
Rajasthan	0.82	0.85	0.83	0.76	0.78	0.78	0.83	0.85	0.77	0.79
Sikkim	0.1	0.04	0.05	0.18	0.09	0.16	0.46	0.51	0.48	0.47
Tamil Nadu	0.85	0.81	0.81	0.76	0.7	0.71	0.87	0.83	0.79	0.73
Tripura	0.1	0.08	0.08	0.16	0.08	0.15	0.45	0.42	0.38	0.33
UP & Utt'chal	0.77	0.79	0.82	0.64	0.68	0.73	0.79	0.81	0.67	0.7
West Bengal	0.5	0.44	0.45	0.45	0.41	0.45	0.6	0.53	0.53	0.48
All- India	0.88	0.88	0.88	0.76	0.79	0.78	0.89	0.89	0.81	0.81

Table I.14: Percentage of Different Crop-groups to Gross Cropped Area

States	Fine Cereals			Coarse Cereals			Pulses			Oilseeds		
	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84
Andhra Pradesh	23.46	28.05	31.23	12.86	13.79	26.42	17.17	12.30	11.19	19.91	25.61	16.87
Assam	65.70	68.24	67.42	0.00	0.00	0.00	0.00	0.00	0.00	7.58	8.12	8.64
Arunachal Pradesh	46.04	49.11	61.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bihar & Jharkhand	71.31	69.66	66.20	9.01	9.54	11.36	9.51	9.13	11.87	1.50	2.46	2.41
Haryana	52.55	47.29	40.77	12.19	11.52	19.87	3.17	8.25	12.54	10.13	10.66	3.63
Jammu & Kashmir	47.00	48.44	48.30	31.65	30.56	32.11	0.00	0.00	0.00	0.00	0.00	0.00
Himachal Pradesh	46.16	46.39	46.33	35.56	36.92	36.77	0.00	0.00	0.00	0.00	0.00	0.00
Gujarat	13.42	10.21	12.29	16.49	18.93	27.54	7.73	8.34	7.70	27.76	28.30	25.55
Karnataka	11.83	12.93	13.19	31.36	30.97	39.28	15.94	12.23	13.71	19.37	25.18	14.60
Kerala	9.69	16.77	25.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maharashtra	9.87	10.77	12.80	29.00	39.56	42.07	15.59	16.06	14.01	12.56	13.30	10.63
MP & Ch'sgarh	38.31	37.74	38.56	11.00	14.02	21.03	22.32	19.61	21.97	21.39	21.43	10.16
Madhya Pradesh	30.04	37.74	38.56	12.29	14.02	21.03	24.26	19.61	21.97	27.67	21.43	10.16
Orissa	51.20	46.82	46.21	1.93	2.46	7.46	8.07	10.26	17.97	3.41	5.64	9.83
Punjab	75.77	72.41	66.02	2.38	3.28	5.72	0.00	0.00	0.00	1.13	2.36	2.23
Pondicherry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rajasthan	10.58	11.17	12.28	37.98	31.94	38.25	18.56	17.30	19.61	15.53	18.75	7.98
Sikkim	4.32	6.30	8.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamil Nadu	22.49	32.27	33.88	15.26	14.39	23.87	8.67	9.64	10.19	11.89	19.00	16.14
Tripura	56.48	53.54	77.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UP & Utt'chal	57.32	56.37	55.37	9.95	11.74	15.40	10.02	11.24	11.16	4.22	6.73	10.16
Uttar Pradesh	58.49	56.37	55.37	9.26	11.74	15.40	10.50	11.24	11.16	4.42	6.73	10.16
West Bengal	64.32	71.31	72.71	0.61	0.92	1.37	2.56	3.11	5.06	6.95	6.11	4.58
All- India	36.30	36.31	36.55	16.19	17.61	23.12	12.32	11.94	13.05	12.46	14.43	10.36

Contd……

States	Plantation Crops			Commercial Crops			Potatoes & Onions			Fruits & Vegetables	
	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94
Andhra Pradesh	1.85	1.28	0.87	9.74	8.91	6.60	0.23	0.16	0.14	6.55	4.15
Assam	7.33	6.57	6.21	2.53	3.14	4.55	1.97	1.57	1.23	7.30	5.48
Arunachal Pradesh	0.84	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.42	12.79
Bihar & Jharkhand	0.01	0.00	0.00	2.85	2.77	2.87	1.59	1.64	1.33	4.99	4.53
Haryana	0.00	0.00	0.00	10.92	11.52	9.57	0.60	0.17	0.16	0.95	1.07
Jammu & Kashmir	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.69	5.56
Himachal Pradesh	0.24	0.21	0.33	0.00	0.00	0.00	1.57	2.05	1.43	10.36	7.49
Gujarat	0.00	0.00	0.00	17.59	12.74	15.45	0.75	0.37	0.24	2.81	1.87
Karnataka	5.98	3.91	3.31	5.55	7.48	9.82	1.33	0.72	0.50	4.37	2.19
Kerala	53.85	52.27	39.17	0.00	0.00	0.00	0.00	0.00	0.00	20.29	18.87
Maharashtra	0.75	0.28	0.16	14.86	13.39	14.43	0.49	0.47	0.27	4.03	2.38
MP & Ch'sgarh	0.00	0.00	0.00	2.60	2.17	2.60	0.29	0.24	0.19	1.20	0.87
Madhya Pradesh	0.00	0.00	0.00	3.37	2.17	2.60	0.37	0.24	0.19	0.98	0.87
Orissa	1.98	1.03	0.83	0.51	0.65	1.47	0.13	0.51	0.54	10.66	10.22
Punjab	0.00	0.00	0.00	7.14	8.66	10.52	0.83	0.39	0.38	1.95	1.09
Pondicherry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.56	2.22
Rajasthan	0.00	0.00	0.00	1.63	2.80	2.20	0.16	0.08	0.06	0.51	0.39
Sikkim	0.23	0.13	0.21	0.00	0.00	0.00	0.00	0.00	0.00	9.09	5.51
Tamil Nadu	9.16	6.33	3.21	4.75	6.85	4.92	0.46	0.42	0.47	8.67	5.00
Tripura	1.58	1.33	1.66	0.00	0.00	0.00	1.30	0.00	0.67	22.22	18.26
UP & Utt'chal	0.00	0.00	0.01	8.07	6.97	6.79	1.64	1.61	1.23	3.67	3.39
Uttar Pradesh	0.00	0.00	0.01	7.95	6.97	6.79	1.72	1.61	1.23	3.68	3.39
West Bengal	1.42	1.47	1.43	6.62	5.65	6.47	3.15	2.65	1.86	13.09	10.03
All- India	2.18	1.83	1.45	6.84	6.44	6.83	0.92	0.76	0.59	4.62	3.59

Table I.15: Categorization of States on the basis of Average Annual Growth Rate in Area for important Crops during the period 1994-2004

Crops	Significant Increase (More than 1%)	Marginal Increase (Between 0.99 to 0.11%)	Stagnant (0.09 to -0.09%)	Marginal Decrease (-0.11 to -0.99%)	Significant Decrease (More than -1%)
Paddy	Haryana, Gujarat, Punjab, UP	MP, BR	Assam, MHT, WB	AP, J & K ,HP, Orissa, Tripura	AP, Karnataka,Rajasthan, Kerala, TN
Wheat	AP, Haryana, Gujarat, Orissa, WB	BR, J & K, Punjab,Rajasthan, UP		HP, Karnataka, MP	Assam, AP, MHT, Sikkim, Tripura
Jowar	Rajasthan		BR & Jharkhand	Orissa	AP, Gujarat,Karnataka, MHT, MP, TN, UP
Bajra	Haryana, J & K ,MP, Rajasthan	Karnataka, UP & UT,		AP	Gujarat, MHT, TN
Maize	AP,BR,Gujarat,Karnataka,MHT,Rajasthan, TN	J& K	MP & CHT	HP, Orissa	Punjab, UP & UT,WB
Gram	AP, Gujarat, Karnataka, MHT,MP & CHT, WB			Rajasthan	BR , Haryana, Orissa,UP
Pigeonpea	AP, BR , Karnataka	MHT			Haryana, Gujarat, MP, Orissa,TN, UP
Pulses	AP,Karnataka,MP, Rajasthan	BR, MHT		Gujarat, UP & UT, WB	Haryana, Orissa, TN
Oilseeds	WB	Haryana	MP & CHT	Assam, Gujarat,,MHT,	AP,BR ,Karnataka, Orissa,Punjab,Rajasthan,TN
Rapeseed & Mustarc	WB	Haryana		Assam	BR, Gujarat, MP, Punjab, Rajasthan, UP
Groundnut				Gujarat	AP, Karnataka,MHT,MP,Orissa,RajasthanTN,U
Soyabean	AP, Karnataka, MHT, MP ,Rajasthan				UP
Sunflower	AP				Haryana, Karnataka, MHT,TN,UP
Sugarcane	AP,Haryana, Gujarat, MHT,Punjab,UP, WB	MP & CHT, Orissa			Assam,BR KarnatakaRajasthan,TN
Cotton	AP, Gujarat, MHT, MP			Haryana	Karnataka, Punjab, Rajasthan, TN
Jute & Mesta	BR, WB				AP, Assam, MHT, Orissa
Tobacco	BR, Karnataka, UP				AP, Gujarat, MHT, TN
Coconut	AP,Assam,Goa,MHT,Karnataka,Orissa,TN	Kerala			
Cashew nut	AP, Karnataka, MHT, Orissa, WB			TN	Kerala
Tea	Assam, , AP., BR, HP,Manipur,TN,UP,Sikkim,Nag	Karnataka, Kerala, WB,Tripura,			
Coffee	Karnataka	Kerala, TN			AP
Rubber	Karnataka	Kerala, TN			
Potato	Assam,Haryana,Gujarat, Karnataka,Punjab,UP, WE	MP & CHT, Meghalaya	BR & Jharkhand		HP, Orissa, TN
Onion	AP, Gujarat,Karnataka,Mahar,MP,TN,Rajasthan				Orissa, UP & UT,
Fruits & Vegetables	AP,Assam,AnP,BR, Delhi, Goa, J & K,HP,Gujarat, MHT, MP, Meghalaya ,Mizoram,Manipur, Nagaland,Punjab,Rajasthan,Sikkim, TN, Tripura, UP, WB	Kerala		Orissa, Haryana	

Note: Abbreviations for states in the above Table are BR-Bihar, MHT-Maharashtra, CHT-Chattisgargh,AP-Andhra Pradesh,,UP-Uttar Pradesh,MP-Madhya Pradesh, J&K –Jammu & Kashmir,TN-Tamil nadu,,UTS-Uttaranchal, WB-West Bengal, HP-Himachal Pradesh,

Table I.16: Categorization of States on the basis of Average Annual Growth Rate in Area for Important Crops during the period 1984-1994

Crops	Significant Increase (More than 1%)	Marginal Increase (Between 0.99 to 0.11%)	Stagnant (0.09 to -0.09%)	Marginal Decrease (-0.11 to -0.99%)	Significant Decrease (More than -1%)
Paddy	AP, Haryana, Gujarat, Karnataka, Punjab	Assam,MHT, MP, Orissa, WB	J & K, UP	BR, TN	AP, HP, Kerala, Rajasthan Tripura
Wheat	A.P., Haryana, J & K, Tripura	BR& Jharkhand, HP, MP, Punjab, UP		Rajasthan, WB	AP,Assam, Gujarat, Karnataka, MHT, Orissa, Sikkim
Jowar				Karnataka, MHT	AP, Haryana,Gujarat, MP, Orissa, Rajasthan ,TN, UP
Bajra				MHT,	AP, Haryana, J & K,Gujarat, Karnataka, MP, Rajasthan,
Maize	Gujarat, Karnataka, MHT, MP, TN	J & K, HP, Rajasthan		AP, UP	BR, Punjab, WB
Gram	AP,Karnataka, MHT, MP				BR, Haryana, Gujarat,Orissa, Rajasthan, UP, WB
Pigeonpea	AP, Haryana, Gujarat, MHT, Orissa	Karnataka, UP		BR,	MP, TN
Pulses	Gujarat, MHT,	AP, UP		Karnataka, MP, TN	BR, Haryana, Orissa, Rajasthan, WB
Oilseeds	AP,Haryana,Gujarat,MP, Karnataka, MHT , TN,Punjab, Rajasthan, WB		Assam	BR,	Orissa, UP & UT,
Rapeseed & Mustard	BR, Haryana, Gujarat, MP, Rajasthan, WB			Assam	Punjab, UP & UT,
Groundnut	AP, Karnataka, Rajasthan, TN			Gujarat	MHT,MP,Orissa, UP
Soyabean	MP & C, Rajasthan				UP & UT,
Sunflower	AP, Karnataka, MHT , TN, UP				
Sugarcane	AP, Karnataka,Gujarat, MHT, TN	UP, MP		BR, Punjab	Assam, Haryana, Orissa, WB
Cotton	AP, Haryana, Rajasthan, TN			MHT	Gujarat,Karnataka, MP, Punjab,TN
Jute & Mesta				BR, Meghalaya, WB	AP, Assam, MHT, Orissa
Tobacco	Karnataka, UP			Gujarat, MHT	AP, BR & Jharkhand, TN
Coconut	AP,Assam,Karnataka, Kerala,Orissa,TN,WB	Goa			MHT
Cashew nut	AP, Karnataka, MHT, Orissa	Kerala			
Tea	AP,Manipur,Nagaland, Orissa	TN	Kerala	Tripura	BR, HP, Sikkim, UP
Coffee	AP, Karnataka, Kerala	Assam, Karnataka, TN, WB		TN	
Rubber	Karnataka, Kerala				
Potato	Assam, ,BR, HP,Haryana, Gujarat, MP, Punjab	Orissa, TN		Meghalaya	Tripura
Onion	Gujarat,Karnataka,MP, MHT,Rajasthan,UP &			Orissa	Haryana, TN
Fruits & Vegetables	AP, Assam,AP, BR, Delhi, Goa,J&K,HP, Punja Karnataka, Meghalaya,Mizoram, Manipur,Nag MP,Rajasthan, Sikkim, TN, Tripura, UP, WB	Kerala		Haryana, Orissa	

Table I.17: Categorization of States on the basis of Average Annual Growth Rate in Area for Important Crops during the period 1984-2004

Years	Significant Increase (More than 1%)	Marginal Increase (Between 0.99 to 0.11%)	Stagnant (0.09 to -0.09%)	Marginal Decrease (-0.11 to -0.99%)	Significant Decr (More than -1%
1994-04	WB	UP, Sikkim, Rajasthan, Punjab, MHT,J & K,Haryana, Bi, AnP, Assam	AP, Gujarat, MP &	HP, Karnataka,Kerala, Orissa, Tripu	Pondicherry, TN
1984-94	AP, Sikkim, Tripura, WB	Assam, Haryana, J&K, Gujarat, Karnataka, Kerala, Mahar, MP, Orissa, Punjab, Pondiccherry Rajasthan,	HP	AP, BR,	
1984-04	Assam,A.P., Haryana, Punjab, Rajasthan, Sikkim, Tripura, WB	J & K, Gujarat, Karnataka, Kerala, Mahar, MP, UP		AP, BR,HP,Orissa,	Pondicherry, TN

The above indices do not explain changes in the pattern of diversification during the reference period. Such aggregate indices often conceal rather than reveal the detailed pattern of agricultural diversification in the country. The diversification indices are obtained from the percent of gross cropped area under different crops and a discussion on the changes in the percent area during the reference period would explain the pattern of crop diversification in agriculture. There are around 40 crops for which the Ministry of Agriculture (MOA) maintains crop-acreage related information. Percent area under these crops has been worked out; in order to make it presentable several commodities are grouped together as commodity groups and percent changes in these commodities group are presented in Table 14. The table shows changes in the percent of area under crops / crop groups for the year 2003-04, 1993-94 and 1983-84. These crops are grouped together under following commodity groups namely, fine cereals, coarse cereals, pulses, oilseeds, plantations and commercial crops. The percent of gross cropped area under potato and onion has been grouped together.

In addition to the percent changes in area, the average annual growth rate in area during the reference period is presented comprehensively in Tables 15, 16 and 17. Table 15 presents the growth in area between 1994 and 2004, whereas Table 16 presents growth in area between 1984 and 1994. The above tables on the basis of the average annual rate of growth in area under important crops categorize states into five groups. The first and second group consists of states that registered significant (more than one percent) and marginal (0.99 to 0.11percent) increase in area under a crop; the third group constitutes states that show stagnation and registered an average annual growth in acreage between 0.09 to –0.09 percent; whereas the fourth and fifth group consists of states registering marginal (-0.11 to –0.99 percent) and significant (more than one percent) decline in area under the selected crops. Again an increase or decrease in area under certain crops in a state has to be viewed in simultaneity with the increase in the gross cropped area. Therefore on the basis of average annual growth rate in gross cropped area, states are presented into five groups. Table 17 presents the growth rate in area during the above two periods. The growth in acreage has to be seen in the backdrop of the percentage of gross cropped area under a crop and the changes in the above percent during the reference period (Table 14). Though these tables are self-explanatory the particular trend across states for crops / crop groups is discussed with figures from Table 14.

