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RESEARCH ARTICLE

RAIN-FED AGRICULTURE AND CLIMATE CHANGE: AN ANALYSIS OF THE MOST APPROPRIATE PLANTING DATES IN CENTRAL DIVISION OF LAIKIPIA DISTRICT, KENYA

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ABSTRACT

Frequent and severe droughts are evidences of climate change in Kenya. The severe effects of droughts on rural livelihoods have prompted many studies on climate change and its effects on human activities such as farming. However, farmers practicing rain-fed agriculture in the semi arid areas of Kenya still suffer from the wrath of droughts despite the well documented research findings and recommendations. Such studies have been conducted in Central Division of the semi arid areas of Laikipia District but farmers still face faced food insecurity caused by droughts. In attempt to analyze analyze the cause of continued food insecurity in Central Division the study evaluated the planting dates for rain-fed crop farmers between 1975 and 2005 and suggested the most appropriate planting dates for the farmers in order to minimise the risk of crop failure. Using Instate Plus v 3.36 statistical software the study established that the median planting dates from the bold and cautious farmers were 6th and 16th of April respectively farmers (early planters) were 16th of March to 10th of April for the cautious farmers (late planters). The risks from replanting were higher for the cautious farmers at 26.6% than for the bold farmers at 19.4%. The most appropriate time for planting in Central Division was from mid March to 10th of April. The results of the study gave an insight to crop farmers in the study area on the risks of early or late season planting under the changing climate and thus make informed decisions on when to plant.

INTRODUCTION

Rain-fed agriculture is practiced on 80% of the world's agricultural area and generates 60-70% of the world staple food (Rockstorm and Karlberg, 2009). In sub-Saharan Africa more than 95% of the farmed land is rain-fed, while in Latin America is almost 90%, for South Asia about 60%, for East Asia 65% and for the Near East and North Africa 75%. In the developing counties, rain-fed agriculture that constitutes the livelihood base for the vast majority of rural inhabitants (about 75 per cent of the poor in south Asia, and about 80 per

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cent of the population in east Africa) is a source of food security, employment and cash income (Wani, *et al.,* 2009). However, rain-fed agriculture is extremely vulnerable to climate change. Higher temperatures cause reduction in yields of desirable crops and encourage weed and pest proliferation while changes in rainfall patterns increase the likelihood of short-run crop failures and long-run production declines (Nelson *et al.,* 2009) causing food insecurity. Of the 6.5 billion population today, about 850 million people face food insecurity and about 60% of them live in South Asia and sub-Saharan Africa (Wani *et al.,* 2009). Agriculture plays a key role in poverty reduction and economic growth and development in sub-Saharan Africa where it accounts for 35% of the Gross Domestic Product (GDP) and employs over 70% of the population. In Tanzania, for instance, agriculture accounted for 45% of the GDP in 2000 (Earth trends, 2003). Rockstorm and Karlberg (2009) observe in many areas poverty is strongly influenced by agricultural production, which is in turn dependent on climate, particularly rainfall. Every 1% increase in agricultural yields translates to a 0.6-1.2% decrease in the percentage of the absolute poor people. In Kenya, over 80 percent of the population earns their living through farming and employment in agricultural sector (Huho, et al. 2010). However, droughts have been the major hindrance to agricultural activities in the arid and semi arid lands affecting large number of people (Table 1).

Despite the ever increasing number of people affected by food insecurity in Kenya, the vast majority of the studies on climate change and rain-fed agriculture in Kenya have tended to focus on the overall effects of droughts on rural livelihoods and adaptation strategies. For instance, researches have focused on smallholder vulnerability and response to drought (Akong'a and Downing, 1985), capacity building for drought risk management (Aboud, 2000), soil and water management as a strategy of coping with drought in semi arid Kenya (Biamah, 2005), environmental impact and assessment of severe drought in Kenya (UNEP and GoK, 2000), drought severity and their effects on rural livelihoods and food security (Huho *et al.,* 2010 and Huho and Mugalavai, 2010). In fact, Kenya has been playing a prominent role in the climate change debate. The first significant declaration on climate change in Africa, which came to be known as the Nairobi Declaration on Climate Change, was made in Kenya in 1990 during the Nairobi Conference of Global Warming and Climate Change (Ogola, no date). In spite of the important role played by Kenya in creating public awareness on climate change issues in Africa, farmers particularly in the semi arid areas of Kenya have continued to experience crop failures and poor yields and subsequently food insecurity. It is against this background that this study examined rainfall trends during the main growing season (March April and May) under the changing.

