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TRENDS IN KENYAN AGRICULTURAL PRODUCTIVITY: 1997-2007

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Abstract

Agriculture continues to be a fundamental instrument for sustainable development, poverty reduction and enhanced food security in developing countries. Agricultural productivity levels in Sub-Saharan Africa are far below that of other regions in the world, and are well below that required to attain food security and poverty reduction goals. On the other hand, the rate of agricultural productivity growth since the early 2000s has been quite impressive in many African countries, including Kenya, yet this is no cause for complacency. Sustained and accelerated growth requires a sharp increase in productivity of smallholder farmers. The Strategy to Revitalize Agriculture (SRA), Kenya Vision 2030, Comprehensive African Agricultural Development Program (CAADP) and Alliance for Green Revolution in Africa (AGRA) have underscored the importance of increasing agricultural productivity in the fight against poverty. In the past, agricultural production was largely a function of acreage, but further growth in production will have to be driven by productivity growth.

This paper analyzes trends in the Kenyan agricultural productivity using household panel survey data collected from 1275 households in eight agro-regional zones for 1996/1997, 1999/2000, 2003/2004 and 2006/2007 cropping years. This panel data analysis overcomes problems of comparability and differences in sample design that compromise other trend assessments and thus provides a unique opportunity to evaluate changes in smallholder agricultural productivity. Productivity changes for maize, tea, coffee, sugarcane, cabbages, Irish potatoes and dairy are examined. The major drivers of the productivity trends across the agro-regional zones are discussed. The paper identifies policy interventions required to either sustain productivity growth or improve declining and stagnating sub-sectors.

Results show a consistent growth in maize productivity across most agro-regional zones and panel years. Some of the key factors that have contributed to productivity growth in maize over the 1997-2007 period include increased percentage of households using fertilizer, increased adoption of high-yielding seed varieties, and an increased density of fertilizer retail outlets leading to a decline in the distances to sellers of agricultural inputs. Fertilizer use dose rates on maize, however, have remained fairly constant. Further analysis reveals that some households

did not use inorganic fertilizers and the defining feature of these households is location in semi-arid areas where fertilizer use on maize may be risky and unprofitable.

The dairy sub-sector recorded impressive growth over the 1997-2007 period. Increased investment in dairy production and production of fodder crops reflects increased adoption of improved breeds, highlighting the importance of investment in knowledge and technology. Tea productivity has grown slightly, driven by increased fertilizer use, especially in the Western regions of Kisii and Vihiga districts. Productivity of sugarcane and coffee, on the contrary, declined during the decade, mainly due to challenges, some related to management, facing the sub sectors. Cabbage and Irish potato productivity fluctuated over the panel period, and did not show any meaningful trend.

The per capita land owned and per capita cultivated land has declined over the panel period, which appears to be related to intensifying population pressures and land fragmentation in many areas of the country. More than 30 percent of the smallholder farms in the sample control less than 1 acre of land. While agricultural productivity in general appears to be rising in Kenya, rising land pressures in the more densely populated areas is a major threat to future food security and rural livelihoods. Productivity growth and market access can partially overcome these threats, but sustainable rural livelihoods may well require attention to improved access to land.

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List of Acronyms

AEZ	-	Agro-ecological Zone
AFC	-	Agricultural Finance Corporation
AGRA	-	Alliance for Green Revolution in Africa
ASPS	-	Agricultural Sector Program Support
CAADP	-	Comprehensive African Agricultural Development Program
CDF	-	Constituency Development Fund
CoDF	-	Coffee Development Fund
GoK	-	Government of Kenya
HYV	-	High Yielding Variety
IFDC	-	International Fertilizer Development Center
KAPP	-	Kenya Agricultural Productivity Project
KARI	-	Kenya Agricultural Research Institute
KNBS	-	Kenya National Bureau of Statistics
KTDA	-	Kenya Tea Development Agency
MFI	-	Micro-finance Institution
MLE	-	Maximum Likelihood Estimation
MSU	-	Michigan State University
NAAIAP	-	National Accelerated Agricultural Inputs Access Program
NALEP	-	National Agriculture and Livestock Extension Program
NGO	-	Non-governmental Organization
NIB	-	National Irrigation Board
OLS	-	Ordinary Least Squares
SACCO	-	Savings and Credit Co-operative Organization
SRA	-	Strategy for Revitalizing Agriculture
SSA	-	Sub-Saharan Africa
TAMPA	-	Tegemeo Agricultural Monitoring and Policy Analysis Project
USAID	-	United States Agency for International Development

1.0 Introduction

1.1 Background

In the 21st century, agriculture continues to be a fundamental instrument for sustainable development, poverty reduction and enhanced food security in developing countries. Agricultural productivity growth is also vital for stimulating growth in other sectors of the economy. Currently, agricultural productivity growth in Sub-Sahara Africa (SSA) lags behind that of other regions in the world, and is well below that required to achieve food security and poverty goals (World Bank, 2007).

The Strategy for Revitalizing Agriculture (SRA) has underscored the importance of increasing agricultural productivity in the fight against poverty (Republic of Kenya, 2004). The strategy has decomposed the productivity problem into three components; an extension problem, a research problem and an economic and financing problem. The Kenya Vision 2030 has also highlighted growth of the agricultural sector as a major challenge (Republic of Kenya, 2007). Other important regional strategies such as the Comprehensive African Agricultural Development Program (CAADP) and the Alliance for Green Revolution in Africa (AGRA) have also underscored the need for productivity growth.

Over the past five years, the Kenyan Government has strived to improve agricultural productivity through government and donor supported programs such as Kenya Agricultural Productivity Project (KAPP), Agricultural Sector Programme Support (ASPS), National Agriculture and Livestock Extension Programme (NALEP), and the National Accelerated Agricultural Inputs Access Programme (NAAIAP). However, there is very little evidence-based documentation showing the impact of these programmes on smallholder farmers. This study seeks to analyze productivity trends in major commodities with an overall objective of establishing if there are lessons that could be learnt from the past. These lessons could provide important guidance as the country strives to implement the Kenya Vision 2030.

1.2 Objectives

The overall objective of the paper is to analyze trends in the Kenyan agricultural productivity using nationwide household panel survey data. In particular, the paper examines productivity trends for selected cereal, industrial, and horticultural crops and dairy sub sectors. The paper identifies commodities that have recorded positive growth in productivity and highlights the major drivers of productivity growth across agro-regional zones. Sub-sectors with declining or stagnating productivity over the decade are also identified. The paper proposes some policy interventions required to sustain productivity growth for sub-sectors with positive growth and improve productivity for sub-sectors showing declining and stagnating trends.

It is envisaged that the study findings will inform stakeholders in the agricultural sector on levels of productivity over time, technology adoption or dis-adoption and the intensity of use of inputs. The study results will reinforce the need to expand support for innovative systems of input distribution such as agro-dealer programs and the proposed fertilizer cost reduction strategy as identified in the Kenya Vision 2030. Results could also provide evidence for the need for targeted interventions.

2.0 Data and Methods

2.1 Data and Sampling

The data for the study is obtained from the Tegemeo/MSU Panel Household Survey for 1996/97, 1999/00, 2003/04 and 2006/07 cropping years. The panel household survey was designed and implemented under the Tegemeo Agricultural Monitoring and Policy Analysis Project (TAMPA), implemented by Egerton University/Tegemeo Institute, with support from Michigan State University.

The sampling frame for the panel was prepared in consultation with the Kenya National Bureau of Statistics (KNBS) in 1997; although KNBS's agricultural sample frame was not made available. Twenty-four (24) districts were purposively chosen to represent the broad range of agro-ecological zones (AEZs) and agricultural production systems in Kenya. Next, all non-urban divisions in the selected districts were assigned to one or more AEZs based on agronomic information from secondary data. Third, proportional to population across AEZs, divisions were selected from each AEZ. Fourth, within each division, villages and households in that order were randomly selected. A total of 1,578 households were selected in the 24 districts within seven agriculturally-oriented provinces of the country. The sample excluded large farms with over 50 acres and two pastoral areas. This analysis is based on 1,275 households which formed a balanced panel for each of the four cropping years, 1996/1997, 1999/2000, 2003/04 and 2006/07 (hereafter referred to as 1997, 2000, 2004 and 2007, respectively). The attrition rate for the panel was 19% over the 10-year period. Some of the main reasons for this attrition are related to death of household heads and spouses leading to dissolution of households, and relocation of households from the study areas. Households in Turkana and Garissa districts were not interviewed in the 2004 and 2007 surveys. The remaining 22 districts in the survey were assigned to agro-regional zones as defined in Table 1.

Table 1: Spread of sampled districts in agro-ecological zones

Agro-ecological zone	Districts	No. of households
Coastal Lowlands	Kilifi, Kwale	75
Eastern Lowlands	Machakos, Mwingi, Makueni, Kitui, Taita-Taveta	145
Western Lowlands	Kisumu, Siaya	153
Western Transitional	Bungoma (lower elevation), Kakamega (lower elevation)	148
Western Highlands	Vihiga, Kisii	129
Central Highlands	Nyeri, Muranga, Meru	242
High-Potential Maize Zone	Kakamega (upper elevation), Bungoma (upper elevation) Trans Nzoia, Uasin Gishu, Bomet, Nakuru, Narok	346
Marginal Rain Shadow	Laikipia	37
Overall sample		**1275**

A major advantage of panel data is that it overcomes problems of comparability over time. In many countries, there are various farm surveys to draw upon to measure trends in livelihoods and agricultural performance over time. However, the comparability of these surveys is often compromised by differences in sampled households, locations, month/season of interview, recall period, and the way in which data is collected. The findings reported in this study are based on a balanced panel of 1,275 households consistently interviewed in 1997, 2000, 2004, and 2007, which provides a unique opportunity to track changes in agricultural performance for a consistently defined nationwide sample of small-scale farmers. Another advantage of panel data is that it allows sorting out economic effects that cannot be distinguished with the use of either cross-section or aggregate time-series data alone (Pindyick and Rubinfeld, 1998). Other studies that have used panel data to measure productivity include Ekborm (1998), Yamano and Jayne

(2004), Suri (2006) and Tegemeo (2005). The present study, however, relies on in-depth and longer panel period (10 years).

2.2 Method of Analysis

The aim of this paper is to provide a fundamental picture of trends in agricultural productivity and hence relies largely on descriptive trends. Descriptive analysis is used to show trends in partial productivity measures such as crop output per unit of land. The paper also examines trends in input use over the panel period. Values over time are expressed in constant terms using mean farm-gate output prices over the four panel survey periods. This procedure enables us to track changes over time in farm output based on changes in physical production per unit of land and labor and effectively purges out the effects of price variations caused largely by exogenous shocks to the sector.

3.0 Agricultural Productivity Trends

This section presents trends in aspects of agricultural productivity. Trends in household land ownership and cultivation are presented in Section 3.1. Section 3.2 presents household income composition and explains the relative importance of various income sources in household total income. Trends in value of crop production are presented in Section 3.3. Productivity trends for selected commodities and drivers of the observed trends are presented in Section 3.4.

3.1 Land Ownership

Household land holdings have generally declined from 6.1 acres in 1997 to 5.8 acres in 2007 (Table 2). This decline was experienced in five out of the eight agro-regional zones, with marginal rain shadow registering the highest decline of 15% from 6.1 acres in 1997 to 4.4 acres in 2007. Western highlands, however, shows a slight increase in mean household land sizes from 2.2 to 2.4 acres during the panel period. The general decline in sizes of landholding reflects the effects of increased population pressures and sub-division in most areas of rural Kenya. The trends also show regional differences in the size of household land holdings, with households in the High potential maize zone owning an average of 10 acres. Households in the Western highlands and Central highlands have the smallest land holdings (between 2 and 3 acres).

Table 2: Trends in mean land size owned (acres[1]/household)

Zone	1997	2004	2007
Coastal Lowlands	5.3	6.3	5.3
Eastern Lowlands[d]	6.7	5.6	6.4
Western Lowlands[d]	3.8	4.2	3.0
Western Transitional[d]	5.9	6.3	5.8
High Potential Maize Zone[d]	10.7	11.0	10.4
Western Highlands	2.2	2.3	2.4
Central Highlands	2.9	2.9	3.0
Marginal Rain Shadow[d]	6.1	5.1	4.4
Overall Sample	**6.1**	**6.1**	**5.8**

Note: [d]=declining sizes of land holdings

The average cropped land per household has declined from 3.5 acres in 1997 to 3.4 acres in 2007 (Table 3). The declining trend in cropped area is also observed in all the regions except Eastern lowlands, where the average area rose from 3.1 to 4.0 acres between 1997 and 2007. The

[1] 1 acre=0.4 hectares

expansion in area in the Eastern lowlands may reflect less intense land pressures in this less densely populated zone and continued reliance on land extensification.

Table 3: Mean area cultivated for main season (acres per household)

Zone	1997	2004	2007
Coastal Lowlands	2.8	4.0	3.3
Eastern Lowlands	3.1	4.4	4.0
Western Lowlands	2.3	3.2	2.3
Western Transitional	4.3	4.2	4.1
High Potential Maize Zone	5.9	5.1	5.1
Western Highlands	1.7	2.1	2.0
Central Highlands	2.2	2.5	2.0
Marginal Rain Shadow	1.9	1.9	1.8
Overall Sample	**3.5**	**3.7**	**3.4**

We further analyse mean cropped land for selected crops. Results show that area under maize production increased from 1.8 acres in 1997 to 2.2 acres in 2000**,** before declining to 1.9 acres in 2004 and 2007 (Table 4). The proportion of households producing maize has remained high and somewhat constant; averaging 99%. This indicates the importance attached to maize by most rural households in Kenya.

Mean area under tea production declined marginally from 1.08 acres in 1997 to 1.05 acres in 2007, but the number of tea growing households in the sample rose from 170 to 194 during the decade, with the net result being a moderate increase in tea productivity over the full sample. This could be a response to liberalization and privatization of tea, which entailed the exit of the government from tea production, revocation of the tea license, and transformation of the Kenya Tea Development Authority to Kenya Tea Development Agency, the latter being owned by the farmers.

The mean area under coffee production declined from 0.56 acres in 1997 to 0.48 acres in 2007. The number of coffee growing households in the sample also fell from 257 in 1997 to 250 in 2007, with the net result being a decline in coffee output over the entire sample. This finding is not surprising given the management difficulties that the sector has suffered over the past decade and beyond (Nyoro and Ngugi, 2006).