Fine cereals include paddy and wheat; the percent area under fine cereals at the all-India level has not changed significantly during the1994-2004, while the percent area under fine cereals has decreased marginally (0.20%) during the pre-liberalization period (1984-94). This decline is on the account of decrease in area under paddy; in fact the percent area under wheat has increased (Appendix Table 2). The states that registered a decline in the percent area under fine cereals are Andhra Pradesh, Kerala, Tamilnadu, Assam, Arunachal Pradesh, Sikkim, West Bengal, and Madhya Pradesh. The decreasing trend was similar for most of the states during the 1980, though the decrease in percent area was sharper for a few states. The states that registered an increase in area under fine cereals are Bihar inclusive of Jharkhand, Orissa, Haryana and Punjab. Though there have been significant efforts towards the reduction of area under fine cereals in the latter group of states, Gujarat and Tripura show a different trend as the percent area under fine cereals has decreased during the first period and increased during the second period.

It is almost a known fact that the area under coarse cereals has been decreasing at the all -India level (Table 11). The rate of decline has however slowed down during the 1990s. In most of the states barring Bihar, HP, Rajasthan, J&K, the percent area under coarse cereals has declined significantly during 1984-2004. There can be many reasons for preferring coarse cereals in these states. The marginal land hypothesis for coarse cereals still prevails. Coarse cereals are good fodder crop and are well suited to the traditional mixed farming system. In difficult areas like J&K, Himachal Pradesh, Bihar people are probably still dependent on coarse cereals as the reach of the Public Distribution System (PDS) in the region is insufficient. For people of some states like Rajasthan, coarse cereals are an integral part of their food consumption basket. It may be noted that coarse cereals as compared to many other cereals provide more nutrients per unit of cereals consumed.

Among coarse cereals only maize registered a significant increase in area under some states in the eighties whereas, in the nineties all coarse cereals (jowar, bajra and maize) registered significant increase in the growth of area in many states of the country. The coarse-cereals based dietary pattern of people in a large part of the country was being changed with the subsidized rice and wheat through the PDS. In the nineties coarse cereals gained in importance with their alternate uses like feed in the poultry industry, raw material for industry. There are sufficient reasons for incorporating coarse cereals in the consumption basket as well.

At the all-India level the percent area under pulses has increased marginally in the 1990s, though this has declined during the entire period of reference (1984-2004). Increase in area under pulses in the 1990s occurred in Andhra Pradesh, Karnataka, Madhya Pradesh and Rajasthan whereas Gujarat, Maharashtra and Uttar Pradesh have registered a decline in the area during this period. The share of pulses in the gross cropped area (GCA) has declined considerably in the states of Orissa and Haryana. The oilseeds contain information for a group of nine oilseeds. A favourable price policy for a group of nine oilseeds during the 1980s has led to an increase in the proportionate area under oilseeds. But with the moderation of price policy in the 1990s, the area under oilseeds has in fact declined at the all-India level during the reference period (1994-04). In states like Orissa and Uttar Pradesh, the area under oilseeds has decreased continuously since the 1980s. Haryana, Gujarat, Madhya Pradesh and Maharashtra were able to hold their share during the 1990s as well. In states like West Bengal and Madhya Pradesh, the area under oilseeds has increased during the 1990s.

Plantation crops include tea, coffee, coconut and rubber. At the all-India level the area under plantation crops has increased during the reference period (1984-04). Plantation crops are concentrated in selected states of the country. The area under plantation crops has increased in Kerala, Karnataka, AP and Maharashtra. The percent area under plantation crops has either stagnated or declined in West Bengal, Himachal Pradesh, Sikkim and Tripura. One can infer that the area under plantation crops has increased in the coastal states with tropical climate; while the same decreased in the hilly states with a temperate kind of climate. This trend has implications for differential performances of plantation crops in the country since the different kinds of plantation crops are cultivated in the hilly and coastal region of the country.

The commercial crops in Table 14 consist of sugarcane and cotton. The percent area under commercial crops has stagnated at the all-India level; however from states there are mixed trends. The percent area under commercial crops has increased in Andhra Pradesh but decreased in Assam, Karnataka, Orissa, Rajasthan and Punjab. In potatoes and onions, increase in the area is observed in the most of the states barring Karnataka, Orissa and Tamilnadu.

Since the nineties, the percent area under fruits and vegetables has increased in the country; this increase in the percent of GCA is only one percent at the aggregate level. A substantial increase in the share of area under fruits and vegetables is observed in the

northeastern states of Sikkim, Tripura and Arunachal Pradesh; while West Bengal, Tamilnadu and Andhra Pradesh registered more than a three percent increase in the area under fruits and vegetables.

The above discussion suggests that there is no significant improvement in diversification indices during the reference period. There are in fact evidences of specialization from certain states. The production basket of a commodity is now less diversified across states; in other words the production of a commodity is getting specialized in states as per the resource endowment and institutional arrangement for that commodity in the individual state. Interestingly, within the commodity groups, the percent area under specific crops has increased while that of other commodities in the same commodity group has decreased. In coarse cereals for instance, the percent area under sorghum and barley has decreased while that of maize and bajra has increased during the reference period. There are also evidences from states of specialization in certain crops. The changes in percent area under crops in the recent decade broadly show that the area under fruits and vegetables has increased significantly, while the area under fine cereals and oilseeds has stagnated. The percent area under coarse cereals and pulses are decreasing since 1970s; decline in the percent of GCA has however ceased in the nineties. Area under commercial crops has not changed significantly in the recent period. The percent change in the GCA for crops clearly shows a periodic shift in the acreage of certain crops in the specific regions of the country following favourable institutions and an incentive structure for these crops in the region.

I.III.B Resource Diversification in Haryana

Following the discussion of crop diversification at the aggregate level in this section, crop diversification at meso-level has been studied for Haryana and all its districts. Diversification indices which include Simpson and Modified-Entropy are worked out with percent of individual crop in gross cropped area for all the 19 districts of Haryana. The reference years, as for the previous analysis, are 1983-84, 1993-94, and 2003-04. These indices are presented in Table 18. As is apparent from the table both the indices have declined for Haryana and for most of the districts of the state during the reference period. Though there are a few exceptions. The differences in diversification indices have implications for the estimation techniques. The Entropy index is not sensitive to changes in the number of crops. Off late in many districts of Haryana, acreage under

many crops goes unreported.[10] This may also be construed as an indication of increased crop specialization in districts.

Table I.18: Temporal and Spatial Diversification Indices in Haryana

Districts	Simpson Index			Mod. Entropy Index		
	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84
Ambala	0.63	0.71	0.74	0.50	0.63	0.65
Panchkula	0.73	_	_	0.67	_	_
Yamunanagar	0.70	0.73	_	0.55	0.60	_
Kurukshetra	0.60	0.57	0.60	0.47	0.41	0.46
Kaithal	0.55	0.58	_	0.37	0.43	_
Karnal	0.55	0.56	0.61	0.39	0.39	0.48
Panipat	0.57	0.57	_	0.41	0.42	_
Sonipat	0.65	0.66	0.70	0.56	0.59	0.64
Rohtak	0.77	0.77	0.78	0.74	0.68	0.69
Jhajjar	0.74	_	_	0.65	_	_
Faridabad	0.60	0.65	0.68	0.56	0.60	0.63
Gurugaon	0.69	0.73	0.74	0.57	0.61	0.64
Rewari	0.70	0.70	_	0.54	0.55	_
Mahendragarh	0.69	0.71	0.72	0.58	0.62	0.67
Bhiwani	0.79	0.78	0.69	0.66	0.64	0.54
Jind	0.68	0.73	0.78	0.57	0.67	0.71
Hisar	0.79	0.80	0.82	0.66	0.67	0.71
Fatehabad	0.72	_	_	0.61	_	_
Sirsa	0.75	0.76	0.79	0.67	0.62	0.67
Haryana	0.77	0.80	0.80	0.68	0.72	0.74

Crop diversification is subsequently discussed with percent area under high value crops in Haryana and each district of Haryana. Since delineation of high value crops is difficult, changes in the percent of cross cropped area under important crops or crop group are discussed in Table 19. Some interesting trends can be seen in the percent area under the crop groups at the all-India level. An attempt has been made herewith to compare temporal changes in the percent area under crops in different districts of Haryana and this is presented in Table 19. It is apparent that while the percent area under fine cereals (rice and wheat) has decreased at the country level, the percent area in Haryana has increased. In most districts of Haryana, percent area under fine cereals has increased; however the district of Kurukshetra has been an exception where the percent area under paddy has decreased after 1993-94. In Kurukshetra, a decline of percent area is also reported for wheat (Table 19). A similar decline in the percent of gross cropped area under wheat is also reported from Kaithal, Karnal, Panipat, Sonipat, and

[10] The prime source of land utilization statistics in Haryana is Statistical Abstract of Haryana. This abstract does not report area under a crop if the cropped area under the said crop is below certain floor limit (for example 500 hectare) in a district.

Mahendragarh. As a matter of fact the area under wheat in these districts has realized to its full potential. With the depletion of ground water table, the availability of assured irrigation has been a major problem for many farmers. This has constrained acreage under water -intensive and sensitive crops like wheat (Jha 2000). Consequently, increase of area under less water-intensive crops like rape-mustard, sunflower and fodder has taken place.

In coarse cereals maize has emerged as an important crop, information for which is therefore presented in Table 19 along with other coarse cereals. As is evident from table, the percent area under these crops has decreased, though the rate of decrease has decelerated during the 1990s. The trend is similar for the most of the districts other than Mohindergarh, Jind, Rohtak and Hissar. In the 1990s the percent area under maize has increased marginally in Jind and Bhiwani. Interestingly, the percent area under coarse cereals has increased in Haryana during the 1990s, though during the 1980s this had declined significantly.

Following the above mode of presentation, the percent area under pulse, oilseeds, commercial crops are presented with the percent area under the most important pulse (gram), oilseed (rape-mustard) and commercial crops (cotton) produced in Haryana (Table 19). The percent area under pulses has been decreasing since 1983-84. The percent area under oilseeds has increased during the reference period; though the area has declined marginally during the 1990s. The sharp increase in the area under oilseeds during 1984-94 is largely due to the Technical Mission on Oilseeds (TMO) initiated during the mid-80s which ushered in the much acclaimed yellow revolution in the country. A bulk of the area under oilseeds in Haryana is under rapeseed and mustard and acreage under these crops did not change significantly during the 1990s, inspite of the fact that the price policy for oilseeds in the nineties was not as favourable as in the late 1980s (Jha 2009). In contrast the percent area under pulses has not increased in the region despite a favourable price policy for pulses in the country. This clearly suggests that there are many factors other than price that affects allocation of land under a crop.

Table I.19: Temporal Changes in Percent of Different Crops to Gross Cropped Area in Haryana and its Districts

Districts	Rice			Wheat			Maize			Coarse Cereals			Total Cereals		
	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84
Ambala	35.36	25.95	23.24	40.43	38.35	35.63	1.45	7.40	7.10	1.59	8.18	8.07	77.44	72.60	67.40
Panchkula	14.68	_	_	37.02	_	_	20.43	_	_	21.49	_	_	73.19	_	_
Yamunanagar	28.12	24.06	_	35.30	32.54	_	0.84	2.64	_	1.24	3.55	_	64.65	60.25	_
Kurukshetra	41.48	41.99	33.57	41.48	42.53	46.46	0.11	0.46	1.49	0.11	0.54	3.99	83.07	85.06	84.38
Kaithal	40.94	34.15	_	45.33	46.84	_	0.03	0.11	_	2.87	2.68	_	89.14	83.76	_
Karnal	43.39	41.10	31.26	43.32	43.99	45.25	0.10	0.44	1.81	0.36	0.94	4.28	87.10	86.11	81.14
Panipat	39.08	34.43	_	43.95	45.45	_	0.05	0.17	_	0.38	0.80	_	83.41	80.74	_
Sonipat	23.71	15.21	8.64	47.73	48.61	47.50	0.18	0.23	0.96	7.52	8.07	20.77	79.17	72.20	77.76
Rohtak	6.38	1.58	0.99	40.55	36.22	31.16	0.00	0.08	0.08	19.04	16.32	31.89	66.70	54.99	65.80
Jhajjar	5.09	_	_	40.26	_	_	0.04	_	_	22.74	_	_	68.70	_	_
Faridabad	10.64	4.84	1.76	49.21	48.25	45.23	0.07	0.44	1.09	10.30	16.35	23.16	70.71	70.95	74.65
Gurgaon	2.46	1.52	0.17	41.76	38.07	36.72	0.00	0.00	0.03	22.82	22.79	26.96	67.91	64.20	69.28
Rewari	0.30	0.06	_	24.46	24.30	_	0.00	0.00	_	30.94	26.15	_	56.34	52.40	_
Mahendragarh	0.00	0.00	0.00	15.30	14.46	18.24	0.00	0.00	0.00	38.86	31.63	37.46	54.41	46.71	58.92
Bhiwani	1.30	0.04	0.06	17.14	13.42	10.19	0.01	0.00	0.02	24.74	25.42	35.66	43.83	39.41	46.33
Jind	19.80	13.28	8.79	44.98	40.47	34.55	0.11	0.00	0.22	10.20	9.09	22.28	75.15	63.26	66.64
Hisar	4.52	4.85	3.07	32.29	29.24	25.23	0.00	0.10	0.17	11.68	8.43	13.86	49.26	43.30	42.80
Fatehabad	16.36	_	_	41.38	_	_	0.00	_	_	3.69	_	_	61.88	_	_
Sirsa	6.87	4.64	4.18	35.14	32.21	25.75	0.00	0.03	0.07	1.18	1.04	2.95	43.92	39.00	33.94
Haryana	15.89	12.98	9.86	36.25	34.28	31.53	0.26	0.51	0.95	11.62	10.81	18.38	64.18	58.74	61.10

Continued .....

Districts	Gram			Total Pulses			Rapeseed & Mustard			Oilseeds			Sugarcane		
	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84
Ambala	0.05	0.95	1.83	1.35	3.68	5.30	0.58	2.69	1.52	1.30	4.92	2.90	7.00	3.51	9.49
Panchkula	1.06	_	_	4.04	_	_	3.19	_	_	5.11	_	_	1.91	_	_
Yamunanagar	0.10	0.51	_	1.39	2.28	_	0.84	1.42	_	1.24	3.10	_	21.04	19.34	_
Kurukshetra	0.04	0.11	0.39	0.33	0.65	1.06	0.11	0.34	0.74	1.15	0.38	0.79	5.52	3.26	2.41
Kaithal	0.08	0.23	_	0.16	0.85	_	0.34	1.64	_	0.37	2.06	_	0.89	0.59	_
Karnal	0.05	0.16	0.28	0.36	0.91	1.45	0.21	0.21	0.49	0.21	0.73	0.53	2.95	1.72	3.73
Panipat	0.05	0.11	_	0.38	1.31	_	0.38	0.28	_	0.38	0.68	_	4.22	2.44	_
Sonipat	0.07	0.35	0.70	2.52	5.37	4.26	1.98	3.05	1.62	1.98	3.36	1.65	5.61	4.40	5.63
Rohtak	0.87	3.88	10.39	4.86	7.92	11.62	8.94	19.80	3.29	9.04	19.90	3.33	8.30	3.41	4.67
Jhajjar	0.87	_	_	2.65	_	_	18.78	_	_	18.78	_	_	1.22	_	_
Faridabad	0.00	0.28	1.37	2.88	3.33	5.63	2.06	4.76	2.38	2.25	5.04	3.05	2.70	3.65	2.15
Gurgaon	0.63	2.64	8.25	1.16	3.23	10.10	17.11	23.31	7.24	17.44	23.79	7.51	0.03	0.11	0.17
Rewari	0.69	3.58	_	0.74	3.69	_	32.28	35.08	_	32.43	35.31	_	0.00	0.00	_
Mahendragarh	6.51	10.12	18.19	6.65	10.16	18.29	30.21	31.63	10.29	30.28	31.67	10.29	0.00	0.00	0.00
Bhiwani	7.57	27.96	30.46	9.29	28.71	31.30	23.36	16.01	2.70	23.41	16.05	2.73	0.34	0.09	0.29
Jind	0.13	3.28	9.46	0.30	4.53	10.50	2.13	4.84	1.90	2.22	5.07	1.98	2.02	1.35	2.65
Hisar	2.65	11.87	14.36	4.88	12.32	14.92	10.48	9.51	5.29	10.57	9.58	5.43	0.95	0.28	0.55
Fatehabad	0.68	_	_	0.90	_	_	4.25	_	_	4.35	_	_	0.50	_	_
Sirsa	2.65	9.52	22.27	3.79	9.70	22.54	9.70	8.09	3.87	10.20	8.21	3.92	0.19	0.02	0.04
Haryana	1.92	6.97	11.39	3.10	8.22	12.66	9.69	9.91	3.44	9.90	10.24	3.63	2.51	1.92	2.33

Continued .....