Table 1. The effects and the number of people affected by recent droughts in Kenya

Drought years	Effects	Number of people affected
1980	Crop production paralyzed and water shortages in towns	40,000
1984-85	Large food deficits leading to consumption of the yellow maize and large food queues in the supermarkets	200,000
1991-92	70% loss of livestock, severe food shortages	1.5 million
1994-96	Large food deficits causing relief food imports	1.4 million
1999-2000	4.7 million people dependent on relief food, water shortages	4.7 million
2004-06	Acute food shortages in pastoral and agro-pastoral areas, 4.4 million people affected. 2.6 million people were at risk of starvation. Up to 70% loss of livestock in some pastoral communities.	4.4 million
2008-09	About 3.8 million people urgently required food aid and about 6.2 million were at risk of starvation. Loss of wildlife animals- 40 elephants died	10 million

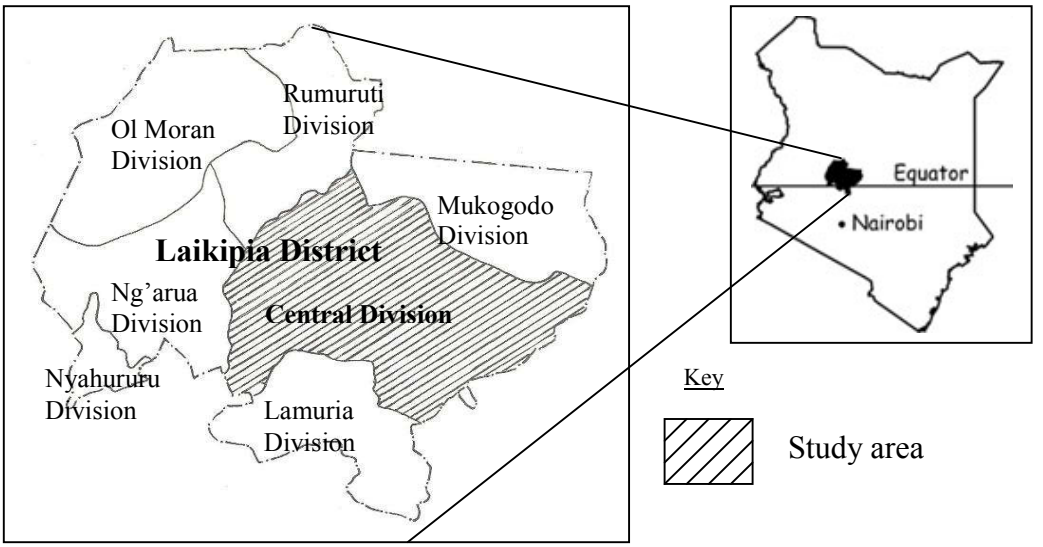

Fig. 1. Location of the Central Division

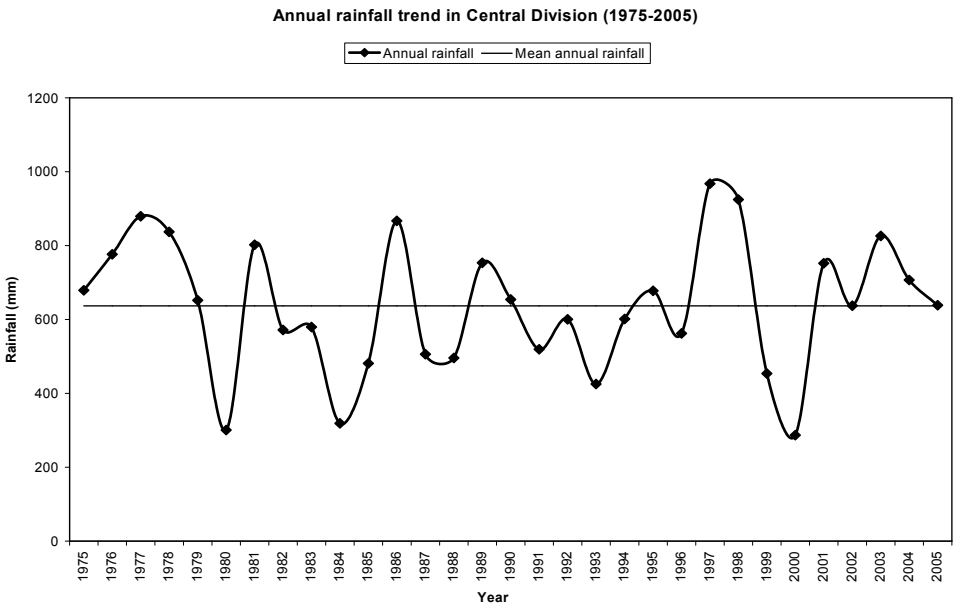

Fig. 2. Annual rainfall trends in Central Division

climate in Central Division of the semi arid Laikipia District, Kenya in order to establish the most appropriate planting dates under rain-fed crop farming as a strategy to minimize crop losses through droughts.

