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Crop Diversification and Growth of Maize in Karnataka: An Assessment

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CROP DIVERSIFICATION AND GROWTH OF MAIZE IN KARNATAKA: AN ASSESSMENT

Komol Singha* **and Arpita Chakravorty****

Abstract

Traditionally, Karnataka is an agriculture-based economy. With the dawn of the secondary and tertiary sectors, the agricultural sector was grossly neglected and consequently its contribution to the State's economy has been declining constantly over the last few decades. On the other hand, the growing needs of the agricultural sector have been greatly felt with the growth of population, not only in terms of food security but also in providing employment. Crop diversification within the sector has also been noticed on a large scale and as a result, the growth in the production of maize has been the highest with CAGR at 8.5 per cent in the last three decades. Using one-way Least Squares Dummy Variable (LSDV) for 27 districts over 12 years, the present study explored that introduction of new hybrid seed (HYV) as one of the most important factors for significant growth of maize in Karnataka. Further, though the crop is suitable in the drier region, the role of timely rainfall also had a significant impact on the yield level.

Key words: Maize, Crop Diversification; HYV Seed

JEL Classification: Q110, Q180, O470

Introduction

Karnataka is known for its rich biodiversity in India. The State has been identified as one of the 10 agro-climatic zones, suited for the majority of agricultural and horticultural crops (GoK, 2011). Despite a paradigm shift in economic activities from agriculture to non-agriculture sectors in recent years in the State, the growing need for increase in agricultural production and productivity has been greatly felt with the growth of the population not only for food security but also for generating employment. The sector still plays an important role in the overall development of the State and supports nearly 65 per cent of the State's population (GoK, 2012). Agricultural structure in the State is now characterised by wide crop diversification and remains highly dependent on the vagaries of the southwest monsoon. Out of the net area sown, hardly 30 per cent is irrigated in the State (Economic Survey, 2010-11). Therefore, crop diversification from wet to dry land farming within the sector has also been widespread. Maize crop was found to be the fastest growing crop in recent years (KCL, 2006). For instance, the Compound Annual Growth Rate (CAGR) of maize production registered at 8.5 per cent compared to the 2.2 per cent of rice in the last three decades (GoK, 2012). At the national level as well, Joshi, *et al.,* (2005) identified that maize has high production potential, provided improved hybrids and adequate irrigation composition is available. However, a thorough understanding of the growth and structure of crops has become a condition for further policy initiatives of the sector's development in the State.

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Objectives of the Study

The Government of Karnataka, in acknowledgement of the importance of agriculture, presented an exclusive Agriculture Budget 2011-12 for the first time and it is the only one of its kind in the country (GoK, 2012). The government also considers the rapid growth of agriculture and allied sectors as a means to accelerate the State's economic growth and enable farmers to earn higher incomes and ensure food security (GoK, 2011). Diversification of cultivation from rice and other conventional crops to maize is of extreme significance in the State (KCL, 2006). Keeping the knowledge of the sector's diversification in mind, the present paper tries to understand the structure and direction of agricultural crop diversification in Karnataka in recent years. What makes the maize crop growing faster in recent years? The specific objectives of the study are given below.

1. To identify the best performing crops and their diversification in the recent past;
2. To understand the growth trend of maize at the district and State levels;
3. To identify the major factors that enhanced maize production/yield in the State.

Brief Review of Related Literature

Maize (*Zea mays L*) is the most important crop in the world after wheat and rice (Verheys, Undated). A study by Wokabi (1998) revealed that traditional maize farming practices are no longer capable of producing maize to meet the growing population in African nations. Therefore, widespread application of scientific methods is essential. In Africa, maize, among other crops, is also identified as a strategic commodity for achieving food security and reduction of poverty. The study result by FARA (2009) revealed that in two decades in Africa – 1986-96 and 1996-2006 – about 50 per cent (8.6 million tons) of the total maize production increased due to growth in yield level.