Mean area under sugarcane during the period rose from 2.18 acres in 1997 to 2.5 acres in 2007, but the number of households in the sample producing sugar cane declined from 161 to 145 between 1997 and 2007.

Cabbages, a major horticultural crop in Kenya, show a decline in the area cultivated from 0.38 acres in 1997 to 0.21 acres in 2007, although the total number of households engaged in cabbage production rose greatly from 1997 to the early 2000s, before declining in 2007. The number of farmers growing Irish potatoes similarly rose dramatically in the late 1990s and early 2000s before declining somewhat between 2004 and 2007. Overall, the percentage of farmers growing potatoes has increased from roughly 25% to 33%. Among farmers who planted potatoes, area cultivated has declined gradually, from 0.58 in 1997 to 0.44 acres in 2007. The declining trend in acreages under most of the crops indicate that land is increasingly becoming a constraining factor in agricultural production, and any increase in agricultural production will need to be attained only through productivity growth. This is consistent with the finding that a smaller share of land is under fallow in 2007 than in 1997.

Table 4: Mean land area under selected crops for households cultivating the crop, main season

Crop	Acres under cultivation for households cultivating the crop							
	1997		2000		2004		2007	
	No. of hhs	Area (acres/hh)	No. of hhs	Area (acres/hh)	No. of hhs	Area (acres/hh)	No. of hhs	Area (acres/hh)
Maize	1260	1.80	1259	2.20	1261	1.90	1254	1.90
Tea	170	1.08	177	1.04	198	1.01	194	1.05
Coffee	257	0.56	308	0.55	283	0.49	250	0.48
Sugarcane	161	2.18	154	2.18	158	2.03	145	2.50
Cabbages	134	0.38	286	0.24	217	0.21	168	0.21
Potatoes	327	0.58	486	0.59	490	0.48	413	0.44

Table 5 provides trends in overall cropped land and proportion allocated to maize production. All the regions show a general declining trend in area under maize; except for Eastern lowlands in which maize area rose form 2.3 acres to 2.9 acres over the decade.

Over 50% of cropped land is allocated to maize, including both intercrop and pure stand maize fields, signifying the importance attached to maize production among the farmers. This proportion is, however, consistently declining during the panel period; from 59% in 1997 to 55% in 2007. Regionally, there is a marked consistent decline in the proportion of area under maize to total cropped area in Western highlands, Western lowlands and Central highlands. It is also observed that these are the regions where mean household landholding size is relatively small compared to other regions, and where other higher-valued crops and activities such as tea, horticulture, dairy and associated fodder crop production may provide higher returns to scarce land. The proportion of land under maize rose between 1997 and 2007 in areas where land pressures are less acute and where landholding sizes are larger, such as the Coastal and Eastern lowlands, Western transitional and Marginal rain shadow regions.

Table 5: Trends in cropped land and land allocation to maize

Zone	Land (acres/hh) cropped	Land (acres/hh) to fields with maize	Proportion (%) of cropped area allocated to fields with maize
Coastal Lowlands			
1997	2.8	1.9	72.2
2000	4.3	2.9	66.1
2004	4.0	2.7	67.1
2007	3.3	2.2	68.8
Eastern Lowlands			
1997	3.1	2.3	73.6
2000	3.9	2.5	63.4
2004	4.4	2.6	59.9
2007	4.0	2.9	73.4
Western Lowlands			
1997	2.3	1.3	65.8
2000	2.8	1.6	66.1
2004	3.2	1.6	60.6
2007	2.3	1.0	50.9
Western Transitional			
1997	4.3	1.5	39.8
2000	4.7	1.7	40.8
2004	4.2	1.7	44.2
2007	4.1	1.4	42.7
High Potential Maize Zone			
1997	5.9	3.1	64.8
2000	7.1	3.8	65.8
2004	5.1	2.9	62.9
2007	5.1	3.3	69.4
Western Highlands			
1997	1.7	0.9	59.1
2000	2.1	1.2	59.2
2004	2.1	1.1	53.8
2007	2.0	0.8	42.0
Central Highlands			
1997	2.2	0.9	41.4
2000	2.4	0.9	38.5
2004	2.5	0.7	35.1
2007	2.0	0.6	35.1
Marginal Rain Shadow			
1997	1.9	1.3	77.2
2000	1.9	1.2	67.2
2004	1.9	1.2	70.4
2007	1.8	1.2	74.9
Nationwide sample			
1997	3.5	1.8	58.7
2000	4.2	2.2	56.8
2004	3.7	1.9	54.3
2007	3.4	1.9	55.3

3.2 Household Income Composition

Household income constitutes income from cropping activities, sale of livestock and livestock products, business activities, income from salaries income and remittance. Decomposition of household income into its components reveals that crop income is a major component of household income, contributing 40% in 1997, 50% in 2000, 46% in 2004 and 44% in 2007 (Table 6). Variations over time in agriculture income shares is highly weather-driven.

Regionally, crop incomes have remained an important contributor to household income in the Western and Central highlands, Western transitional and High potential maize zones, contributing between 41% and 65% over the decade. In the semi-arid areas such as Coastal and Eastern lowlands and Marginal rain shadow, crops generally contribute less to total household incomes – between 10% and 43% - compared to the high potential agricultural regions. In the Marginal rain shadow, however, crop's contribution to household income consistently rose from 13% in 1997, 23% in 2007, 33% in 2004, to 36% in 2007.

Table 6: Household mean annual income shares (% of total household income)

Zone	Year	Crops	Livestock	Business	Salary
Coastal Lowlands	1997	10.3	5.3	38.7	45.7
	2000	39.1	3.1	37.1	20.7
	2004	24.1	4.0	42.2	29.7
	2007	28.8	1.9	48.8	20.5
Eastern Lowlands	1997	21.8	16.4	13.3	48.5
	2000	43.1	12.3	19.7	24.9
	2004	34.4	11.2	24.3	30.1
	2007	40.1	13.0	20.8	26.1
Western Lowlands	1997	41.0	17.7	13.0	28.3
	2000	50.3	15.0	17.1	17.6
	2004	37.4	12.9	23.6	26.2
	2007	39.8	7.4	30.1	22.7
Western Transitional	1997	47.1	24.4	13.6	15.0
	2000	61.9	10.4	16.1	11.6
	2004	56.2	14.8	15.3	13.7
	2007	47.7	16.7	23.2	12.4
High Potential Maize Zone	1997	48.6	24.3	9.6	17.5
	2000	40.6	24.5	18.6	16.3
	2004	50.6	20.7	12.8	15.9
	2007	38.3	25.8	19.7	16.3
Western Highlands	1997	45.5	21.8	10.7	22.0
	2000	58.8	14.7	8.0	18.5
	2004	49.2	17.7	10.8	22.3
	2007	54.8	11.5	15.6	18.1
Central Highlands	1997	43.9	19.4	9.7	27.0
	2000	64.7	8.6	11.7	15.0
	2004	53.2	17.3	11.5	18.0
	2007	54.7	15.8	13.2	16.3
Marginal Rain Shadow	1997	12.9	35.0	14.9	37.2
	2000	22.9	10.2	34.2	32.7
	2004	32.9	22.9	16.2	28.0
	2007	36.2	26.2	16.1	21.6
Overall Sample	1997	40.0	21.0	13.0	27.0
	2000	50.0	15.0	17.0	18.0
	2004	46.0	16.0	17.0	21.0
	2007	44.0	16.0	21.0	18.0

Income from livestock contributed 21% of household income in 1997, but the contribution declined to 16% in 2007. While the declining trend in livestock contribution to household income is mirrored across all the regions, in the Marginal rain shadow livestock contribution to household income shows a general increasing trend between 10 % in 2000 and 26% in 2007.

The proportion of income from business rose from 13% in 1997 to 21% in 2007. The increase in the proportion of business income to total household income over the decade is also observed in all the regions. The largest increases were in the Western lowlands (from 13% in 1997 to 30% in 2007), Coastal lowlands (from 39% in 1997 to 49% in 2007) and the High potential maize zone (from 10% in 1997 to 20% in 2007). The contribution of salaries and remittances show a declining trend for all the zones from 27% in 1997 to 18% in 2007.

Jointly, the contribution from on-farm income earning activities (crops and livestock income) declined gradually but consistently from 65% in 2000 to 60% and 2007. The proportion of off-farm income (business and salary incomes combined) increased from 35% in 2000 to 38% in 2000 to 40% in 2007. This shows the increasing importance of off-farm activities to rural agricultural households. However, farming is still a major source of household income among the rural households. Agricultural productivity growth, therefore, remains a major target in efforts to improve incomes and well-being of the majority of the rural households.

3.3 Value of Crop Production

The value of crop production is defined as the product of the quantity of crop harvested and the price for all the crops produced by the household. Since the value of crop production changes with the change in either price or quantity, we use constant prices[2] to evaluate the changes in order to determine whether the changes are as a result of changes in quantities of production. Holding prices of all commodities constant, we observe a general increase in the value of crop production over the decade across all the zones (Table 7). Overall, the mean value of crop production per household at constant prices rose from Ksh 62,000 in 1997 to Ksh. 72,264 in 2007. However, the values were higher in 2000 and 2004. A similar trend is observed in the value of crop production per acre which rose from Ksh. 16,005 in 1997 to Ksh. 19,869 in 2007.

Regionally, the Central highland has the highest mean value of crop production per acre, ranging from Ksh. 30,808 in 1997 to Ksh. 40,200 in 2007. The High potential maize zone recorded the second highest value of crop production per acre; the value increased from Ksh 16,000 in 1997 to Ksh, 19,241 in 2007. Western highlands also recorded an increase in mean crop value per acre from Ksh. 11,325 in 1997 to Ksh. 17,662 in 2007. Western transitional had the fourth largest

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Crop value at time t is computed as

$$V_t = \sum_{i=1}^{n} \left\{ Q_{it} \times \left[\left(\sum_{t=1}^{4} P_{it}^{dm} \right) / 4 \right] \right\}$$

V_t = Gross crop value at time t
Q_t = Quantity in kilograms of crop i at time t
P_{it}^{dm} = Median district price per kilogram of crop i at time t
t=year, 1=1997, 2=2000, 3=2004, 4=2007

crop value per acre of Ksh. 12,317 in 1997 to Ksh 15,504 in 2007. The lowest value of crop produced per acre was recorded in the Eastern lowlands, Western lowlands, Coastal lowlands and the Marginal rain shadow. These trends imply that the main source of increase in the value of crop production is yield growth and shifts from low-value to high-value crops, as area under cultivation has declined somewhat over the panel period.

Table 7: Household total value of crop production at constant prices

Zone	Value of crop output (Ksh/hh)		Value of crop output (Ksh/acre)	
	Mean	Median	Mean	Median
Coastal Lowlands				
1997	17,113	10,046	7,288	3,034
2000	50,540	25,201	13,401	8,832
2004	41,160	17,117	7,494	4,650
2007	38,004	24,976	7,891	6,666
Eastern Lowlands				
1997	36,466	16,146	11,249	4,338
2000	66,736	42,593	13,431	8,782
2004	62,039	47,444	11,545	8,414
2007	55,934	38,246	10,459	7,839
Western Lowlands				
1997	18,605	11,124	8,635	4,287
2000	30,589	16,891	8,665	5,969
2004	32,821	16,746	7,845	5,774
2007	31,931	20,490	9,851	8,472
Western Transitional				
1997	57,238	28,171	12,317	6,419
2000	118,730	92,205	23,968	16,911
2004	78,982	41,691	16,788	11,449
2007	71,776	45,154	15,504	11,642
High Potential Maize Zone				
1997	99,272	48,749	16,845	13,493
2000	101,000	48,757	15,310	13,709
2004	114,109	64,725	21,820	17,446
2007	92,479	58,180	19,241	15,926
Western Highlands				
1997	29,765	20,971	11,325	9,280
2000	69,039	38,175	28,163	17,297
2004	72,135	42,129	21,831	16,598
2007	53,634	44,831	17,662	15,432
Central Highlands				
1997	90,158	54,405	30,808	21,938
2000	122,356	83,588	41,513	37,671
2004	130,290	105,335	46,259	41,858
2007	101,734	77,113	40,200	35,922
Marginal Rain Shadow				
1997	21,633	7,127	7,045	2,421
2000	19,526	10,674	6,923	4,636
2004	58,688	33,242	17,335	11,830
2007	53,741	35,952	18,945	11,130
Overall Sample				
1997	62,025	26,642	16,005	10,612
2000	86,255	45,729	21,234	14,254
2004	87,317	48,814	22,069	15,273
2007	72,264	45,564	19,869	14,576

Although the data has shown a general increase in the value of crop production during the panel period, there is still a gender disparity in the value of crop between the female and male-headed households. The female-headed households generally recorded lower values of crop production than their male-headed counterparts (Annex 1). It is noted that female-headed households in the higher productive zones had higher crop values than their counterparts in the lower productive zones. Over the panel period, the proportion of female- headed households doubled from 11.9% to 23.5%, mainly as a result of death[3] of male heads and male migration off the farm in search on non-farm jobs.

3.3.1 Contribution of Selected Crops to the Total Crop Value

The total value of crop constitutes revenue from cereals, tubers, pulses, fruits and vegetables, industrial crops and fodder. On the overall, maize contributed 36% of the total value of crop in 1997, before declining to 29% (Table 8). This proportion rose to 34% in 2007. Regionally, the contribution of maize to total crop value in the High potential maize zone declined from 52% in 1997 to 48% in 2000 and 2004 and later rose to 51% in 2007. A similar trend has been observed across the other agro-regional zones, where the proportion of maize value in total crop value declined in 2000 and then took an upward trend between 2004 and 2007. In the Central highlands, the proportion of maize value to total crop value has remained low, declining from 14% in 1997 to 11% in 2004, and then rising to 12% in 2004 and 2007.

The importance of other crops in contributing to value of crop varies across regions. In the Coastal lowlands, vegetables and fruits contributes over 40% of the crop value. Over the panel years, there was a steady increase of contribution of pulses from 9% to 14%. This could be attributed to increased promotion of drought resistant crops in the region. In the Eastern lowlands, pulses, vegetables and fruits contribute over 50% of the total crop value, but during the panel period there was a marked increase in the proportion of crop revenue generated from fodder crops. In the Western lowlands, other cereals such as millet and sorghum contributed over 20% of the total value of crop. Over the panel period we observe a substantial increase in the

[3] Further analysis of the mortality revealed that most of the household heads that died were male and the main causes of death were cancer (14.9%) and asthma (10.4%) between 2000-2004, and malaria and old age (each 10.9%) and accident (9.4%) between 2004-2007

proportion of crop revenue generated from fruits (2% in 1997 to 13% in 2007) and vegetables (1% in 1997 to 14% in 2007).

