Bee Farmers' Perceptions on the Effects of Rainfall Variability in Kamwenge District-Western Uganda

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Abstract

This paper characterizes rainfall variability in Kamwenge district, establishes its implications on farmers' livelihoods and suggests possible coping strategies. The main source of data for the paper was derived from a survey that was conducted in Kamwenge district in January 2017. Comprehensive questionnaires were used in data collection from household farmers. A total of 312 respondents (156 males and 156 females) were purposively selected and interviewed. The respondents were sampled from three sub-counties of Kibale and Kitagwenda counties namely Busiriba and Bihanga and Ntara respectively. Additionally, the study conducted Six Focus Group Discussions (FGDs) and 12 Key Informants who provided additional detailed information. Content analysis was carried out on qualitative data to draw themes. The primary data was supplemented with, historical meteorological datathat was accessed from Uganda National Meteorological Authority (UNMA) and statistical abstracts from Uganda Bureau of Statistics (UBOS). Results show that rainfall has significantly reduced in amount, delays to begin and cessation is significantly early. As a result, drought is a common phenomenon leading to loss of crops, increase in prevalence of pests and diseases and therefore keeping farmers in poverty. Coping strategies proposed include: afforestation, agroforestry, environmental conservation, establishment of dams to conserve water for livestock and irrigation of crops. The paper recommends that the district should encourage afforestation, environmental conservation and agroforestry while emphasizing bee farming. Trees should be planted on the boundaries of banana gardens as wind brakes and government should accelerate hydropower grid connection to reduce dependency on charcoal as cooking source of energy.

Keywords: Rainfall variability, livelihoods, bee farming, coping strategies.

1.0 Introduction

Rainfall variability and associated negative impacts has in the recent decades occupied fundamental positions in environment debates. Globally, rise in temperatures and high rainfall variability are projected to increase which are likely to result in declining agricultural productivity(Intergovernmental Panel on Climate Change (IPCC), 1997; IPCC, 2007). According to Shankar et al., (2015), water and agriculture will be the most vulnerable sectors affected by rainfall variability. Climate change and rainfall variability specifically with implications such as prolonged periods of drought and flood as well as longer-term change, directly or indirectly affect livelihood productivity and access to sufficient food nutrients (Ziervogel et al., 2006).

Sub Saharan Africa is probably worse off not only because of the reduction or mean variation in rainfall(MacDonald and Calow; 2009),but as a result of high poverty rates, exclusive dependence on natural resource-based livelihoods being highly dependent on rain-fed agriculture and significant limited adaptive capacity(Ellis., 2000; Kurukulasuriya and Mendelsohn, 2006; Waha et al., 2013). A significant percentage of community livelihoods in Sub Saharan Africa (SSA) and South Western Uganda specifically are intrinsically linked to the rainfall amounts and seasonality; any changes will have direct implications on their livelihoods as widely reported in the literature (Calzadilla et, al., 2014; Dumenu & Obeng, 2016; FAO, 2010; Leal et, al., 2015; Mertz et al., 2009).

Rainfall variability leads to increased occurrence of climate stresses especially droughts and floods, increased decline in crop and animal yields, prevalence of pests and diseases and above all extinction of endangered species. The population at risk of increased rainfall variability and water stresses is projected to increase with about 350–600 million people by the 2050s (Food and Agriculture Organization (FAO), 2005; Leary and Conde, 2013; Nyong and Adesina, 2007; Ashton, 2002; Ziervogel and Nyong, 2006).

Rainfall variability coupled with the increasing population in Kamwenge district has hindered the development of other sustainable livelihoods like bee farming by reducing the per capita and land acreage(Tumwine et al., 2018). Beekeeping is an important component of agriculture and rural development programs in many countries and provides nutritional, economic and ecological security to rural communities at household level and is an additional income source and employment generating activity. It is an environmentally sustainable activity. Bees contribute to biodiversity through pollination (Bunde and Kibet, 2015).The objectives of this paper are to characterize rainfall variability in Kamwenge district, establish implications of rainfall variability on farmers' livelihoods and suggest possible coping strategies to rainfall variability in the district.

2.0 Materials and Methods

2.1 Study area

Kamwenge District, located in South Western Uganda (in between latitudes 00˚10'00"S ; 00˚40'00"N and longitudes 30˚50'00"E ; 30˚20'00"E)is bordered by Kyenjojodistrict to the North, Kyegegwa and Kiruhura districts to the North East, Ibandato the East and South East, Bunyaruguruto the South, Busongora to the West and Bunyangabo district to the North West(Tumwine et al., 2018). It covers an area of approximately 2,439.4 square kilometers and of this, 64.1 square kilometers (2.6%) is covered by open water. It is predominantly a rural district with very high poverty levels in the country (UBOS, 2016).In fact, Tumwine et al (2018) observed high levels of absolute poverty (26.9%) especially among the female headed households (21.9%) in the district.

The district is gifted with tropical high forests dominated by Kibale National Forest Park and Kakasi-Kitomi Forest Reserve (10.43%), woodland (11.12%), grassland (21.83%), papyrus reeds/swamp (3.08%), open water (2.63%) with farmland and built up area covering 49.19% and 0.03% respectively. In Bwizisub-county, there are pockets of highland tropical forest on the mountain ranges. Additionally, there are numerous aquatic systems within the district like Katonga nature reserve, Queen Elizabeth National Game Park, Rwenshama falls, Rivers Mpanga, Kitomi, Nkurungo, Kikoyo, Ruhagura, Kyarutanga, Rwengo, Rwambu and Rushango and Lake George (Figure 1).

The district receives well distributed bimodal annual rainfall (February to April and September to December) averaging 1200mm throughout the year for most parts. The greatest amount of rainfall is received in the North-Eastern and Southern parts of the district. On the other hand, the district also has drought prone areas such as Nkoma, Rwizi, Kamwenge and Nyabbani sub-counties which are part of the cattle corridor of Uganda (Tumwine et al, 2018). Altitude of the district ranges between 914m to 1952m above sea level (Figure 1). The landscape of the Kamwenge is representative of Wayland's peneplain II underlain by Precambrian rocks which are either wholly granitizedamphibolitic or under differentiated acid gneisses. As a result, temperatures range between 20˚C and 30˚C.