At the national level, according to Joshi, *et al.,* (2005), the improvement in maize yield in recent years is credited to adoption of modern maize varieties. Karnataka is categorised as non-traditional maize growing area, which mostly favours commercial crops. They realised that hybrids (improved seed) outperformed local and composite cultivars in terms of yield and profitability. Hybrids are popular mostly in Andhra Pradesh and Karnataka, where the seed sector is strong. Though the crop is suitable for dry-land farming, the role of irrigation was not ignored by the scholars. Timely rainfall or proper irrigation enhanced maize output of maize crop.

The study by Wasim (2007) revealed that the influence of High Yielding Varieties (HYV) seed on production, yield and area for major food crops in Punjab, Pakistan, was mixed. Its contribution to production, area and yield growth for wheat was remarkable. However, the adoption of HYV seed helped to accelerate the growth rate of production and yield of maize from 1965 to 1978, the 40 year-period taken for the study in Punjab, Pakistan from 1951-52 to 1994-95.

In Haryana, Yadav, *et al.,* (2011), found that with the reduction of groundwater, the farmers were shifting from unprofitable cultivation of rice to maize because it could be managed with three to four periods of light irrigation. They also explored the role of HYV seeds in maize crop cultivation but the State faced the shortage of good hybrid seed. Similarly, Karnataka is a dry land farming area and shortage of water or rainfall was also one of the important factors responsible for many farmers switching over from rice to maize cultivation (Singha and Naphade, 2012).

As for the adoption of improved seed, Kaliba, *et al.,* (2000), found that the farmers' physical and capital endowment had no significant influence on the use of new seeds. Intensity of extension services was the major factor that positively influenced the use of improved maize seeds. The probability of using improved maize seeds by farmers in the lowlands that generally receive lower rainfall was higher by 25 per cent than in the intermediate altitude areas of Tanzania. This implies that the demand of improved seeds in dry land was higher than in the rain-fed regions.

Further, using primary data of eastern and southern African nations, Smale and Jayne (2003) found that the success of maize in the future would continue to depend on the strategic improvement of seeds. Since maize would remain a crucial part of the food security equation even while the agricultural economies of the region diversify, continued investments in both maize research and market institutions, some of which must be public, were essential in Africa.

Similarly, Thanh Ha*, et al.,* (2004), found that the production of maize has risen sharply since 1990 in Vietnam, when the government began to strongly support and promote maize hybrid technology. Vietnamese farmers have also widely adopted high-yielding hybrid maize varieties. This was a timely response to Vietnam's growing livestock and poultry industry, which in turn generates an increasing demand for more maize as feed. This further verifies that the lion's share of the demanded for maize is from the feed industry and the development of this sector is mainly encouraged by improved seeds.

In Karnataka, Vishwanatha (2005) focuses on the harvesting constraints on maize in Haveri and Davanagere districts. Using 2005-06 data of the two districts, threshing of maize due to the lack of labour was one of the major constraints in Karnataka. The results of the study revealed that among traditional methods of threshing, manual separation and beating was adopted by 62.50 and 26.67 per cent of farmers respectively. Whereas, in the case of mechanical threshing methods, the maize thresher and sheath were used by 34.17 and 27.50 per cent of farmers respectively.

Methodology of the Study

According to Mishra (2007), the growth of the agricultural sector may well be judged by the increase in production over time. Three factors account for the increase in the total agricultural production: (a) increase in the total area under various crops, (b) increase in the yield rate of various crops and (c) substitution of more remunerative crops for less remunerative crops.

With the help of secondary data from the Reserve Bank of India, Economic Survey of Karnataka, Economics and Statistics of Karnataka, Ministry of Agriculture and others, the present paper analysed the growth trends and yield of maize. Using the semi-log growth model of Wasim (2007), Deosthali and Nikam (2004) and Bhatia (1999), the growth trend of the area and production of maize for 12 years (1998-99 to 2009-10) is estimated in 27 districts of Karnataka. As productivity (yield) incorporates area and production, the yield function is employed for the analysis of the growth of the crop (Singha, 2012, Quddus, 2009). In the analysis, using One Way Least Squares Dummy Variable (LSDV) in the panel data of the 12 years mentioned above, the paper tries to explore the factors that influence the growth of maize in the State. Through this process, districts that perform better can be

identified as model districts and set as a target for the weaker districts of similar agro-climatic conditions for further development of the crop (Nath and Borah, 2011).