In Western transitional zone, over 25% of the crop revenue is generated from industrial crops; mainly sugarcane. During the panel period we observed an increase in proportion of revenue generated by a combination of fruits and vegetables (from 17% in 1997 to 20% in 2007). In the High potential maize zone, other cereals such as wheat contributed over 10% of the crop value. However, during the years under examination, we observe an increase in the importance of fruits and vegetables (from 7% in 1997 to 14% in 2007) in the region. In addition, fodder contributed 5% of the crop value in 2007 compared to 1% in 2000. In the Central highlands, industrial crops (e.g. tea and coffee) contributed the highest proportion (over 32%). There were, however, wide fluctuations in this proportion over the decade, which could be associated with challenges in the coffee sub-sector. An increasing trend in the contribution of fodder to total crop revenue is observed for the region; from 6% in 2000 to 8% in 2007. Overall, we observe an increasing importance of contribution of fodder crop (related to dairy) and horticulture to value of crop production during the panel period.

Table 8: Proportional (%) contribution various crops to total crop gross revenue

Zone	Maize	Other cereals	Tubers	Pulses	Vegetables	Fruits	Industrial	Fodder
Coastal Lowlands								
1997	34	10	10	9	7	30	0	0
2000	29	2	11	6	13	39	0	0
2004	28	5	11	10	13	33	0	0
2007	37	2	7	14	11	30	0	0
Eastern Lowlands								
1997	34	1	5	24	15	19	2	1
2000	27	1	6	20	16	25	2	3
2004	29	1	6	21	14	23	1	5
2007	35	1	2	23	14	19	1	6
Western Lowlands								
1997	38	15	13	20	1	2	11	0
2000	31	17	8	12	6	15	9	0
2004	26	10	7	14	19	14	9	0
2007	35	14	4	14	14	13	6	1
Western Transitional								
1997	31	2	13	11	3	14	25	0
2000	19	2	6	7	6	12	46	2
2004	35	2	7	8	10	9	26	2
2007	33	1	4	10	9	11	29	3
High Potential Maize Zone								
1997	52	17	3	11	3	4	8	0
2000	48	12	5	9	9	8	8	1
2004	48	13	4	9	9	6	7	3
2007	51	10	3	9	8	6	8	5
Western Highlands								
1997	40	3	2	8	15	16	15	2
2000	25	3	3	7	10	25	20	6
2004	33	3	3	8	16	15	12	9
2007	26	3	2	8	13	19	22	7
Central Highlands								
1997	14	0	16	4	9	18	38	0
2000	11	0	12	4	11	12	44	6
2004	12	0	14	6	13	16	32	7
2007	12	0	13	5	11	16	36	8
Marginal Rain Shadow								
1997	19	2	27	20	31	1	0	1
2000	5	1	25	12	43	9	0	5
2004	21	7	15	22	22	5	0	8
2007	25	3	13	19	31	4	0	6
Overall Sample								
1997	36	8	9	12	8	12	16	0
2000	29	6	7	9	11	16	19	3
2004	32	6	7	11	13	14	14	4
2007	34	5	5	11	11	13	15	5

3.4 Productivity Trends

This section examines productivity trends for selected crops; in cereals (maize), industrial crops (tea, coffee and sugarcane), and horticulture (cabbages and Irish potatoes); and dairy sub sector. Productivity for a crop in this paper refers to quantity of the crop harvested in kilograms from one acre of land cultivated with that crop. In some instances, we show productivity for crops in terms of bags/acre (maize), kg/bush (tea) and tones/acre (sugar cane). For dairy, productivity refers to the quantity in kilogram of milk per year per milked cow. In all the cases, mean values of productivity are discussed, although median values are provided in some tables. Except for dairy, productivity for crops was computed from the main harvest (season) only for each cropping year. Short harvests (seasons) were not included in the computation.

3.4.1 Maize Productivity

The overall mean maize productivity measured in 90-kg bags per acre shows a consistent and impressive growth from 6.6 bags in 1997, 7.2 in 2000, 8.2 in 2004, to 9.3 in 2007 (Table 9). Similar findings have been reported by the Ministry of Agriculture; nationally the rising maize yield is attributed to a combination of good weather, use of improved seeds, higher fertilizer application and adoption of modern farming techniques and technologies (Economic Review of Agriculture, 2008).

The High potential maize zone, Central highlands, Western transitional and the Western highlands recorded higher level of productivity compared to the Coastal lowlands, Eastern lowlands, Western lowlands and the Marginal rain shadow. However, the lower maize productivity regions of Coastal lowlands, Eastern lowlands and Western lowlands over the decade recorded impressive increase in maize productivity per acre: from 2.0 bags in 1997 to 4.2 bags in 2007 for Coastal lowlands; from 2.3 bags in 1997 to 4.7 bags in 2007 for Eastern lowlands; and from 3.0 bags in 1997 to 5.6 bags in 2007 for Western lowlands. Maize productivity also increased from 2.1 bags/acre in 1997 to 4.6 bags/acre in 2007 for the Marginal rain shadow. The High potential maize zone, else referred to as the Kenyan grain basket, recorded maize productivity increase from 11.5 bags/acre in 1997 to 13.3 bags/acre in 2007.

Disaggregating maize yield by cropping system shows that maize productivity has been on an increasing trend for both the pure-stand and inter-crop. Productivity for the pure-stand is, however, higher than for the inter-crop. The mean maize yield per acre for the pure-stand rose from 9.8 bags in 1997 to 11.2 bags in 2007, while that for the inter-crop rose from 6.1 bags in 1997 to 9.1 bags in 2007. It is further observed that productivity for the inter-crop maize is very close to the overall maize productivity, an indication that intercropping maize with other crops is the norm rather than the exception for smallholder maize farmers.

Table 9: Mean maize productivity (main season)

Zone	Overall maize		Pure stand maize		Intercrop maize	
	Yield (kg/acre)	Yield (bags/acre)	Yield (kg/acre)	Yield (bags/acre)	Yield (kg/acre)	Yield (bags/acre)
Coastal Lowlands						
1997	178.1	2.0	175.9	2.0	177.1	2.0
2000	361.8	4.0	470.8	5.2	359.9	4.0
2004	217.5	2.4	168.7	1.9	221.3	2.5
2007	374.0	4.2	347.5	3.9	378.4	4.2
Eastern Lowlands						
1997	206.2	2.3	437.8	4.9	161.4	1.8
2000	334.1	3.7	601.7	6.7	309.3	3.4
2004	322.6	3.6	561.7	6.2	264.4	2.9
2007	423.1	4.7	447.3	5.0	415.3	4.6
Western Lowlands						
1997	267.9	3.0	300.1	3.3	268.8	3.0
2000	233.3	2.6	600.3	6.7	230.5	2.6
2004	231.1	2.6	233.3	2.6	250.5	2.8
2007	505.8	5.6	527.9	5.9	508.3	5.6
Western Transitional						
1997	480.8	5.3	502.1	5.6	487.0	5.4
2000	677.2	7.5	926.8	10.3	675.2	7.5
2004	794.0	8.8	739.8	8.2	805.5	9.0
2007	961.0	10.7	888.8	9.9	973.7	10.8
High Potential Maize Zone						
1997	1035.5	11.5	1441.8	16.0	943.2	10.5
2000	940.0	10.4	1006.1	11.2	940.7	10.5
2004	1239.9	13.8	1443.5	16.0	1233.7	13.7
2007	1196.2	13.3	1265.3	14.1	1165.3	12.9
Western Highlands						
1997	500.4	5.6	486.4	5.4	508.2	5.6
2000	682.1	7.6	657.0	7.3	679.7	7.6
2004	597.8	6.6	1063.1	11.8	600.8	6.7
2007	795.5	8.8	622.6	6.9	797.8	8.9
Central Highlands						
1997	633.3	7.0	726.9	8.1	626.8	7.0
2000	794.4	8.8	1129.6	12.6	757.1	8.4
2004	829.2	9.2	770.1	8.6	813.7	9.0
2007	930.6	10.3	978.5	10.9	916.9	10.2
Marginal Rain Shadow						
1997	190.7	2.1		0.0	190.7	2.1
2000	79.6	0.9	240.0	2.7	65.4	0.7
2004	375.8	4.2	240.0	2.7	373.9	4.2
2007	409.7	4.6		0.0	409.7	4.6
Overall Sample						
1997	591.1	6.6	883.3	9.8	550.8	6.1
2000	644.8	7.2	861.5	9.6	635.0	7.1
2004	737.7	8.2	939.5	10.4	731.3	8.1
2007	839.1	9.3	1003.8	11.2	818.5	9.1

We present in Table 10 maize productivity trends for three zones, focusing on the proportion of households who produce at least 20 bags per acre. The table shows that the proportion of households whose maize productivity is at least 20 bags/acre rose from 8% in 1997 to about 14% in 2007 in Western Transitional, High potential maize zone and Central highlands combined. This general trend is repeated within the individual regions: the proportion rises from 12% to 18% in the High potential maize zone; from 2% to 7% in the Western transitional; and from 5% to 11% in the Central highlands, between 1997 and 2007. These trends may indicate that more households are becoming more efficient in maize production in the high potential agricultural regions.

Table 10: Proportion (%) of households that produced at least 20 bags/acre of maize (main season)

Zone	1997	2000	2004	2007
Western Transitional	2.0	2.7	6.1	7.4
High Potential Maize Zone	12.4	14.7	19.1	18.5
Central Highlands	5.0	7.0	7.0	10.7
Total	**7.9**	**9.8**	**12.5**	**13.7**

3.4.1.1 Factors Driving Maize Productivity Growth

The impressive growth in maize productivity could be attributed to several factors, including increased input use and physical and market infrastructural developments. Some of these factors are discussed in the following sub-sections.

Use of High Yielding Maize Varieties

The quality of planting material has a significant impact on crop productivity. The limited potential for further expansion of area under maize cultivation due to diminishing availability of arable land implies that future growth in maize production would have to depend on yield gains made by wide-spread use of productivity-enhancing technologies, among which include high yielding varieties (HYVs). Results show a general increasing trend in the proportion of households planting HYVs over the panel period from 70% in 1997, 69% in 2000 and 2004 and 74% in 2007 (Table 11). However, analysis by zone reveals increasing, stagnating or declining trends in adoption of HYVs. Some of the agro-regional zones that have recorded a progressive increase in the proportion of households using HYVs are; Western transition (from 74% in 1997 to 87% in 2007); High potential maize zone (from 89% in 1997 to 94% in 2007); Western highlands (from 75% in 1997 to 83% in 2007) and Western lowlands (from 14% in 1997 to 32% in 2007).

Proportion of households using HYVs in the lower maize productivity regions of Coastal lowlands and Eastern lowlands have stagnated at 44% and 53%, respectively. On the contrary, in the Central highlands and Marginal rain shadow, the proportion of households that planted HYVs on maize declined from 89% in 1997 to 83% in 2007 and 89% in 1997 to 65% in 2007, respectively. The uniquely declining adoption levels of HYVs' in Central highlands and Marginal rain shadow over the panel period could be a pointer to declining importance attached to maize enterprise in the regions. Nationally, quantity of improved maize seed used rose by 13% from 45,000 metric tonnes in 1996/97 to 51,000 metric tonnes in 2006/07 (Economic review of Agriculture, 2008, FAOSTAT)- Annex 2.

Table 11: Proportion (%) of households that planted high yielding maize varieties (main season)

Zone	1997		2000		2004		2007	
	No. of hhs	%	No. of hhs	%	No. of hhs	%	No. of hhs	%
Coastal Lowlands	29	44	30	45	27	39	29	44
Eastern Lowlands	79	54	56	39	59	41	76	53
Western Lowlands	22	14	36	24	41	27	48	32
Western Transitional	110	74	109	74	110	75	126	86
High Potential Maize Zone	306	89	304	88	308	90	322	94
Western Highlands	96	75	103	80	98	76	106	83
Central Highlands	215	89	211	87	204	85	201	83
Marginal Rain Shadow	32	89	28	76	28	76	24	65
Overall Sample	**889**	**70**	**877**	**69**	**875**	**69**	**932**	**74**

Combined Use of High Yielding Maize Varieties and Fertilizer

While HYVs contribute towards improved crop yields, their use must be supplemented by other productivity enhancing inputs, mainly fertilizer, to exploit their full productivity potential. Analysing patterns in simultaneous use of fertilizer and HYVs on maize can shed more light on the observed productivity trends and provide information that can be useful in proposing measures to improve agricultural productivity. Table 11 presents that analysis. There is a consistent general increase in the proportion of households combining fertilizer and HYVs for maize across the zones and the panel period, from 51% in 1997 to 61% in 2007 (Table 12).

Regionally, there are distinct variations in the rate of adoption of the combined fertilizer-improved seed package. An impressive increase in the proportion of households combining use of fertilizer and HYVs is observed over the panel period in Eastern lowlands (from 16% in 1997 to 31% in 2007), Western transitional (37% in 1997 to 74% in 2007), High potential maize zone (77% in 1997 to 88% in 2007) and Western highlands (70% in 1997 to 82% in 2007). Adoption of fertilizer and HYVs doubled in Western transitional, and this is reflecting on maize productivity in the region, which has consistently increased, and more than doubled over the panel period.

The Coastal and Western lowland regions have the lowest (less than 9%) adoption levels of combined fertilizer and HYVs on maize. With adoption levels of HYVs only ranging between 2% in 1997 and 8% in 2007 in Coastal lowlands and 1% in 1997 and 37% in 2007 in Western lowlands, it means that the majority of users of HYVs on maize in the two regions do not use the combination. These semi-arid regions are where rainfall is least reliable and where soil organic matter is commonly a problem, reinforcing low returns and high risks to fertilizer application. These areas are hence where maize productivity is lowest. Recent analysis by Marenya and Barrett (2008) also underscores the importance of soil organic matter in limiting fertilizer use in these areas. Their analysis concludes that "farmers cultivating more degraded soils may find it unprofitable to invest in soil nutrient inputs, not necessarily because the fertilizer/crop price ratio is too high or due to credit, information or risk constraints, nor because of supply-side impediments that limit fertilizer's physical availability, but because marginal yield response to nitrogen application is low on carbon-deficient soils" (p. 24).

The findings in also show a slight decline in the use of the combined fertilizer/HVY package in the Central highlands and Marginal rain shadow. This trend is mainly reflecting the decline in HYV use as shown in Table 11.