Study area and methods of data collection

The study was carried out in Central Division of the semi arid Laikipia District. The division lies approximately between longitudes $30^0$34" and $37^0$24"E and latitudes 0^0 2"S and $0^0$28"N. The study area is located in the rain shadow of Mount Kenya making it dry (Figure 1).

Rainfall in the study area follows the seasonal movements of the Inter Tropical Convergence Zone (ITCZ) resulting in two rainfall seasons, the "long rains" that occur in March, April and May (MAM) and the "short rains" that occur in October, November and December (OND). The MAM rainfall season receives the highest rainfall with mean seasonal totals of 223 mm between 1975 and 2005. This was the main growing period for farmers in Central Division. Planting begun in March and continued up to April. The mean seasonal rainfall during the OND season was 188 mm for the same period. Less rain-fed farming activities took place during this season. Generally, rainfall in Central Division is low with mean annual rainfall of 637 mm and was characterized by high year-to-year variability. The main economic activity is mixed farming, where farmers grow crops and keep livestock at the same time. Data for the study was obtained through the use of questionnaires and structured interviews. A total of 328 subsistence farmers out of a population of 77,478 were interviewed. Rainfall data for 31 years (1975-2005) was obtained from Laikipia Airbase meteorological station, which was located in Central Division. *Instat plus v 3.36* computer statistical software was used to analyze the dates when rainfall started, dates for successful planting after the start of rains and the risks from replanting due to unsuccessful planting.

Objectives of the study

The study aimed at establishing the most appropriate planting dates in Central Division of the semi arid Laikipia District in order to minimise the risks replanting. The specific objectives were to:

a) Examine the rainfall trends during the main growing period in Central Division of Laikipia District
b) Identify the start of the rains and the first planting dates in Central Division
c) Analyse the risks from replanting after the first planting dates
d) Establish the most appropriate planting dates in Central Division

RESULTS

Rainfall characteristics in Central Division

Rainfall in Central Division is highly variable with 14 out of 31 years (1975-2005) recording below average rainfall. The dry years (below average rainfall) occurred between 1980 and 2000 (Figure 2). This could be attributed to the warming sea surface temperatures, especially in the southwest Indian Ocean, which was responsible for the droughts in the equatorial and subtropical Eastern Africa during the 1980 to the 2000s (World Wide Funds for Nature (WWF) (2006). For example, the 1999-2000 drought in Central Division was caused by La Niña weather phenomenon that occurred in Kenya. For the period under study (1975-2005) in Central Division, the year 2000 was the driest with annual rainfall total of 287.1 mm in 75 rainy days. This was a La Niña year in Kenya. The maximum monthly rainfall amount was 64.0 mm, which was received in October while the minimum monthly rainfall was recorded in February when there was no rain (Table 2). The year 1997, was the wettest recording annual rainfall totals of 967.8 mm in 114 rainy days. This was an El Niño year in Kenya. The maximum monthly rainfall total was 211.1 mm, which was recorded in October while the minimum monthly rainfall was recorded in January and February when there was no rain (Table 3). Interviews with farmers in Central Division revealed that farmers relied heavily on the "long rains" i.e. the MAM rainfall season for crop farming. Typically, under rain-fed conditions planting begun from late February to early March.