Growth Trend of Major Crops

According to Dev (2012), there are three goals of agricultural development in the country. They are (a) achieve four per cent growth and raise income by increasing productivity (land, labour), diversification to high value agriculture and by maintaining food security, (b) sharing growth (equity) by focusing on small and marginal farmers, lagging regions, women, etc., and (c) to maintain sustainability of agriculture by focusing on environmental concerns. Karnataka has achieved an impressive growth rate in the overall infrastructural development compared to some other weaker States in the country. However, the development of agricultural infrastructure has not been evenly distributed within the State. This has resulted in regional imbalances in the State (Venkatachalam, 2003). Therefore, development should be inclusive and balanced among the districts. Using composite development index of 39 components, Narain, *et al.,* (1997) studied district-level development in Karnataka and found wide disparities within the State. Further, they explored a positive co-relation between agricultural growth and socio-economic development in the State. In the context of maize cultivation, two things should be kept in mind: 1) yields during the winter were higher than in the rainy season; hybrid yields are substantially higher than that of composite and local/traditional cultivars (Joshi, *et al.,* 2005). Therefore, maize cultivation is preferred by the farmers in Karnataka and is beneficial because the State is a dry region.

Based on decadal growth rate estimated from the data provided by the Ministry of Agriculture, three cereal crops – maize, tur (arhar) and rice – enjoyed positive and significant growth, in terms of area expansion and production in the recent decades (GoK, 2012). Based on area and production expansion, maize was identified as the best performing crop in the State from 1980-81 to 2010-11, followed by tur during the same period. The production of rice, which was the leading crop in the 1980s and 1990s, fell after 2000 (Table 1).

Table 1: CAGR of Area and Production of Major Crops in Karnataka

Crop	Area/Production*	1980-81	1990-91	2000-01	2010-11	CAGR
Rice	Area	11.1	11.7	14.8	15.4	1.1
	Production	22.6	24.3	38.5	43.0	2.2
Maize	Area	1.6	2.5	6.7	12.9	**7.2**
	Production	3.8	6.3	21.4	44.4	**8.5**
Tur	Area	3.4	4.6	5.8	8.9	3.3
	Production	1.3	1.8	2.6	5.3	4.9

* Area in Lakh Ha; Production in Lakh ton

Source: GoK (2012)

From the Table 1, we can deduce that the growth rate of maize was the highest compared to other traditional crops (rice, tur) in the State. For instance, the growth rate (CAGR) of maize was 8.5 per cent and 7.2 per cent for production and area expansion respectively in the last 30 years. It is much higher than the growth of rice, which registered at 2.2 per cent and 1.1 per cent of production and area expansion respectively during the same period. The same holds true for the tur crop as well – the growth rate of area and production of tur was much lower than that of maize during the same period. As the growth rate of maize is higher than the growth rate of its area expansion during the last three decades, it infers that the yield level of the crop was good during the period.

Further, to identify growth performance of the four best crops (as selected in this study) in the last decade (1998-99 and 2009-10) in the State, an analysis is made of area and production in Tables 2 and 3 respectively. The contribution of the districts to the State's total, in terms of area and production is assessed. The districts that have a larger share of area and production are also analysed. In Table 2 we find that the growth rate of area expansion of maize from 1998-99 to 2009-10 outperformed other competing crops – rice and tur. Twenty-four districts, barring Bangalore (u), Kolar and Udupi, showed positive and significant growth rate. The area share of maize to the State's total is very low but the growth rate of the districts of Chikmaglur, Hassan, Mandya and Uttarakanada in the last decade was extremely high.