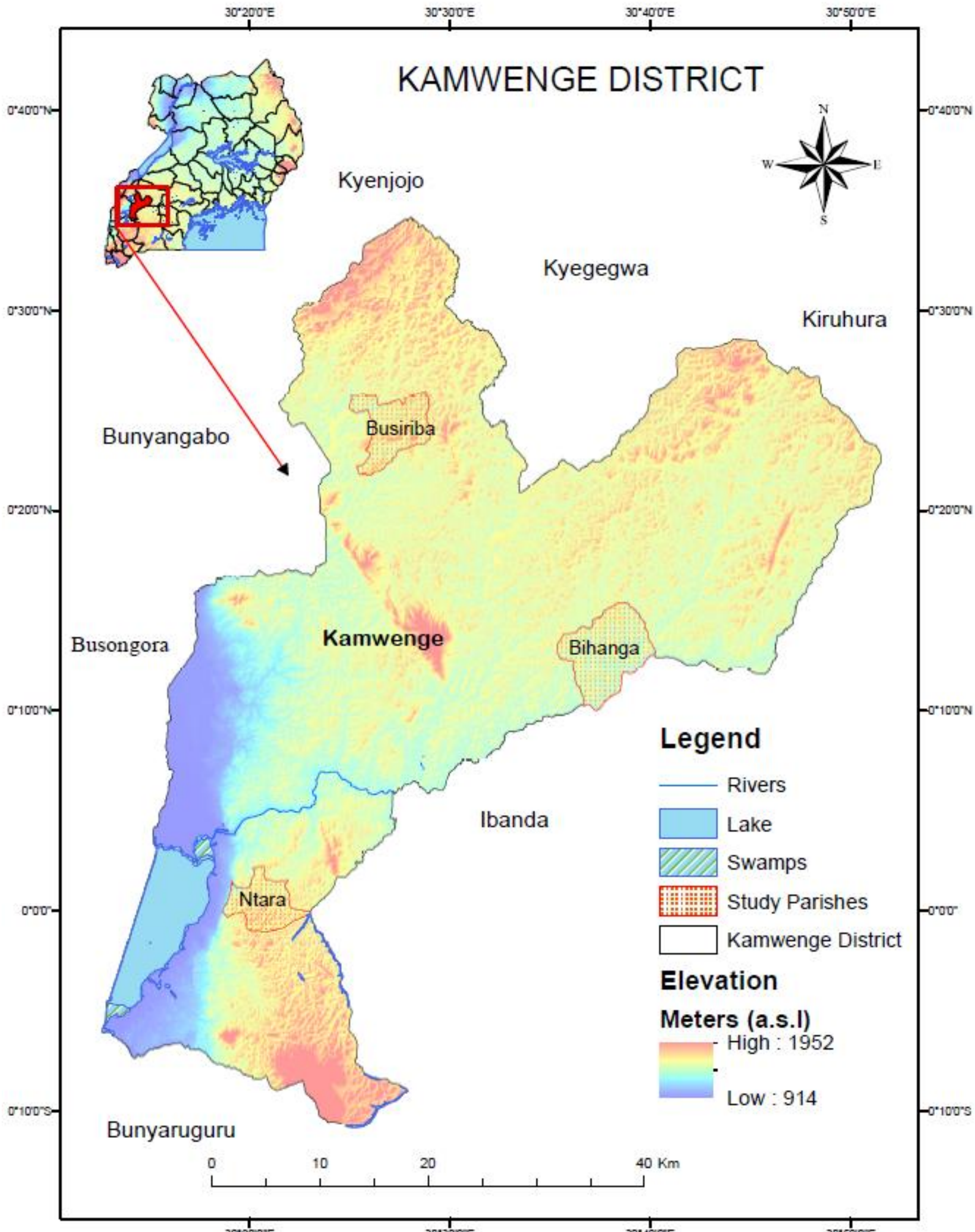

Figure 1: Location of Kamwenge District in relation to the neighboring Districts and the selected study parishes.

The district population was 201,700 according to the 1991 national population census. The next census in 2002, put the population in the district at 263,700, of whom 51.5% were female and 48.5% were male. In 2014, the population of the district was 332,000. According to Uganda Bureau of Statistics, (2017); in 2016, Kamwege district had a population estimate of 442,600 of which 56,938 (13%) were refugees. By May 2017 the district hosted 62,250 refugees. Kamwenge is one of the districts with one of the highest population growth rates in the country (3.91%) during the period 2002 to 2014 compared to the national average of 3.03% (UBOS, 2016). The increasing population has resulted in an increase in the population density from 82.69, 114.7 and 172.8 persons per square km in 1991, 2002 and 2014 respectively (Tumwine et al, 2018).

Although there are other socio-economic activities, agriculture is the main source of livelihoods in Kamwenge with the main cash crops being coffee, tea, sun flower, cotton and pine apples (though not in large scale) and the food crops include bananas, maize, millet, beans, peas, ground nuts, sorghum, tomatoes, onions among others. Recently, bee farming (apiculture) has been well embraced by several households in Kamwenge district potentially suggesting a paradigm shift in economic activities (Tumwine et al, 2018).

2.2 Data Sources and methodology

Primary data for this paper was derived from a survey that was conducted in Kamwenge district in January 2017. Comprehensive questionnaires were used in data collection from house hold farmers. A total of 312 respondents (156 males and 156 females) were purposively selected and interviewed. The respondents were sampled from three sub-counties of Kibale and Kitagwenda counties namely Busiriba, Bihanga and Ntara respectively. Six Focus Group Discussions (FGDs) and 12 Key Informants provided additional detailed information.