Table 2. Rainfall distribution during the year 2000 drought, the driest year

Display of daily data for year 2000

Mon Day.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	--	--	--	--	--	--	--	--	--	3.4	--	--
2	--	--	--	--	2.4	--	--	--	--	--	--	--
3	--	--	--	--	3.2	--	--	--	0.4	--	0.6	--
4	--	--	--	--	--	--	--	1.9	--	--	--	--
5	--	--	--	1.2	--	--	--	--	--	0.6	0.4	--
6	--	--	--	--	--	--	10.0	--	--	--	13.4	--
7	--	--	--	--	--	--	1.1	2.6	--	21.1	--	--
8	--	--	--	11.5	2.0	--	--	3.1	--	3.1	--	--
9	--	--	--	--	--	--	--	0.5	--	--	--	0.5
10	--	--	--	--	--	1.5	--	--	--	--	6.5	1.7
11	--	--	--	--	2.5	--	--	1.5	--	2.6	0.6	4.8
12	--	--	--	--	--	--	--	--	--	--	1.2	--
13	--	--	--	--	--	--	--	--	--	--	--	0.8
14	--	--	--	2.4	1.0	--	--	6.0	--	--	--	--
15	--	--	--	2.2	--	--	--	--	0.6	12.7	--	--
16	--	--	--	--	1.1	--	--	0.7	1.1	--	--	2.0
17	--	--	--	--	--	--	--	--	--	5.1	--	1.5
18	3.6	--	--	--	--	--	--	--	--	4.8	--	--
19	21.0	--	--	--	--	--	--	--	0.6	3.6	--	--
20	--	--	--	--	--	2.6	--	--	--	--	--	--
21	--	--	--	0.4	--	--	8.5	--	1.5	1.5	1.5	--
22	--	--	--	--	--	--	14.1	--	--	2.0	3.1	--
23	--	--	1.8	--	--	--	--	--	--	--	16.3	--
24	--	--	--	11.2	--	--	--	--	--	--	2.4	--
25	--	--	--	1.9	--	--	--	0.8	--	--	--	--
26	--	--	--	2.9	6.6	--	--	--	--	1.2	4.1	--
27	--	--	--	9.8	3.0	--	--	0.7	--	--	--	--
28	--	--	0.5	--	--	--	--	--	--	--	--	--
29	--	--	--	--	--	2.8	--	--	--	--	--	--
30	--		0.5	0.6	--	--	--	--	--	--	--	--
31	--		--		--		--	5.8		2.3		--
Total										(Overall: 287.1)		
	24.6	0.0	2.8	44.1	21.8	6.9	33.7	23.6	4.2	64.0	50.1	11.3
Minimum										(Overall: 0.0)		
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum										(Overall: 21.1)		
	21.0	0.0	1.8	11.5	6.6	2.8	14.1	6.0	1.5	21.1	16.3	4.8
Number greater than 0										(Overall: 75)		
	2	0	3	10	8	3	4	10	5	13	11	6

However, farmers pointed out that rainfall pattern in the division had changed with a notable decline in March rainfall totals. Analysis of rainfall data (1975-2005) revealed that the during the MAM seasonal rainfall, the month of March showed a gradual decline in rainfall amounts while April and May showed increased monthly rainfall totals (Figure 3). The month of June was characterized by declining rainfall totals (Figure 4) an indication of emerging shorter growing periods.

Planting dates in Central Division

Interviews with farmers in Central Division revealed that the traditional early planting i.e., late February to early March, had changed due to the