Table 2: Area of Three Major Crops in different Districts, their Share to State Total and Growth Rate between 1998-99 and 2009-10

Districts	Rice			Tur			Maize		
	1998-99	2009-10	Change*	1998-99	2009-10	Change*	1998-99	2009-10	Change*
Bagalkot	197 (0.01)	133 (0.01)	-32.5	6154 (1.3)	4811 (0.8)	-21.8	43402 (8.5)	82030 (6.8)	89.0
Bangalore (r)	20967 (1.5)	1667 (0.1)	-92.0	5522 (1.2)	1306 (0.2)	-76.3	5368 (1.0)	10935 (0.9)	103.7
Bangalore (u)	7245 (0.5)	2041 (0.1)	-71.8	936 (0.2)	617 (0.1)	-34.1	1415 (0.3)	655 (0.1)	-53.7
Belgaum	62731 (4.4)	71888 (4.9)	14.6	8602 (1.8)	4671 (0.8)	-45.7	109370 (21.3)	162344 (13.5)	48.4
Bellary	68854 (4.8)	120414 (8.2)	74.9	7563 (1.6)	8938 (1.5)	18.2	32090 (6.3)	100517 (8.4)	213.2
Bidar	9587 (0.7)	5039 (0.3)	-47.4	54354 (11.4)	67000 (11.2)	23.3	306 (0.1)	1685 (0.1)	450.7
Bijapur	394 (0.01)	27 (0.01)	-93.1	14304 (3.0)	104091 (17.4)	627.7	12170 (2.4)	64558 (5.4)	430.5
Chamnnagar	18465 (1.3)	17114 (1.2)	-7.3	2487 (0.5)	1949 (0.3)	-21.6	9129 (1.8)	37899 (3.2)	315.1
Chikmagalur	49841 (3.5)	43642 (3.0)	-12.4	1035 (0.2)	717 (0.1)	-30.7	460 (0.1)	10697 (0.9)	2225.4
Chitradurga	9422 (0.7)	11075 (0.8)	17.5	7582 (1.6)	8012 (1.3)	5.7	33386 (6.5)	84438 (7.0)	152.9
Dakshinnada	67754 (4.7)	54899 (3.7)	-19.0	-	-	-	-	10 (0.001)	-
Davangere	118178 (8.3)	137449 (9.3)	16.3	6657 (1.4)	4385 (0.7)	-34.1	103680 (20.2)	174172 (4.5)	68.0
Dharwad	37633 (2.6)	26958 (1.8)	-28.4	2473 (0.5)	2573 (0.4)	4.0	18569 (3.6)	51862 (4.3)	179.3
Gadag	1044 (0.1)	2012 (0.1)	92.7	2449 (0.5)	2939 (0.5)	20.0	18063 (3.5)	48292 (4.0)	167.4
Gulbarga	22202 (1.6)	79472 (5.4)	257.9	273391 (57.5)	336853 (56.4)	23.2	2021 (0.4)	6352 (0.5)	214.3
Hassan	66684 (4.7)	47659 (3.2)	-28.5	3730 (0.8)	2235 (0.4)	-40.1	5242 (1.0)	62825 (5.2)	1098.5
Haveri	54375 (3.8)	49995 (3.4)	-8.1	7477 (1.8)	2546 (0.4)	-65.9	54083 (10.6)	125965 (10.5)	132.9
Kodagu(coorg)	40666 (2.9)	34844 (2.4)	-14.3	-	-	-	1495 (0.3)	3576 (0.3)	139.2
Kolar	29267 (2.1)	7096 (0.5)	-75.8	12694 (2.7)	1852 (0.3)	-85.4	14021 (2.7)	845 (0.1)	-94.0
Koppal	68847 (4.8)	73955 (5.0)	7.4	13481 (2.8)	11005 (1.8)	-18.4	15664 (3.1)	41056 (3.4)	162.1
Mandya	79892 (5.6)	79961 (5.4)	0.1	2060 (0.4)	1316 (0.2)	-36.1	22 (0.01)	4073 (0.3)	18413.6
Mysore	109666 (7.7)	123650 (8.4)	12.8	6687 (1.4)	3368 (0.6)	-49.6	17602 (3.4)	29391 (2.5)	67.0
Raichur	117347 (8.2)	176440 (12.0)	50.4	19100 (4.0)	12984 (2.2)	-32.0	249 (0.01)	915 (0.1)	267.5
Shimoga	158633 (11.1)	133259 (9.0)	-16.0	508 (0.1)	362 (0.1)	-28.7	8295 (1.6)	69481 (5.8)	737.6
Tumkur	47448 (3.3)	36335 (2.5)	-23.4	15946 (3.4)	12229 (2.0)	-23.3	6219 (1.2)	20306 (1.7)	226.5
Udupi	69598 (4.9)	57509 (3.9)	-17.4	-	-	-	33** (0.01)	15 (0.001)	-54.5
Uttaranada	89868 (6.3)	80272 (5.4)	-10.7	204 (0.01)	45 (0.01)	-77.9	47 (0.01)	4451 (0.4)	9370.2
State Total	**1426800** (100)	**1474805** (100)		**475400** (100)	**596804** (100)		**512401** (100)	**1199345** (100)	