This study used both primary and secondary data. The secondary data were obtained from the Uganda National Meteorological Authority (UNMA) and statistical abstracts from the Uganda Bureau of Statistics (UBOS). The data were entered, processed and analyzed using IBM-SPSS 23. Quantitative results like descriptive statistics such as frequencies and percentages were generated using Microsoft Excel spread sheets. The qualitative data was analyzed thematically after conducting content analysis. Additionally, the qualitative data represented together with quantitative data since they tend to explain each other's idea and further make the paper comprehensive.

3.0 Results and Discussion

3.1 Rainfall variability

3.1.1. Rainfall amounts

Table 1 illustrates bee farmers' perceptions with regards to the current rainfall amounts received in Kamwenge district as compared to the previous decades. The results shown in Table 1, reveal that 0.6% of the respondents reported that rainfall amounts had not changed at all. The results further shows that a very small proportion (1.3%) of the respondents reported rainfall amounts to have moderately increased and 5.8% reported rainfall amounts to have significantly increased. However, the highest percentage (76.3% and 16%) of respondents disclosed that rainfall amounts had reduced and significantly reduced respectively. Table 1 further explores bee farmers' perception of the current rainfall amounts in comparison to the previous decades in the three sub counties of Kamwenge district. The percentage of respondents who reported that rainfall amounts had significantly increased were 3% in Busiriba sub-county; 3% in Bihanga sub-county and 11% of the respondents in Ntarasub-county. Although no respondent in Bihanga sub-county reported that rainfall amounts had moderately increased, 1% of the respondents in Busiriba and 3% of the respondents in Ntara sub-counties reported rainfall amounts to have moderately increased.

The respondents who reported to have experienced no change in rainfall amounts exclusively were from Busiriba Sub County only (2%); no respondents in Bihanga and Ntara sub-counties acknowledged to have experienced this trend. With regards to reduced rainfall amount category, 94% of the respondents from Busiriba, 64.4% from Bihanga and 72% from Ntara reported that rainfall amounts had reduced. As regards to the category of significantly reduced rainfall amounts, 1% of the respondents from Busiriba, 32.7% from Bihanga and 14% of the respondents from Ntarasub counties reported to have experienced significantly reduced rainfall amounts. It should be noted that when the chi-square test was conducted, there was a significant relationship between the farmers' sub-county of origin and their perceptions on rainfall amounts ($p=0.000$). All the socio-economic characteristics of the respondents in Table 1shows that 76% and 16% perceived reduced and significantly reduced rainfall. This perception is in agreement with the results shown in Figure 1 for the last five years.

Table 1: Cross tabulation of the socio-economic characteristics of the Bee farmers and their perceptions on the current rainfall variability as compared to the previous decades.

Variables / Drivers	Perceptions										Total	
	Significantly increased		Moderately increased		Not Changed		Reduced		Significantly reduced			
Sub County	No	%	No	%	No	%	No	%	No	%	No	%
Busiriba	3	3	1	1	2	2	94	93	1	1	101	100
Bihanga	3	3	0	0	0	0	67	64	34	33	104	100
Ntara	12	11	3	3	0	0	77	72	15	14	107	100

Total	**18**	**6**	**4**	**1**	**2**	**1**	**238**	**76**	**50**	**16**	**312**	**100**
Chi-square = 54.337, p =0.000												
Tribe												
Mutagwenda	6	21	2	7	0	0	16	57	4	14	28	100
Mukiga	6	4	2	1	1	1	128	85	13	9	150	100
Munyankole	2	3	0	0	0	0	56	72	20	26	78	100
Mufumbira	1	3	0	0	0	0	21	62	12	35	34	100
Mutoro	3	15	0	0	1	5	15	79	0	0	19	100
Other tribes	0	0	0	0	0	0	2	67	1	33	3	100
Total	**18**	**6**	**4**	**1**	**2**	**1**	**238**	**76**	**50**	**16**	**312**	**100**
Chi-square = 59.788, p = 0.000												
Occupation												
Farmers	16	6	3	1	1	0.4	208	76	45	17	273	100
Professionals	0	0	0	0	1	5	12	67	5	28	18	100
Traders	2	14	1	7	0	0	11	79	0	0	14	100
Students	0	0	0	0	0	0	7	100	0	0	7	100
Total	**18**	**5.8**	**4**	**1.3**	**2**	**1**	**238**	**76**	**50**	**16**	**312**	**100**
Chi-square = 42.278, p = 0.000												
Education												
No Formal Education	0	0	0	0	0	0	36	75	12	25	48	100
Primary	10	5.6	1	1	1	1	142	80	23	13	177	100
Secondary	8	11	3	4	1	1	51	21	8	11	71	100
Tertiary	0	0	0	0	0	0	9	56	7	44	16	100
Total	**18**	**6**	**4**	**1**	**2**	**1**	**238**	**76**	**50**	**16**	**312**	**100**
Chi-square = 20.196, p = 0.000												
Gender												
Male	10	6	1	1	1	1	133	85	11	7	156	100
Female	8	5	3	2	1	1	105	67	39	25	156	100
Total	**18**	**6**	**4**	**1**	**2**	**1**	**238**	**27**	**50**	**16**	**312**	**100**
Chi-square = 28.325, p = 0.005												

Rainfall data from Kasese district that lies to the west of Kamwenge and is in the same climatic zone was used to show the annual trends of rainfall variability amounts for three decades (1987 to 2016) in the region (Figure 2). Although annual rainfall amounts range between 753mm and 1288mm per year, overall the lowest rainfall amount (721mm) was received in 2003 closely followed by low rainfall amounts below 800mm (753mm, 760mm and 768mm) were in 1991, 2008 and 1992 respectively.