Table 12: Proportion (%) of households combining fertilizer and high yielding maize varieties (main season)

Zone	1997		2000		2004		2007	
	No. of hhs	%	No. of hhs	%	No. of hhs	%	No. of hhs	%
Coastal Lowlands	1	2	4	6	3	4	5	8
Eastern Lowlands	23	16	24	17	42	29	44	31
Western Lowlands	1	1	2	1	9	6	10	7
Western Transitional	55	37	86	58	94	64	109	74
High Potential Maize Zone	265	77	276	80	279	81	302	88
Western Highlands	89	70	98	76	98	76	105	82
Central Highlands	202	83	201	83	193	80	190	79
Marginal Rain Shadow	2	6	5	14	4	11	4	11
Overall Sample	**638**	**51**	**696**	**55**	**722**	**57**	**769**	**61**

Development and Adoption of New Maize Varieties

Enhanced availability of HYVs has been fuelled by the liberalization of the seed market. By 2004 there were 14 registered maize seed companies. Between 1994 and 2003 a total of 71 maize cultivars (11 from public sector and 60 from the private sector) were released into the market (MoA, 2004). The benefit of liberalisation of the seed market is traced in the panel analysis. The number of maize seed varieties planted by the households increased between 2004 and 2007 in all the agro-regional zones (Table 13).

Western highlands registered the highest number of maize seed varieties from 9 to 18 (100% increase). The Western lowlands and Western transitional zones also saw a significant increase in the number of seed varieties by 75% and 59%, respectively. There was also a significant increase in number of seed varieties in Central highlands (by 76%) and Marginal Rain Shadow (by 64%). The High potential maize zone, Eastern lowlands and Coastal lowlands had the lowest increase in the number of varieties of 39%, 36% and 33%, respectively. These trends are indications that maize growing households have many seed varietal alternatives from which to choose, and further explain the high adoption levels of HYVs.

Table 13: Number of maize seed varieties planted by households by region

Zone	2004	2007	% change
Coastal Lowlands	6	8	33
Eastern Lowlands	11	15	36
Western Lowlands	12	21	75
Western Transitional	17	27	59
High Potential Maize Zone	23	32	39
Western Highlands	9	18	100
Central Highlands	17	30	76
Marginal Rain Shadow	11	18	64

Fertilizer Use

Expanding fertilizer use is widely considered to be a pre-condition for broad-based farm productivity growth. Profitability of fertilizer use is, however, dependent on several factors, one being agro-ecological conditions (Marenya and Barrett, 2008). The differences in agro-ecological conditions facing Kenyan small-scale farmers have contributed to variations in fertilizer use among different regions. Table 14 shows trends in fertilizer adoption by households during the panel period. In general, the proportion of households using fertilizer has risen from 64% in 1997 to 76% in 2007, a 20% increase over this ten year period.

The largest growth in the proportion of households using fertilizer over the decade is observed in the semi-arid regions of Western Lowlands (400%), Coastal Lowlands (300%), Marginal Rain Shadow (440%) and Eastern Lowlands (63%). The High Potential Maize Zone and Western Highlands have the lowest growth in fertilizer adoption rate of 9% and 3% during the panel period, because most farmers in these zones were already using fertilizer in 1997. It is important to note that the Central Highlands region has not registered any growth in the proportion of households using fertilizer. Instead, it has recorded a decline in fertilizer adoption from 99% in 1997 and 2000 to 97% in 2004 and 2007.

The proportion of households using fertilizer in the semi-arid regions was comparatively lower (3% - 57%) compared to high potential agricultural regions (58% - 100%) during the panel period.

Regional analysis of fertilizer use patterns provides insight into how agro-ecological differences affect fertilizer use by influencing profitability of use. Disaggregating households' fertilizer use patterns by crop sheds more light on the crops that account for growth in fertilizer use, and gives an indication of which fertilizer distribution systems are responsible for the patterns, since in Kenya different crops are managed under specific input distribution systems.

Table 14: Proportion of households using fertilizer (main and short season)

Zone	**1997**		**2000**		**2004**		**2007**	
	No. of hhs	%	No. of hhs	%	No. of hhs	%	No. of hhs	%
Coastal Lowlands	2	2.7	5	6.8	6	8.0	9	12.3
Eastern Lowlands	51	35.2	70	48.3	82	56.6	82	56.6
Western Lowlands	9	5.9	18	11.8	23	15.0	46	30.5
Western Transitional	86	58.1	114	77.0	127	85.8	130	87.8
High Potential Maize Zone	298	86.1	313	90.5	313	90.5	323	93.6
Western Highlands	118	91.5	116	89.9	119	92.2	122	94.6
Central Highlands	240	99.2	241	99.6	235	97.1	237	97.9
Marginal Rain Shadow	10	27.0	13	35.1	12	32.4	20	54.1
Overall Sample	**814**	**63.9**	**890**	**69.9**	**917**	**71.9**	**969**	**76.3**

The number of households producing maize has remained high and about the same over the panel period, pointing to the importance attached to maize by the smallholder farmers. The proportion of these households using fertilizer on maize consistently increased during the panel period from 57% in 1997, 63% in 2000, 67% in 2004, to 71% in 2007 (Table 15). This represents a 24% increase in the proportion of households using fertilizer on maize over the 1997-2007 period.

Table 15: Proportion (%) of households using fertilizer on maize (main and short season)

Zone	**1997**		**2000**		**2004**		**2007**	
	No. of hhs	%	No. of hhs	%	No. of hhs	%	No. of hhs	%
Coastal Lowlands	2	3	4	6	5	7	8	12
Eastern Lowlands	41	28	49	34	71	49	81	56
Western Lowlands	3	2	8	5	11	7	18	12
Western Transitional	60	41	95	64	105	71	123	84
High Potential Maize Zone	289	84	307	89	305	89	316	92
Western Highlands	102	80	111	86	118	91	121	95
Central Highlands	224	93	223	92	223	93	219	91
Marginal Rain Shadow	3	8	5	14	4	11	6	16
Overall Sample	**724**	**57**	**802**	**63**	**842**	**67**	**892**	**71**

Intensity of fertilizer application on maize has, on the contrary, fluctuated between 55kg and 60kg per acre over the panel period (Table 16). The general increasing trend in maize productivity can, therefore, be attributed more to increased adoption of fertilizer than to intensity of use, by maize farmers.

Table 16: Fertilizer use rate (kg/acre) on maize (users only), main season

Zone	**1997**	**2000**	**2004**	**2007**
Coastal Lowlands	11	5	3	7
Eastern Lowlands	10	18	15	16
Western Lowlands	24	14	10	12
Western Transitional	54	48	62	71
High Potential Maize Zone	65	67	74	75
Western Highlands	31	36	46	47
Central Highlands	**68**	**64**	**64**	**58**
Marginal Rain Shadow	12	15	43	43
Overall Sample	**56**	**55**	**60**	**59**

A more detailed analysis of fertilizer use patterns on maize is presented on Table 17. The trends show an overall decline in the proportion of households using lower quantities of fertilizer (less than 25kg per acre) from 31% in 1997, 30% in 2000 and 2004, to 28% in 2007. This decreasing trend is more pronounced in the Western highlands. On the contrary, in the Coastal lowlands, all the households that use fertilizer have applied less than 25 kg/acre across the panel years. Compared to other regions, the intensity of use is lowest in the Coastal lowlands, Eastern lowlands, Western lowlands and the Marginal rain shadow.

A similar trend is observed in the category of farmers using fertilizer quantities that range from 25kg/acre to 50 kg/acre. The proportion of households in this category has declined from 35% in 1997, 33% in 2000 to 29% in 2004 and 2007. The proportion of households applying more than 50kg /acre has increased consistently from 34% in 1997, 37% in 2000, 41% in 2004 to 43% in 2007.

Nationally, quantity of chemical aggregated fertilizer in Kenya used rose by 65 % from 255,000 metric tonnes in 1996/97 to 411,000 metric tonnes in 2006/07 (Economic review of Agriculture, 2008, FAOSTAT) - Annex 2.

Table 17: Intensity of fertilizer application on maize (main season)

Zone	% of households											
	1997			2000			2004			2007		
	>0 and <=25kg	>25 and <=50 kg	>50kg	>0 and <=25kg	>25 and <=50 kg	>50kg	>0 and <=25kg	>25 and <=50 kg	>50kg	>0 and <=25kg	>25 and <=50 kg	>50kg
Coastal Lowlands	100			100			100			100		
Eastern Lowlands	90	10		80	10	10	86	10	4	83	12	5
Western Lowlands	67		33	88		13	100			94	6	
Western Transitional	25	37	38	35	33	33	27	28	46	26	20	54
High Potential Maize Zone	11	49	40	14	41	45	12	36	51	13	32	55
Western Highlands	57	29	14	47	33	20	38	29	33	25	39	36
Central Highlands	33	25	42	25	30	46	26	29	45	25	34	41
Marginal Rain Shadow	100			80	20		50		50	50	33	17
Overall Sample	**31**	**35**	**34**	**30**	**33**	**37**	**30**	**29**	**41**	**28**	**29**	**43**

Further analysis show that the use of organic fertilizer (farmyard and compost manure) is also rising in importance across the zones, and reflects farmers' attempts to raise soil fertility. The proportion of households using organic fertilizer increased from 44% in 2000 to 50% in 2007 (Table 18). The Central highlands region has the highest proportion of households using organic fertilizers. This could probably explain why maize productivity has increased in the region despite a decline in use rate of inorganic fertilizers on maize in that zone; from 68kg/acre in 1997 to 58kg/acre in 2007

Table 18: Proportion (%) households using organic fertilizer, 2000-2007

Zone	2000	2004	2007
Coastal Lowlands	29	34	32
Eastern Lowlands	75	80	83
Western Lowlands	19	25	36
Western Transitional	44	33	44
High Potential Maize Zone	22	22	24
Western Highlands	38	35	23
Central Highlands	73	92	95
Marginal Rain Shadow	76	68	68
Overall Sample	**44**	**47**	**50**

In spite of the impressive growth in the adoption of fertilizer, the study shows that 17% of the households in the sample did not use fertilizers in any of the panel years. Of these households, 80% are in the Coastal, Eastern and Western lowlands, areas where fertilizer application is often relatively risky and in places unprofitable due to erratic rainfall and poor soil fertility. Some of these semi-arid regions are only marginally suitable for crop production. In these relatively disadvantaged areas, 80% of the households in the full sample are also in the lowest income group.

Asked why they did not use fertilizer, 47% of the consistent non-users of fertilizer gave inability to afford fertilizer as the reason. About 20% of the non-users said they prefer to use organic fertilizer, while 8% said they lack technical advice on fertilizer usage.

Reduced Distances to Input Stockists

Distance to the market, both for inputs and output, has been found to be a key issue in productivity analysis. Omamo (1998) found that distance to the market and related transportation costs affect crop choice decisions. Distance to particularly inputs markets has a bearing on the inputs' use and, consequently productivity. Table 19 shows a general decline in the mean distance to nearest fertilizer stockist, from 8km in 1997 to 3km in 2007. This trend is mirrored across all the regional zones. Central highlands, Western highlands, High potential maize zone and Western transitional regions in that order have the shortest and declining distances to the nearest fertilizer stockist over the period. It is noteworthy that fertilizer adoption in these regions is higher compared to the Lowlands and the Marginal rain shadow. The Lowlands and the Marginal rain shadow have equally declining distances to the fertilizer stockist over the panel period, but the distances are longer than in the other regions for all the years except 2007. Coastal lowlands has the longest (though declining) mean distances of 31km in 1997, 24km in 2000, 18km in 2004 and 11km in 2007. It is in this region where fertilizer adoption level is lowest. The general decline in distance to fertilizer stockist is consistent with the International Fertilizer Development Centre (IFDC)'s (2001) finding that the number of fertilizer retailers in Kenya expanded tremendously after the fertilizer market was deregulated.

A similar trend is observed for distances to the nearest hybrid maize seed stockist, which generally declined from 6km in 2000 to 3km in 2007. The Highlands, Western Transitional and High potential maize zone regions have the shortest and generally declining distances. The Lowlands and Marginal rain shadow have the longest albeit declining distances. In all the regions, except Coastal lowlands, the distances to hybrid maize supplier reported were highest for 2004.

Table 19: Mean distance (km) to fertilizer and hybrid maize seed stockist

	Distance to fertilizer stockist				Distance to hybrid maize seed stockist		
Zone	**1997**	**2000**	**2004**	**2007**	**2000**	**2004**	**2007**
Coastal Lowlands	30.6	24.3	18.4	11.3	21.8	18.7	9.5
Eastern Lowlands	9.8	5.4	4.2	2.7	6.4	3.7	3.0
Western Lowlands	16.0	11.6	7.5	3.8	9.1	5.4	3.8
Western Transitional	6.3	4.6	2.8	3.6	4.2	2.7	3.7
High Potential Maize Zone	5.0	4.0	3.0	3.6	4.5	3.0	3.7
Western Highlands	3.3	2.2	1.4	2.4	2.6	1.6	2.4
Central Highlands	2.7	1.5	1.4	1.3	1.9	1.5	1.5
Marginal Rain Shadow	26.2	5.8	5.4	2.3	5.2	4.3	2.3
Overall Sample	**8.1**	**5.7**	**4.1**	**3.4**	**5.6**	**3.9**	**3.4**

To summarize, there has been a consistent increase in smallholder fertilizer use in Kenya over the past decade. This increase may be attributed to several factors: (a) increased accessibility of fertilizer by smallholder farmers due to availability of the input in small packs that more farmers can afford; (b) reduction in the distance from the household to the nearest fertilizer stockist, reflecting increased investment in private fertilizer retailing; (c) a reduction in real fertilizer prices in Kenya up to 2007, reflecting reduced marketing costs in fertilizer marketing costs (Ariga, Jayne and Nyoro, 2006) – this trend has been reversed since 2007 with the dramatic rise in world fertilizer prices; and (d) more farmers have been organized into groups, providing a variety of benefits such as group loans for input purchase, information to improve farmers' management practices such as soil testing services, increased awareness of fertilizers' role in increasing maize productivity, and information on how and when to apply fertilizer efficiently. This growth in smallholder fertilizer use in general, and on maize in particular, has occurred during a period when real maize prices, ironically, have declined significantly during the 1997-2007 period.