Source: MoA (2012)

* Percentage change from 1998-99 to 2009-10; ** data of 2005-06

Notes: Figures in parentheses are per cents of the state total; Area in hectare

Table 3: Production of Three Major Crops in different Districts, their Share to State Total and Growth Rate (between 1998-99 and 2009-10)

Districts	Rice			Tur			Maize		
	1998-99	2009-10	Change*	1998-99	2009-10	Change*	1998-99	2009-10	Change*
Bagalkot	316 (0.01)	381 (0.01)	20.6	2602 (1.2)	2610 (0.9)	0.3	121873 (7.3)	197519 (7.1)	62.1
Bangalore (r)	61073 (1.7)	7189 (0.2)	-88.2	2151 (1.0)	1069 (0.4)	-50.3	16189 (1.0)	50412 (1.8)	211.4
Bangalore (u)	21102 (0.6)	6016 (0.2)	-71.5	436 (0.2)	285 (0.1)	-34.6	4175 (0.2)	1627 (0.1)	-61.0
Belgaum	114147 (3.1)	84042 (2.2)	-26.4	3645 (1.6)	1424 (0.5)	-60.9	306391 (18.3)	343578 (12.3)	12.1
Bellary	224687 (6.1)	380920 (9.9)	69.5	2234 (1.0)	3303 (1.2)	47.9	99860 (6.0)	198142 (7.1)	98.4
Bidar	5825 (0.2)	3857 (0.1)	-33.8	41464 (18.7)	49647 (18.0)	19.7	715 (0.01)	1406 (0.1)	96.6
Bijapur	541 (0.01)	77 (0.01)	-85.8	5191 (2.3)	31050 (11.3)	498.2	35920 (2.1)	96242 (3.4)	167.9
Chamnnagar	59350 (1.6)	45717 (1.2)	-23.0	572 (0.3)	1494 (0.5)	161.2	34231 (2.0)	82932 (3.0)	142.3
Chikmagalur	118813 (3.2)	108173 (2.8)	-9.0	482 (0.2)	332 (0.1)	-31.1	1567 (0.1)	29449 (1.1)	1779.3
Chitradurga	27541 (0.8)	22137 (0.6)	-19.6	3393 (1.5)	4635 (1.7)	36.6	105152 (6.3)	141928 (5.1)	35.0
Dakshinnada	141211 (3.9)	124141 (3.2)	-12.1	-	-	-	-	12 (0.008)	-
Davangere	390808 (10.7)	469296 (12.2)	20.1	3482 (1.6)	4066 (1.5)	16.8	383332 (22.9)	518239 (18.5)	35.2
Dharwad	35730 (1.0)	31584 (0.8)	-11.6	611 (0.3)	1995 (0.7)	226.5	65302 (3.9)	118104 (4.2)	80.9
Gadag	2565 (0.1)	3722 (0.1)	45.1	503 (0.3)	782 (0.3)	55.5	65112 (3.9)	91242 (3.3)	40.1
Gulbarga	41335 (1.1)	180692 (4.7)	337.1	124147 (56.0)	153285 (55.6)	23.5	5859 (0.4)	7141 (0.3)	21.9
Hassan	156248 (4.3)	127886 (3.3)	-18.2	858 (0.4)	871 (0.3)	1.5	17271 (1.0)	222250 (7.9)	1186.8
Haveri	83333 (2.3)	60166 (1.6)	-27.8	2216 (1.0)	1461 (0.5)	-34.1	175258 (10.5)	262420 (9.4)	49.7
Kodagu(coorg)	85142 (2.3)	85137 (2.2)	0.0	-	-	-	5800 (0.3)	16736 (0.6)	188.6
Kolar	79828 (2.2)	12830 (0.3)	-83.9	11239 (5.1)	1510 (0.5)	-86.6	47194 (2.8)	2122 (0.1)	-95.5
Koppal	233409 (6.4)	245406 (6.4)	5.1	2818 (1.3)	2415 (0.9)	-14.3	55687 (3.3)	61771 (2.2)	10.9
Mandya	245663 (6.7)	263413 (6.9)	7.2	959 (0.4)	609 (0.2)	-36.5	77 (0.01)	5261 (0.2)	6732.5
Mysore	333026 (9.1)	381919 (9.9)	14.7	1957 (0.9)	1766 (0.6)	-9.8	75139 (4.5)	92500 (3.3)	23.1
Raichur	395453 (10.8)	492337 (12.8)	24.5	3429 (1.5)	3626 (1.3)	5.7	816 (0.05)	1855 (0.1)	127.3
Shimoga	383617 (10.5)	319806 (8.3)	-16.6	236 (0.1)	167 (0.1)	-29.2	32134 (1.9)	199932 (7.1)	522.2
Tumkur	136903 (3.7)	92959 (2.4)	-32.1	6787 (3.1)	7098 (2.6)	4.6	16144 (1.0)	39348 (1.4)	143.7
Udupi	122106 (3.3)	138204 (3.6)	13.2	-	-	-	117** (0.01)	40 (0.001)	-65.8
Uttaranada	157039 (4.3)	155245 (4.0)	-1.1	95 (0.01)	21 (0.01)	-77.9	94 (0.01)	16361 (0.6)	17305.3
State Total	**3656900** (100)	**3843252** (100)		**221500** (100)	**275521** (100)		**1671300** (100)	**2798569** (100)	