Districts	Total Cotton			Commercial Crops			Total Fruits & Vegetables			Other Crops		
	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84
Ambala	0.00	0.17	0.85	7.00	3.68	10.33	2.17	3.02	1.86	10.73	12.11	12.20
Panchkula	0.00	_	_	1.91	_	_	2.41	_	_	13.34	_	_
Yamunanagar	0.00	0.15	_	21.04	19.49	_	1.99	1.80	_	9.70	13.07	_
Kurukshetra	0.00	0.04	1.20	5.52	3.30	3.61	2.73	2.31	0.90	7.19	8.30	9.26
Kaithal	0.44	2.03	_	1.33	2.63	_	0.41	0.34	_	8.60	10.36	_
Karnal	0.03	0.13	0.81	2.98	1.85	4.54	1.12	0.95	1.23	8.24	9.44	11.11
Panipat	0.11	0.17	_	4.32	2.61	_	1.80	1.96	_	9.71	12.69	_
Sonipat	0.72	0.54	1.47	6.33	4.94	7.10	1.45	3.59	1.79	8.55	10.55	7.44
Rohtak	5.28	3.38	1.72	13.58	6.79	6.39	0.70	0.61	0.51	5.13	9.79	12.35
Jhajjar	1.48	_	_	2.70	_	_	0.39	_	_	6.79	_	_
Faridabad	0.04	0.24	0.47	2.73	3.89	2.62	1.88	1.47	0.98	19.54	15.32	13.09
Gurgaon	0.10	0.07	0.00	0.13	0.19	0.17	1.44	1.35	0.92	11.92	7.23	12.01
Rewari	2.13	0.06	_	2.13	0.06	_	0.43	0.15	_	7.93	8.40	_
Mahendragarh	1.92	0.39	0.02	1.92	0.39	0.02	0.28	0.31	0.26	6.45	10.78	12.21
Bhiwani	8.14	6.89	4.29	8.49	6.99	4.58	0.24	0.35	0.29	14.74	8.49	14.77
Jind	9.39	12.84	7.11	11.41	14.19	9.76	0.60	0.63	0.37	10.31	12.33	10.75
Hisar	22.89	25.29	21.85	23.84	25.57	22.40	0.70	1.00	0.77	10.75	8.23	13.67
Fatehabad	21.88	_	_	22.39	_	_	0.64	_	_	9.83	_	_
Sirsa	23.50	31.44	23.28	23.69	31.46	23.31	0.63	0.55	0.33	17.77	11.07	15.95
Haryana	8.23	9.68	7.13	10.74	11.61	9.46	0.93	1.09	0.78	11.14	10.11	12.38

Note: The horizontal line (dash) (–) shows that the corresponding figures are not available. Source: Statistical Abstract of Haryana.

In Haryana, sugarcane and cotton constitute the commercial crops together. Sugarcane accounts for only 2.5 percent of the gross cropped area of the state. Acreage under sugarcane has increased marginally in Haryana; an increase in the percent area has been very significant in certain districts. It may be noted that the profitability of sugarcane in the vicinity of a sugar factory is very high and farmers prefer it over other crops inspite of the fact that it is a highly water-intensive crop. In the 1990s, the area under cotton declined in the most of the districts of Haryana, barring Rohtak, Rewari, Mahendragarh and Bhiwani. In these districts, the ground water table being low and the water quality saline, the farmers therefore have limited options in the cultivation of crops other than cotton in the *kharif* season. The above example argues for a specialization of cotton cultivation in certain districts. Interestingly, the area under cotton in the districts discussed above has increased, though the crop area has declined at the level of state and country.

In Haryana, unlike for India, the percent area under fruits and vegetables has declined during the 1990s; though the corresponding area has increased during the 1980s. Districts show a different pattern for example the percent area under fruits and vegetables has increased marginally in Kurukshetra, Karnal, Kaithal, Faridabad, Gurgaon, Rewari, Rohtak, Yamunanagar and Sirsa districts. Many of these districts are relatively better connected with the city / town; and this has played an important role in the diversification of area under fruits and vegetables. Urbanization-led agricultural diversification in favour of fruits and vegetables has been explained by Joshi et al. 2007. Again if we compare temporal changes in the percent area under crops in different districts of Haryana, it would be evident that Kurukshetra and Karnal have been leading other districts of Haryana on the basis of certain parameters of intensive agriculture (Jha 2000). Kurukshetra for example was ahead of other districts in the adoption of intensive agriculture in the 1980s; whereas in the year 2003-04, Kurukshetra again led other districts as far as adjustment to the consequences of intensive agriculture is concerned. One may note that the percent area under paddy and wheat started decreasing in the

above districts in the recent decade on account of the stress on natural resources. An increase of percent area under fruits and vegetables in the district may also be construed as another step towards the adjustment against resource stress.

If the percent area under the above crops is discounted from the gross cropped area, in most districts of Haryana around 10 percent of GCA remained unaccounted for during all the reference years. This figure is not too small to be ignored. Field visits to the villages in Haryana suggest that most of the farmers allocate a significant proportion of their area to fodder crops. This is however, not reported in the existing system of land utilization statistics published from states and country. If we consider this residual as fodder then the area under fodder crops has increased in the 1990s. This increase is more in the districts of Faridabad, Gurgaon, Hissar, Bhiwani, Sirsa. The earlier two districts are highly urbanized and the demand for milk is generally high in such districts. This is also on account of increased emphasis on dairy in the state.

In summing up, some of the salient points that emerged after comparing crop diversification in the districts of Haryana with the diversification trend at the all-India level are as under:

a. The percent area under fine cereals decreases at the all-India level; the corresponding figure has however increased in Haryana. In some of the progressive districts of Haryana, the percent of gross cropped area has started declining under resource stress.

b. The percent area under coarse cereals increases in certain districts of Haryana, though the corresponding figure has declined at the all-India level.

c. The area under oilseeds increases in many districts of Haryana though the percent area has declined for the commodity-group at the state level.

d. Despite some encouraging trends in certain districts of Haryana, the percent area under pulses has not increased in any of the districts of Haryana. This highlights the limitations of price-induced incentives for growing certain crops.

The above discussion shows that small crop-specific pockets such as for fine cereals, oilseeds, sugarcane, cotton, coarse cereals are being created in Haryana. Though many of the above changes in per cent area under crops are influenced with the state of natural resources in the region, institutions and the incentive structure provide the necessary impetus for the above specialization.

I.IV Farm level Diversification in Kurukshetra district of Haryana

The previous section shows that on many accounts, diversification at the state and district levels has been different. As these disparate trends are often not understandable, therefore the pattern of agricultural diversification at the level of farm is studied here. Farm-level diversification has been examined for the Kurukshetra district of Haryana, as this has been one of the most progressive districts as far as the adoption of agricultural practices is concerned. Again most of the districts in Haryana are moving towards the pattern followed by Kurukshetra district (Jha 2008). Agriculture in many other states is also developing in a manner similar to Haryana. In this backdrop, the study of farm-level diversification in Kurukshetra district may guide us in understanding the pattern of agricultural diversification in the country. The sample farmers are selected by adopting a multistage stratified random sampling technique (Jha 2009a).

Table 20 presents a profile of small, medium and large farms with an average operational holding of 2.8, 12.3, and 22.5 acres, respectively an equivalent to 1.13, 4.97, 9.12 hectares, respectively in the study area. Table 20 presents crop-enterprise mixes for average farms of small, medium and large categories of sample farmers. Table 20 shows that paddy and wheat account for more than two-thirds of the gross cropped area. On the basis of intensity of enterprises, the difference between medium and large farms is not very significant. On the large farm, the percent area under basmati paddy, sugarcane, pulses, oilseeds, fruits and vegetables are higher than the medium farm whereas the area under wheat, potato and fodders is lower than in the medium farm. Small farmers are distinguished in terms of smaller area allocated for cash crops (sugarcane, basmati paddy), and higher allocation for fodder and vegetables.

Table I.20: Enterprise Patterns and Earnings on Average Farms in Kurukshetra District

Particulars		Small	Medium	Large
Cultivated area (in acres)		2.8	12.3	22.5
Percent area under enterprise				
	Paddy	30.0	30.5	28.0
	Paddy (Basmati)	5.2	10.7	12.7
	Wheat	31.9	34.0	31.2
	Pulses	1.2	2.2	3.3
	Oilseeds	3.0	4.9	6.1
	Potato	3.8	3.0	2.4
	Sugarcane	0.0	2.1	3.0
	Fodder	17.7	8.1	7.0
	Fruits and vegetables	8.0	4.2	5.5
	Agro-forestry	0.1	0.3	0.8
Cropping Intensity		225	219	210
Livestock				
	Cattle per acre	0.5	0.3	0.2
	Buffalo per acre	0.8	0.4	0.5
Gross return (Rs/acre)		19522	18628	18427
Working capital (Rs/acre		12448	13220	14347
Net return (Rs/acre		7074	5408	4180
Diversification Indices in terms of acreage				
Maximum proportion index		0.32	0.34	0.31
Simpson index		0.75	0.79	0.79
Modified Entropy Index		0.76	0.81	0.81
Diversification Indices in terms of gross income				
Maximum proportion index		0.29	0.22	0.14
Simpson index		0.82	0.86	0.87
Modified Entropy Index		0.89	0.94	0.95

There can be different reasons for the above crop-wise trend in the region. The oilseed cultivated in the region is rape-mustard, and to lesser extent sunflower. These oilseeds as compared to late-sown wheat (competing crops in the region) are less resource intensive. The percent area under fodder depends on the level of dairy enterprises on farm. Dairy as compared to other enterprises is more labour intensive, while the demand for labour is also less skewed; therefore the intensity of dairy is more on the small farm. This explains the higher share of fodder crops on small farm. Like fodder and livestock enterprises, potato and other vegetables are also labour intensive in nature; the percent area under these crops is therefore less on the large farm. A higher percent area under fruits and vegetables on the large farm is more on account of fruits rather than vegetables. In the sample households, *kinnow* orchard is reported from two large farmers. Though the size of the orchard is of around five acres, the percent area on the average large farm has been

significant on account of the small numbers of large farmers in the sample. In the study area *eucalyptus, papular* plants are planted around a farm near or on the boundary of the holding; some large farmers have also allocated a small piece of land exclusively for agro-forestry.

The extent of diversification involving alternate indices is presented in Table 21. The simplest way to measure diversification at the farm level is by means of the number of enterprises undertaken on a farm. The number of enterprises on a small farm is 11; whereas, it is 12 on medium and large farms. These figures indicate that small farms are less diversified than medium and large farms. The difference in number is on account of cultivation of sugarcane; the small farmers in the sample households did not cultivate sugarcane during the survey year (2000-01). While sugarcane is one of the most profitable crops in the region, its cultivation depends on the proximity of a sugar processing plant in the region.

Though the number of enterprises within an individual production unit is one of the simplest ways of measuring diversification, this does not explain the levels of activities in a farm portfolio. In this context, the index of maximum proportion (MPI), another measure of diversification compares the share of individual enterprise in the aggregate farm portfolio, and reports the share of the enterprise that commands the maximum share in farm portfolio. The MPI suggests that if the share of individual enterprise in a farm is high, say more than 50 percent of the total cropped area or farm income then the above farm is specialized in favour of that enterprise. The index of maximum proportion can be worked out on the basis of acreage, resources diversification and farm income, and income diversification. The MPI estimates, based on acreage, show that the large farms are more diversified than medium and small farms. Amongst different crops, the share of wheat has been the maximum in a farm portfolio which is true across farm sizes. Paddy would record the maximum proportion in area, if the areas under basmati and non-basmati paddy are combined. The share of wheat on a medium farm is higher than on the small farm.

In terms of gross income (G1), the index of maximum proportion is 29 percent on the small farm; the corresponding figures for medium and large farms are 22 and 14 percent, respectively. The index of maximum proportion indicates that the small farms are less diversified than the other farms of the region. On small farms, buffalo accounts for the maximum proportion in the gross income of farms; whereas, on medium and large farms it is wheat. In terms of gross income, rice would command the maximum proportion if we combine the contribution of basmati and non-basmati rice on an average farm. The above trend is similar to the agricultural economy at the aggregate level. Towards the end of the 1990s, milk has taken over rice as the maximum contributor to the agricultural income in the country. A comparison of livestock statistics with operational holding at the aggregate level shows that the small and marginal farms in the country are more livestock-centric.

The index of maximum proportion does not give due importance to enterprises other than the most dominant one. In order to improve this limitation, Simpson and Modified-Entropy indices are calculated both for acreage and farm income. These indices are based on the share of all individual enterprises on an average farm. The above indices like earlier indices have also been worked out with respect to the area (resources) and farm income. The Simpson index for area and gross income is at the minimum for small farms indicating a lower diversification on small farms. However, differences in indices for crop area are small suggesting less variation in crop diversification across farms. The difference in either of the above indices worked out in terms of income or acreage is less for medium and large farms. This manifests a similar level of area and income diversification on these farms. The differences across farms are more conspicuous with the Entropy Index. The index for small farms is significantly lower than for the medium and large farms which confirms the earlier findings that the small farm is the least diversified in north-west India. The difference in crop diversification between medium and large farms is less; though the enterprise diversification on large farms is slightly

more than for the medium farms suggesting a positive relationship between farm size and diversification.

The above relationship is perplexing in the light of the fact that risk aversion is negatively associated with the size of holding and diversification is a risk management practice. Diversification with crops is not a risk management practice in the study area since crop incomes are not negatively associated amongst themselves. (Jha *et.al.* 2009) In northwest India, wheat and paddy as compared to other crops involve less risk. In these crops, price-induced risk is low owing to an assured market;[11] and the production-induced risk is also less on account of assured irrigation (Jha, 1995). The above discussion therefore suggests that as the percent area under crops other than paddy and wheat increases, the risk on farm also increases. It is also evident from Table 20 that the proportionate area under basmati paddy increases with the increase of operational holding. An increase of crop diversification with the operational landholding is therefore, not unfounded in the study area. Wheat and paddy being remunerative and less risky in irrigated conditions have substituted other crops and led to specialization in the region.

In brief, farm-level diversification has been studied with the sample households from Kurukshetra district of Haryana. The study categorizes farmers into small, medium and large. The study found that the large farms are the most diversified while small farms are the least diversified in northwest India. The positive relationship between farm size and risk management is difficult to accept in the light of the established literature on diversification, risk management and the risk attitude of farmers. Diversification with crops is not a risk management practice in the study area. The study further argues that with commercialization, the subsistence type of crop production has been replaced by specialized farms. There may be several reasons for the increasing trend towards specialization in agriculture for example; agro-climatic conditions, suitability of technology for specific regions, concentration of irrigation facilities, assured market,

[11] Government largely depends on the northwest India to procure wheat and paddy for the public distribution system; the market for wheat and paddy is therefore, assured in the region.

remunerative prices, supportive institutions, increased communication and transportation facilities among others.

This present study discusses the pattern of agricultural diversification considering different definitions of agricultural diversification. Though the share of agriculture in the overall economy has been decreasing, the share of livestock and fisheries in agriculture has increased. There have been significant structural changes in the livestock and fisheries sectors of the economy. For many commodities, the production basket has concentrated over the years. For most of the crops, the percent share of leading producing states has increased during the reference period (1983, 2003 and 2006-07). This suggests an increasing trend towards specialization in agricultural production. Changes in the percent of gross cropped area also suggest a move towards specialization. There has been a significant increase in the percent of gross cropped area under fruits and vegetables. On this account, a threat to the availability of fine cereals is however a long drawn one since the crop diversification trends from states like Haryana are not necessarily supportive to the diversification trend as available at the aggregate level. The micro-level evidences suggest that the certain crops are more remunerative in the given resource endowments and institutional framework. Farms in the region are getting specialized under these crops and such specialization has not increased risk on the farm.