3.4.2 Tea Productivity

During the panel period, there was a marginal increase in the mean tea productivity of 15% from 3,931 kg/acre (1.12 kg/tea bush) in 1997 to 4,507 kg/acre (1.29 kg/tea bush) in 2007 of green leaf tea (Table 20). However, in 2000, productivity was lowered by drought. Tea productivity was driven by the Western regions; Kisii and Vihiga districts. In Kisii, tea productivity doubled from 0.61 kg/tea bush in 1997 to 1.22 kg/bush in 2007, while in Vihiga a similar trend was observed where productivity grew from 0.26 kg/bush in 1997 to 1.3 kg/bush in 2007. Tea productivity in parts of Central highlands such as Murang'a and Nyeri has remained fairly constant during the panel period. However, the Central highland has maintained highest level of productivity.

Table 20: Mean annual tea productivity

Zone	District	Year	Productivity (kg/acre)	Productivity (kg/tea bush)	Mean area under tea (acres/hh)
High Potential Maize Zone	Bomet	1997	4,017	1.15	1.40
		2000	3,765	1.08	1.52
		2004	3,878	1.11	1.77
		2007	3,704	1.06	1.88
Western Highlands	Kisii	1997	2,142	0.61	0.49
		2000	3,154	0.90	0.33
		2004	3,358	0.96	0.37
		2007	4,278	1.22	0.48
	Vihiga	1997	897	0.26	0.67
		2000	1,624	0.46	0.70
		2004	2,642	0.75	0.47
		2007	4,549	1.30	0.45
Central Highlands	Meru	1997	4,364	1.25	1.05
		2000	4,444	1.27	0.80
		2004	5,510	1.57	0.80
		2007	5,147	1.47	0.78
	Muranga	1997	4,722	1.35	0.47
		2000	4,461	1.27	0.45
		2004	4,215	1.20	0.44
		2007	4,674	1.34	0.43
	Nyeri	1997	4,653	1.33	1.41
		2000	4,295	1.23	1.50
		2004	4,514	1.29	1.42
		2007	4,706	1.34	1.43
Overall Sample		1997	3,931	1.12	1.08
		2000	3,869	1.11	1.04
		2004	4,206	1.20	1.01
		2007	4,507	1.29	1.05

Overall, the mean area under tea production per household has fairly remained constant at 1 acre. However, there is a slight but consistent decline in the area under tea production in Meru (1.08 acres in 1997 to 0.78 acres in 2007) and in Muranga (0.47 acres in 1997 to 0.43 acres in 2007). A similar trend is observed in Vihiga, where the mean area has declined from 0.67 acres in 1997 to 0.45 acres in 2007. This could be associated with increasing fragmentation of land as a result of population pressure.

The tea sector is currently facing many challenges such as global oversupply of tea, high cost of production, concentration on a few traditional markets, inefficiencies in the management of small holder tea sub-sector, among others. However, the major challenge is the weakening of the dollar, which has led to lower tea returns in the recent past. For example, the average price per kilogram of made tea declined from USD 2.11 in 2000 to USD 1.76 in 2007. Additionally, small land sizes under tea (over 50% of the households have less than 1 acre under tea) pose a big challenge to the tea sector.

3.4.2.1 Factors Driving Growth in Tea Productivity

Fertilizer adoption rate in tea consistently rose from 84% in 1997 to 98% in 2007, an average growth of 16% over the ten years (Table 21). Regionally, Western highland districts of Kisii and Vihiga recorded the highest growth in fertilizer adoption compared to other districts. The proportion of households applying fertilizer on tea increased in Kisii from 70% to 94% during the decade, while in Vihiga fertilizer adoption on tea by households rose from 64% in 1997 to 94% in 2007. In Nyeri, Muranga, Nyeri and Bomet districts, the proportion of households applying fertilizer on tea has generally remained above 90% over the decade.

Fertilizer application rate on tea has, however, declined by 4% over the period, from 385 kg/acre in 1997 to 373 kg/acre in 2007. Regional analysis, however, shows disparities in trends in the application rate. Kisii and Vihiga districts show increasing trends in fertilizer application rates on tea from a mean of 241 kg/acre in 1997 to 360 kg/acre in 2007 and 124 kg/acre in 1997 to 394 kg/acre in 2007, respectively. Increasing trends in fertilizer application rate is also observed in Meru (from 410 kg/acre to 419 kg/acre) and Muranga (from 287 kg/acre to 499 kg/acre) over the decade. Bomet and Nyeri districts, however, registered a decline in fertilizer application rate in tea from 298 kg/acre to 264 kg/acre and from 545 kg/acre to 382 kg/acre, respectively, between 1997 and 2007. It is worth noting that Western highland districts of Kisii and Vihiga where growth in fertilizer adoption and application rates were highest also registered the highest growth in tea productivity during the panel period. The fertilizer distribution system in the tea sector is the reason behind the impressive performance in fertilizer adoption on tea. Kenya Tea Development Agency (KTDA) supplies fertilizer on credit to smallholder tea farmers and then deducts the cost plus interest from their deliveries of tea, which is sold by KTDA on behalf of the farmers.

Table 21: Application rates of and proportion (%) of households applying fertilizer on tea

District	No. of hhs producing tea	% of hhs using fertilizer	Fertlizer application rate (kg/acre) -users only	
			Mean	Median
Bomet				
1997	32	94	298	310
2000	33	97	283	243
2004	34	94	322	267
2007	34	100	264	256
Kisii				
1997	30	70	241	200
2000	32	83	458	333
2004	39	84	348	300
2007	35	94	360	278
Vihiga				
1997	11	64	124	100
2000	13	69	250	333
2004	19	83	339	333
2007	21	95	394	270
Meru				
1997	32	84	410	300
2000	32	91	403	364
2004	35	97	520	345
2007	34	97	419	400
Muranga				
1997	10	100	287	283
2000	11	100	399	350
2004	13	92	511	387
2007	13	100	499	250
Nyeri				
1997	55	85	545	450
2000	56	100	396	378
2004	58	97	350	350
2007	57	100	382	357
Overall Sample				
1997	170	84	385	300
2000	177	93	377	333
2004	198	93	388	333
2007	194	98	373	333

3.4.3 Coffee Productivity

Coffee productivity rose from a mean of 1,459 kg/acre in 1997, before declining consistently to 1,826 kg/acre in 2000, 1,577 kg/acre in 2004 and 1,285 kg/acre (Table 22). This trend is observed across the agro-regional zones, although, in some cases there is no clear trend observed.

Table 22: Mean productivity of coffee cherries

Zone	Year	Productivity kg /acre	Mean area under coffee (acres/hh)
Eastern Lowlands	1997	790	0.93
	2000	326	0.67
	2004	134	0.70
	2007	432	0.77
Western Lowlands	1997	279	0.71
	2000	429	0.17
	2004	569	0.69
	2007	321	0.07
Western Transitional	1997	800	0.25
	2000	262	0.15
	2004	176	0.16
	2007	41	0.26
High Potential Maize Zone	1997	551	0.68
	2000	539	0.45
	2004	352	0.53
	2007	357	0.46
Western Highlands	1997	986	0.44
	2000	1,285	0.62
	2004	1,849	0.35
	2007	993	0.37
Central Highlands	1997	1,933	0.55
	2000	2,616	0.52
	2004	1,810	0.54
	2007	1,639	0.53
Overall Sample	1997	1,459	0.56
	2000	1,826	0.55
	2004	1,577	0.49
	2007	1,285	0.48

3.4.3.1 Factors Contributing To Decline in Coffee Productivity

The gloomy picture of the once vibrant coffee sector is a result of international market forces such as declining prices of world coffee in the early 1990's, mismanagement of coffee co-operatives and high cost of production. The farm level production costs have escalated in the recent past. The high costs of production of coffee have exposed producers further to the world coffee price risks and fluctuation. Coffee production, particularly by the small-scale producers, is likely to remain low unless there are improvements in farm productivity and coffee prices, as well as a reduction of transaction costs. Making new hybrids that are resistant to diseases available for adoption by farmers could reduce production costs. Availability of these varieties has, however, been constrained in the past by restricted multiplication of the seeds and seedlings by the Coffee Research Foundation (Nyoro et al., 2001).

The proportion of households using fertilizer on coffee rose from 44% in 1997 to 51% in 2000, and then took a downward turn to 45% in 2004 (Table 23). In 2007, only 37% of households producing coffee used fertilizers. The decline in proportion of households using fertilizer on coffee averaged 16% over the panel period. Fertilizer application rate on coffee indicates an average of 20% decline over the panel period. A closer look reveals that the application rate consistently declined from 364 kg/acre in 2000, to 256 kg/acre in 2004, to 147 kg/acre in 2007, an average decline of 148% in a span of seven years. The gloomy picture in fertilizer use patterns on coffee is as a result of two main factors: alleged mismanagement of coffee cooperatives, which are the main channels through which members receive their fertilizer; and poor international coffee prices. Mismanagement in the cooperatives has made some farmers abandon coffee production while other farmers have opted to directly access fertilizers from private traders. This has made them disadvantaged in that they no longer access input credit facilities offered by the cooperatives as was the custom during the days when the cooperative movements were active and efficiently run.

Table 23: Mean application rates of and proportion (%) of households applying fertilizer on coffee

	1997	**2000**	**2004**	**2007**
kgs/acre cultivated (users only)	183	364	256	147
% of households using fertilizer	**44**	**51**	**45**	**37**
No. of households producing coffee	257	308	283	250

3.4.4 Sugar Cane Productivity

The overall sugar cane productivity per acre increased from 22 tonnes in 1997 to 27 tonnes in 2004, but declined to 24 tonnes in 2007 (Table 24). The largest decline in sugar cane productivity was in Bungoma, where the productivity fell from 37 tonnes/acre in 1997 to 27 tonnes/acre in 2007. An increase in productivity was registered in Kisumu (from 18 tonnes/acre to 21 tonnes/acre) and Kakamega (from 20 tonnes/acre to 23 tonnes/acre) between 1997 and 2007. The mean area under production per household has remained at 2 acres; however, there was a slight increase in acreage from 2 acres to 2.5 acres in 2007.

Table 24: Mean productivity of sugar cane

Zone	District	Year	Productivity (tonnes/acre)	Mean area under production (acres/hh)
Western Lowlands	Kisumu	1997	18.1	1.93
		2000	15.9	2.10
		2004	15.7	2.51
		2007	21.4	1.70
Western Transitional	Bungoma	1997	37.4	2.49
		2000	31.6	2.45
		2004	34.8	2.10
		2007	27.4	3.48
	Kakamega	1997	20.2	2.25
		2000	26.8	2.10
		2004	26.2	1.85
		2007	23.4	2.33
Overall Sample		1997	22.5	2.18
		2000	26.1	2.18
		2004	27.1	2.03
		2007	24.0	2.50

3.4.4.1 Factors Contributing To Stagnating Productivity of Sugarcane

Fertilizer adoption on sugarcane over the ten-year period showed an impressive average growth of 138%, the highest of all the four crops (Table 25). The proportion of households using fertilizer on sugarcane grew from a low of 29% in 1997 to stand at 69% in 2007. Regional analysis show that fertilizer use on sugar cane expanded in all the sample districts growing sugar cane. The proportion of households applying fertilizer on sugar cane rose from 8% to 37% in

Kisumu, 40% to 95% in Bungoma, and 31% to 68% in Kakamega, between 1997 and 2007. The trends reveal that Western lowlands lags behind Western Transitional in fertilizer use on sugarcane in the Western sugar belt.

Fertilizer application rate on sugarcane declined from 118 kg/acre in 1997 to 110 kg/acre in 2007. Kisumu and Bungoma districts, however, recorded an increase in fertilizer application rate on sugar cane from 67 kg/acre to 119 kg/acre and 85 kg/acre and 108 kg/acre, respectively, between 1997 and 2008. In Kakamega, fertilizer application rate fell from 140 kg/acre in 1997 to 111 kg/acre in 2007.

Increased fertilizer adoption in smallholder sugarcane farming can be attributed to provision on credit of fertilizer and other inputs to smallholder cane farmers by the cooperatives to which the farmers belong. The dwindling fertilizer application rate, however, is a cause to worry about, since it may smother the expected gains from increasing rate of adoption. Declining application rate may be as a result of inadequate supply of fertilizer by the cooperatives relative to farmers' demand, or it may be as a result of farmers' diversion of fertilizer acquired from the cooperatives from use on sugarcane to use on other crops. The latter has been alleged by Ariga, *et al* (2006), who posited that some of the fertilizer acquired for intended use on the cash crops such as coffee and sugarcane under cooperative schemes is appropriate for use on maize and most horticultural crops as well, and there is likely to be some diversion of fertilizer targeted for use on sugarcane and coffee to food crops.

Table 25: Mean application rates of and proportion (%) of households applying fertilizer on sugar cane

District	No. of hhs producing sugar cane	% of hhs using fertilizer	Mean fertilizer application rate (kg/acre) -users only
Kisumu			
1997	30	8	67
2000	29	7	54
2004	31	7	85
2007	27	37	119
Bungoma			
1997	40	40	85
2000	34	79	113
2004	38	53	107
2007	37	95	108
Kakamega			
1997	91	31	140
2000	91	53	251
2004	89	60	156
2007	81	68	111
Overall Sample			
1997	161	29	118
2000	154	51	197
2004	158	49	141
2007	145	69	110

That the Kenyan sugar sub-sector is experiencing difficulties in sugar production is demonstrated by its appeal for an extension of the COMESA Safeguard for a further 4 years after it expired in February, 2008. This was despite the fact that this protocol was first negotiated in 2000 with the understanding that Kenya was to bring down its production costs to a world competitive level.

The COMESA safeguard clause demands of Kenya to allow a maximum of 200,000 tonnes of duty free to meet the domestic shortfall. The rest of the imports attract 100% duty or USD $ 200 per tonne. Once the Safeguard is removed, there will be no duty levied on imports from COMESA.

In an assessment in the *National Adoption Strategy for the Sugar Industry of Kenya, 2007,* the industry regulatory body, Kenya Sugar Board (KSB), identifies the following, among others, as the industry's major challenges*:*

- Old factories whose equipments are obsolete rendering these factories inefficient and thus high cost centers. The average ex-factory sugar price in Kenya in 2005 was 534.6 Euros per tonne which was 3 times the world market price of Euros 174 per tonne, and about 60% higher than the new EU Sugar Protocol for 2009/10.
- Heavy debt burdens facing all factories, with a cumulative debt of Ksh 58 billion
- Poor cane varieties whose sucrose levels are low, but high in fibre and take long to mature. Among the world Sugar producing countries, it is only in Kenya where cane is produced as a perennial crop. In other countries sugar cane takes 12 months to mature, but in Kenya cane can last in excess of 48 months.
- Long distances covered on bad roads to collect cane from fragmented farms that increase cost of operation.