Source: MoA (2012)

* Percentage change from 1998-99 to 2009-10; ** data of 2005-06

Notes: Figures in parentheses are percents of the state total; Production in tonnes

From Table 3 we can further clarify that the growth rate of production of maize was better than that of rice and tur. Similar to area expansion in the last decade (1998-99 to 2009-10), the growth rate of production in the three districts of Bangalore (u), Kolar and Udupi has shown negative growth rate. This is probably because Udupi district was bifurcated recently from Dakshinakannada and both are highly developed districts in terms of the secondary and tertiary sectors. The agricultural contribution of these two districts is extremely low. Similarly, the districts of Bangalore (U) and Kolar are also extremely poor in terms of agriculture due to urbanisation. Besides, the Kolar district is an extremely dry area and the irrigation facility is also neglected in the district. But, further research is needed for the purpose.

The above discussion and evidences provided by the Tables 1 to 3 certify that the growth rate of maize was better than that of rice and tur. This envisaged us to analyse the growth trend of area and production of maize crop by district. It will show us the performance of the districts within the State over a period of time. The detail growth trend of area and production of maize by district is given in Table 4. The growth rate is calculated by using the equation, $LogY_t = a + bt + x_t$ Where Y= production/area of Maize; a=constant; b=coefficient; t=time variable in year (1, 2, ..., 12).

Table 4 shows that the districts of Uttarakanada and Chikmagalur witnessed a significantly high growth rate in terms of area and production, followed closely by the districts of Bijapur, Hassan, Raichur and Shimoga. The remaining districts have had a moderate growth rate, ranging from 3 to 10 per cent in area and 4 to 12 per cent in production. However, there has been a substantial fall in the growth rate of area and production in the districts of Bangalore (Urban) and Kolar due to the factors mentioned above. However, the growth rate in the districts of Udupi, Mandya and Dakshinakannada was not estimated in this present study due to data constraints.