Table 3. Rainfall distribution during the 1997 wettest year

Display of daily data for year 1997

Mon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day.												
1	--	--	--	--	34.3	--	--	23.1	--	--	41.0	--
2	--	--	--	3.1	--	--	4.2	--	--	--	1.0	3.2
3	--	--	--	--	--	--	--	--	--	--	14.5	6.2
4	--	--	--	--	1.1	--	--	0.7	--	--	14.3	13.4
5	--	--	--	--	--	--	--	--	--	--	3.4	3.5
6	--	--	--	36.0	12.3	7.0	45.4	--	--	10.2	3.1	2.9
7	--	--	--	13.5	--	--	1.0	14.8	3.8	6.4	--	3.4
8	--	--	--	17.7	--	0.6	--	--	--	5.3	--	--
9	--	--	0.7	11.2	--	0.9	--	--	--	2.2	2.4	--
10	--	--	--	17.5	--	--	--	--	--	--	6.6	--
11	--	--	--	--	--	--	--	--	--	--	0.7	--
12	--	--	--	--	--	--	--	--	--	19.8	16.6	--
13	--	--	--	15.0	--	--	--	--	--	34.5	2.1	--
14	--	--	--	--	--	--	--	--	6.3	1.2	--	--
15	--	--	--	1.7	--	4.3	--	--	--	9.7	--	--
16	--	--	0.4	4.0	--	--	--	--	--	12.9	4.0	--
17	--	--	--	1.9	--	--	--	--	--	--	11.5	0.4
18	--	--	--	--	1.9	37.0	--	13.7	--	3.4	14.7	11.4
19	--	--	--	--	--	2.2	--	--	--	1.8	--	--
20	--	--	--	1.1	--	--	--	0.4	--	7.5	7.5	--
21	--	--	--	0.8	--	--	--	--	--	29.8	--	5.9
22	--	--	--	2.1	--	--	2.3	--	10.0	6.4	9.7	--
23	--	--	3.9	4.8	--	--	14.0	--	3.5	4.9	0.5	--
24	--	--	--	10.1	--	--	4.4	0.7	--	--	1.6	--
25	--	--	5.9	4.0	0.5	--	--	--	--	--	0.7	--
26	--	--	3.9	--	0.5	--	--	--	--	11.8	2.1	--
27	--	--	--	--	--	--	4.0	1.5	--	--	4.0	--
28	--	--	--	--	1.0	--	--	0.4	--	0.5	14.0	--
29	--	tr	--	6.3	0.1	11.0	1.7	--	5.4	23.2	--	--
30	--		--	5.3	--	--	--	--	--	17.1	5.8	47.1
31	--		29.5		--		--	--		2.5		1.1
Total										(Overall: 967.8)		
	0.0	0.0	44.3	156.1	51.7	63.0	77.0	55.3	29.0	211.1	181.8	98.5
Minimum										(Overall: 0.0)		
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum										(Overall: 47.1)		
	0.0	0.0	29.5	36.0	34.3	37.0	45.4	23.1	10.0	34.5	41.0	47.1
Number greater than 0										(Overall: 114)		
	0	0	6	18	8	7	8	8	5	20	23	11

declining March rainfall totals. April and some times to early May depending on the rainfall onset. However, most of the planting was confined in March and April. Basing on farmers' planting behaviours, the study identified two categories of farmers: the bold and the cautious farmers. The bold farmers, who accounted for 73.9% of the farmers, planted early in the MAM season i.e., in early March. The bold farmers stated that early planting allowed the crops to take advantage of all the rains during the MAM season. They argued that farmers who early planted had higher chances of better harvests more than farmers who planted late in the season. The cautious farmers, who accounted for 26.1% of the farmers, planted late in the MAM

season since they were not ready to risk losing their crops due to

cautious farmer was defined as the first occasion after 1st April with 20 mm or more of rain in 1 or 2

Table 4. Planting dates for bold and cautious farmers in Central

Year	Early planting for bold farmers			Late planting for cautious farmers			Recommended planting dates		
	Start of rains (early March)	Successful planting date (early March)	Successful planting	Start of rains (early April)	Successful planting date (early April)	Successful planting	Start of rains (Mid March)	Successful planting date (mid March)	Successful planting
1975	16th Apr	16th Apr	√	16th Apr	16th Apr	√	16th Apr	16th Apr	√
1976	14th May	14th May	√	14th May	14th May	√	14th May	14th May	√
1977	22nd Mar	22nd Mar	√	3rd Apr	3rd Apr	√	22nd Mar	22nd Mar	√
1978	23rd Mar	23rd Mar	√	6th Apr	6th Apr	√	23rd Mar	23rd Mar	√
1979	8th Sept	8th Sept	√	8th Sept	8th Sept	√	8th Sept	8th Sept	√
1980	24th Jun	0	x	24th Jun	0	x	24th Jun	0	x
1981	16th Mar	16th Mar	√	4th Jun	27th Aug	x	16th Mar	16th Mar	√
1982	7th Apr	7th Apr	√	7th Apr	7th Apr	√	7th Apr	7th Apr	√
1983	19th Apr	19th Apr	√	19th Apr	19th Apr	√	19th Apr	19th Apr	√
1984	24th Jul	8th Nov	x	24th Jul	8th Nov	x	24th Jul	8th Nov	x
1985	1st Apr	1st Apr	√	1st Apr	1st Apr	√	1st Apr	1st Apr	√
1986	6th Mar	6th Mar	√	20th Apr	20th Apr	√	20th Apr	20th Apr	√
1987	9th Apr	9th Apr	√	9th Apr	9th Apr	√	9th Apr	9th Apr	√
1988	24th Mar	23rd Sept	x	2nd May	23rd Sept	x	24th Mar	23rd Sept	x
1989	21st Mar	21st Mar	√	23rd Apr	23rd Apr	√	21st Mar	21st Mar	√
1990	1st Apr	1st Apr	√	1st Apr	1st Apr	√	1st Apr	1st Apr	√
1991	3rd Apr	3rd Apr	√	3rd Apr	3rd Apr	√	3rd Apr	3rd Apr	√
1992	7th Apr	7th Apr	√	7th Apr	7th Apr	√	7th Apr	7th Apr	√
1993	16th Apr	16th Apr	√	16th Apr	16th Apr	√	16th Apr	16th Apr	√
1994	17th Apr	21st Aug	x	17th Apr	21st Aug	x	17th Apr	21st Aug	x
1995	3rd Mar	3rd Mar	√	1st May	1st May	√	16th Mar	16th Mar	√
1996	7th Jul	15 Aug	x	7th Jul	15th Aug	x	7th Jul	15 Aug	x
1997	31st Mar	31st Mar	√	1st Apr	1st Apr	√	31st Mar	31st Mar	√
1998	20th Apr	20th Apr	√	20th Apr	20th Apr	√	20th Apr	20th Apr	√
1999	13th Apr	13th Apr	√	13th Apr	13th Apr	√	13th Apr	13th Apr	√
2000	22nd Jul	7th Jul	x	22nd Jul	7th Oct	x	22nd Jul	7th Jul	x
2001	25th Mar	25th Mar	√	5th Apr	5th Apr	√	25th Mar	25th Mar	√
2002	22nd Mar	22nd Mar	√	11th Apr	11th Apr	√	22nd Mar	22nd Mar	√
2003	31st Mar	31st Mar	√	1st Apr	1st Apr	√	31st Mar	31st Mar	√
2004	31st Mar	31st Mar	√	1st Apr	1st Apr	√	31st Mar	31st Mar	√
2005	6th Apr	6th Apr	√	6th Apr	6th Apr	√	6th Apr	6th Apr	√