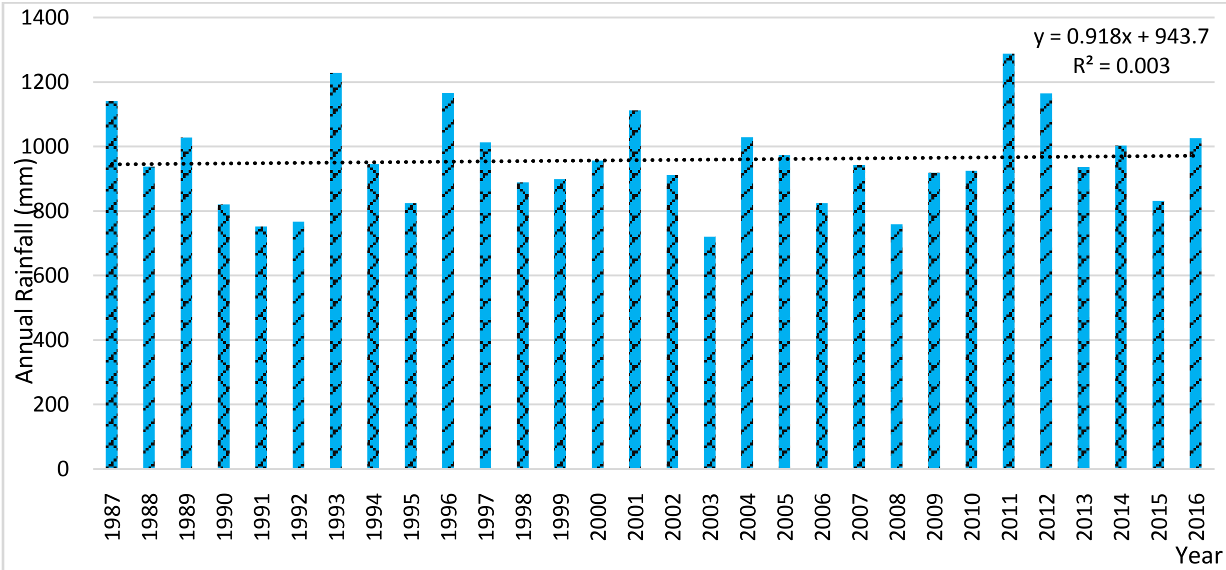

Figure 2: The annual rainfall variability for the three decades in Kasese district

However, highest annual rainfall amounts (above 1150mm) were recorded in 2011, 1993, 1996 and 2012, with amounts of 1288, 1228, 1167 and 1165mm respectively. The annual rainfall amounts in the last five years (2011 to 2016) show a declining trend (Figure 2). These annual rainfall amounts have implications on human activities in Kamwenge District.

Figure 3 shows the average monthly rainfall variability for the three decades (1987 to 2016) in the region. As depicted in Figure 2, annual average rainfall amount in these three decades was 964mm. The highest average monthly rainfall (above 80mm) were received in the two rainy seasons (MAM and SON rainfall seasons) with the average peaks in November (127mm) and March (126mm) followed by October (120mm), May (110mm), September (94mm) and March (81mm). It further shows that on average, highest rainfall amounts (341mm) were received in the second (SON) season as compared to 318mm received in the first (MAM) season.

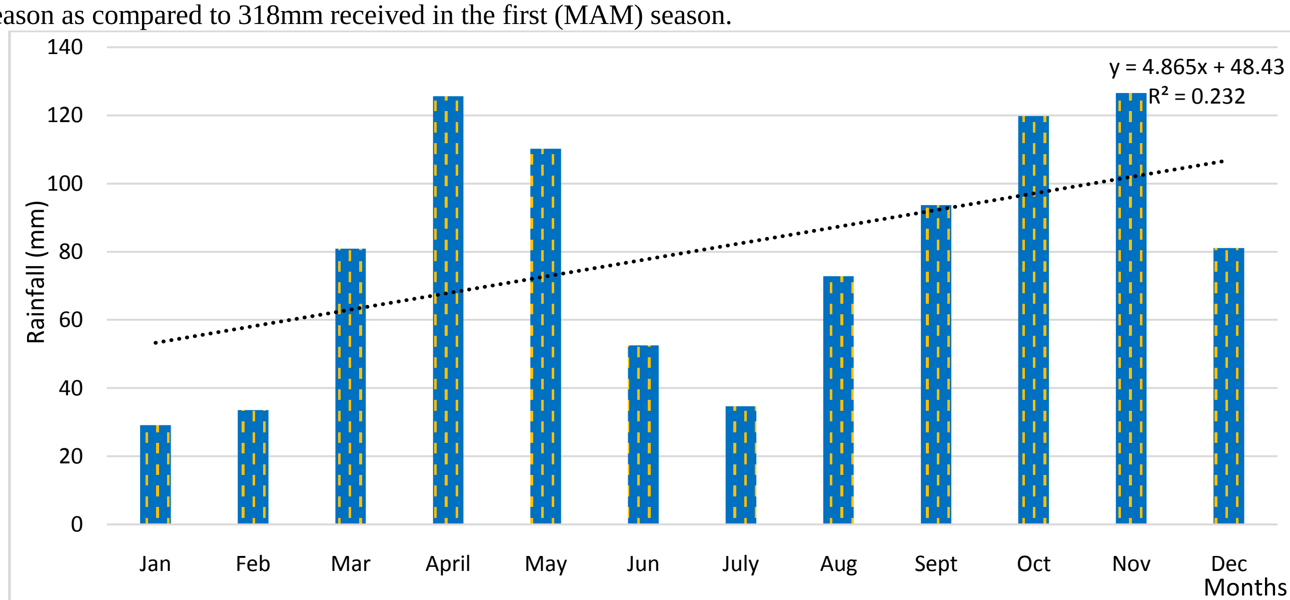

Figure 3: The average monthly rainfall variability for three decades (1986 to 2016) in Kasese district.

As regards to the dry season, the first dry (DJF) season received slightly higher average rainfall amount (144mm) with the peak (81mm) in December with the lowest (29mm) in January closely followed by February with 34mm. Although the average rainfall amount in the second dry (JJA) season (161mm) was more than that in the first dry season, August recorded 72mm average rainfall amount closely followed by June with 53mm and the lowest amount in July with 35mm.