Table 4: Log-linear Regression Growth Trend of Area and Production of Maize (1998-99 to 2009-10)

District	Area (in %)	Production (in %)
Bagalkot	5.760** (2.6)	7.090** (2.9)
Bangalore (rural)	6.609* (6.9)	11.572* (6.1)
Bangalore (urban)	-7.781** (-2.4)	-6.947) (-2.1)
Belgaum	3.977** (2.5)	5.443 (1.9)
Bellary	9.527* (9.3)	6.609* (4.7)
Bidar	8.405** (2.2)	4.362 (1.2)
Bijapur	16.767* (5.1)	13.928* (3.5)
Chamarajannagar	12.817 (9.4)	11.561* (5.2)
Chikmagalur	37.438* (10.6)	38.542* (6.9)
Chitradurga	6.716* (3.3)	1.816 (0.5)
Dakshinakannada	NA	NA
Davangere	4.603* (5.1)	5.232 (1.6)
Dharwad	12.075* (3.2)	10.960 (1.6)
Gadag	9.450 ** (2.5)	9.013 (1.5)
Gulbarga	9.09* (3.7)	5.106 (1.7)
Hassan	20.804* (11.5)	19.339* (6.8)
Haveri	8.004* (5.3)	4.949*** (1.8)
Kodagu	8.394* (8.1)	12.345* (6.1)
Kolar	-22.740** (-2.75)	-21.667** (-2.9)
Koppal	10.296* (5.01)	4.959 (1.7)
Mandya	NA	NA
Mysore	6.078* (4.5)	6.056** (2.6)
Raichur	21.531* (4.9)	19.877* (3.5)
Shimoga	20.081* (7.1)	18.341* (5.9)
Tumkur	10.175* (8.1)	9.429* (4.1)
Udupi	NA	NA
Uttarakannada	56.988* (9.2)	63.395* (8.2)

Source: Authors estimation from MoA (2012)

* 1% level of significance; ** 5% level of significance; *** 10% level of significance

Notes: Values in the parentheses are the t-value

Growth Performance and Yield Function of Maize

Karnataka is considered as one of the largest maize producing States, contributing 10 per cent to the India's total maize production in 1995 (Singh and Morris, 1997). It rose to 15.3 per cent in 1999 (Joshi, *et al.,* 2005). In terms of yield, Karnataka maintains the first position in India with 3.10 tonnes per hectare in 1999 (Joshi, *et al.,* 2005), but according to Sridhar (2008), it was 2.79 tonnes per hectare in 2006-07. Whichever the estimate, it is much higher than 1.7 ton/ha produced by the major maize producing countries of Africa during the same time (FARA, 2009). On the demand side, the major factors for speedy development of maize in Karnataka in recent years are high demand from the feed industries, assured market price and introduction of hybrid seed (Joshi, *et al.,* 2005) and the same holds true in Vietnam (Thanh Ha, *et al.,* 2004); in Africa (Verheye, Undated). The share of human consumption of maize crop is relatively much lower than the demand from the feed industries. There is a growing need of semi-finished products in the form of baby corn, sweet corn, and pop corn in the recent years. Taken together, the total production of maize crop in the State would have been higher than the estimates given by the government agencies, especially in Karnataka (Singha and Naphade, 2012). Of course, it needs further research and does not directly related to the present study. The very study focuses on the supply sides of the crop.

To determine the growth rate of yield of maize, three independent variables have been incorporated. They are – High Yielding Varieties Seed (HYV seed), average annual rainfall and type of soil, for 12 years in the 27 districts of the State. Technically, the data set used in the analysis is considered as an unbalanced panel because 25 districts out of 27 have 12 years' time series data of the three independent variables – HYV, annual rainfall and type of soil. However, two districts – Dakshinkannada and Udupi – have three and five years time series data respectively, for the three independent variables.

In the process of analysis, the basic assumptions of the classical regression model are tested. The multicolinearity test was done by using the VIF method (VIF < 10). The Breusch-Pagan and White's test was also done to check the heteroscedasticity problem and confirmed the presence of non-constant variance across the districts. In order to specify the appropriate model to fit the panel data, the F-statistic obtained from Fixed Effects estimation and the LM Statistic from the Random Effect estimation were also used. Further, the Hausman test rejected the null hypothesis of the presence of Random Effects thereby accepting the presence of Fixed Effects in the model. Since the time effects were jointly significant, time dummies were included in the Fixed Effects model. Hence, the One Way Least Squares Dummy Variable (LSDV) was found to be the best fit to estimate the panel data. The yield function of maize is given as:

$$Y_{it} = a + b_1 \ln HYVarea_{it} + b_2 \ln rain_{it} + b_3 s_i + d_i t_{it} + x_{it} \quad \text{..... (1)}$$

Where, Y_{it} is the dependent variable of maize yield in the districts, b_1 is the coefficient of the total area covered by HYV seed, b_2 is the coefficient of average annual rainfall, b_3 coefficient of soil type in the districts, d_i is the coefficient of time dummies.