3.4.5 Cabbage Productivity

Cabbages are produced in all the agro-regional zones but by a few households per zone. In order to improve the precision of the information on cabbages, we analyze trends for producers in the High potential maize zones and the Central highlands, where the number of households producing cabbages is above than 30. The overall mean cabbage productivity measured in kilograms produced per acre has fluctuated across the panel period from 7,464 in 1997; 9,269 in 2000; 8,184 in 2004; to 9,222 in 2007 (Table 26). However, the area allocated to cabbage production for the two agro regional zones declined from 0.37 acre in 1997 to 0.17 acre in 2007. An important observation is that the number of farmers producing cabbages in Central highlands increased by 50% from 61 farmers to 92 farmers between 1997 and 2007.

Table 26: Cabbage productivity, area and fertilizer use

Zone	Year	No. of hhs producing cabbages	Area under production (acres/hh)	Mean productivity (kg/acre)	% of hhs using fertilizer
High Potential Maize Zone	1997	31	0.34	8,948	64
	2000	112	0.20	7,188	51
	2004	81	0.18	3,304	50
	2007	45	0.17	5,338	47
Central Highlands	1997	65	0.38	6,783	68
	2000	91	0.29	11,829	83
	2004	79	0.18	13,187	78
	2007	93	0.17	11,101	80
Overall Sample	1997	96	0.37	7,464	66
	2000	203	0.24	9,269	67
	2004	160	0.18	8,184	64
	2007	138	0.17	9,222	63

3.4.6 Irish Potato Productivity

Potatoes are produced in most agro-regional zones, but mainly in the High potential maize zone and the Central highlands. In order to improve precision of the information on potatoes, we analyze trends for producers in the two zones, where the number of households producing potatoes was more than thirty.

The overall mean potato productivity does not show a particular trend (Table 27). The mean acreage allocated to potatoes has stagnated at 0.25 acre per household. However the number of households producing potatoes has increased by 64% in the high potential maize zone and 22% in the central highlands during the panel period. Irish potato faces challenges of proliferation of soil borne diseases and unavailability of clean planting materials (Economic Review of Agriculture, 2008).

Table 27: Potato productivity, area and fertilizer use

Zone	Year	No. of hhs producing potatoes	Area under production (acres/hh)	Mean productivity (kg/acre)	% of hhs using fertilizer
High Potential Maize Zone	1997	85	0.58	2,526	45
	2000	190	0.68	4,291	49
	2004	182	0.48	2,651	48
	2007	140	0.54	3,013	42
Central Highlands	1997	179	0.49	2,398	79
	2000	212	0.51	5,169	87
	2004	219	0.43	2,860	83
	2007	219	0.34	2,810	85
Overall Sample	1997	264	0.52	2,440	62
	2000	402	0.59	4,752	68
	2004	401	0.45	2,765	66
	2007	359	0.42	2,889	63

3.4.7 Dairy Productivity

The dairy sub –sector has also experienced a significant growth in milk productivity per cow. Generally, the mean annual milk productivity declined from 1164 liters/cow in 1997 to 1079 liters/cow in 2000 (Table 28). This decline could be associated with the drought in 1999/2000 cropping year. But since then, milk productivity grew steadily to 1298 liters/cow in 2004 to 1371 liters/cow in 2007. This trend is observed in all the agro-regional zones.

The Central highlands zone has the highest level of milk productivity and has grown steadily from 1856 liters/cow in 1997 to 1991 liters/cow in 2007. The High potential maize zone is the second milk producing region, but with lower level of productivity rising from 1,269 liters/cow in 1997 to 1,692 liters/cow in 2007. The Western transition, Western highlands and the Marginal rain shadow form the medium productivity regions, while the Coastal and Western lowlands recorded the lowest level of milk productivity.

Table 28: Mean productivity (liters/cow) per year of cow milk by zone

Zone	1997	2000	2004	2007
Coastal Lowlands	139	418	207	701
Eastern Lowlands	688	856	785	890
Western Lowlands	327	360	367	367
Western Transitional	677	662	812	1,022
High Potential Maize Zone	1,269	973	1,313	1,692
Western Highlands	902	1,005	1,071	836
Central Highlands	1,856	1,969	2,243	1,991
Marginal Rain Shadow	1,015	632	1,488	1,434
Overall Sample	**1,164**	**1,079**	**1,298**	**1,371**

Further analysis of milk productivity by wealth quintiles shows that the level of productivity is lowest for the least wealthy households, while that of the wealthiest households more than doubles productivity for the least wealthy households (Table 29).

Table 29: Mean productivity (liters/cow) per year of cow milk by wealth quintile

Wealth quintile	1997	2000	2004	2007
Lowest	838	711	834	765
2	919	895	831	1,060
3	1,094	898	1,231	1,220
4	1,203	1,078	1,509	1,530
Highest	1,451	1,535	1,646	1,878
Overall Sample	**1,164**	**1,079**	**1,298**	**1,371**

3.4.7.1 Factors Driving Productivity Growth in Dairy

Households' increased investment in the dairy enterprise is the major reason for increased milk productivity. Table 30 shows that the proportion of households growing fodder increased from 16% in 1997 to 53% in 2007. The Central and Western highlands regions have the largest proportions of households growing fodder; from 40% in 1997 to 94% in 2007 and from 19% in 1997 to 92% in 2007, respectively. Fodder growers also increased substantially in Marginal rain shadow (3% in 1997 to 65% in 2007) and Eastern lowlands (5% in 1997 to 54% in 2007). The proportion of fodder growers did not rise as much in High potential maize zone (16% in 1997 to

44% in 2007) and Western transitional (10% in 1997 to 43% in 2007). Fodder growing is least popular in the Coastal and Western lowlands.

The likely reason for more popularity of fodder growing in Central and Western highlands than in the High potential maize zone, even though dairy is an equally important enterprise in the High potential maize zone, is that household land holdings are smaller in the Central and Western highland zones, limiting open pasture grazing. We, therefore, see by these trends a tendency towards more intensive dairy production. But how much land do the households allocate to fodder?

Table 30: Proportion (%) of households growing fodder[4]

Zone	1997	2000	2004	2007
Coastal Lowlands	-	-	1	-
Eastern Lowlands	5	48	54	54
Western Lowlands	-	3	6	5
Western Transitional	10	18	26	43
High Potential Maize Zone	16	16	33	44
Western Highlands	19	74	81	92
Central Highlands	40	88	94	94
Marginal Rain Shadow	3	19	35	65
Overall Sample	**16**	**37**	**46**	**53**

Table 31 shows the proportion of cultivated land allocated to fodder production by households. The proportion of cultivated land under fodder generally tripled from 3% in 1997 to 12% in 2007. Regionally, the Marginal rain shadow and Eastern lowlands registered the largest increase in the proportion of cultivated land under fodder from 1% to 34% and 2% to 23%, respectively, between 1997 and 2007. Land allocation to fodder in Central highlands substantially increased from 9% in 1997 to 22% in 2007, while in the High potential maize zone the proportion rose from 2% to 9% during the period. Fodder production, on the other hand, is very minimal in Western lowlands and Western transitional zones, and virtually absent in the Coastal lowlands.

[4]Fodder includes nappier/elephant grass, oats, lucerne, maize meant for fodder

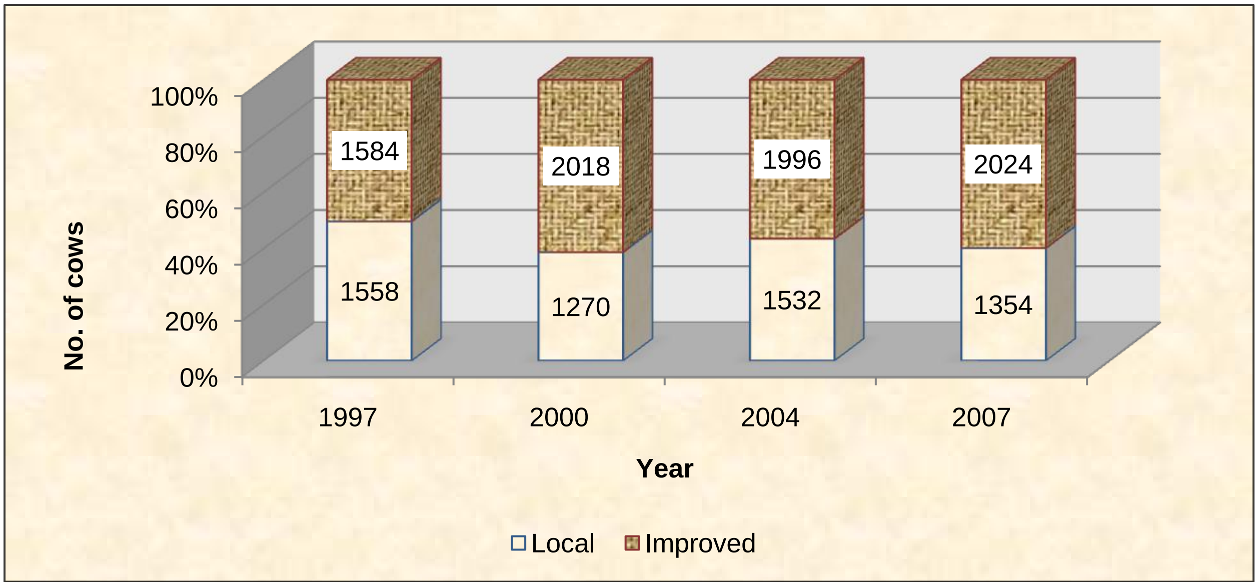
While the increase in the proportion of cultivated land under fodder in Central highlands and the Marginal rain shadow can be reflected in increase in milk productivity in the regions, the same cannot be said of Eastern lowlands, where milk productivity has remained about the same over the panel period.

Table 31: Proportion (%) of cultivated land allocated to fodder

Zone	**1997**	**2000**	**2004**	**2007**
Coastal Lowlands	0	0	0	0
Eastern Lowlands	2	6	9	23
Western Lowlands	0	0	0	1
Western Transitional	1	2	1	5
High Potential Maize Zone	2	3	5	9
Western Highlands	4	12	12	11
Central Highlands	9	17	15	22
Marginal Rain Shadow	1	11	10	34
Overall Sample	3	6	7	12

A part from feed and animal husbandry, on-farm milk productivity is also a function of genetic make-up of an animal. Figure 1 presents a chart showing the total number of cows by type reported owned in the overall sample. We see an increase in the number of improved cows from 1,584 in 1997 to 2,024 in 2007. At the same time, the number of indigenous (local) cows declined from 1,558 in 1997 to 1,354 in 2007. The trends show that households are generally moving away from keeping local cows to keeping improved cows. This again reflects on the general increase milk productivity.

Figure 1: Number of cows owned in the sample by type



To give a clearer picture of the regional patterns in cow types kept, we present in Table 32 the proportion of cow-owning households keeping improved cows. This proportion generally consistently increases from 62% in 1997, 65% in 2000 to 70% in 2004, but declines slightly to 66% in 2007. The proportion remains high in the Central highlands (between 98% and 100%) and High potential maize zone (between 83% and 88%) over the decade. Western highlands and Marginal rain shadow register impressive increases in the proportion of households keeping improved cows; from 39% in 1997 to 75% in 2007 and from 67% in 1997 to 81% in 2007, respectively. There is also an impressive increase in this proportion in the Coastal lowlands from 0% in 1997 to 25%. Keeping improved cows, on the other hand, seems to be a rarity in the Western lowlands, with the proportion of households rising from 3% in 1997 to 5% in 2004, and then drastically declines to only 1% in 2007. It is in this region where milk productivity is lowest.

Table 32: Proportion (%) of cow-owning households keeping improved cows[5]

Zone	1997	2000	2004	2007
Coastal Lowlands	0	0	26	25
Eastern Lowlands	34	32	54	42
Western Lowlands	3	4	5	1
Western Transitional	32	35	37	34
High Potential Maize Zone	84	83	88	85
Western Highlands	39	71	72	75
Central Highlands	98	98	100	99
Marginal Rain Shadow	67	77	83	81
Overall Sample	**62**	**65**	**70**	**66**

Farmers can only invest their time and money in dairy production if they are assured of making profits thereof. Price levels are an incentive to farmers to invest in an enterprise. Trends in the dairy productivity and investment in productivity enhancing inputs can be explained by trends in producer milk prices. Table 33 shows that nominal producer price per litre of milk generally rose from Ksh 14 in 1997 to Ksh 19 in 2007. In the highest milk producing regions of Central highlands and High potential maize zones, the price per litre of milk rose from Ksh 11 and Ksh 12 respectively in 1997 to Ksh 16 in 2007. Milk price equally increased from Ksh 18/litre to Ksh 23/litre between 1997 and 2007 in the Western highlands, and from Ksh 14 to Ksh 21 between the same period in the Western transitional zone. It is worth noting that milk prices remained high in the lowlands (between Ksh 21/litre and Ksh 34/litre) between 2000 and 2007. The lowest milk prices were recorded in the Marginal rain shadow, rising from Ksh 12/litre in 1997 to Ksh 14/litre in 2000 and then drops back to Ksh 12/litre in 2004 to settle at Ksh 13/litre in 2007. These trends, showing marginal milk price increases could have acted as incentives for farmers to invest in dairy production. However, the real prices calculated using Gross Domestic Product (GDP) deflator[6] shows that the real producer prices have declined over the decade from Ksh. 25 per litre to Ksh. 19 per litre.

[5] Improved cow refers to pure grade cow or a cow cross-bred between pure grade and indigenous type
[6] Base year = 2007

Table 33: Producers' milk prices (Ksh. /litre)

Zone	Nominal price (Ksh/litre)				Real price (Ksh/litre) (Using GDP deflator)			
	1997	**2000**	**2004**	**2007**	**1997**	**2000**	**2004**	**2007**
Coastal Lowlands	9	34	21	23	16	50	26	23
Eastern Lowlands	15	24	25	30	26	35	31	30
Western Lowlands	20	21	25	24	35	31	31	24
Western Transitional	14	21	21	21	25	31	26	21
High Potential Maize Zone	12	16	15	16	21	23	19	16
Western Highlands	18	21	22	23	32	31	27	23
Central Highlands	11	15	15	16	19	22	19	16
Marginal Rain Shadow	12	14	12	13	21	20	15	13
Overall Sample	**14**	**18**	**18**	**19**	**25**	**26**	**22**	**19**

3.5 Cross-Cutting Factors Driving Productivity Growth

3.5.1 Improved Access to Markets

Reduced Distances to Motorable Roads

Although distance to the market is a key issue in productivity, quality of roads is a critical factor in determining access to markets, both for inputs and outputs, and merits consideration in agricultural productivity debate. Distances to motorable and tarmac roads are presented in Table 34. There is a significant decline in distances to a motorable road from an average of 1 km in 1997 to 2004 to 0.5 km in 2007. The reduction in distances to motorable road could be associated with investments in maintenance of feeder roads (graders, bridges, culvert, murram) in the rural areas following the introduction of the Constituency Development Fund (CDF). This is a decentralised fund introduced in 2003 where all the 210 constituencies are allocated 2.5% of the total government revenue. Analysis show that in 2005, road related projects at the constituency level accounted for 11% of the total constituency budget (authors' calculation from www.cdf.go.ke).