uncertainty in March rainfall. The cautious farmers therefore, commenced sowing in late March but mostly in April when rainfall was certain. The cautious farmers attributed the shifts in planting dates from March to April to the changing rainfall patterns in order to avoid the cost repeated sowing in occasions when March rainfall delayed. To analyze the most appropriate planting dates under the changing climate in Central Division, the study adopted the following definition for planting dates. The first planting date for a bold farmer in the study was defined as the first occasion after 1st March with 20 mm or more of rain in 1 or 2 consecutive days while the first planting date for a consecutive days. In the analysis, the start of the rains signified the first planting dates. The study established that the earliest planting date between 1975 and 2005 for the bold farmers was 3rd of March in 1991 and 1995 while the latest planting date was 8th of September in 1979 (Table 4). The variation in planting dates was 189 days. With exception of the severe drought years, i.e. 1979, 1980, 1984, 1988, 1994, 1996 and 2000 in Central Division, planting dates ranged from 3rd of March to 20th of April, a total of 48 days. The median planting date for the bold farmers during this period was 6th of April. By end of March, 12 out of the 31 (37.5%) years had the rains started and planting done. For cautious farmers, the earliest

planting date occurred in 1st April in 1985, 1990, 1997, 2003 and 2004 while the latest planting date occurred in 8th of September in 1979 (Table 4). The variation in planting dates was 160 days. With the exception of severe droughts,

50% by 6th April, 75% by 19th April and 81.3% by 14th May. For the cautious farmers, the probability that planting was done by the end of April was 68.8% of the years under study. About 25% of the years had planting done by 5th April,