II

Traditionally, agricultural diversification referred to a subsistence kind of farming wherein farmers were cultivating varieties of crops on a piece of land and undertaking several enterprises on their farm portfolio. Household food and income security were the basic objectives of agricultural diversification. In the recent decades, agricultural diversification is increasingly being considered as a panacea for many ills in the agricultural development of the country. Diversification at the farm level is supposed to increase the farm income; the utility of diversification as risk management practices however, remains. At the country level, diversification is supposed to increase the extent of self-sufficiency for the country. At the regional level, diversification is being promoted to mitigate negative externalities associated with mono-cropping[12]. Some of the above expectation is also rooted in different interpretations of agricultural diversification in the country.

While diversification was historically construed as the opposite of concentration; increase in area under the high value commodities is being referred as agricultural diversification in the recent period. The high value commodities refer to a group of commodities wherein trade was liberalized in the nineties; and difference between domestic and international prices was very high during the initial period of trade liberalization in the country. The above difference in price tapered-off for some commodities and the concept/term 'high value' was not very relevant for few commodities in the subsequent period. The high value usually refers to fruits, vegetables and many agricultural exportable commodities. The fruit and vegetable -led diversification in the recent period has been presumed as a precondition for achieving the four percent rate of growth in agriculture. Considering the multi-dimensional importance of agricultural diversification, it is important to understand the drivers of agricultural diversification in the country? The present study attempts to answer this question.

[12] Mono-cropping is about cultivation of the same set of crops in a region over a long period of time.

As is apparent from the above discussion there are two broad approaches to agricultural diversification. Thus, in the first approach, diversification is measured with the concentration ratio; while in the second approach, diversification as measured by percent of non-food crops in the gross cropped area is considered to study drivers of agricultural diversification in the country. There are different parameters with respect to which diversification in agriculture can be studied; accordingly they have been referred to as income or resource diversification. For studying the determinants of agricultural diversification the present study has considered resource diversification; this has certain merits over income and output diversification. These are as follows: first, resources are more fundamental than income since income from agriculture is rooted in allocation of land under crops; second, quality data for resources like land is better than that for other resources such as labour and capital in the country. Moreover information on many of the factors responsible for agricultural diversifications is in physical terms; therefore, it would be better to consider land-based resource diversification for the regression analysis.

The determinants of resource diversification have been studied at the macro-, meso-, and micro-levels. At macro-level resource diversification has been studied for the country and the states. Subsequently, one of the relatively progressive states, Haryana has been chosen purposively to study diversification at the regional level, which referred here as diversification at meso-level. The state of Haryana as compared to many other states is relatively uniform; and it would be easy to understand the role of various factors in agricultural diversification. Average farms have subsequently been chosen to study diversification at the micro- level.

Factors responsible for agricultural diversification depend on the way we define and measure agricultural diversification and also the region for which agricultural diversification are being studied. The next section (Section II) reviews studies related to the determinants of agricultural diversification and discusses the basis for the selection of variables. Section III empirically investigates the determinants of agricultural diversification at the all-India level. Whereas, Section IV examines the determinants of

agricultural diversification in Haryana. Section V discusses the process of agricultural diversification from farm-level evidences. Section VI finally, concludes the study and also discusses policy implications.

A review of some of the studies that have dealt with the determinants of agricultural diversification in the country will help us in identification of possible factors to explain agricultural diversification in the country. Most of the previous studies on the determinants of crop diversification deal with micro-level situations. Walker et al. (1983) has found that the kind of diversification and its consequences and implications are strongly conditioned by different regional agro-climatic and soil environments. Differences in the quantity and quality of resource basis were largely responsible for variation in diversification. Gupta et al. (1985) found that irrigation intensity, farm net worth, price risk, and farm size were strong variables affecting the level of crop diversification. Singh et al. (1985) at micro-level has found diversification inversely related to the size of farm. Anosike et al. (1990) has found land tenures, off-farm work, education and environmental variation as important determinant of diversification at the farm level.

Agricultural diversification in most of the above studies is concentration ratios; whereas agricultural diversification is increasingly being referred as increase in the production of high value crops. The present study has considered both versions of agricultural diversification in the analysis. The first version of diversification is illustrated by the Simpson index (see analytical framework presented in Appendix 2) often referred as diversification indices. Whereas, the second version of diversification in the present analysis includes the concept of high value agriculture. Several researchers have considered the value of fruits and vegetables in high value agriculture, though commodities other than fruits and vegetables are at times considered as high value (Haque 1995). The present investigator further argues that some of the items being considered as high value may not remain so after a period of time if supply matches demand for the commodity. This study therefore aggregates the percent area under fruits, vegetables, plantation crops, commercial crops and terms this aggregate as area under

non-food grain crops in percent (NFCP). This aggregation is also important in the light of the recent concerns that area under non-food crops is increasing at the cost of food grain in the country (Jha 2008).

The studies reviewed above discuss the possible factors that increase agricultural diversification at the level of farm. The above studies are reported from different micro-level settings; forces that drive agricultural diversification in a particular socio-economic set up may be different in another set up. The determinants for other measures of agricultural diversification namely increase in area under non-food crops (NFCP), may however be discussed in an objective fashion. Like most of the economic phenomena the present analysis also discusses determinants of agricultural diversification in terms of supply and demand. Thus, it argues that the increase in area under high value crops have been driven by demand, which can be distinguished as domestic and international demand. In the domestic market, demand for high value crops is influenced by rising income. As income increases consumer's preference shifts from staple food items such as rice, wheat, and coarse cereals to high value food items like fruits, vegetables, dairy, poultry, meat, and fish products.[13] The above changes in the consumption pattern encourage the farming community to diversify its production portfolio in favour of high value food items. Experiences from developing countries have revealed similar changes in the production portfolio on account of altering dietary patterns (Barghouti et al. 2003). Joshi et al. (2007) has also found that urbanization is the most important factor behind the growth of high value crops. Domestic demand therefore, remains important.

Demand for some high value commodities has also increased on account of the international market. Jha (2006) clearly shows the effect of trade on structural changes in the production of agricultural commodities in the country. Appendix Table 1 shows that fruits, vegetables, condiments and spices have emerged as important exportable commodities after the 1990s. The relative prices of these commodities have increased

[13] In India, the share of high value food items in total expenditure on food increased from 34 percent in 1983 to 44 percent in 1999-2000 in the rural areas, and from 55 percent to 63 percent in urban areas (Kumar and Mruthyunjaya 2002).

after trade liberalization and this has encouraged farmers to grow more of the above commodities in their field. These agricultural commodities in the present study are included as non-food crops (NFCs).

Changes in the relative prices of crops have influenced the crop enterprise mix immensely. Price is basically a reflection of the demand and supply situation and this is discussed in the following paragraph. In a closed economy, the price that farmers receive alternately, farm harvest price (FHP) is influenced by the minimum support price (MSP) and the MSP has been influencing acreage under crops. A significant area under coarse cereals was replaced by fine cereals in the seventies; similarly, the area under food crops were replaced by non-food crops like oilseeds in the eighties. The pattern of MSP for crops has influenced the above changes in the land allocation (Acharya 2005). Trends in MSP and farm harvest prices for commodities as in Haryana are presented in the Appendix Table 2. With the opening of economy trade has emerged as important for many commodities as it has started influencing the relative prices of commodities.

Most of the econometric studies attempt to explain the acreage under a crop, while considering one or the other variant of prices for the current or historical years. Though there are issues as to which price: minimum support price, farm harvest price, or wholesale price that affects acreage under a crop. The selection of price becomes problematic when acreage under a group of commodities as in the NFCs needs to be explained with the price. In such circumstances, the suitable price-index that can collectively explain changes in acreage under non-food crops is difficult to arrive at. In order to avoid these inconveniences, the present analysis has not considered price as one of the explanatory variables for percent area under non-food crops. The importance of price however does not diminish, and MSP, FHP, WSP indices of crops are presented in the Appendix Table 2. The appendix table broadly shows movement of the above prices for different agricultural commodities and provides an opportunity to collate the movement of prices with the percent of area under different food crops in the country.

On the supply side, diversification is influenced by improvement in infrastructure: (roads and markets) and technology (Joshi et al. 2007). In the innumerable studies on

crop-acreage response; infrastructure, technology and institutions are important non-price factors that influence acreage under a crop. Though there are numerous infrastructures, that affect acreage under a crop, network of road is one of the most important factors. Technology has different dimensions among which intensive agricultural practices is the most important while assured irrigation is important for the adoption of intensive agricultural practices. The range of institutions that affect acreage under a crop is wide and varied; structure of land holding and institutional credit facilities are important as well.

Different variants of agricultural diversification, concentration ratios and changes in the percent of non-food crops are explained in the present discussion with the structure of land holdings, irrigation intensity, institutional credit, road network and urbanization. The regression analysis has been undertaken at the level of country and also for the state of Haryana. It may be noted that the individual state is an observation in the country-level regression analysis while districts are observations in the state-level analysis. Since per capita income is not available for districts, income as an explanatory variable has been considered at the country level only.

Linear and double-log equations were estimated with the ordinary least square technique (OLS) for the year 2003-04, 1993-94 and 1983-84. The results from the log-based OLS estimates were more suitable and were therefore presented in Table 2. The linear OLS estimates are also presented in Appendix Table 7. Since the results of the above estimation (OLS) are not very encouraging, the cross section and time series data were pooled from the selected states of India to estimate the regression equations with the Generalized Least Square estimation technique.[14] The merits of GLS over OLS are well

[14] Eighteen out of twenty eight states were selected for the present analysis, namely, Andhra Pradesh, Assam, Arunachal Pradesh, Bihar, Haryana, Jammu & Kashmir, Himachal Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.

documented.[15] The present study uses GLS with the random-effect model to estimate these equations. Model and Specification of variables are as under:

$$AGDIV1/2 = \oint(PCI, AOH, SMH, IRIP, RDEN, URB, ICD, MKTP)$$

where,

AGDIV1 = Agricultural diversification as measured with Simpson Index

AGDIV2= Percent of cropped area under non-food crops (NFCP)

PCI = Per capita net state domestic product at 1993/94 prices, used in aggregate level analysis

SMH = Percent of small and marginal holdings in total agricultural holdings, used in the aggregate level analysis

AOH = Average size of operational holdings in hectare in state-level analysis

IRIP = Intensity of irrigation is percent of gross irrigated to gross sown area

RDEN = Road density is the length of road (in km) per thousand square km of geographical area in the country level analysis while road density in state-level analysis is percent of villages connected with metal road

URB = Urbanization and road density is highly correlated; URB is the percent of urban to total population in the district and states. URB has been used for the state level analysis.

ICD = Institutional Credit is the ground-level credit disbursed for agricultural and allied activities per unit of gross cropped area

MTPI = Market Penetration is the net sown area per unit of regulated market. This is an adverse measure of market penetration.

II.II Determinants of Agricultural Diversification in India

[15] The Generalized Least Square (GLS) estimation technique eliminates the effect of hetroscedasticity arising due to cross-sectional data and autocorrelation due to time series data. In addition, the number of observations also increases as the technique pools cross section and time series data.

The present section discusses the results of a regression undertaken to assess the determinants of agricultural diversification at the country level for the years 1983-84, 1993-94 and 2003-04. Agricultural diversification in the present analysis is resource diversification studied with the Simpson Index and the percent of area under non-food crops; these estimates are presented in Table 1. The table presents the temporal and spatial trends in resource diversification for the country. Diversification indices as is evident from the table are relatively higher for the larger states. A large state consists of diverse agro-climatic regions suitable for cultivating diverse crops; as a result a significant proportion of the GCA in a large and diverse state is under many crops and diversification indices are also higher for such a state.

At the all-India level there is no significant change in diversification indices during the reference period (1983-84 to 2003-04). Though there was a marginal change in the diversification indices for some states during the above period. The increase in diversification index was significant in the state of Goa, West Bengal (WB), Maharashtra, Andhra Pradesh (AP), Tamilnadu (TN). The states showing a significant decline in diversification indices during the reference period are Haryana, Meghalaya and Orissa. The percent of GCA under non-food crops, another measurement of resource diversification, has increased significantly during the reference period. This increase in percent is observed in many states; some states that show a dissimilar trend from the above are Bihar, Haryana, Karnataka, Punjab and Rajasthan.

Table II.1: Agricultural Diversification in India

	Simpson Index			Percent of Non-Food Crops		
State	**1983-84**	**1993-94**	**2003-04**	**1983-84**	**1993-94**	**2003-04**
Andhra Pradesh	0.83	0.83	0.87	31.16	45.86	46.51
Assam	0.45	0.42	0.42	32.58	31.76	34.3
Arunachal Pradesh	0.07	0.08	0.1	38.98	50.89	53.96
Bihar	0.7	0.68	0.67	10.57	11.67	10.17
Haryana	0.8	0.79	0.77	26.82	32.94	32.09
Jammu & Kashmir	0.7	0.69	0.69	19.59	21	21.35
Himachal Pradesh	0.67	0.65	0.64	16.9	16.69	18.28
Gujrat	0.87	0.88	0.88	52.47	62.52	62.36
Karnataka	0.89	0.9	0.92	33.82	43.87	40.84

Kerala	0.71	0.71	0.68	74.13	83.23	90.31
Maharashtra	0.84	0.86	0.88	31.12	33.61	45.54
Madhya Pradesh	0.87	0.87	0.86	18.44	28.63	33.41
Orissa	0.66	0.5	0.41	28.36	40.46	38.8
Punjab	0.64	0.63	0.61	28.26	24.31	21.85
Rajasthan	0.83	0.85	0.82	29.86	39.59	32.88
Tamil Naddu	0.81	0.81	0.85	32.06	43.7	53.58
Uttar Pradesh	0.82	0.79	0.77	18.07	20.65	21.06
West Bangal	0.45	0.44	0.5	20.86	24.66	32.51
All India	0.88	0.88	0.88	26.68	34.14	35.19

In order to assess the determinants of resource diversification, alternate measures of agricultural diversification are regressed on a set of independent variables; the results of the regression analysis estimated from double log specifications and results from the linear specification are presented in Table 2 and Appendix Table 7, respectively. The estimated results are with respect to the Simpson Index and also the percent of GCA under non-food crops. The estimated coefficients with t-statistics in parentheses for different variables: per capita income, structure of land holding (SMH), irrigation intensity (IRIP), institutional credit (ICD), and road density (RDEN) are presented in Table 2.

The studies that relate diversification indices with income have largely reported a positive relationship between them, though the extent of such a positive relationship depends on the region from where the results are reported.[16] In such studies largely related to farm-level diversification, income from livestock is an important constituent of farm income. Income in the present analysis is per capita state domestic product at the 1993-94 prices; this presents an aggregate picture. The results of regression analysis that are presented in Table 2 and Apndx Table 7 shows that income has a negative effect on the diversification index (Simpson Index); the negative sign for the estimate (effect) is consistent during all the reference years. The coefficients / estimates for income are

[16] Singh et al.(1985) studying diversification in Punjab has reported a significant positive increase in income; whereas Walker et al. (1982) studying farm-level diversification in the semi-arid region of the country have found increase in assured return, in other words, simultaneous increase in income and decrease in risk at the level of farm.

significant in the year 1983-84 and 2004-05. The negative relationship is against the established findings that relate diversification indices and income. A perusal of data for states shows that states like Punjab, Haryana are less diversified; alternately, these states are highly specialized under paddy and wheat crops (Table 1). These are also states with a relatively higher per capita income. A negative relationship between income and diversification indices follows from the above analysis.

The per capita income is hypothesized to affect the diversification as measured with the percent of non-food crops in either way. The non-food crops more specifically, fruits and vegetables are increasingly recognized as a new source of growth in agricultural income. On the other hand, increase in per capita income is the cause of shift in consumers' preferences from staple to food items like fruits and vegetables. The above changes in dietary pattern are the cause of a diversification of production portfolio (Barghouti et al. 2003). This implies a positive effect of income on the percent of GCA under non-food crops in the country. The estimated coefficient has a positive sign and is also significant in the year 2003-04.

The size and the quality of land has always been an important factor in agricultural production relations. Average size of operational holding (AOH) is often considered as an important determinant of crop diversification. These variables are supposed to have a negative effect on diversification indices. The average size of operational holding was initially considered in the present analysis; subsequently, it was dropped because distribution of land as reflected in the percent of small and marginal holdings in total agricultural holdings in a state show better result than the AOH. The SMH has therefore been considered in the present analysis. The structure of land holding reflects the distribution of land and land tenure system in a state[17]. The percent of small and marginal holdings in total agricultural holdings (SMH) should affect the Simpson Index positively, if diversification is a risk management practice and the small farmers

[17]Historically, the land tenure system has been specific to a region and this has implications for the distribution of land in the region. The *zamindari* system in the eastern part of India is said to have led to a more skewed distribution of land whereas, the *ryotwari* system in the western part of the country has resulted in a relatively better distribution of land in the region.

are more risk averse than the large farmers[18]. The estimates for SMH are however, negative and statistically insignificant for each of the reference years (see Table 2 and Apndx. Table 7).