Distances to tarmac roads, however, did not change during the panel period. Households have to cover longer distances to reach tarmac roads. Households in Central highlands and Western lowlands have the shortest distances, between 5km and 6km, away from tarmac roads. Households in the Western highlands, Western transitional and High potential maize zone regions have distances to tarmac roads ranging between 7km and 8km. The most disadvantaged regions in terms of distance to the tarmac road are Marginal rain shadow and Eastern Lowlands, where households cover between 11km and 16km to reach tarmac roads.

Table 34: Distance (km) to motorable and tarmac roads

	Distance to motorable road				Distance to tarmac road			
Zone	**1997**	**2000**	**2004**	**2007**	**1997**	**2000**	**2004**	**2007**
Coastal Lowlands	1.5	1.6	1.6	1.0	8.9	10.2	9.8	9.2
Eastern Lowlands	1.5	1.1	2.3	0.5	14.9	11.9	11.9	12.4
Western Lowlands	2.1	1.1	1.1	0.6	5.9	6.0	6.4	6.5
Western Transitional	0.5	0.7	0.8	0.4	7.2	8.7	8.0	8.4
High Potential Maize Zone	0.8	1.8	0.6	0.6	8.2	6.8	6.5	6.6
Western Highlands	1.5	1.2	1.2	0.5	8.2	7.3	7.9	7.4
Central Highlands	0.5	0.7	0.7	0.2	5.6	5.2	5.5	5.4
Marginal Rain Shadow	2.2	3.2	2.0	1.0	11.4	15.7	13.5	12.4
Overall sample	**1.1**	**1.3**	**1.1**	**0.5**	**8.2**	**7.7**	**7.6**	**7.6**

3.5.2 Improved Access to Extension and Financial Services

Extension and financial services are among some of the important factors determining agricultural productivity performance. Sustained access to these services by farmers is critical in ensuring improved agricultural productivity. Over the panel period, information on households' proximity to sources of extension and veterinary services were gathered. Households' access to credit (agricultural and non-agricultural) was also explored. Summary of the results are presented in the following sub-sections.

Reduced Distances to Extension Services

There exists a general consensus that if properly designed and implemented, extension services improve agricultural productivity (Romani, 2003; Evenson and Mwabu, 1998). Agricultural extension services provide farmers with important information, such as patterns in crop and livestock prices, new and existing technologies, crop and livestock management, and marketing. Exposure to such information enhances farmers' ability to optimize use of the scarce resources at their disposal. Awareness of existing technologies generates effective demand by providing a critical signal to input distribution systems (Davidson *et al*, 2001). Extension systems and input distribution systems are, therefore, mutually reinforcing in their contribution to agricultural productivity (Muyanga et al., 2006).

Proximity to extension service providers is critical in access to extension services. Table 35 presents mean distances between farmers' homesteads to where they can access both crops and livestock advisory services, either private or public, over the panel period.

Table 35: Distance (km) to crop and veterinary extension service provider

	Distance to source of crops extension service				Distance to source of veterinary service			
Zone	**1997**	**2000**	**2004**	**2007**	**1997**	**2000**	**2004**	**2007**
Coastal Lowlands	9.8	12.4	12.3	5.8	9.0	12.2	10.9	4.7
Eastern Lowlands	5.5	4.6	6.0	5.5	5.2	3.9	4.8	3.7
Western Lowlands	6.7	7.7	6.6	5.9	6.3	2.5	5.6	5.3
Western Transitional	5.4	4.6	4.5	4.3	4.6	4.3	3.7	3.8
High Potential Maize Zone	5.4	5.9	5.6	5.6	5.1	4.5	4.6	5.3
Western Highlands	5.3	5.2	4.8	3.8	3.5	3.0	3.4	2.8
Central Highlands	3.6	3.0	2.2	2.3	2.9	2.4	1.7	2.0
Marginal Rain Shadow	2.8	2.0	3.0	2.3	4.2	2.8	3.0	4.5
Overall Sample	**5.4**	**5.5**	**5.2**	**4.6**	**4.8**	**4.0**	**4.3**	**4.0**

Households' proximity to crop extension service providers improved from a distance of 5.4 km in 1997 to 4.8km in 2007, while that to veterinary extension service providers improved from 4.8km in 1997 to 4km in 2007. The reduction in distances to extension service providers is seen in all the regions. Households closer to extension service providers used high yielding technologies and realized higher yields than households far away from such providers. While other factors most likely contribute to these relationships, the proximity to extension services does appear to be correlated with small farmers' uptake of productivity enhancing technologies (Muyanga et al., 2006).

However, the distances vary in length across the regions. Households in Central highlands and Marginal rain shadow have the shortest distances to both crop and veterinary extension services. Households in the Lowlands, on the other hand, are the farthest from extension services, with Coastal lowlands' households as far as 5.8km and 4.7km from crops and veterinary extension services respectively in 2007. It is noteworthy that the Lowlands, where distances to extension services are longest, are associated with lower maize productivity. Muyanga *et al* (2006) argue that this can be interpreted to mean that either absence of extension services at close proximity to households causes low agricultural productivity or that agricultural extension agents are not keen to serve regions with low agricultural productivity. The former argument seems plausible since it is the Lowlands which are associated with lower adoption levels of fertilizer and high yielding maize seed varieties compared to other regions (except Marginal rain shadow).

Improvement in distances to extension services could be attributed to conglomeration of interventions by many stakeholders such as the Government through the National Agricultural Livestock Extension Program (NALEP), Private commercial companies (promotion, advertisement, field trials, and business fairs), Non-governmental Organisations (NGOs) among other players.

Access to Financial Services

Although agricultural extension service is necessary to raise the awareness of farmers of existing and new technologies, it is not sufficient in itself to raise agricultural productivity due to many factors that influence productivity. The panel data reveals a considerable widespread and increasing adoption of fertilizers and high yielding maize varieties. Nevertheless, it is probably the quantities and types of fertilizer and quality of seeds available to the farmers, rather than just awareness by the farmers of their existence, that have the biggest impact on productivity. Consequently, availability of working capital to the farmers to acquire adequate productivity enhancing inputs is of critical importance in strategies aimed at improving agricultural productivity. Rural financial services, therefore, are an important component in the set of services necessary for agricultural productivity growth. Using a Levene test of variance, Kibaara, (2006) demonstrated that farmers who accessed agricultural credit recorded higher level of maize productivity than those that did not.

The proportion of households that sought general credit increased from 46% in 1997 to 53% in 2007. Similarly, the proportion of households seeking agricultural credit rose from 29% in 1997 to 37% in 2007. Table 36 shows that the proportion of households receiving agricultural credit increased from 26% in 1997 to 30% in 2000. This proportion declined to 26% in 2004, but rose again to 33% in 2007. The trend reveals an increasing, albeit slowly, access to agricultural credit among rural households in Kenya.

Table 36: Proportion (%) of households that received agricultural credit

Zone	1997	2000	2004	2007
Coastal Lowlands	5.3	1.3	1.3	9.3
Eastern Lowlands	17.2	8.3	1.4	17.2
Western Lowlands	5.2	12.4	7.8	19.6
Western Transitional	28.4	46.6	39.9	47.3
High Potential Maize Zone	15.6	15.9	13.3	19.1
Western Highlands	34.9	41.9	36.4	42.6
Central Highlands	60.7	65.3	64.0	65.3
Marginal Rain Shadow	8.1	24.3	8.1	18.9
Overall Sample	**25.7**	**29.6**	**25.5**	**32.8**

Agricultural credit appears to be more accessible in the more agriculturally productive regions of Central and Western highlands, Western transitional and High potential maize zone, than in less agriculturally productive regions; the Lowlands and Marginal rain shadow. In the Central Highlands, the proportion of households that received agricultural credit over the decade remained in the range of 61%-65%, while in the Western highlands this proportion ranged from 35% to 43%. In the Western transitional zone, the proportion of households receiving agricultural credit rose form 28% in 1997 to 47% in 2007, while in the High potential maize zone agricultural credit recipients rose form 13% to 19% between 1997 and 2007. In the Coastal lowlands, the proportion of households receiving agricultural credit declined from 5% in 1997 to 1% in 2004, but rose to 9% in 2007. It is in this zone where agricultural credit is least accessible. It is observed that the regions with higher access to agricultural credit are those in which industrial crops such as tea, coffee, and sugar cane are produced. Some of these crops have organised inputs credit schemes.

Close to 50% of the households received agricultural credit from the commodity based credit providers such as KTDA and sugar companies (Table 37). The informal money lenders (self help groups, shylocks, community associations, merry go round, village ‘banks’) surpasses the cooperatives and the banks in provision of informal agricultural related credit.

Table 37: Percentage shares of sources of agricultural credit

Sources of agricultural credit	1997	2000	2004	2007
Commodity based credit providers (KTDA, sugar companies, NIB)	13.5	55.8	62.2	48.7
Informal money lenders	16.5	10.6	8.6	19.8
Traders/Input stockists	10.4	6.2	3.7	10.5
Cooperatives/SACCOs	55.8	25.9	21.9	10.3
Agricultural Finance Corporation	3.0	0.5	1.7	5.2
MFI/NGO	-	0.5	0.6	3.1
Commercial banks	0.8	0.5	1.2	2.5

The traders or input stockists have continued to provide credit to farmers. Results reveal a gloomy trend in provision of credit by cooperatives, such as coffee cooperatives, where the credit market share has declined from 55% in 1997 to only 10% in 2007. This is one of the contributing factors to the poor performance of the coffee sub sector.

Provision of Agricultural credit by AFC to the farmers in this sample has slightly increased from 0.5% in 2000 to 5.5%. This is associated with the revival of AFC following revamp of Ksh. 1.3 billion for the period 2003-2007. This enabled AFC to resume the seasonal crop credit and development loans. In addition, AFC is implementing the wholesale lending approach. However, AFC's contribution to smallholder farmers is still very insignificant. Trends also show more financial stakeholders increasing their participation in the credit landscape. In 1997, there was no MFI/NGO that gave credit to farmers in this sample, however by 2007; the MFIs accessed credit to 3.1% sampled households. In 1997, the banks provided agricultural credit to less than 1% of the sampled households before increasing to 2.5% in 2007.

3.6 How Does Kenya's Agricultural Productivity Compare with Other Countries?

As alluded to earlier, agricultural productivity levels in Sub-Sahara Africa are still far below that of other regions in the world, and are well below that required to attain food security and poverty reduction goals. Even though Kenya's agricultural productivity has improved in the last decade, it is important to understand where it stands relative to other parts of the world. This will provide an indication on the potential the country has in further improving its agricultural productivity. Table 38 provides that comparison. Kenya's maize productivity (9 bags/acre) is ahead that of Tanzania (4 bags/acre), Uganda (7 bags/acre) and Malawi (7 bags/acre). However, maize productivity is higher in Argentina (31 bags/acre) and South Africa (13 bags/acre).

Coffee yield in Kenya (214kg/acre) is lower than in Columbia (436 kg/acre) and Brazil (345 kg/acre), but higher than in Uganda (213 kg/acre). Sugar cane productivity in Kenya (25 tonnes/acre), on the other hand, lags behind that in Malawi (43 tonnes/acre), Sudan (42 tonnes/acre) and Egypt (40 tonnes/acre)

Kenya seems to have the highest productivity on tea (4,507 kg/acre) of the five countries: Malawi (3,523 kg/acre); India (2,774 kg/acre); Uganda (2,601 kg/acre); Tanzania (2,348 kg/acre) and China (1,369 kg/acre).

Milk productivity in Kenya (1,371 kg/cow) lags behind that in Argentina (4,773 kg/acre) and South Africa (3,093 kg/care), but is far much higher than other countries such as Malawi (461 kg/cow) and Tanzania (173 kg/cow).

These productivity figures reveal that even though Kenya is doing better than some African countries in terms of agricultural productivity, its productivity still lags behind more developed countries such as Argentina and South Africa. But there is potential for Kenya to increase its productivity on the commodities in which it has lower productivity levels to match those of countries such as Egypt, South Africa and Argentina.

Table 38: Comparison of Kenya's agricultural productivity with other countries

Commodity	Productivity		
		Yield (bags/acre)	
	Tegemeo Panel	**Other countries**	
Maize	9	Uganda	7
		Tanzania	4
		S/Africa	13
		Malawi	7
		Argentina	31
		Yield (kg/acre) of green coffee	
	Tegemeo Panel	**Other countries**	
Coffee	214	Brazil	345
		Columbia	436
		Uganda	213
		Yield (tonnes/acre)	
	Tegemeo Panel	**Other countries**	
Sugar Cane	25	Egypt	40
		Malawi	43
		Sudan	42
		Yield (kg/acre) of green tea	
	Tegemeo Panel	**Other countries**	
Tea	4,507	Malawi	3,523
		India	2,774
		Uganda	2,601
		Tanzania	2,348
		China	1,369
		Yield (kg/cow) per year	
	Tegemeo Panel	**Other countries**	
Milk	1,371	Argentina	4,773
		South Africa	3,093
		Malawi	461
		Uganda	331
		Lesotho	245
		Tanzania	173

Source: Tegemeo; FAOSTAT

4.0 Conclusion

4.1 Summary of Key Findings

The analysis in this report underscores several major findings:

First, the mean land owned per household has declined have the past decade, from 6.1 to 5.8 acres. This is attributed to increasing rural population pressures and land fragmentation. Cultivated land has also declined slightly, especially for area under coffee, Irish potatoes, cabbages, and in some areas, maize. Maize continues to be an important crop among rural farm households and still accounts for over 50 percent of the cultivated land nationwide.