Table 5: LSDV Estimates

Yield	Coef.	Robust std err	T	P>|t|	95% conf. interval	
ln_hyv	0.047161	0.0190598	2.47	0.014*	0.009647	0.084675
ln_rain	0.026461	0.0126578	2.27	0.024**	0.005159	0.049406
s1	-0.15046	0.301399	-0.5	0.618	-0.74368	0.442768
s2	-0.30658	0.25875	-1.18	0.237	-0.81586	0.202703
t2	-0.43197	0.1392916	-3.1	0.002*	-0.70613	-0.15781
t3	0.021751	0.1228444	0.18	0.86	-0.22004	0.263538
t4	-0.42391	0.180062	-2.35	0.019**	-0.77831	-0.0695
t5	-0.80062	0.1690933	-4.73	0*	-1.13344	-0.46781
t6	-0.73627	0.2099845	-3.51	0.001*	-1.14957	-0.32297
t8	-0.08301	0.1729611	-0.48	0.632	-0.42343	0.257422
t9	-0.31688	0.1975338	-1.6	0.11	-0.70567	0.071914
t10	-0.11752	0.1426048	-0.82	0.411	-0.3982	0.163162
t11	-0.27205	0.1694805	-1.61	0.11	-0.60563	0.061527
t12	-0.74077	0.1997242	-3.71	0*	-1.13388	-0.34767
_cons	1.139347	0.9830767	1.16	0.247	-0.79558	3.074273

* Significant at 1 per cent; ** Significant at 5 per cent

lnhyv = Log of High Yielding Verities Seed

lnrain = Log of average annual rainfall

s_i (i = 1 to 3) implies Soil Dummies (s1= Red and black; s2 = Red, Black and Laterite, s3 = Red, Alluvial and Laterite)

t_i (i = 1 to 12) implies Time Dummies

From the Table 5, it is clear that the impact of HYV seed to maize yield is significant. With a change of one unit in HYV area of maize in the State, we observe a change of 4.7 per cent in yield of maize. Similarly, the impact of average annual rainfall on the growth of yield is 2.4 per cent. However, the impact of soil on the growth of yield is not significant. As for the time dummies, we found that between 2001 and 2003 there was a significant growth in yield of maize compared to 1998.

Conclusion and Suggestions

From the above analysis, we can summarise that the role of agriculture in the State's economy is still significant in Karnataka. Crop diversification within the sector is widely noticed. Though the contribution of agriculture has been declining consistently, majority of the rural masses are directly or indirectly depending on it and the State's contribution to the sector at the national level is still very big. In the recent past, the growth rate of maize crop in terms of area and production has increased significantly and overtaken the traditional crop and has the largest share of area and production in the State. In this manner, Karnataka, traditionally known for rice cultivation has slowly switched over to the cultivation of maize in the recent years.

Among the districts, Utttarkannada, Shimogha, Raichur, Hassan and Chigmaglur have been identified as better performing districts in terms of growth of area and production of maize. The districts of Chamranagar, Dharwad and Bijapur, etc., have increased their area and production of maize moderately. In totality, the growth of maize is enthused by the performance of yield, which is much higher than not only the national average but also the other competing crops in the State. The recent growth in maize production is credited to the HYV seed and timely rainfall. Therefore, the better performing districts mentioned above can be set as targets for the weaker districts in the State.

As the modern seed (HYV seed) has been identified as an engine of growth for maize in the State, the government should make these seeds available to the farmers at affordable prices. For better and faster marketing, the necessary processing units can be made available at the farmers' doorstep and support price should be strengthened. Of course, necessary irrigation and finance at a low interest rate should be made available.

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