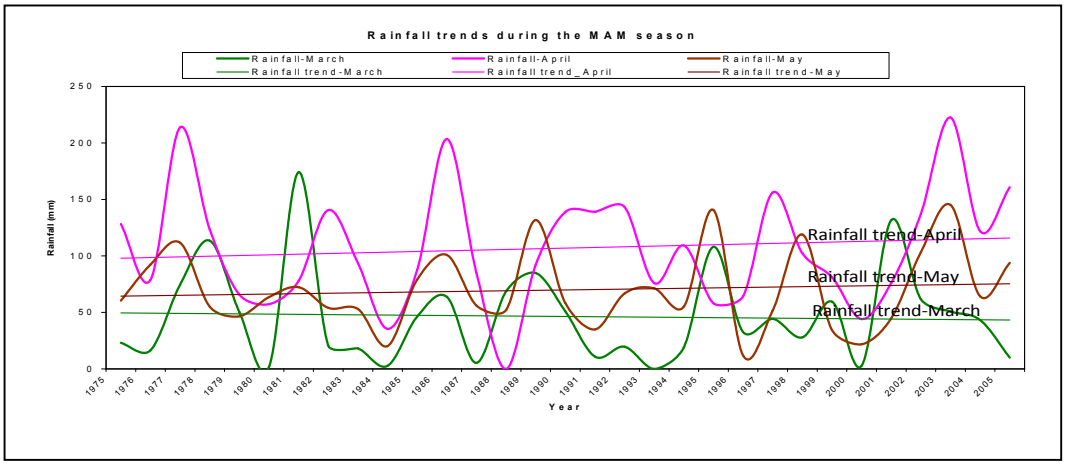

Fig.3. Rainfall trends during the MAM season

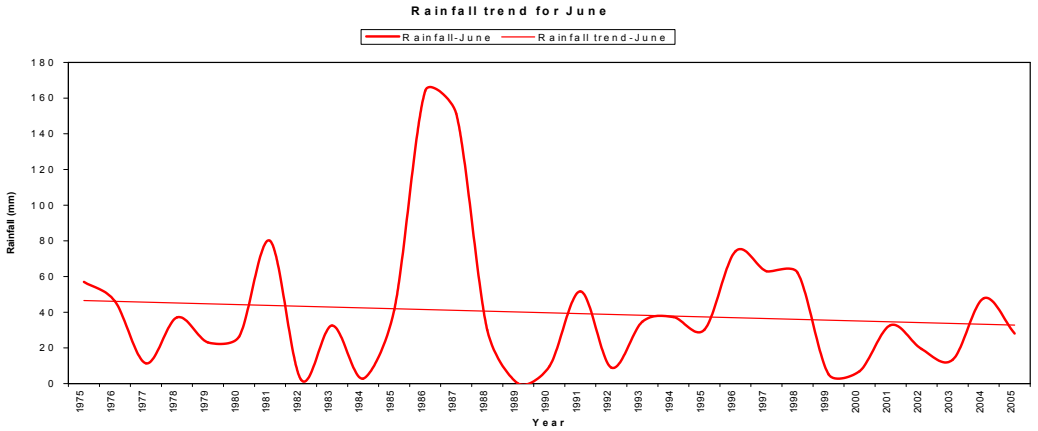

Fig. 4. Rainfall trends during the month of June

planting dates ranged from 1st of April to 4th of June, a total of 64 days. The median planting date for the cautious farmers was 16th of April. By the end of April, 22 out of the 31 (68.8%) years had the rains started and planting done. In analyzing the planting dates for the bold and the cautious farmers in Central Division, the study established that the probability that planting was done by 31st March was 37.5% of the years for the bold farmers. About 25% of the years had planting done by 24th March,

50% by 16th April, 75% by 2nd May and 78.1% by 14th May (Table 5).

The risks from replanting

According to Kitheka (2005) and Glantz (1987), occurrence of a dry spell early in the season onset leads to loss of seedlings necessitating replanting. In the study, unsuccessful planting which necessitated replanting occurred when a dry spell

of 10 or more days occurred in the next 30 days following the first planting for both bold and cautious farmers. The study revealed that unsuccessful planting for the bold farmers occurred in 6 out of 31 years (Table 4). That was in 1980, 1984, 1988, 1994, 1996 and 2000. These were

Table 5: The percentage probability for planting dates for bold and cautious farmers

Planting dates for bold farmers		Planting dates for cautious farmers	
Planting date	Probability planting was done	Planting date	Probability planting was done
3rd Mar	3.1	1st Apr	3.1
6th Mar	6.3	1st Apr	6.3
16th Mar	9.4	1st Apr	9.4
21st Mar	12.5	1st Apr	12.5
22nd Mar	15.6	1st Apr	15.6
22nd Mar	18.8	3rd Apr	18.8
23rd Mar	21.9	3rd Apr	21.9
24th Mar	25.0	5th Apr	25.0
25th Mar	28.1	6th Apr	28.1
31st Mar	31.3	6th Apr	31.3
31st Mar	34.4	7th Apr	34.4
31st Mar	37.5	7th Apr	37.5
1st Apr	40.6	9th Apr	40.6
1st Apr	43.8	11th Apr	43.8
3rd Apr	46.9	13th Apr	46.9
6th Apr	50.0	16th Apr	50.0
7th Apr	53.1	16th Apr	53.1
7th Apr	56.3	17th Apr	56.3
9th Apr	59.4	19th Apr	59.4
13th Apr	62.5	20th Apr	62.5
16th Apr	65.6	20th Apr	65.6
16th Apr	68.8	23rd Apr	68.8
17th Apr	71.9	1st May	71.9
19th Apr	75.0	2nd May	75.0
20th Apr	78.1	14 May	78.1
14th May	81.3	14 Jun	81.3
24th Jun	84.4	24th Jun	84.4
7th Jul	87.5	7th Jul	87.5
22nd Jul	90.6	22nd Jul	90.6
24th Jul	93.8	24th Jul	93.8
8th Sep	96.9	8th Sep	96.9