Regarding the effect of land distribution on the percent of non-food crops (NFCP), it is argued here that SMHP should have a negative effect on the NFCP. This is hypothesized on the account of the fact that cultivation of non-foodgrain crops (NFCP) exposes farmers to market induced risk; so small and marginal farmers should allocate less of their land to the NFCs on account of farmers' attitude towards risk. In brief, the author expects a negative relationship between NFCP and SMH. In the regression analysis, the effect of SMH on NFCP is insignificant during each of the reference years: 2003-4, 1993-94, and 1983-84. The sign of the estimate for SMH is as per expectation only in the year 1993-94. The sign of the coefficient may be ignored as the estimates are not statistically significant. The results for SMH imply that farmers of all sizes are preferring cultivation of NFCs in the recent years. This is plausible considering the increased dependence of farmers on market for their household consumption needs; this tendency has further increased with the commercialization.[19] The above findings on SMH are similar to the earlier findings in relation to the Simpson Index.

Quality of land has always been an important determinant of diversification (Walker 1983) and the intensity of irrigation reflects the quality of land in the present analysis. Irrigation intensity in the present study is the percent of irrigated area under principal crops (IRIP). If diversification is a tool to reduce risk, then IRIP should have a negative effect on diversification as measured with the Simpson index since irrigation reduces production risk in agriculture. In the present analysis, the estimate for irrigation intensity (IRIP) is positive for the years 1983-84, 1993-94; while the estimate is negative

[18] Farmers on the basis of their attitude towards risk-return trade-off are of three types: risk averse, risk neutral and risk taker /preferrer. Indian farmers are generally risk averse; the degree of risk aversion increases as the size of asset decrease. Land is the most important asset of farmers in rural India (Jha and Jha 1995).

[19] Commercialization refers to increased dependence of farmers on market. With commercialization, farmers are increasingly turning to the market for their consumption needs. The earlier notion of subsistence farming is fast depleting with commercialization.

in the year 2003-04. The estimates are statistically insignificant for each of the above years. This demonstrates that irrigation intensity has no significant effect on diversification. Similar results are also observed in the regression analysis with the pooled data (see Table 3).

If diversification as is generally believed in the recent years is an income increasing practice and is revealed in the NFCP, then irrigation facilities should have a positive effect on NFCP. This essentially means that with increase in irrigation facilities the percent area under non-food grain crops (NFCP) should increase in the state. Results from regression analysis are however, contrary to the expectation. The estimates for irrigation intensity are negative for each of the reference years. The estimate is statistically significant at the 10 percent level for year 1993-94 and at the 5 percent level for year 2003-04. The results suggest that as the intensity of irrigation increases, the share of gross cropped area allocated to non-food crops decreases and agriculture is specialized towards food crops. This is plausible considering the association of fine cereals with the assured irrigation.

Credit can influence diversification indices in a different way. Credit is believed to increase the risk bearing ability of farmers; therefore one can expect a positive effect of credit on agricultural diversification provided increase in diversification fulfills the objective of rational farmers. Institutional credit in the present analysis is the ground-level credit disbursed per unit of gross cropped area for agricultural and allied activities (ICD). The sign of the coefficients is as per the expectation. The signs of the regression coefficient for ICD are positive during each of the reference years and the coefficients are statistically significant only for the years 1983-84 and 2003-04. The signs and significance of ICD suggests that as intensity of credit from an institutional source increases diversification also increases in the states.

Credit reflects farmers' dependence on market purchased inputs, which in turn highlights the commercialization of agriculture in the region. Non-food crops are believed to be associated with the commercialization of agriculture. Following this argument, credit should have a positive effect on the percent of GCA under non-food

crops. The regression analysis for the years 2003-04 and 1983-84 suggest that credit has a negative impact on NFCPs whereas the estimate for the year 1993-94 shows a positive effect on NFCPs. The negative impact can also be defended on account of the fact that many of the non-food crops are self liquidating in nature and non-institutional loans are easily available from the *arhat* (wholesale traders) for such purpose. The association of commercialization and area under non-food crops is more relevant in the international context; such distinction is difficult to draw for India since in a significant part of the country, paddy and wheat are being grown as commercial crops.

Expansion of rural road reflects the strengthening of market-related infrastructure in the state. Market encourages farmers to get rid of their subsistence type of production system. Expansion of road therefore should have a negative effect on diversification indices. Road density in the present analysis is metalled road in kilometers (km) per thousand square km of geographical area (RDEN). The regression analysis shows that the effect of road on DVIN is statistically significant in the year 2003-04; and the sign of the coefficient is as per the expectation. The estimate is insignificant for the year 1993-94, suggesting that the diversification is independent of road density in the particular year. One may note that the concentration of rural road has increased in the nineties.

If diversification is about increase in percent area under NFCs, then the road density may have a positive effect on diversification. The coefficient for RDEN is expected to affect NFCP positively; this suggests increased allocation of land to the NFCs following the spread of road in a region / state. The NFCP also include area under fruits and vegetables, many of these are perishable in nature; a positive relationship between road and percent of GCA under non-food crops is therefore expected. The estimates are however not significant, this is true for the year 2003-04 as well.

Table II.2: Estimated Regression Results (log specification) to study the Determinants of Crop Diversification at all-India level

	Simpson Index			Percent of non-food Crops		
Variables	**2003-04**	**1993-94**	**1983-84**	**2003-04**	**1993-94**	**1983-84**
PCI	-0.71	-0.42	-1.12**	0.98**	0.04	0.96
	(-2.01)	(-0.59)	(-2.52)	(2.68)	(0.08)	(1.96)
SMH	-0.35	-0.74	-0.63	0.43	-0.54	0.05

	(-0.83)	(-0.90)	(-1.55)	(0.98)	(-0.90)	(0.11)
IRIP	-0.24	0.28	0.10	-0.09	-0.34*	-0.32**
	(-1.23)	(1.17)	(0.87)	(-0.46)	(-1.93)	(-2.58)
ICD	0.61***	0.11	0.29***	-0.17	0.24	-0.02
	(3.63)	(0.49)	(5.44)	(-0.96)	(1.44)	(-0.27)
RDEN	-0.39*	0.18		0.29	0.04	
	(-2.02)	(1.07)		(1.45)	(0.30)	
No. of observation	18	18	18	18	18	18
Adjusted R^2	0.49	0.00	0.64	0.43	0.26	0.24
F – statistics	4.31	0.97	8.68	3.54	2.20	2.32

Note: Asterisk shows level of significance, (*) shows significant at 10% level, (**) shows significance at 5% level and, (***) shows significance at 1% level. Values in parentheses show t-statistics.

In brief, the present section discusses determinants of agricultural diversification with the help of OLS and GLS regression techniques. The regression considers two variants of crop diversification namely the Simpson Index and the percent of area under non-foodgrain crops (NFCP) as dependent variables. The set of independent variables are per capita income, concentration of small and marginal farmers (SMH), irrigation intensity (IRIP), institutional credit (ICD) and road density (RDEN).

The effects of the above variables have fluctuated over the years. The percent area under non-food grain crops in the year 2003-04 is affected positively by the per capita income. Road density is emerging as important in deciding the area under NFCs. Though irrigation has affected increase in area under non-food crops adversely, the increase in percent area under non-foodgrain is indifferent to farm sizes. Though the above set of independent variables together explain the variation in diversification indices better than the percent of GCA under non-food crops, the estimated results contradict many of the established findings on the determinants of farm-level diversification in the country.

Table II.3: Estimated Regression Coefficients to study the Determinants of Crop Diversification at all-India level

	Simpson Index		Percent of Non-Food Crops	
Variables	**Model1**	**Model2**	**Model1**	**Model2**
Income		-1.12 (1.94)		0.97*** (1.91)
SMH		-0.63 (-1.20)		0.05 (0.11)
IRIP		0.09 (0.67)		-0.32** (2.52)
RDEN				
ICD		0.29* (4.20)		-0.02 (-0.26)
D_1		-1.87 (-0.22)		8.66 (1.14)
D_1Income	-0.42 (-0.70)	0.45 (0.57)	0.04 (0.08)	-0.97 (-1.42)
D_1SMH	-0.74 (-1.07)	-0.26 (-0.32)	-0.54 (-0.94)	-0.62 (-0.86)

D_1IRIP	0.28 (1.39)	0.18 (0.73)	-0.34** (-2.00)	-0.03 (-0.13)
D_1ICD	0.11 (0.58)	-0.08(-0.46)	0.23 (1.49)	0.27*** (1.77)
D_1RDEN	0.18 (1.26)		0.04 (0.32)	
D_2	2.58 (0.27)	-8.16(-1.09)	-12.62 (-1.58)	-0.64 (-0.10)
D_2Income	-0.29 (-0.38)	0.79(1.17)	0.94 (1.49)	-0.27 (-0.46)
D_2SMH	0.39 (0.44)	0.40 (0.55)	0.97 (1.32)	0.29 (0.45)
D_2IRIP	-0.52 (1.62)	-0.09 (-0.39)	0.25 (0.93)	0.04 (0.21)
D_2RDEN	-0.58** (-1.99)		0.26 (1.06)	
D_2ICD	0.50*** (1.74)	0.05 (0.33)	-0.41 (-1.68)	0.05 (41)
Observation	36	54	36	54
Adj R^2	0.45	0.50	0.54	0.50
Wald-stat	19.17	38.12	28.35	38.57

Note: Model 1 includes road density, Model 2 however does not include road density. Data related to road density are not available for year 1983-84; Model 1 therefore, presents estimates for years 1993-94 and 2003-04, whereas Model 2 presents estimates for all the reference years 1983-84, 1993-94, and 2003-04. Values in parentheses show t-statistics.

II.III Determinants of Agricultural Diversification in Haryana

The results on the determinants of agricultural diversification have been perplexing in some sense. Though this could be so for many counts, the levels of aggregation are probably the most important. In this perspective, the present section attempts to assess the determinants of agricultural diversification for a relatively homogeneous state like Haryana. The regression like the previous analysis considers alternate measures of diversification: Simpson and the percent of area under non-food crops (NFCP). The analysis includes all the districts of Haryana and the reference years are same as that for the previous analysis. Alternate measures of diversification: Simpson and the percent of area under non-food crops are presented for all the districts of Haryana in the years 1983-84, 1993-94, 2003-04 (in Table 4). As is apparent from the table both the indices have declined for Haryana and for most of the districts of the state during the reference period. The decline of the Simpson Index clearly suggests a trend towards specialization. This specialization is in favour of more remunerative crops like fine cereals and oilseeds. The district of Kurukshetra is an exception as Simpson indices increased in 2003-04 over the previous years. It may be noted that Kurukshetra district has been in the forefront of intensive agriculture practices and towards the end of the nineties, severe constraints on account of utilization of natural resources surfaced in the region. There are also evidences

of farmers' adjusting to the above degradation by decreasing acreage under paddy, wheat and increasing acreage under fodder and vegetable crops (Jha 2000).

The diversification indices are alternately regressed on a set of independent variables that possibly affect agricultural diversification in the state. Most of the independent variables are similar to the analysis at the aggregate level. These variables are related to the size and the quality of land, market, credit and infrastructure facilities in the districts. There are minor variations in the specification of some of these variables depending on the accessibility of data on the above parameter. The per capita income for instance, was not incorporated in the district-level analysis as income-related data are not available at the district level. At times variables specified in the state level analysis are marginally different on logical considerations too; for example, structure vis-à-vis size of holding. The above variables for different districts of Haryana are presented in Appendix Table 4. As discussed earlier, regression with linear and log specifications have been tried. The regression results with a log specification are presented below in Table 5 whereas results from the linear specification are illustrated in Appendix Table 8. The reference years for the present analysis are same namely, 1983-84, 1993-94 and 2003-04.

Table II.4: Agricultural Diversification in Haryana

District	Simpson Index			Percent of Non-Food Crops		
	1983-84	1993-94	2003-04	1983-84	1993-94	2003-04
Ambala	0.74	0.71	0.63	27.3	23.72	21.21
Panchkula			0.73			22.77
Yamunanagar		0.73	0.70		37.47	33.96
Kurukshetra	0.60	0.57	0.60	14.56	14.29	16.6
Kaithal		0.58	0.55		15.39	10.7
Karnal	0.61	0.56	0.55	17.41	12.98	12.54
Panipat		0.57	0.57		17.95	16.21
Sonipat	0.70	0.66	0.65	17.98	22.43	18.31
Rohtak	0.78	0.77	0.77	22.58	37.09	28.44
Jhajjar			0.74			28.65
Faridabad	0.68	0.65	0.60	19.72	25.72	26.41
Gurgaon	0.74	0.73	0.69	20.62	32.57	30.93
Rewari		0.70	0.70		43.91	42.92
Mahendragarh	0.72	0.71	0.69	22.79	43.13	38.94
Bhiwani	0.69	0.78	0.79	22.37	31.88	46.88
Jind	0.78	0.73	0.68	22.86	32.21	24.55
Hisar	0.82	0.80	0.79	42.28	44.38	45.86

Fatehabad			0.72			37.22
Sirsa	0.79	0.76	0.75	43.52	51.3	52.29

The average size of holding (AOH) in Haryana is better distributed than in many parts of the country. The average size of holding at the level of the state has deteriorated from 3.52 hectare in the year 1980-81 to 2.13 hectare in the year 1995-96[20] (Apndx Table 4). In some districts like Sirsa, Bhiwani, Hisar, the size of operational holdings is significantly higher than the state average. These districts may however, rank lower on the basis of quality of land. In terms of structure of land holdings that is, the share of small and marginal farmers in total holdings, there is no significant variation across the districts in a state. The average size of the holding (AOH) instead of the proportion of small and marginal farmers in total agricultural holding (SMH) has therefore been considered in the state-level analysis.

The quality of land in the state-level analysis is the irrigation intensity, and this is measured as the percent of gross cropped area irrigated. This variable is the same as that of the country-level analysis. In Haryana, irrigation intensity has been very high, around 72 percent of gross cropped area was irrigated in the year 1983-84, the figure has further risen to 94 per cent in the year 2003-04; while in 10 out of 19 districts irrigation intensity has been 100 per cent. The variable for institutional credit is the loan advanced by primary agricultural societies per unit of gross cropped area in the district. This includes credit from cooperative societies and accounts for a bulk of production loan obtained from institutional sources. Most of the above information is also available from the Statistical Abstract of Haryana.

Several studies suggest that diversification in recent years has been market driven; market is therefore considered as an important determinant of crop diversification in Haryana. Market in the state-level analysis is the net sown area per unit of regulated market; this is an adverse measure of market penetration. Though the recent amendment

[20] One may note the differences in reference years, sources for land related data is Agricultural Census and this census is undertaken after an interval of five years.

in State Agricultural Produce Market Regulation Act allows people to set up a market yard, the number of regulated markets in a district remains an important indicator of expansion of market for agricultural commodities in a district.

Infrastructure has many components, road is one of the most important indicators of forward-linked rural infrastructure. Road undoubtedly affects agricultural diversification in states; however, road density could not be worked out for the districts of Haryana since metal road and the geographical area of the districts are not available consistently for the chosen years of reference. The percent of villages connected with metal road in the districts has therefore been considered in the present analysis. The statistics related to road connectivity are not very robust[21]; results from the regression analysis are also not very encouraging. Tractor is another variable often considered by researchers as to explain agricultural development. Tractors are associated with prosperity; in that sense this is closer to income and also reflects the infrastructure facilities in the region. Tractorization[22] in districts is associated with certain variables like road, irrigation; as a consequence regression results are not satisfactory and tractorization has subsequently been dropped from the regression analysis.

Infrastructure is often associated with urbanization. At the country-level analysis, infrastructure as measured with road density has provided satisfactory results, therefore urbanization was not considered in the country-level regression analysis. Joshi et al. (2007) while studying diversification with district-level data has found urbanization as an important determinant of agricultural diversification. The present study has therefore considered urbanization as an important factor to influence diversification in the state of Haryana.

Some of the above variables are regressed on alternate measures of diversification and the results are presented in Table 5. Since the anticipated relationship of some of the

[21] In Haryana almost 100 per cent villages are connected with metal road in the year 2003-04, the corresponding figures were 99 and 98 per cent during earlier years of reference. The figures were similar in different districts of Haryana.

[22] Tractorization referred here is increase in the number of tractors per unit of total cropped area in the districts.

above variables with alternate measures of diversification vary widely, the regression results with alternate indices are discussed separately; discussion of regression results with Simpson indices takes precedence over the others.