3.1.2 Rainfall Onset

Table 2shows the bee farmers' perception as regards to the current trends of rainfall onset as compared to the previous decades in Kamwenge district. Whereas 9.9% of the total percentage of the respondents reported a moderately delayed rainfall onset; 90.1% of the respondents reported that rainfall onset significantly delayed. In Bihanga sub-county, all the 104 respondents (100%) disclosed that the onset of the rains significantly delays currently as compared to the previous decades as compared to 96% of the respondents from Busiriba Sub County and 75% from Ntarasub-county. Overall, 90% of the respondents in the district reported significant delay of rainfall as compared to the previous decades. When subjected to chi-square test, it was established that there was a significant relationship between farmer's sub counties and their perceptions on rainfall onset. One of the Key Informants in Bihanga had this to say about the delay in the rainfall onset: *"I'm now 76 years old, in my life time I have never experienced such a long spell of dry season in this area"*

Table 2: Cross tabulation of the socio-economic characteristics of the Bee farmers and their perceptions on the rainfall onset as compared to the previous decades.

Sub County	Rainfall onset						Total	
	Significant delay		Moderate delay		Significantly Early			
	No	Percent	No	Percent	No	Percent	No	Percent
Busiriba	97	96.0%	4	4.0%	0	0.0%	101	100.0%
Bihanga	104	100.0%	0	0.0%	0	0.0%	104	100.0%
Ntara	80	74.8%	27	25.2%	0	0.0%	107	100.0%
Total	**281**	**90.1%**	**31**	**9.9%**	**0**	**0.0%**	**312**	**100.0%**
Chi-square 43.485, p = 0.000								
Gender								
Male	142	91.0%	14	9.0%	0	0.0%	156	100.0%
Female	139	89.1%	17	10.9%	0	0.0%	156	100.0%
Total	**281**	**90.1%**	**31**	**9.9%**	**0**	**0.0%**	**312**	**100.0%**
Chi-square = 0.322, p = 0.570								
Education								
No formal Education	47	97.9%	1	2.1%	0	0.0%	48	100.0%
Primary	162	91.5%	15	8.5%	0	0.0%	177	100.0%
Secondary	58	81.7%	13	18.3%	0	0.0%	71	100.0%
Tertiary	14	87.5%	2	12.5%	0	0.0%	16	100.0%
Total	**281**	**90.1%**	**31**	**9.9%**	**0**	**0.0%**	**312**	**100.0%**
Chi-square = 9.411, p = 0.024								
Marital Status								
Never Married	29	93.5%	2	6.5%	0	0.0%	31	100.0%
Married	243	89.3%	29	10.7%	0	0.0%	272	100.0%
Divorced / Widowed	9	100.0%	0	0.0%	0	0.0%	9	100.0%
Total	**281**	**90.1%**	**31**	**9.9%**	**0**	**0.0%**	**312**	**100.0%**
Chi-square = 1.574, p = 0.664								
Occupation								
Farmer	250	91.6%	23	8.4%	0	0.0%	273	100.0%
Professionals	10	83.3%	2	16.7%	0	0.0%	12	100.0%
Traders	11	78.6%	3	21.4%	0	0.0%	14	100.0%
Others	3	50.0%	3	50.0%	0	0.0%	6	100.0%

Student	7	100.0%	0	0.0%	0	0.0%	7	100.0%
Total	**281**	**90.1%**	**31**	**9.9%**	**0**	**0.0%**	**312**	**100.0%**
Chi-square = 14.905, p = 0.005								
Tribe								
Mutagwenda	20	71.4%	8	28.6%	0	0.0%	28	100.0%
Mukiga	136	90.7%	14	9.3%	0	0.0%	150	100.0%
Munyankole	72	92.3%	6	7.7%	0	0.0%	78	100.0%
Mufumbira	33	97.1%	1	2.9%	0	0.0%	34	100.0%
Mutoro	17	89.5%	2	10.5%	0	0.0%	19	100.0%
Others	3	100.0%	0	0.0%	0	0.0%	3	100.0%
Total	**281**	**90.1%**	**31**	**9.9%**	**0**	**0.0%**	**312**	**100.0%**
Chi-square = 13.563, p = 0.019								
Age Group								
15 to 30	71	92.2%	6	7.8%	0	0.0%	77	100.0%
31 to 50	131	87.3%	19	12.7%	0	0.0%	150	100.0%
51 plus	79	92.9%	6	7.1%	0	0.0%	85	100.0%
Total	**281**	**90.1%**	**31**	**9.9%**	**0**	**0.0%**	**312**	**100.0%**
Chi-square = 2.432, p = 0.296								
Annual Income								
Less than 720.000/=	136	90.7%	14	9.3%	0	0.0%	150	100.0%
720.000/= to 2,400.000/=	6	85.7%	1	14.3%	0	0.0%	7	100.0%
2,400.001 to 6,000.000/=	89	86.4%	14	13.6%	0	0.0%	103	100.0%
Over 6.000.000/=	12	85.7%	2	14.3%	0	0.0%	14	100.0%
Total	**243**	**88.7%**	**31**	**11.3%**	**0**	**0.0%**	**274**	**100.0%**
Chi-square = 1.304, p = 0.728								

Figure 4 shows the average decadal daily rainfall for the first 15 days of the month of March for the daily rainfall over Kasese station in the three decades. With regards to the first rainy (MAM) season, rainfall is usually expected to start in the beginning of March which was the trend in the first decade (1986 to 1996) with progressive increase in rainfall amounts in the first week followed by fluctuations in the second week.

In the subsequent two decades (1997 to 2006 and 2007 to 2016), rainfall onset rather depicts an irregular fluctuation in average diurnal rainfall amounts where the diurnal rainfall amounts in the second week fall below 1.5mm more especially in the most recent decade (2007 to 2016).

