Working Paper Series No. E/303/2009

Drivers of Agricultural Diversification in India, Haryana and the Greenbelt Farms of India

Brajesh Jha
Amarnath Tripathi
Biswajit Mohanty

Institute of Economic Growth
University of Delhi Enclave
North Campus
Delhi – 110 007, India
Fax: 91-11-27667410
Gram: GROWTH – Delhi – 110 007
Phones: +91-11-27667101, 27667288, 27667365
WEBSITE: iegindia.org

Drivers of Agricultural Diversification in India, Haryana and the Greenbelt Farms of India

Brajesh Jha, Amarnath Tripathi and Biswajit Mohanty[#]

Abstract

The present 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. Introduction

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[1]. Some of

[#] Associate Professor, Research Assistant and Analyst respectively in Institute of Economic Growth (IEG), New Delhi. This is the revised version of a paper presented in a seminar on October 24, 2008 at the institute.

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

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.

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 present study is organized into the following sections: 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.

Section II: Review of Literature and Selection of Variables

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.[2] 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.

[2] 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).

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 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.[3] The merits of GLS over OLS are well documented.[4] The present study uses GLS with the random-effect model to estimate these equations. Model and Specification of variables are as under:

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

[3] 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.

[4] 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.

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. Determinants of Agricultural Diversification in India

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 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.[5] 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 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

[5] 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.

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[6]. 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 are more risk averse than the large farmers[7]. 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.[8] 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

[6]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.

[7] 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).

[8] 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.

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

Variables	Simpson Index		Percent of Non-Food Crops	
	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.

IV 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 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[9] (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 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

[9] 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.

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[10]; 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[11] 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 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

[10] 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.

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

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.[12] 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.,

[12] 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).

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.

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 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.

III. 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 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.[13] 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 constrained on account of insufficient irrigation. The Government statistics however, show that the region is

[13] 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).

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).[14] The non-negative correlation amongst different crop enterprises has resulted in an increase of risk 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

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

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.

IV. Conclusions

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.

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

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

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

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

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

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

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 and Prospects," 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.

___(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.

___(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.

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). *Agricultural Diversification and Smallholders in South Asia* (ed.) 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 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 2: 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 3: 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

Contd…

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	24.67	46.1	49.5	2147	10315	24613
Manipur	268.52	-	57.08	512.05	471.56	26.4	27.52	23.88	2370	7120	15401

						2					
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 4: 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	297.3	210.6	129.6	53.11	45.83	19.3	100	98.8	91.92

							5	5	7						
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

Contd…

	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 5a: 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 5b: 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 5c: 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 6A: 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 6B: 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 6C 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 7: 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 Table 8: 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 9: 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

Apndx I. Analytical Framework - Diversification Indices

The present study has used various concentration indices: Harfindhal and Entropy to workout agricultural diversification. Harfindhal index (DHI) is the sum of square of the proportion of individual activities in a portfolio. With an increase in diversification, the sum of square of the proportion of activities decreases, so also the indices (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 index: Harfindhal, is a measure of concentration and the index decreases with diversification, while the Entropy indices discussed below constitute 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. The Entropy index increases with an increase of diversification. The Entropy index 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 the logarithm's base, and it is less than one when the number of crops is lower than the base of logarithm. Thus, a 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.

Maximum M.E.I. (when Pi approaches 1/N) = $\sum$ 1/N * logNN

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 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; alternately resources at farmers 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 enterprise on 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.

—

RECENT WORKING PAPERS

Title	Author (s) Name	Paper No.
Ageing, Socio-Economic Disparities and Health Outcomes: Some Evidence from Rural India	Moneer Alam	E/290/2008
Productivity Increase and Changing Sectoral Composition: Contribution to Economic Growth in India	Bishwanath Goldar Arup Mitra	E/291/2008
Childhood Mortality and Health in India	Suresh Sharma	E/292/2008
Import Penetration and Capacity Utilization in Indian Industries	Bishwanath Goldar V.S. Renganathan	E/293/2008
IT & ITES as an Engine of Growth: An Exploration into the Indian Experience	Seema Joshi	E/294/2009
Addressing Coastal Vulnerability at the Village Level: The Role of Socio-economic and Physical Factors	Saudamini Das	E/295/2009
Literacy and School Attendance in India	Suresh Sharma	E/296/2009
Impact of Trade on Employment Generation in Manufacturing in India	Bishwanath Goldar	E/297/2009
Impact of Trade on Employment in the Services Sector in India	Arup Mitra	E/298/2009
Evaluating Agricultural in a Farming System Framework: A Case Study From North West India	Brajesh Jha	E/299/2009
The Impact of Economic Reforms on Indian Manufacturers: Evidence from a Small Sample Survey	Eckhard Siggel Pradeep Agrawal	E/300/2009
Informal Wage and Formal Sector Productivity: Theory and Evidences from India	Dibyendu Maiti Sugata Marjit	E/301/2009
Pattern of Agricultural Diversification In India	Brajesh Jha Nitesh Kumar Biswajit Mohanty	E/302/2009