The effect of average size of holding on diversification indices is not significant. The sign of the above relationship is negative in the year 2003-4; this has however, been positive during the earlier years of reference. The positive relationship suggests that diversification has decreased with decrease of average holdings in Haryana. Irrigation intensity has a significant (at 10 per cent level of significance) effect on diversification indices in the years 1993-94 and 2003-04. The negative sign of the coefficient suggests that diversification has decreased in Haryana with increase in the intensity of irrigation. In actual fact, with assured irrigation, the area under certain crops like paddy, wheat, etc., increased at the cost of other crops; this has resulted in the decline of diversification indices (Simpson Index) as the intensity of irrigation increase. It may be noted that paddy and wheat are not only remunerative but also provide an assured return to farmers in Haryana.

Following the traditional argument that increased penetration of market would lead to specialization of agriculture in a region, we would expect a positive relationship between the diversification index (Simpson Index) and Net Sown Area per regulated market. The coefficient for MPTI is positive for the year 2003-04; the strength of the relationship has also increased during the reference period. The positive relationship signifies that agriculture in districts with less penetration of market is more diversified. This clearly indicates that market penetration has led to the specialization of agriculture in Haryana.

Penetration of market is just the first step in commercialization; with commercialization borrowing for production purposes increases. The present analysis considers institutional credit (IC) as a factor to explain diversification. The coefficient for this variable is not significant in any of the reference years; the signs of this coefficient have also changed during the reference years. These results in fact suggest that institutional credit is not an important determinant of crop diversification in Haryana. It

may be noted that in Haryana wholesale traders (*arhat)* emerged as an important intermediary in credit disbursal. Loans advanced from institutional agencies possibly account for less than half of the total credit requirement of farmers in different districts of Haryana.

Road generally precedes market infrastructure. At the all-India level road density emerged as an important determinant of agricultural diversification; road in the present analysis is actually connectivity of road as reflected by the percent of villages connected with metal road. The estimates for road connectivity are weak and the sign is not plausible on account of data on road density.[23] Road connectivity is therefore replaced with urbanization which plays an important role in the OLS regression analysis. The positive and near significant estimates for the years 1993-94 and 2003-04 shows that with increased urbanization, agricultural diversification as measured with the Simpson Index has increased in the state. With increased urbanization, demand for specific agricultural commodities like milk, vegetables, etc., increases; this has led to increased diversification of agriculture in the region adjacent to an urban centre.

The regression of Simpson indices on a set of independent variables suggests that with increased irrigation, a region is specialized under paddy and wheat crops. This specialization is however, discouraged with urbanization and market penetration. This specialization is independent of the size of holding and institutional credit

The results of regressing percent area under non-food grain crops (NFCP) on average size of operational holding (AOH), irrigation intensity (IRI), inverse of market intensity (MPTI), institutional credit (IC) and urbanization (URB) are presented in Table 5. These are the same set of variables considered in the previous regression analysis with Simpson indices for Haryana. The average size of holding has a positive effect on NFCP. The estimate is significant in the year 1983-84. The estimate has weakened over the years. The positive relationship suggests that the area allocated to non-food crops increases with the increase of average size of holding.

[23] In the year 2003-4, 13 out of 19 districts of Haryana were 100 per cent connected with metal road, and in the remaining districts corresponding figures were as high as 99 per cent (Apndx. Table 4).

The irrigation intensity has a negative effect on NFCP. The negative relationship though not significant is consistent over the years. The estimate is almost significant for the year 1993-94. The negative relationship suggests that with assured irrigation, acreage under fine cereals has increased and that under NFCP has decreased in Haryana. The weakening of this relationship in the year 2003-04 suggests increased importance of NFCs in the state. There is a possibility that non-food crops like fruits and vegetables have emerged as remunerative in the recent period and with the increase of irrigation intensity, the area under fine cereals has not increased. There is another possibility as well; farmers in spite of assured irrigation are not going for water intensive crops like fine cereals since the stress on the availability of groundwater has been acute in the recent period.

Table II.5: Regression Estimates for Determinants of Crop Diversification in Haryana

	Simpson Index			% of Non Food Crops		
Variables	**2003-04**	**1993-94**	**1983-84**	**2003-04**	**1993-94**	**1983-84**
AOH	-.02	.26	.14 (0.89)	.06	.73	1.02***
	(-0.14	(1.6)		(0.10	(1.12)	(2.49)
IRI	-0.29***	-.32***	-.04	-1.05***	-.98***	-.32
	(-3.69)	(-2.78)	(-.30)	(-3.19)	(2.18))	(1.09)
MPTI	.08	.09*	-.02	.23	.35	0.16 (0.47)
	(1.46)	(1.73)	(-0.11)	(1.02	(1.61)	
URB	.12*	.16	.06 (0.48)	.48(1.62)	.37	0.58*
	(1.68)	(1.66)			(0.99)	(1.88)
ICD	-.15	.06	-.08	-.68	.11	.06
	(1.37)	(0.50)	(-0.60)	(-1.56)	(0.26)	(0.17)
No. of observation	19	16	12	19	16	12
R-squared	0.649	0.606	0.266	0.619	0.544	0.619
Adjusted R^2	0.514	0.408	-0.00	0.473	0.316	0.301
F – statistics	4.80	3.07	0.44	4.23	2.39	1.95

Note: Asterisk shows level of significance, (*) shows significance at 10% level, (**) shows significance at the level of 5% and, (***) shows significance at 1% level. Values in parentheses show t-statistics.

The regression results show that the inverse of market intensity (MPTI) does not have a significant effect on NFCPs in Haryana; in other words, increase in area under NFCPs is largely unaffected by the market intensity. The signs of estimates are positive during all the reference years. Since MPTI is an inverse measure of market intensity and the positive relationship shows that as market intensity decreases, area under non-food crops increases. Food in northwest India largely refers to fine cereals and fine cereals in

the region are associated with the increase in regulated market in which the bulk of central government's requirement of paddy and wheat for the public distribution system is procured from the region.

Market is often associated with the extension of road. Road connectivity in the present analysis affects NFCP adversely. The negative sign is consistent with the findings of market penetration. A weak relationship between road connectivity and NFCP is also on account of the quality of data on road connectivity as explained earlier. Urbanization therefore replaces road connectivity; the estimates for urbanization (URB) are positive and also significant. The positive relationship suggests that with increase in urbanization, area under non-food crops has increased in Haryana. The connotations for NFCs have changed over the years; now the non-food crops include fruits and vegetables. Credit is often associated with commercialization and market intensity. Institutional credit however does not have a significant effect on NFCP. The sign of the estimate has changed during the reference period. These results suggest that ongoing diversification in favour of non-food crops is least affected by the institutional credit advanced to farmers by the cooperative societies.

The above relational analysis shows that irrigation has led to specialization in fine cereals. Infrastructure and market penetration has further contributed to the above trend towards specialization whereas urbanization encourages area under non-food crops in Haryana. The above process of specialization is increasingly indifferent to the size of holding. Institutional credit is also not important in explaining the above process of diversification. A comparison of the country and state-level analysis shows that the determinants of diversification at the state level are definitely more discernible than the country level results. This further encourages the extension of the present analysis at the level of farm.

II.IV Drivers of Farm Level Diversification

The determinants of farm-level diversification have been studied in the Kurukshetra district of Haryana. This district has been one of the frontrunners in the adoption of

intensive agricultural practices; again in terms of allocation of land under crops most of the districts in Haryana are conforming to trends seen in Kurukshetra district. The pattern of growth in agriculture further suggests that most of the states in India are getting specialized in a manner similar to Haryana and Punjab. The study of farm-level diversification in Kurukshetra district would probably have important lessons for the region.

Table II.6: Extent of Farm Level Diversification

Farm Size	MPI	SI	MEI
Index in terms of Acreage (resource diversification)			
Small	0.32	0.75	0.76
Medium	0.34	0.79	0.81
Large	0.31	0.79	0.81
Index in terms of gross income (income diversification			
Small	0.29	0.82	0.89
Medium	0.22	0.86	0.94
Large	0.14	0.87	0.95

Note: MPI = Maximum proportion index, SI = Simpson Index, and MEI = Modified entropy index

Extent of diversification is measured by the index of maximum proportion, Simpson and Modified-Entropy indices. These indices are calculated on the basis of crop acreage and farm income and the result is presented in Table 6. All these indices clearly show that the small farm is the least diversified in the northwest of India. The difference in crop diversification between medium and large farms is less; though enterprise diversification on large farms is slightly more than for the medium farms. A comparison of the present study with similar farm-level studies (Walker et al. 1983) reveals that farms in the region are less diversified than those in the other regions of the country. In fact, wheat and paddy being remunerative and less risky in irrigated conditions have substituted other crops and led to specialization on farms in the region. This has discouraged farm-level diversification in the northwest of India. The levels of diversification across farms can broadly be explained with the following groups of variables; for instance, personal characteristics of decision makers, resource endowments of farm households and market access opportunities.

The important dimensions of farm household resource base include quantity and quality of land, irrigation facilities, availability of draught power and family labour. The

quality of land and irrigation facilities across farms is not significantly different in the study area. Some differences on account of assured irrigation have however, emerged in the recent period due to depletion of ground water.[24] There has been a positive correlation between land holdings, availability of family labour and draught power (Jha 1994). It is hypothesized that with an increase in land holding, draught power and family labour, the opportunities of diversifying agriculture increases for an average farmer. The medium farms are therefore, more diversified than small farms. Further increase in operational holding is not accompanied by a proportionate increase in the complementary resources, like family labour. This to some extent constrains a proportionate increase in diversification on large farms. This also explains the reason for a similar level of diversification on medium and large farms in the study area.

The market access opportunity may further be disaggregated into market-related infrastructure and institutions. In the Kurukshetra district of Haryana, crops such as basmati paddy, potato and sugarcane have been relatively more remunerative. Farmers however face different kinds of market imperfections in the marketing of these crops. Price uncertainty, for instance, is very conspicuous in basmati paddy since the domestic price of basmati depends on the export market of the commodity. Cultivation of potato is constrained by the limited storage facility available for the crop; though the district has greater cold storage facilities than do the districts of the other states. Sugarcane is one of the most remunerative crops; this also provides an assured return to the farmers though at times payment to cane growers is delayed on account of a glut in sugar. An assured market for sugarcane however, depends on the capacity of the sugar-processing mills in the region. Similarly, the area under vegetables and fruits depends on the kind of return it provides to the farmers. With the depletion of groundwater, the shallow tubewell has become ineffective and the cultivation of crops like paddy and wheat is increasingly

[24] The present study has found that with the depletion of ground water, the shallow tube well has become non-functional. It is difficult for small farmers to invest in a submersible pump especially with the non-availability of institutional credit for the purpose. Small farmers as a result have become water purchasers and with a dearth of assured irrigation they are choosing fodder instead of wheat during *rabi* season. (Jha 2000).

constrained on account of insufficient irrigation. The Government statistics however, show that the region is irrigated. The insufficient irrigation for crops on account of depletion of ground water is particularly reported from the small farms of Haryana.

The kind of return from the market for a crop depends on the availability of market and market-related institutions for these crops in the region. The region has sufficient infrastructure for procurement of paddy and wheat; remunerative price is therefore assured for growers of paddy and wheat crops. Remunerative prices for commodities other than paddy and wheat has been a problem. Though contract farming has emerged as an important institution for marketing of fruits and vegetables; the investigator of the present study has not come across any such arrangement for the marketing of vegetables in the area. Certain small farmers in the study area individually go to the nearby urban market to sell their own as also neighbors' output of vegetables. The market imperfections as mentioned in some of the above crops restrict a proportionate increase in area under crops other than paddy and wheat, with the increase in operational holdings. The levels of diversification on medium and large farms have therefore, been similar in the study area.

Out of different personal characteristics, risk attitude is supposed to have a significant impact on the levels of diversification (Fraser, 1991). The negative association of risk aversion with assets is an established fact and this holds true for the region as well (Jha, 1995). Following this one may presume that if diversification is a risk management practice, small farms should be more diversified than medium and large farms in the region as risk aversion is negatively associated with the size of asset. Diversification results presented in Table 6 are however, contrary to it. An enquiry into the same reveals that with increase in diversification, the risk on farm has not reduced in the study area; in fact risk has increased further as the crop incomes are not negatively correlated amongst themselves in the study area (see Apndx. Table 9).[25] The non-negative correlation amongst different crop enterprises has resulted in an increase of risk

[25] The essential condition for diversification to reduce risk in a farm portfolio is that the activities are negatively correlated or least correlated amongst themselves.

with the increase of crop diversification on farm. Several studies show that wheat and paddy involve less risk as compared to other crops; the price-induced risk is low owing to an assured market in the region; production-induced risk is also low since these crops in the northwest of India are cultivated with assured irrigation; yield uncertainty decreases with assured irrigation (Jha, 1995). The above discussion therefore suggests that as percent area under crops other than paddy and wheat increases risk also increases on farm. The proportionate area under basmati paddy for instance increases with the increase of operational holding. An increase of crop diversification with the operational landholding is therefore, not unfounded in the study area. Crop and dairy enterprises are negatively correlated amongst themselves; further diversification with dairy animals therefore reduces risk on farm; diversification with crops however increases risk in the north-west of India.

The findings from farm-level diversification, in brief, suggest that farms in the region are less diversified than other parts of the country. Again small farms are less diversified than medium and large farms; though there is no significant difference between the levels of diversification on the medium and large farms of the region. Assured irrigation and a market for wheat and paddy crops has led to specialization in favour of these crops in the north-west of India. Crops like basmati paddy, potato, vegetables are remunerative; but these involve more risk. The study also found that diversification with crops is not a risk-reducing proposition whereas diversification with dairy enterprises reduces risk in the farm portfolio.

Considering the multidimensional importance of agricultural diversification, the present study assesses the determinants of resource diversification at different levels: country, state (Haryana) and farms in the Kurukshetra district of Haryana. The study considers alternate approaches to resource diversification namely; first, the concentration index as measured by Simpson Index and second, percent area under non-food crops. These alternate measures of diversification have been regressed separately on a set of independent variables like the size and the quality of land, institutional credit, road

density, (market, urbanization) and income at the country level. The OLS estimates suggest that the percent area under non-food grain crops in the year 2003-04 is affected positively by the per capita income and is indifferent to the concentration of small farmers and institutional credit. Irrigation intensity has influenced the above variable negatively while road density has influenced it positively.

The country-level analysis of regression with the Simpson Index often goes against the established findings on the determinants of agricultural diversification in the country. The regression results with diversification indices start becoming clearer from the state-level analysis. A negative relationship of alternate measures of diversification with irrigation intensity clearly shows that an increase in irrigation is leading to specialization under paddy and wheat crops. This process is strengthened with the penetration of the regulated market. In the recent decade, urbanization has emerged as important; this has a positive effect on agricultural diversification. Farm-level diversification suggests that the small farm is less diversified in the Kurukshetra district of Haryana. Interestingly, diversification with crops is increasing risk in the farm portfolio; whereas, diversification with livestock reduces risk in farm income.

References

Acharya S. S. (2005). "Agricultural Marketing and Rural Credit: A Policy paper for strengthening Indian Agriculture", presented in an ADB-sponsored seminar on Agriculture, Food security and Rural Development in NCAP, Pusa, New Delhi.

Anosike N. and C. M. Coughenour (1990). "The socio-economic basis of farm enterprise diversification decisions" World Agricultural Economics and Rural Sociology Abstract, 32: 700

Barghouti, S., S. Kane and K. Sorby (2003). "Poverty and Agricultural Diversification in Developing Countries", The World Bank (memeo) Washington DC, USA.

Das, Saudamini (2009). "Addressing Coastal Vulnerability at the Village Level: The Role of Socio-economic and Physical Factors". *IEG Working Paper Series No.E/295/2009*, Institute of Economic Growth, New Delhi.

Fertiliser Association in India (2008). *Fertilizer Statistics*, Several Issues, Fertiliser Association in India, New Delhi.

Fraser, R.W. (1991). "Production risk, product complementarity and product diversification," Journal of Agricultural Economics, 43(1): 103-107.

Government of India (2008). *Agricultural Statistic at a Glance*, Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi.

Government of India (2008). *National Accounts Statistics*, Central Statistical Organization, Ministry of Statistics and Programme Implementation, New Delhi, India.

Government of India (2008). *National Accounts Statistics: Back Series 1950/51 to 1999/2000*, Central Statistical Organization, Ministry of Statistics and Programme Implementation, New Delhi, India.

Government of India (2008). *State Domestic Products*, Central Statistical Organization, Ministry of Statistics and Programme Implementation, New Delhi, India.