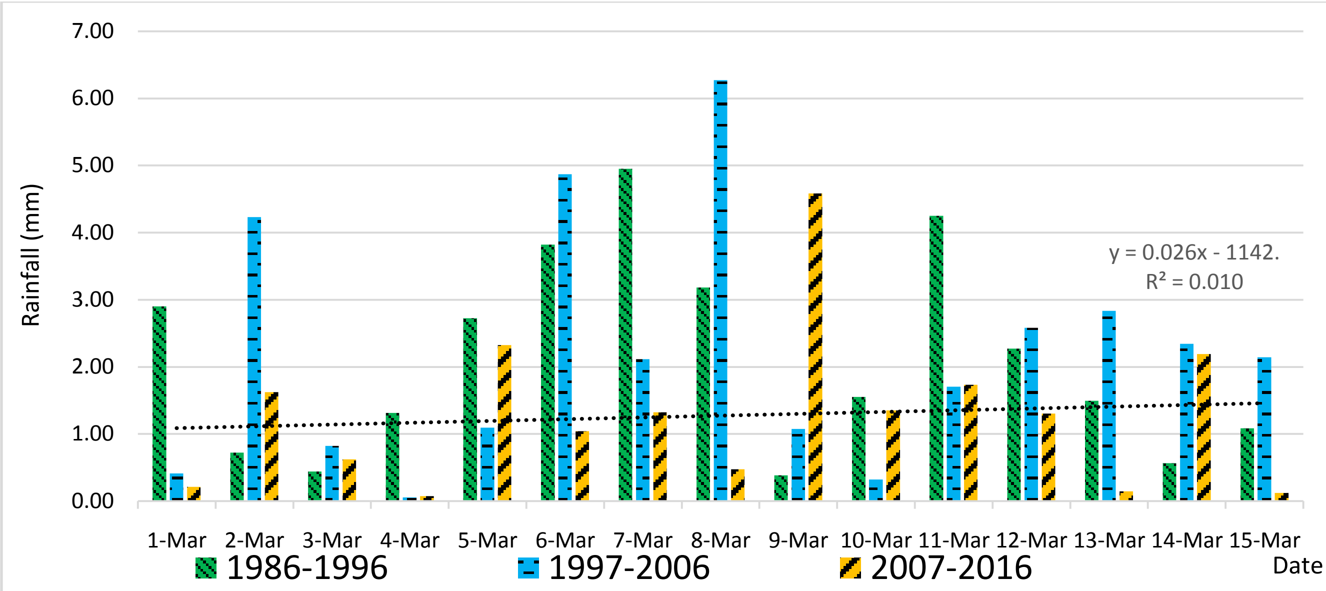

Figure 4: Shows the average decadal daily rainfall for the first 15days of the month of March. The decades considered are 1986-1996, 1997-2006 and 2007-2016.

It should however be noted that during the onset of rainfall in the MAM season, average peak rainfall amounts (above 4.5mm) were received at the end the first week in all the three decades (4.95mm in 1986 – 1996 decade on 7th March; 6.27mm in 1997 – 2006 decade on 8th March and 4.58mm in 2007 – 2016 decade on 9th March). The lowest average diurnal rainfall amounts (below 0.4mm) was recorded on 9th March for the first decade (1986 – 1997), on 4th and 10th March for the second decade (1997 – 2006) and on 1st, 4th 13th and 15th March in the most recent decade (2007 – 2016).

Figure 5 displays trends in the average daily rainfall amounts for the first 15 days of the month of September in the second rainy (SON) season. Overall, average rainfall amounts in the first decade (1986 – 1996) were generally higher than in the subsequent decades. This was the case especially in the second week with the average highest diurnal rainfall amounts (above 5mm) on 2nd and 9th September and the lowest amount (0.2mm) recorded on 15th September.

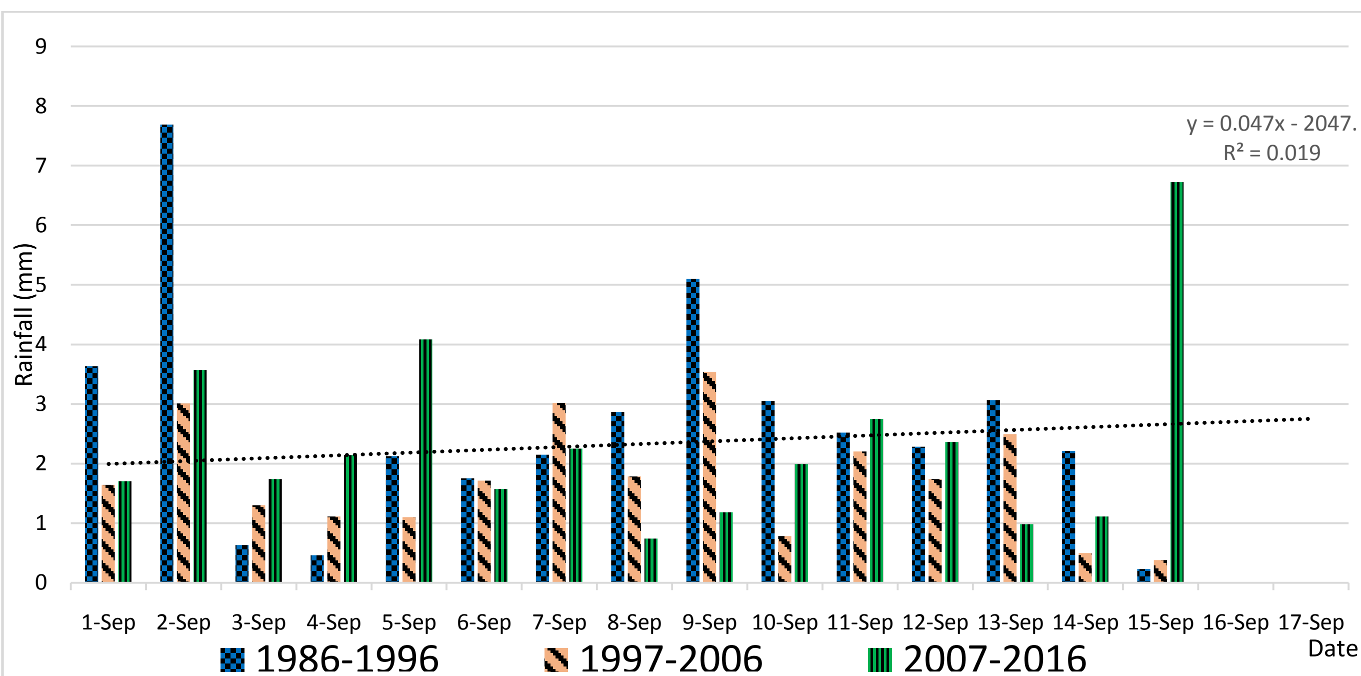

Figure 5: Trends of rainfall onset in the second season (SON season) in Kasese zone