years of severe droughts not only in Central Division but in Kenya at large. Whereas the bold farmers had to wait for 107, 183, 126, 39 and 77 days in 1984, 1988, 1994, 1996 and 2000 respectively before successful planting, the year 1988 was very dry and there was no successful planting at all. The percentage risk from replanting for the bold farmers was 19.4%. For cautious farmers, planting failed in 7 out of 31 years. This was in 1980, 1981, 1984, 1988, 1994, 1996 and 2000 (Table 4). The cautious farmers had to wait for 84, 107, 144, 126, 39 and 77 days before successful planting in 1981, 1984, 1988, 1994, 1996 and 2000 respectively. Like for the bold farmers, the there was no successful sowing in 1980. The percentage risk from replanting for the cautious farmers was 22.6%.

DISCUSSION

Interviews with farmers revealed that there had been a gradual shift in planting dates from March to April with the perceived changes in rainfall patterns due to climate change. Farmers attributed the shifts in planting dates to declines in March rainfall. As a result, 26.1% to the crop farmers changed their planting dates from March to April. The fact that 68.8% of the years under study had rainfall started and planting done during the month of April triggered the cautious farmers to opt for late planting. However, the bold farmers argued that early planting allowed planted crops to take advantage of all the rains in March, April and May and therefore, continued planting in March despite having only 37.5% of the years with the rainfall started and planting done. Even with the declining rainfall totals in June, crops planted early in the season (if the sowing was successful) produced better yields compared crops plants planted later in the season. The declining rainfall totals in June caused mid-season water stress to crops leading to delayed flowering with pronounced negative effect on yields for crops planted late in the season by cautious farmers. Plate 1 shows a maize crop affected by mid season drought.

Plate 1: Tasseling stunted maize crop during the 1999 drought in Central Division

The median planting date for the bold farmers for the 31 years studied was 6th April while for the cautious farmers was 16th April. This implied that when in 50% of the 31 years, rainfall had started

and planting done by 6th April for bold farmers only 31.3% of the 31 years had planting done for the cautious farmers. On the other hand, when in 50% of the 31 years had rainfall started and planting done by 16th April for cautious farmers, in 68.8% of the 31 years, rainfall had started and planting done by the bold farmers. The study established that by 14th of May 81.3% and 78.1% of the 31 years had planting done by the bold and cautious respectively. Except for years with severe droughts, planting in March therefore had an advantage over planting in April because crops planted in March had an extended growing period of adequate rains. Due to this factor, the risk from replanting was lesser for the bold farmers at 19.4% compared to 22.6% for the cautious farmers. The study established that the most appropriate time for planting was between 16th March to 10th April. This is because in during this period rainfall had started and planting done in 96% of the years under study with exception of 1979, a year with extreme late onset of the rains, and years with severe droughts (1984, 1988, 1994, 1996 and 2000) when there unsuccessful planting. The study established that 50% of the planting was done and was successful by 1st of April. In the first half of March (1st-15th), only 2 out of the 31 years had rainfall started and planting done. This signified the uncertainty of rainfall during the first half of March.

Conclusion and recommendations

Increased food insecurity in Central Division was caused by improper timing of the planting date during the main growing season rainfall. The perceived shifts in March rainfall led to some shifts in planting dates from March to April by 26.1% of the farmers. This increased the risks of unsuccessful planting. Moreover, the early planting tradition which saw the bold farmers plant at the beginning of March also increased the risks of replanting because of the delayed rainfall onset. Considering the declining rainfall totals in March and June, the study established that the most appropriate planting dates in Central Division should be from mid March to early April. Planting during this period could greatly reduce the risk from replanting caused by uncertainty of March rains. Between 16th March and 10th April, 96% of the years had rainfall started and sowing was successful. The study also recommended that researches focusing on climate change and agricultural production should be specific to the needs of the affected farmers in order to give ideal information on cropping behaviours. Such studies will help farmers in identifying the most appropriate planting dates in relation to the changing rainfall patterns.

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