Gupta R. P. and S K Tewari (1985). "Factors affecting Crop Diversification: An empirical analysis", *Indian Journal of Agricultural Economics* 40(3): 304-311

Haque T. (1995) (ed) *Small Farm Diversification - Problems & Prospect,* NCAP, New Delhi.

Jha, Brajesh. (1994). "Production Decisions under Risk on mixed farms of Kurukshetra district", An unpublished thesis submitted to National Dairy Research Institute (ICAR), Karnal, India.

Jha, Brajesh. (1995) "Growth and Instability in Agriculture Associated with New Technology: District Level Evidences" *Agricultural Situation in India,* 49(7): 517-524

---------- (1996). "Farm-level Diversification: Some Disconcerting Evidences from the Green belt of India." *Agricultural Economics Research Review,* 9(1): 49-56.

---------- (2000). "Implications of Intensive Agriculture on Soil and Groundwater Resources." *Indian Journal of Agricultural Economics*, 55(2): 182-193.

---------- (2004). "Towards Measuring Sustainability of Indian Greenbelt" *IEG Discussion Paper Series No. 88/2004*, Institute of Economic Growth, New Delhi**.**

---------- (2006). "Employment Wages and Productivity in Indian Agriculture", *IEG Working Paper Series No.E/266/2006*, Institute of Economic Growth, New Delhi.

___(2008). "Agricultural Diversification in India with Special Reference to Haryana", an unpublished report submitted to Ministry of Agriculture, GOI, Institute of Economic Growth, New Delhi.

---------- (2009). "Evaluating Agricultural Policy in a Farming System Framework: A Case Study from North West India", *IEG Working Paper Series No.E/299/2009*, Institute of Economic Growth, New Delhi.

Jha, B. and D. Jha (1995). "Farmers attitude towards risk in the Greenbelt of India". *Journal of Rural Development*, 14(3): 231-240.

Joshi P. K., A. Gulati and Ralph Cummings Jr. (2007) (ed). *Agricultural Diversification and Smallholders in South Asia,* New Delhi: Academic Foundation.

Kumar, P. and Mruthyunjaya. 2002. Long term changes in food basket in India. Paper presented in an International workshop on *Agricultural Diversification in South Asia*, jointly organized by MoA, Bhutan, NCAP and IFPRI, Paro, Bhutan, 21-23 November 2002.

Singh A. J., K. K. Jain and Inder Sain (1985). "Diversification of Punjab Agriculture: An Econometric Analysis" *Indian Journal of Agricultural Economics* 40(3): 298-303.

Shiyani R.L. and H.R. Pandya (1998). Diversification of Agriculture in Gujarat: A Spatio-temporal Analysis" *Indian Journal of Agricultural Economics*, 53, (4): 627-639.

Walker T.S., R. P. Singh and N. S. Jodha (1983). "Dimensions of Farm Level Diversification in the Semi-arid Tropics of Rural South India." Economic Programme Progress Report 51, ICRISAT, Hyderabad.

Appendices

Apndx Table 1: Important Exportable and Importable Agricultural Commodities with its respective Share in Agriculture during Selected Years

Commodities	1990-91	1991-92	1992-93	2001-02	2002-03	2003-04
Agri-exportables						
Tea, coffee & tobacco	26.47	24.5	20.2	12.18	10.58	10.23
Spices	3.82	4.74	4.35	5.04	4.77	4.14
Sugar	0.62	2.01	3.91	5.41	5.11	3.25
Fruits & vegetables	4.64	5.52	4.8	5.94	5.82	6.67
Marine products	15.96	18.41	19.3	19.83	19.99	16.45
Poultry products	0	0	0	0.49	0.52	0.67
Agri-exp as % of Exports	18.49	17.8	16.84	14.22	13.58	12.65
Agri-importables						
Pulses	39.2	17.26	11.63	19.44	15.54	10.28
Oils & oilseed	28.1	17.5	6.23	39.84	50.01	53.44
Agri-import as % of Imp	2.79	3.09	4.54	6.63	5.92	6.19

Source: Agricultural Statistics at a Glance 2004, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

Apndx. Table 2: Correlation coefficient between gross return of different farm activities

Activity	Cross-bredcow	Buffalo	Desi cow	Paddy kharif	Paddy basm-ati	Paddy summer	Wheat	Rape mus-tard	Potato	Lentil	Sun-flower	Jowar	Berseem
Cross-bred cow	1.00												
Buffalo	-.32	1.0											
Desi cow	0.90***	-.31	1.00										
Paddy Kharif	0.81***	-.68***	0.67***	1.00									
Paddy basmati	-.15	-.40	-.14	0.36	1.00								
Paddy summer	0.69***	-.51**	0.46**	0.88**	0.48	1.00							
Wheat	0.12	-.28	0.37	0.38	0.61***	0.14	1.00						
Toria	0.31	-.57***	0.62***	0.27	0.05	0.05	0.42	1.00					
Potato	0.10	.47	0.02	0.07	-.05	-.09	0.31	-.56**	1.00				
Lentil	0.38	-.35	0.69***	0.26	0.13	0.16	0.45**	0.93**	-.50**	1.00			
Sun-flower	0.70***	-.65***	0.86***	0.70***	0.21	0.53**	0.49**	0.85**	-.35	0.86	1.00		
Jowar	-.43	.68	-.43	-.82***	-.81***	-.78***	-.68***	-.36	0.06	-.40	-.68	1.0	
Ber-seem	0.88***	-.27	0.95***	0.75***	0.01	0.50**	0.53**	0.46**	0.27	0.54**	0.78	-.34	1.00

Note: Single(*), double(**) and triple asterisks (***) shows levels of significance at 10, 5 and 1 percent level of significance.

Apndx Table 3: Important Exportable and Importable Agricultural Commodities with its respective Shares in Agriculture during Selected Years

Commodities	1990-91	1991-92	1992-93	2001-02	2002-03	2003-04
Agri-exportables						
Tea, coffee & tobacco	26.47	24.5	20.2	12.18	10.58	10.23
Spices	3.82	4.74	4.35	5.04	4.77	4.14
Sugar	0.62	2.01	3.91	5.41	5.11	3.25
Fruits & vegetables	4.64	5.52	4.8	5.94	5.82	6.67
Marine products	15.96	18.41	19.3	19.83	19.99	16.45
Poultry products	0	0	0	0.49	0.52	0.67
Agri-exp as % of Exports	18.49	17.8	16.84	14.22	13.58	12.65
Agri-importables						
Pulses	39.2	17.26	11.63	19.44	15.54	10.28
Oils & oilseed	28.1	17.5	6.23	39.84	50.01	53.44
Agri-import as % of Imp	2.79	3.09	4.54	6.63	5.92	6.19

Source: Agricultural Statistics at a Glance 2004, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

Apndx Table 4: Annual Compound Growth Rates (in percent) in Minimum Support Prices (MSP), Wholesale Price Indices (WSP) and Farm Harvest Prices (FHP in Haryana) of Principal Crops

Crops	Period I (1980/81 to 1989/90)		Period II (1990/91 to 1999/00)			Period III (2000/01 to 2006/07)		
	MSP	FHP	MSP	WSP	FHP	MSP	WSP	FHP
Paddy	6.5	8.6	7.9	8.1	11.4	2.1	1.2	-9.8
Wheat	5.4	4.7	8.7	9.2	9.4	2.7	3.6	2.4
Maize	5.3	6.7	7.7	7.6	7.4	3.2	4.2	1.3
Jowar	5.1	7.6	6.2	12.9	6.4	2.9	5.3	-0.8
Bajra	5.1	4.9	6.2	8.2	6.7	2.9	4.3	-3.1
Barley	5.2	6.9	7.5	-	7.2	2.3	-	4.7
Gram	12.4	9.4	7.9	3.1	6.9	4.9	5.0	1.4
Arhar	9.9		8.2	10.3		2.4	3.4	-4.4
Rapeseed and Mustard	10.9	9.4	5.5	6.2	4.5	6.9	6.1	5.3
Cotton (Desi/F414)	10.7	6.9	9.4	5.1	10.2	1.5	-0.1	3.5
Cotton (Ameri/H4)	9.8	4.7	8.6	5.1	9.9	1.5	-0.1	-2.7

Note: The Farm harvest Prices (FHP) at the time of analysis were available till the year 2003-04; ACGR in FHP during period III therefore refers to growth in FHP between 2000-2004.

Apndx Table 5: Some Possible Determinants of Crop Diversification in India during Selected Years

States	Average size of op. holding(ha)	Total no. of op. holdings	Per cent of marginal and small holdings to total holdings			Per cent of Gross Cropped Area Irrigated			Fertilizer Consumption (kg/ hectare)		
	1995/96	1995/96	1995/96	1990/91	1980/81	2002/03	1993/94	1983/84	2003/04	1993/94	1983/84
Andhra Pradesh	1.36	10603	80.94	77.32	72.78	39.2	39.6	39.5	136.8	117	69.6
Assam	1.17	2683	83.12	82.48	82.07	5.5	15	18.7	46.6	8.7	25.2
Arunachal Pradesh	3.31					16.3	14		2.8	2.2	
Bihar	0.75	14155	90.92	89.7	86.72	68.1	43.2	24.2	80.5	57.7	27.4
Delhi									29.8	238.4	87
Goa	0.84					24	21.6		35.7	39.7	33
Haryana	2.13	1728	66.72	60.52	51.38	86.2	77.6	68.3	167.1	120.6	56
J & K	0.76	1336	91.92	90.3	87.25	40.3	41.1	44.4	71.4	39.2	16.8
Himachal P	1.16	863	84.47	83.69	77.27	18.8	17.5	18.5	49.4	29.2	10.1
Gujarat	2.62	3781	55.33	52.29	45.9	31.4	28.9	27.7	95.1	63.7	46.1
Karnataka	1.95	6221	69.39	66.62	59.09	24.5	23.9	17.7	74.9	65.6	43.4
Kerala	0.27	6299	98.11	97.75	96.1	14.5	13.6	1.8	63.6	58.5	44.5
Maharashtra	1.87	10653	69.86	63.39	52.05	18.1	15.3	13.3	65.7	59.5	31.5
MP & Ch'sgarh	2.28	9603	64.46	60.15	51.93	46.6	22.3	13.3	53.0698	33.5	14.5
Meghalaya	1.33	160	72.5	64.33	65.29	26.6	18.8	24.3	17	13.4	13.8
Mizoram	1.29	1.29				11	7.5			9.7	
Manipur	1.22	143	82.52	83.1	83.09	34.2	37.7	41.7	130.5	47.5	18.2
Nagaland	4.83	149	20.13	23.94	25.86	22	29	48.7	2.2	5.1	1.9
Orissa	1.3	3966	81.97	79.86	73.61	21.8	25.8	24.2	41.4	21.2	11.8
Punjab	3.79	1093	35.41	44.76	38.66	97.8	94.9	91.3	184	159.5	143.2
Pondicherry									918.1	428.2	264.7
Rajasthan	3.96	5364	50.26	49.66	48.92	39.9	29.1	22.8	40.5	27.8	11.3
Sikkim	1.66	44	77.27	71.15	69.64	13.6	12.6				
Tamil Nadu	0.91	8012	89.68	89.05	86.55	50.5	49.5	49.2	112.5	111.9	84.9
Tripura	0.6					14.1	13	3.6		_	
UP & Utt'chal	0.86	21529	89.98	89.35	86.83	113.9	64.1	48.1	126.7	88.7	66.2
West Bengal	0.85	6547	93.23	91.44	89.23	36.7	28.7	27.1	122.4	86	49.8
All- India	1.41	115580	80.31	78.29	74.59	40.2	36.7	31.7	89.8	67.7	43.5

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States	Credit flow (in Rs./ Ha.) for agri. and allied activities			Road Density (Km per sq. km of geo. area)		Urbanization (%)			Per capita GDP		
	2003/04	1993/94	1982	2001/02	1994/95	1981	1991	2001	1983/84	1993/94	2002/03
Andhra Pradesh	7850.61	581.34	103.26	714.91	624.56	23.32	26.78	27.08	2346	8701	21433
Assam	483.42	-	2.84	1140.85	868.05	9.88	11.1	12.72	2409	6756	13720
Arunachal Pradesh	145.52	-	0.55	219.31	141.63	6.56	12.8	20.41	2986	10330	17988
Bihar	1638.82	77.39	27.01	807.66	933	13.14	12.47	10.47	1565	2641	6525
Delhi	466090	-	88.9	17422.3	16562.2	92.73	89.93	93.01	6233	22283	54275
Goa	2344.05	149.96	57.27	2614.05	1973.78	32.03	41.01	49.77	5443	20488	63809
Haryana	9949.67	1248.48	266.52	637.93	614.34	21.88	24.63	29	3784	13443	31521
Jammu & Kashmir	598.46	-	36.71	105.42	56.65	21.05	23.83	24.88	2976	NA	NA
Himachal Pradesh	3999.16	274.75	87.65	532.01	537.56	7.61	8.69	9.79	2633	9249	26452
Gujarat	4470.11	584.52	180.41	702.06	437.55	31.1	34.49	37.35	3720	11909	27880
Karnataka	5420.74	277.85	104.77	801.05	728.76	28.89	30.92	33.98	2588	9133	22767
Kerala	12617.1	6610.65	837.11	3881.91	3585.18	18.74	26.39	25.97	2464	30	78
Maharashtra	2361.32	508.18	142.97	869.17	731.12	35.03	38.69	42.4	3736	14356	30545
Madhya Pradesh	1604.42	-	64.86	523.48	686.26	20.29	23.18	26.67	2198	5737	13666
Meghalaya	1871.48	152.52	13.73	426.46	344.23	18.07	18.6	19.63	2232	8514	18833
Mizoram	461.02	1365.75	-	240.75	312	24.6	46.1	49.5	2147	10315	24613

						7					
Manipur	268.52	-	57.08	512.05	471.56	26.42	27.52	23.88	2370	7120	15401
Nagaland	196.3	-	-	1267.85	776.84	15.52	17.21	17.74	2693	11365	NA
Orissa	1452.19	76.42	72.83	1522.28	1360.18	11.79	13.38	14.97	2164	5855	12088
Punjab	11456.4	795.46	405.91	1221.8	1132.63	27.68	29.55	33.95	4363	14914	29570
Pondichery	17871.8	918.73	169.07	5356.25	4771.43	52.28	64	66.57	4403	12148	45471
Rajasthan	1509.74	152.44	71.71	387.1	380.1	21.05	22.88	23.38	2295	7492	15114
Sikkim	321.97	-	-	284.37	256.9	16.15	9.1	11.1	2533	9286	23152
Tamil Nadu	11165.5	731.6	200.22	1276.8	1077.92	32.95	34.15	43.86	2406	10303	24971
Tripura	709.22	59.17	16.47	1553.23	1401.91	10.99	15.29	17.02	2073	6446	20685
Uttar Pradesh	3156.26	-	88.27	1026.7	832.38	17.95	19.84	20.78	1975	5783	11774
West Bengal	2177.56	-	-	1036.86	769.74	26.47	27.48	28.03	2804	7847	20694
India	3989.6	383.96	123.22	755.44	641.56	23.34	25.71	27.78	2967	9446	19944

Sources: Fertilizer Statistics, Fertilizer Association in India, New Delhi

Apndx Table 6: Some of the Possible Determinants of Crop Diversification in Haryana

	Average Size of holding (in Hectares)			Percent of small and marginal to Total Holdings			Fertilizer Consumption in kg./ hect. of Cropped Area			Number of Tractors Per 000 hect. of cropped Area			Gross Irrigated Area as % of Total Cropped Area (both in '000 ha.)		
Districts	1995/96	1990/91	1980/81	1995/96	1990/91	1980/81	2004/05	1993/94	1983/84	2003/04	1993/94	1983/84	2003/04	1993/94	1983/84
Ambala	1.67	1.88	2.86	0.71	0.7	0.56	241.67	140.68	92.86	41.26	29.94	16.84	87.4	69	50.64
Panchkula	1.14	-	-	0.84	-	-	201.93	-	-	34.4	-	-	38.3	-	-
Yamunanagar	1.99	2.17	-	0.68	0.65	-	336.32	179.56	-	65.27	0	-	91.1	80.7	-
Kurukshetra	2.12	2.33	3.69	0.62	0.61	0.49	297.35	210.65	129.67	53.11	45.83	19.3	100	98.8	91.92
Kaithal	2.18	2.69	-	0.67	0.58	-	243.84	159.46	-	35.65	0	-	99.7	98.3	-
Karnal	2.22	2.45	3.18	0.66	0.62	0.54	406.96	192.53	144.18	49.25	31.05	26.9	99.7	98.7	91.16
Panipat	1.79	1.86	-	0.7	0.68	-	371.47	202.97	-	63.01	0	-	100	98.9	-
Sonipat	1.68	1.87	2.81	0.75	0.7	0.61	324	129.37	64.2	64.53	22.06	38.95	97.5	95.4	69.85
Rohtak	1.81	2.25	3.04	0.72	0.62	0.57	171.21	101.76	30.1	54.65	20.88	36.47	83.9	72.2	48.07
Jhajjar	-	-	-	-	-	-	118.16	-	-	72.94	-	-	77.4	-	-
Faridabad	1.44	1.63	2.14	0.77	0.71	0.64	212.18	108.62	43.13	61.93	17.24	26.72	87.6	77.8	56.64
Gurugaon	1.5	1.87	2.45	0.77	0.63	0.62	111.38	82.29	28.62	45.36	12.76	22.36	67.4	54.3	39.25
Rewari	1.96	2.26	-	0.68	0.64	-	130.65	81.46	-	36.06	-	-	70.8	61.5	-