It was closely followed by the recent decade (2006 – 2016) with the peak average diurnal rainfall on 15th September with the lowest amount (0.7mm) on 8th September. The mid-decade (1997 – 2006) recorded the lowest average diurnal rainfall amount (below 4mm) though with the highest amount (3.5mm) on 9th September and the lowest (0.3mm) on 15th September. This therefore signifies that although the onset of rainfall starts within the starting months (that March and September), the daily rainfall amounts are low generally (below 5mm) with minimal progressive increase.

3.1.3 Rainfall Cessation

Table 3 displays perceptions of the bee farmers as regards to the current trend of rainfall cessation as compared to the previous decades. Overall, the highest percentage (88.1%) of the respondents disclosed that rainfall cessation currently is significantly early as compared to the previous decades. However, the smallest percentages (9%, 1.9% and 1%) of the respondents disclosed that rainfall cessation currently occurs moderately early, delays and significantly delays respectively.

Table 3: Cross tabulation of the socio-economic characteristics of the Bee farmers and their perceptions on the rainfall cessation as compared to the previous decades.

Sub County	Rainfall cessation								Total	
	Significantly Early		Moderately early		Delay		Significantly delay			
	No	Percent	No	Percent	No	Percent	No	Percent	No	101
Busiriba	97	96.0%	1	1.0%	2	2.0%	1	1.0%	101	100.0%
Bihanga	101	97.1%	1	1.0%	2	1.9%	0	0.0%	104	100.0%
Ntara	77	72.0%	26	24.3%	2	1.9%	2	1.9%	107	100.0%
Total	**275**	**88.1%**	**28**	**9.0%**	**6**	**1.9%**	**3**	**1.0%**	**312**	**100.0%**
Chi-square = 49.379 , p = 0.000										
Gender										
Male	140	89.7%	9	5.8%	5	3.2%	2	1.3%	156	100.0%
Female	135	86.5%	19	12.2%	1	0.6%	1	0.6%	156	100.0%
Total	**275**	**88.1%**	**28**	**9.0%**	**6**	**1.9%**	**3**	**1.0%**	**312**	**100.0%**
Chi-square = 6.662 , p = 0.083										
Education										
No formal Education	45	93.8%	2	4.2%	1	2.1%	0	0.0%	48	100.0%
Primary	160	90.4%	12	6.8%	4	2.3%	1	0.6%	177	100.0%
Secondary	57	80.3%	11	15.5%	1	1.4%	2	2.8%	71	100.0%
Tertiary	13	81.3%	3	18.8%	0	0.0%	0	0.0%	16	100.0%
Total	**275**	**88.1%**	**28**	**9.0%**	**6**	**1.9%**	**3**	**1.0%**	**312**	**100.0%**
Chi-square = 12.072 , p = 0.209										
Marital Status										
Never Married	24	77.4%	4	12.9%	2	6.5%	1	3.2%	31	100.0%
Married	242	89.0%	24	8.8%	4	1.5%	2	0.7%	272	100.0%
Divorced / Widowed	9	100.0%	0	0.0%	0	0.0%	0	0.0%	9	100.0%
Total	**275**	**88.1%**	**28**	**9.0%**	**6**	**1.9%**	**3**	**1.0%**	**312**	**100.0%**
Chi-square = 7.570 , p = 0.578										
Occupation										

Farmer	241	88.3%	24	8.8%	6	2.2%	2	0.7%	273	100.0%
Professionals	15	83.3%	3	16.7%	0	0.0%	0	0.0%	18	100.0%
Traders	12	85.7%	1	7.1%	0	0.0%	1	7.1%	14	100.0%
Others	7	100.0%	0	0.0%	0	0.0%	0	0.0%	7	100.0%
Student	275	88.1%	28	9.0%	6	1.9%	3	1.0%	312	100.0%
Total	**241**	**88.3%**	**24**	**8.8%**	**6**	**2.2%**	**2**	**0.7%**	**273**	**100.0%**
Chi-square = 8.856 , p = 0.715										
Tribe										
Mutagwenda	18	64.3%	8	28.6%	0	0.0%	2	7.1%	28	100.0%
Mukiga	135	90.0%	12	8.0%	2	1.3%	1	0.7%	150	100.0%
Munyankole	71	91.0%	5	6.4%	2	2.6%	0	0.0%	78	100.0%
Mufumbira	33	97.1%	1	2.9%	0	0.0%	0	0.0%	34	100.0%
Mutoro	16	84.2%	1	5.3%	2	10.5%	0	0.0%	19	100.0%
Others	2	66.7%	1	33.3%	0	0.0%	0	0.0%	3	100.0%
Total	**275**	**88.1%**	**28**	**9.0%**	**6**	**1.9%**	**3**	**1.0%**	**312**	**100.0%**
Chi-square = 40.355 , p = 0.266										
Age Group										
15 to 30	65	84.4%	7	9.1%	4	5.2%	1	1.3%	77	100.0%
31 to 50	132	88.0%	14	9.3%	2	1.3%	2	1.3%	150	100.0%
51 plus	78	91.8%	7	8.2%	0	0.0%	0	0.0%	85	100.0%
Total	**275**	**88.1%**	**28**	**9.0%**	**6**	**1.9%**	**3**	**1.0%**	**312**	**100.0%**
Chi-square = 7.638 , p = 0.000										
Annual Income										
Less than 720,00/=	132	88.0%	13	8.7%	4	2.7%	1	0.7%	150	100.0%
720.000/= to 2,400.000/=	7	100.0%	0	0.0%	0	0.0%	0	0.0%	7	100.0%
2,400.001 to 6,000.000/=	87	84.5%	13	12.6%	2	1.9%	1	1.0%	103	100.0%
Over 6.000.000/=	13	92.9%	1	7.1%	0	0.0%	0	0.0%	14	100.0%
Total	**239**	**87.2%**	**27**	**9.9%**	**6**	**2.2%**	**2**	**0.7%**	**274**	**100.0%**
Chi-square = 2.979 , p = 0.965										