Second, while crop production remains an important source of household income, its significance declined during the panel period. Off–farm income and specifically business activities are increasing in importance. Overall, maize contributes over 30% to full household income. However, results have shown that the contribution of horticulture (fruits and vegetable) and fodder crops (reflecting the rising importance of dairy) is increasing.

Third, while the value of agricultural output per household and per unit of land has risen by 16% and 24%, respectively, over the 1997-2007 period, there are variations in performance by crop. We categorise the commodities under examination into three; increased productivity, fluctuating productivity and declining productivity.

i. **Increased Productivity**: There is a marked increase in **maize** productivity. The key drivers of this change are; liberalization of the seed industry leading to increased adoption of high-yielding varieties, increased adoption of fertilizer use, reduced distances to agricultural input stockists, and greater density of agricultural input stockists in smallholder farming areas, leading to reduced transaction costs of accessing these inputs. However, among households using fertilizer on maize, mean application rates did not change much over the past decade. **Tea** productivity has slightly increased but mainly in the western region. This is mainly driven by increased adoption of fertilizer and also the quantities of fertilizer applied. **Dairy** has also recorded a marked growth in productivity. Some of the driving factors include; technological improvements leading to adoption of improved breeds, increased smallholder production of fodder crops, and higher farm gate milk prices.

ii. **Declining productivity: Coffee and sugarcane** productivity has declined. From the data, there is a marked decline in fertiliser use. This could be related to the various management challenges facing these two sub-sectors.

iii. **Fluctuating productivity: Cabbages and Irish potatoes** show fluctuation in productivity. Fluctuation in productivity of Irish potatoes could be attributed to challenges in sourcing clean planting material

Other factors that could have contributed to productivity growth are: improved access to extension as a result of increased participation of the private sector, NGOs and Government in supporting extension. There is also a slight increase in the proportion of households that received agricultural credit, albeit only a third of the households. Results show a declining role of cooperatives in provision of agricultural credit. However, the commodity-based credit providers such as KTDA and sugar companies) are the highest providers of agricultural credit. There is an increase in participation of the informal money lenders and the input stockists who jointly provide credit to more households than the SACCOS, banks and AFC all combined. Results show an increased participation of AFC, Micro Finance Institutions (MFIs) and commercial banks.

4.2 Policy Implications

1. The study shows that increased adoption of fertilizer has contributed to productivity growth in Kenya. The liberalization of the maize seed and fertilizer sub-sectors has lead to increased national consumption of fertilizer and Kenya has been a success case where the private sector has thrived relatively well. The study has shown an increase in the proportion of households that reported fertilizer use in the panel years. Although Kenya has registered high rates of fertilizer adoption, raising the intensity of use still remains a challenge. One of the current factors impeding fertilizer use the high world fertilizer prices in relation to the output price for commodities. The situation is worsened by the current trends in global fertilizer prices where the price of fertilizer such as DAP has increased from US$ 260 in 2007 to US$ 800 in 2008. The rising price of fertilizer and other farm inputs may erode productivity gains and especially in the maize productivity.

In order to sustain productivity growth and encourage the farmers to increase production and productivity of major enterprises, the farmers will require an improvement in innovative financial services. For example, Through the Private Public Partnership, some of the institutional innovations on agricultural inputs could be up scaled such as the credit guarantee scheme. The most recent example that could be up scaled is the partnership by AGRA, Equity Bank Limited, IFAD, and the Ministry of Agriculture that launched a loan facility of US$ 50 million (Ksh. 3.1 billion) in May 2008 to accelerate access to affordable financing for farmers and agricultural value chain members such as rural input dealers, input wholesalers and importers, grain traders and food processors. The cash guarantee fund of US $ 5 million by AGRA and IFAD would reduce part of the risk of lending by Equity Bank, adding an element of security. The response by farmers and agro-dealers to this initiative has been impressive. By June 2008, US$3 million (Ksh. 1.8 billion) had already been loaned out.

2. Efforts to improve farmers' efficient use of fertilizer and reducing the costs of fertilizer delivery would also help to offset the effects of rising world prices. A forward-looking approach to input market development requires attention to the various determinants of farmers' effective demand for fertilizer. Government can take a number of steps to increase farmers' demand for fertilizer: invest in rural infrastructure, efficient port facilities and standards of commerce to reduce the costs of distribution; scale-up funding of agricultural research to produce seeds that respond to fertilizer; and nurture the development of rural financial systems, market information systems, institutions for contract enforcement, and telecommunications to attract new investments by commodity marketing firms. These "public goods" investments, often considered outside the scope of fertilizer marketing policy, nevertheless strongly affect the demand for fertilizer and hence whether sustainable markets for fertilizer can arise.

3. The study has shown that an estimated 17% of the households did not use inorganic fertilizer during the panel period. One of the impeding factors for none use of fertilizer is the high prices. This indicates that some farmers are still trapped in abject poverty and would need to be 'kick started'. From a welfare and poverty alleviation standpoint, a compelling case can be made to provide free or subsidized inputs for the poor. The debate on "smart subsidies" received new attention after deliberations of the Abuja meeting where African governments

agreed to introduce smart subsides for the poor and vulnerable. However, difficulties with effective targeting may stymie the development of sustainable commercial input delivery systems. Above all, the costs can be high, effectively crowding out public funding of other important investments to help reduce poverty and promote agricultural growth. One such program is the National Accelerated Agricultural Input Access Program (NAAIAP), a program by the Kenyan Government targeting 2.5 million farmers owning below 1 hectare of land in 38 districts. The program provides 10kg of seed, 50kg of DAP fertilizer and 50 kg of topdressing fertilizer.

4. The study has also shown the emerging role of input dealers in provision of credit. Currently, there are initiatives of mainstreaming the agro dealers in improving access to agricultural inputs. Though private public partnership, the recent innovation such as the training of agro dealers could be up scaled. The training increase credibility status and increase opportunities for financing from the input manufacturers.

5. Given the existing distribution of landholding sizes within the small farm sectors of in Kenya, land allocation and land settlement will need to be on the policy agenda. Average farm size within the small farm sector is continuing to gradually decline with modest population growth and the closing of the land frontier in many areas. Under existing conditions, the ability of this bottom land quartile to escape from poverty directly through agricultural productivity growth is limited by their constrained access to land and other resources. In the long run, education and dynamic economic growth leading to improved off-farm employment opportunities will offer the best prospects for relieving rural land pressures. However, in the short and medium run, other options will need to be considered.

   Improving access to land among the most land-constrained smallholder households would be a seemingly effective way to reduce poverty. Statistical evidence in Jayne et al (2003) indicates that even a very small incremental addition to land for small farms is associated with a large relative rise in income. Yet improving land access for smallholders is fraught with difficulties. Expropriating land reform is politically difficult, expensive, and subject to rent-seeking, and “market-assisted” or “community-based” approaches have achieved very little success to date. Hence, perhaps the most promising scope for policy discussions on agricultural and rural poverty entail “land settlement” – how to provide incentives for rural families to re-locate to sparsely populated but productive land and provide a reasonable chance for them to become viable economic and social units.

Basic public investments to encourage the productive utilization of currently under-utilized areas with good agro-ecological potential also has a potential in Kenya to address the current land constraints faced by many of its impoverished and isolated rural smallholder households. The basic investments include feeder roads linked to trunk highways, health care facilities, schools, electrification, irrigation and tax incentives for agribusiness investment. A policy environment conducive to business development can also attract new capital into newly settled areas with good agricultural potential.

6. Coffee Sector: The study has shown a decline in productivity for the once vibrant coffee sector which produced over 130,000 tonnes per year in late 1980s. Today, the country only produces 53,000 tonnes. However, the sector has faced many challenges related to world prices in the early 1990’s, poor management of co-operatives society, high level of indebtness among others.

   The Government has intervened to save the industry from an apparent collapse by relieving debts amounting to Ksh. 5.8 million. Other reforms include; reduction in government involvement in coffee marketing and milling while encouraging farmers and private sector participation. The introduction of direct payment system operate alongside the Central Auction system of coffee marketing where farmers were paid more quickly and good quality coffee that fetches high premiums also receives the weekly auction price rather than the yearly average price. To some extent this has avoided the adverse selection problem inherent in the former pool payment system. The establishment of a ‘Second Window’ and the licensing of the marketing agents have improved prices that are received by the farmers. A Coffee Reform Secretariat was formed in 2005 and one of the mandates was operationalizing the Coffee Development Fund (CoDF). A total of Ksh 100 million was provided to CoDF by the government as seed capital for farm inputs. The Fund started a roll out by giving loans to farmers in January 2007.

In spite of all the reforms, the sector is still underperforming. Although coffee prices have increased from $1.8 per kg in 2000 to $3.0 per kilogram in 2007, the exchange rate has eroded these gains. In addition, farmers have not ripped this benefit as a result of high cost of production. Kenya is among the countries with highest cost of coffee production at $3.5 to $4 per kg. The global average is $1.5 for per kg of clean coffee. Neighboring countries like Ethiopia, Tanzania and Rwanda produce the beans at about $1.2 a kilo. The situation is worsened by transaction costs of handling processing and marketing.

7. Although Irish potatoes could be an important food security crop and especially with escalating prices of maize, little effort has been done to promote access to clean seed. Currently, there are no certified potato seed growers in the country. However, a few farmers buy clean seeds directly from the research stations (KARI –Tigoni). The seeds available in this institution are breeders' seed, which are very costly and their volumes cannot cater for all the farmers. There is need to establish potato seed growers.

8. In sugarcane there is need to develop high yielding and early maturity planting materials such as other efficient countries

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Annexes

Annex 1: Mean Value of Crop production at constant price, by zone and gender of household head

Agro-regional zone	Value of farm output (Ksh/hh)		Value of farm output (Ksh/acre)	
Coastal Lowlands	Male-headed	Female-headed	Male-headed	Female-headed
1997	16,269	31,039	7,402	5,414
2000	48,369	87,976	13,814	6,282
2004	46,813	17,037	8,314	4,163
2007	41,093	20,873	8,049	7,010
Eastern Lowlands				
1997	38,909	21,199	12,239	5,063
2000	63,848	84,788	13,670	11,940
2004	64,274	53,471	12,224	8,943
2007	59,217	47,371	11,170	8,622
Western Lowlands				
1997	19,667	14,063	9,237	6,059
2000	33,198	19,437	9,300	5,950
2004	41,596	17,000	8,205	7,032
2007	38,221	23,796	10,032	9,718
Western Transitional				
1997	61,101	36,245	13,182	7,621
2000	121,762	102,249	24,469	21,241
2004	86,859	53,191	16,890	15,818
2007	74,139	64,148	15,709	14,839
High Potential Maize Zone				
1997	104,434	48,622	17,035	14,983
2000	104,242	69,194	15,133	17,037
2004	119,179	83,931	22,031	20,636
2007	101,441	56,054	20,068	15,932
Western Highlands				
1997	31,099	20,978	11,796	8,219
2000	71,229	54,610	29,603	18,678
2004	83,321	34,535	23,475	16,155
2007	57,741	40,301	17,365	18,861
Central Highlands				
1997	94,432	47,426	31,935	19,547
2000	126,893	76,995	42,518	31,464
2004	137,603	97,382	48,317	36,999
2007	108,912	77,125	42,033	33,624
Marginal Rain Shadow				
1997	22,662	11,348	7,446	3,033
2000	20,546	11,106	7,308	3,748
2004	61,207	42,565	18,078	12,578
2007	59,155	25,769	20,957	8,549
Overall Sample				
1997	66,079	31,864	16,784	10,215
2000	89,090	65,192	21,868	16,523
2004	95,912	54,928	23,401	17,085
2007	79,726	49,022	21,023	16,245

Annex 2: Trends in fertilizer and maize seed consumption in Kenya, 1986 – 2004

Cropping season	Quantity of fertilizer (Metric tonnes)	Quantity of seed in (Metric tonnes)
1986/87	227,000	42,209
1987/88	238,000	43,528
1988/89	270,531	42,600
1989/90	237,362	41,400
1990/91	228,215	39,300
1991/92	254,087	42,210
1992/93	232,895	40,305
1993/94	286,519	45,000
1994/95	281,221	43,162
1995/96	289,000	44,670
1996/97	249,000	45,145
1997/98	255,044	44,272
1998/99	264,000	47,017
1999/00	336,000	45,000
2000/01	317,000	49,200
2001/02	329,000	47,769
2002/03	335,009	50,127
2003/04	312,440	49,943
2004/05	351,776	51,000
2005/06	383,285	51,000
2006/07	410,214	51,000
growth 97/07	*65*	*13*

Source: Ministry of Agriculture and FAOSTAT

Annex 3: Percent allocation of CDF to the constituencies in 2004/05

Constituency	Percentage	Constituency	Percentage
Amagoro	11.6	Lugari	8.7
Bahari	2.7	Lurambi	6.1
Baringo Central	9.4	Magarini	13.0
Baringo East	15.2	Makadara	6.3
Bomet	7.0	Malava	9.1
Butere	5.7	Marakwet West	15.4
Central Imenti	24.3	Mathira	2.6
Cherangani	19.0	Matunga	16.7
Dagoreti	38.6	Molo	11.9
Gachoka	14.2	Mosop	11.0
Ganze	12.2	Msambweni	16.9
Gatundu North	7.0	Mukwereini	4.9
Gatundu South	3.5	Mumias	3.4
Gem	11.5	Mutito	2.0
Githunguri	6.1	Mwala	12.9
Igembe	16.8	Mwateta	4.4
Isiolo North	13.9	Mwea	5.6
Kacheliba	11.2	Mwingi North	16.9
Kajiado Central	14.8	Naivasha	11.5
Kajiado North	11.8	Narok South	11.8
Kajiado South	13.9	Ndaragwa	32.9
Kandara	13.9	Nithi	9.6
Kapenguria	14.1	North Mugirango	14.0
Karachuonyo	7.1	Ntonyiri	13.7
Kasarani	28.0	Nyaribari Masaba	26.7
Kasipul	9.1	Ol' Kalau	28.7
Kathiani	11.5	Othaya	2.6
Keiyo North	16.0	Rangwe	8.9
Keiyo South	16.0	Rongai	14.2
Kibwezi	11.7	Runyenjes	18.4
Kieni	0.7	Sabatia	3.8
Kigumo	15.0	Saboti	12.7
Kimilili	8.5	Saikago	8.2
Kinango	11.0	Saku	9.4
Kinangop	22.1	Sigor	7.4
Kipipiri	15.5	Sirisa	13.0
Kisauni	2.1	South Imenti	9.6
Kisumu Townwest	4.6	South Mugirango	11.2
Kitui Central	14.6	Tharaka	3.9