Mahendragarh	2.16	2.32	3.18	0.66	0.65	0.54	93.67	88.12	26.7	17.18	10.32	5.75	51.2	41.5	29.1
Bhiwani	2.89	2.8	4.09	0.57	0.52	0.45	61.13	54.14	8.46	27.16	6.25	13.9	56.2	41.9	30.52
Jind	2.3	2.73	4.59	0.65	0.58	0.43	192.34	134.22	49.42	35.81	16.11	23.13	92.8	89.5	79.74
Hisar	2.44	2.89	4.35	0.6	0.54	0.39	141.19	118.87	63.81	31.43	10.2	29.49	84.5	80.09	78.49
Fatehabad	-	-	-	-	-	-	203.95	-	-	35.36	-	-	96.5	-	-
Sirsa	3.15	3.55	6.07	0.52	0.45	0.34	187.66	150.04	76.43	39.95	21.71	34.63	89.5	84.2	67.77
Haryana	2.13	2.43	3.52	0.67	0.61	0.51	198.13	128.51	65.46	42.25	15.35	29.98	83.6	77.6	63.2

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	Loans Advanced per hectare of net sown area (in '00 Rs.)			Net Sown Area (in 000 ha.) per Regulated Market			Percent of Villages Connected with metalled Roads.			Net Sown Area (in 000 ha.)		
Districts	2004/05	1993/94	1983/84	2003/04	1993/94	1983/84	2004/05	1993/94	1983/84	2003/04	1993/94	1983/84
Ambala	89.13	25.72	6.99	19.14	16.33	20.58	100	97.31	96.32	134	147	247
Panchkula	180.51	-	-	8	-	-	98.21	-	-	24	-	-
Yamunanagar	79.31	26.46	-	17.86	20.33	-	99.34	98.89	-	125	122	-
Kurukshetra	72.39	22	5.25	21.43	21	28.25	100	99.75	99.72	150	147	339
Kaithal	54.81	18.46	-	28.14	27.86	-	100	99.31	-	197	195	-
Karnal	80.72	18.01	5.45	19.7	27.57	32.6	100	99.2	96.66	197	193	326
Panipat	106.51	18.3	-	18.6	15.67	-	100	100	-	93	94	-
Sonipat	80.05	23.19	4.09	49	86.5	58	100	99.19	99.11	147	173	174
Rohtak	41.87	13.39	1.86	47.67	50	53	100	99.58	99.77	143	300	318
Jhajjar	62.4	-	-	77	-	-	100	-	-	154	-	-
Faridabad	88.15	12.41	2.71	23.83	31.2	33.8	99.55	96.71	92.71	143	156	169
Gurugaon	83.03	15.65	3.1	21.75	21.88	24.88	99.85	98.37	96.14	174	175	199
Rewari	55.27	16.9	-	64.5	63.5	-	100	99.75	-	129	127	-
Mahendragarh	45.05	11.71	2.31	38.25	37.5	53	99.72	100	99.29	153	150	265
Bhiwani	41.87	8.83	1.96	57.57	50.14	57.14	100	99.76	99.53	403	351	400
Jind	46.34	13.22	3.1	39.67	37.83	36.71	99.35	100	100	238	227	257
Hisar	50.58	12.45	3.64	51.83	49.33	49.09	100	99.8	99.4	311	592	540
Fatehabad	43.96	-	-	32.14	-	-	100	-	-	225	-	-
Sirsa	31.8	11.93	2.76	65.67	60.67	73.2	100	98.74	98.42	394	364	366
Haryana	59.12	15.25	3.59	33.34	35.13	39.56	99.7	98.99	97.85	3534	3513	3600

	Total Cropped Area (in 000 ha.)			Urbanization (%)		
Districts	**2003/04**	**1993/94**	**1983/84**	**1981**	**1991**	**2001**
Ambala	207	242	389	32.9	35.54	35.2
Panchkula	47	-	-	-	-	44.49
Yamunanagar	202	197	-	-	33.69	37.73
Kurukshetra	270	261	557	16.46	24.01	26.11
Kaithal	383	354	-	-	14.7	19.39
Karnal	386	383	509	26.18	27.46	26.51
Panipat	185	176	-	-	27.16	40.53
Sonipat	278	259	272	17.96	23.58	25.12
Rohtak	218	399	493	19.83	21.31	35.06
Jhajjar	230	-	-	-	-	22.17
Faridabad	267	252	256	40.82	48.57	55.65
Gurugaon	301	269	293	19.91	20.3	22.23
Rewari	202	179			15.27	17.79
Mahendragarh	281	258	409	13.07	12.41	13.49
Bhiwani	760	544	629	16.02	17.25	18.97
Jind	460	430	464	13.8	17.19	20.3
Hisar	619	1009	874	19.29	21.12	25.9
Fatehabad	398	-	-	-	-	17.63
Sirsa	694	603	543	20.44	21.16	26.28
Haryana	6388	5815	5688	21.88	24.63	28.92

Apndx. Table 7a: Correlation Matrix among Variables at the country (India) level: 1983/84

	Simp Ind	NFCP	PCI	SMH	IRI	ICD
Simp Ind	1					
NFCP	-0.14	1				
PCI	-0.03	0.32	1			
SMH	-0.22	-0.16	-0.65	1		
IRI	-0.06	-0.40	0.36	-0.27	1	
ICD	0.77	0.16	0.27	-0.25	-0.12	1

Apndx. Table 7b: Correlation Matrix among Variables at the country (India) level: 1993/94

	Simp Ind	PNFC	PCI	SMHS	GIA	ICD	RDEN
Simp Ind	1						
NFCP	-0.10	1					
PCI	0.02	0.46	1				
SMH	-0.23	-0.16	-0.50	1			
IRI	0.36	-0.36	0.04	-0.25	1		
ICD	0.10	0.53	0.62	0.02	-0.01	1	
RDEN	0.33	0.19	-0.04	0.07	-0.01	0.28	1

Apndx. Table 7c: Correlation Matrix among Variables at the country (India) level: 2003-04

	Simp Ind	NFCP	PCI	SMH	GIA	ICD	RDEN
Simp Ind	1						
NFCP	-0.10	1					
PCI	0.18	0.56	1				
SMH	-0.17	0.03	-0.44	1			
IRI	0.38	-0.45	-0.04	-0.30	1		
ICD	0.69	0.16	0.50	-0.22	0.42	1	
RDEN	0.24	0.31	0.08	0.07	-0.10	0.59	1

Apndx Table 8A: Correlation Matrices among Variables at the Level of State (Haryana) for 1983/84

	Simp Ind	AOH	GIA	MPTI	RC	ICD	PNFC	Tractor'n
Simp Ind	1							
AOH	0.3121	1						
GIA	-0.2055	0.2672	1					
MPTI	0.3361	0.5169	-0.147	1				
RC	0.2566	0.6388	0.0292	0.4822	1			
ICD	-0.3976	-0.1213	0.5909	-0.6442	-0.1928	1		
PNFC	0.7899	0.5881	-0.0333	0.4053	0.1499	-0.1762	1	
Tractor'n	0.137	0.424	0.861	0.646	0.851	0.682	0.865	1

Apndx Table 8B: Correlation Matrices among Variables at the Level of State (Haryana) for 1993/94

1993/94	Simp Ind	AOH	GIA	MPTI	RC	ICD	PNFC	Tractor'n
Simp Ind	1							
AOH	0.297	1						
GIA	-0.5778	0.0019	1					
MPTI	0.4587	0.3994	-0.1696	1				
RC	-0.1171	0.3724	0.0105	0.1841	1			
ICD	-0.4637	-0.449	0.5243	-0.4602	-0.1457	1		
PNFC	0.8969	0.305	-0.5567	0.4946	-0.0479	-0.4825	1	
Tractor'n	0.259	0.743	0.489	0.112	0.431	0.454	0.362	1

Apndx Table 8C Correlation Matrices among Variables at the Level of State (Haryana) for 2003/04

2003/04	Simp Ind	AOH	GIA	MPTI	RC	ICD	PNFC	Tractor'n
Simp Ind	1							
AOH	0.239	1						
GIA	-0.4757	0.2985	1					
MPTI	0.4823	0.6574	0.1555	1				
RC	-0.0876	0.5727	0.6171	0.5676	1			
ICD	-0.4264	-0.826	-0.2171	-0.8062	-0.4877	1		
PNFC	0.8463	0.3437	-0.382	0.5122	-0.0736	-0.5135	1	
Tractor'n	0.237	0.095	0.467	0.105	0.115	0.229	-0.292	1

Apndx. Table 9: Estimated Regression Results (Linear) to study Determinants of Crop Diversification at all-India level.

	Simpson Index			Percent of non-food Crops		
Variables	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84
PCI	0.00001	-0.00001	-0.0002	0.001	0.0001	0.005
	(0.25)	(-0.56)	(-1.36)	(0.96)	(0.35)	(0.63)
SMH	-0.001	-0.006	-0.01*	0.02	-0.30	-0.03
	(-0.18)	(-1.37)	(-2.05)	(0.08)	(-1.22)	(-0.17)
IRIP	0.001	0.001 (0.63)	0.001	-0.28	-0.28	-0.27*
	(0.31)		(0.23)	(-1.95)	(-1.99)	(-2.04)
ICD	0.00002	0.00003 (0.38)	0.0003	0.0001	0.001	0.05**
	(0.65)		(1.19)	(0.38)	(1.80)	(3.93)
RDEN	-0.00005	0.000004 (0.03)		0.01	-0.001	
	(-0.48)			(1.80)	(-0.14)	
No. of observation	18	18	18	18	18	18
Adjusted R^2	-0.12	-0.15	0.03	0.54	0.49	0.52
F – statistics	0.63	0.54	1.16	4.94	4.34	5.67.

Note: *: Significant at 10% level, **: Significant at 5% level, ***: Significant at 1% level. Values in parentheses show t-statistics

Apndx Table10: Estimated Regression Coefficients (Linear) to study Determinants of Crop Diversification in Haryana

	Simpson Index			% of Non Food Crops		
Variables	2003-04	1993-94	1983-84	2003-04	1993-94	1983-84
AOH	0.005	0.65	0.03	7.20	10.46	7.01**
	(0.12)	(1.61)	(0.99)	(1.10)	(1.71)	(2.24)
IRI	-0.001	-0.002**	-0.001	-0.32**	-0.34**	-0.10
	(-1.77)	(-2.80)	(-0.73)	(-2.19)	(-2.38)	(-0.76)
MPTI	0.001*	0.001	-0.0003	0.12	0.17	0.16
	(1.95)	(1.25)	(-0.12)	(0.83)	(1.33)	(0.68)
RC	-0.65	-0.014	0.0003	-3.92	-1.12	-1.49
	(-1.35)	(-0.79)	(0.02)	(-0.51)	(-0.41)	(-1.16)
ICD	-0.001	0.001	-0.01	-0.14	0.11	1.32
	(-0.96)	(0.34)	(-0.35)	(-1.15)	(0.18)	(0.63)
No. of observation	19	16	12	19	16	12
Adjusted R^2	0.49	0.41	0.00	0.50	0.39	0.30
F – statistics	4.48	3.15	0.56	4.62	2.96	1.94

Note: * Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level. Values in parentheses show t-statistics.

Apndx. Table 11: Correlation coefficient between Gross return of different farm activities on an Average farm

Activity	Crossbesd cow	Buffalo	Desi cow	Paddy kharif	Paddy basmati	Paddy summer	Wheat	Toria	Potato	Lentil	Sunflower	Jowar	Berseem
Crossbred cow	1.00												
Buffalo	-. 32	1.00											
Desi cow	0.90***	-. 31	1.00										
Paddy Kharif	0.81***	-.68***	0.67***	1.00									
Paddy basmati	-.15	-.40	-.14	0.36	1.00								
Paddy summer	0.69***	-.51**	0.46**	0.88**	0.48	1.00							
Wheat	0.12	-.28	0.37	0.38	0.61***	0.14	1.00						
Toria	0.31	-57***	0.62***	0.27	0.05	0.05	0.42	1.00					
Potato	0.10	.47	0.02	0.07	-.05	-.09	0.31	-.56**	1.00				
Lentil	0.38	-.35	0.69***	0.26	0.13	0.16	0.45**	0.93**	-50**	1.00			
Sunflower	0.70***	-.65***	0.86***	0.70***	0.21	0.53**	0.49**	0.85**	-.35	0.86	1.00		
Jowar	-.43	.68	-.43	-.82***	-.81***	-.78***	-.68***	-.36	0.06	-.40	-.68	1.00	
Berseem	0.88***	-.27	0.95***	0.75***	0.01	0.50**	0.53**	0.46**	0.27	0.54**	0.78	-.34	1.00

Appendix. Analytical Framework

Towards Measuring Diversification

The present study has used various concentration indices: Harfindhal and Entropy to work out agricultural diversification. The Harfindhal index (DHI) is a sum of the square of the proportion of individual activities in a portfolio. With an increase in diversification a sum of the square of the proportion of activities decreases and so also the DHI. This is a measure of concentration, alternately, an inverse measure of diversification since the Harfindhal index decreases with an increase in diversification. The Harfindhal index is bound by zero (complete diversification) to one (complete specialization).

Harfindhal index (D_h) = $\sum P_i^2$,

Where, $P_i = A_i / \sum_1 A_i$ is the proportion of the i th activity in acreage / income.

The above Harfindhal index is a measure of concentration and the index decreases with diversification, while Entropy indices discussed below is a positive measure of diversification. In order to make the DHI comparable with the Entropy index, the Simpson index that is (1-Harfindhal Index) has been worked out.

The Entropy index is a direct measure of diversification having a logarithmic character. This index increases with an increase of diversification. It approaches zero when the farm is specialized and takes a maximum value when there is perfect diversification. The upper limit of the Entropy Index is determined by the base chosen for taking logarithms and the number of crops. The upper value of the index can exceed one, when the number of total crops is higher than the value of logarithm's base, and it is less than one when the number of crops is lower than the base of logarithm. Thus the major limitation of the Entropy Index is that it does not give a standard scale for assessing the degree of diversification.

Entropy index (EI) = $\sum_i P_i * \log (1/P_i)$

The modified Entropy index is used to overcome the limitations of the Entropy index by using a variable base of logarithm instead of a fixed base of logarithm. The EI lies between zero (complete specialization) to one (perfect diversification). The Entropy index is bound by zero and one. It can be computed as:

$$MEI = -\sum_i (P_i * \log_N P_i)$$

The MEI is equal to EI/logN, it is worth mentioning that the base of the logarithm is shifted to 'N' number of crops. This index has a lower limit equal to zero when there is complete specialization or concentration and it assumes an upper limit of one in the case of perfect diversification, i.e. it is bounded by zero and one.

$$\text{Maximum M.E.I. (when Pi approaches 1/N)} = \sum 1/N * \log NN = \sum 1/N = 1 \quad (4)$$

Since the modified entropy index imparts uniformity and fixity to the scale used as a norm to examine the extent of diversification; the index is quite useful. The MEI however, measures deviations from equal distribution among existing activities i.e. the number of crops only, and does not incorporate the number of activities in it. This index measures diversification given the number of crops and the index is not sensitive to the change in the number of crops (Shiyani and Pandya 1998).

Agricultural diversification at the level of farm is also studied in terms of enterprise income and acreage under crops, and alternately resources at farmer's disposal. Resource diversification based on acreage explains the diversification of crops only, whereas enterprise diversification involves all enterprises both crops and livestock. Diversification was measured by enumerating the number of enterprises on the farm. The expressions for these indices are as follows:

$$\text{Index of maximum proportion } (D_m) = \text{Max } P_i.$$

For increasing diversification D_m should decrease; and the maximum share held by any activity in total income/cropped area decreases and that of other activities increase with an increase in diversification. This index is however silent about the share of other enterprises on total farm income/cropped area.