As per sub-county, whereas the smallest percentages (1%, 2% and 1%) of the respondents in Busiriba sub-county reported the current rainfall cessation to be moderately early, delays and significantly delays respectively as compared to the96% of the respondents who reported that currently the rainfall cessation occurs significantly early as compared to the previous decades. In Bihanga sub-county,97% of the respondents reported that rainfall cessation occurs significantly early as compared to 1%,2% and 0% of the respondents who reported that rainfall cessation moderately delays, delays and significantly delays respectively. For the case of Ntarasub-county, 72% of the respondents reported that rainfall cessation was significantly early whereas 24%, 2% and 2% of the respondents reported that rainfall cessation is moderately early, delays and significantly delays respectively.

Overall, 88% of the respondents in the district were of the view that rainfall cessation was significantly early while 9%, 2% and 1% fell in the moderately early, delay and significantly delay categories. When subjected to chi-square tests, it was established that there was a significant relationship between farmer's sub counties and their perceptions on rainfall cessation (p=0.000). In agreement with the results from the quantitative analysis, a Key Informant from Bihanga sub-county exclaimed: *"I do not know what has bewitched our country, the rains do not begin when expected and even when they arrive, they do not last long"*

Another Key informant aged84 years while referring to windy rain received on the 21st March 2019, in Kitagwenda county in Kamwenge district, said:*"Apart from the rains delaying, they last for a short time. To make matters worse, even when they come, they are destructive. Since I was born I have never seen such destruction by rain accompanied with wind. We shall take a whole year before we test bananas"* Figure 6 shows some of the damaged banana plantations.

Figure 6: The effects of torrential rains on banana plantation in Kamwenge District

The trends of diurnal average amounts during rainfall cessation in the first rainy (MAM)season shown in the last two weeks of May is illustrated in Figure 7. Overall, the average dailyrainfall amounts show a diminishing trend with the amounts declining from above 5mm in the second last week of May to daily rainfallamounts that go below 5mm in the last week of May with a few outliers.

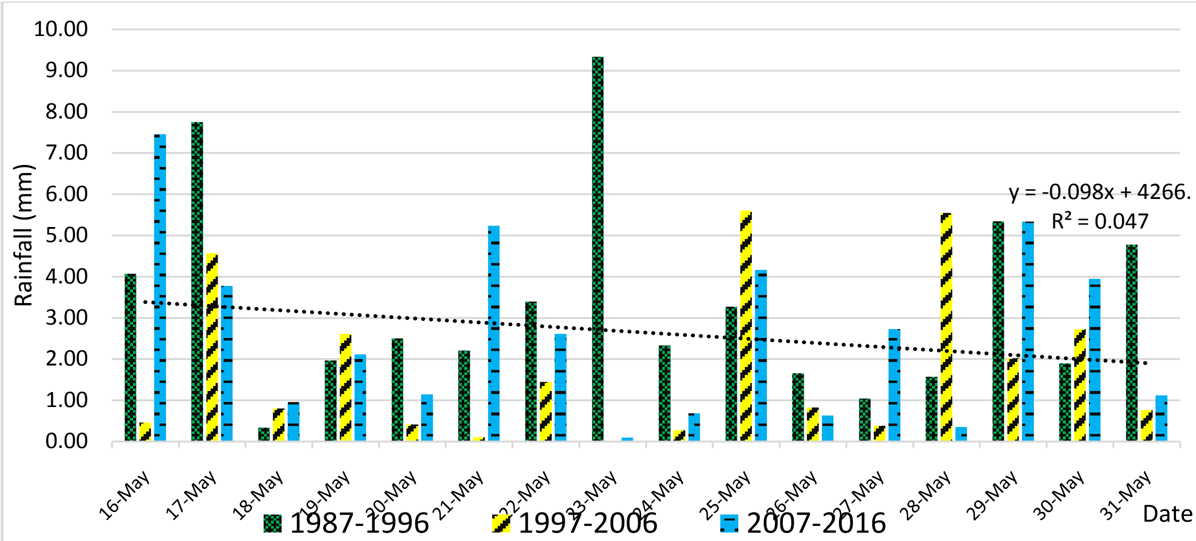

Figure 7: Shows the average decadal daily rainfall amounts for the last 15 days of the month of May

When collapsed to decades, rainfall cessation in the recent decades (1997 – 2006 and 2007 – 2016) started very much early as compared to the previous decade (1987 – 1996). Specifically, average dailyrainfall amounts below 1mm were first recorded on 16th and 17th May respectively. Although the same trend was recorded in 1987 – 1996 decade, much of the latter's average diurnal rainfall amounts were generally higher (above 7mm) as seen on 17th, 23rd, and 29th May (with 7.8mm, 9.3mm and 5.4mm respectively) as compared to the successive decades where in 1997 – 2006, the highest average diurnal rainfall in the last two weeks off May was recorded on 25th and 28th May (5.6mm and 5.5mm respectively) which were even lower than 7mm. Surprisingly, the most recent decade (2007 – 2016) slightly recorded higher average diurnal rainfall amounts that were higher than the 1997 – 2006 decade with the highest average amount (7.5mm) on 16th May of which afterwards rainfall cessation started. Although average diurnal rainfall amounts in the last two weeks of MAM rainy season were moderate (above 4mm), it should be noted that rainfall cessation started significantly earlier than expected since the very lowest average diurnal rainfall amounts (below 0.5mm) at the start of the third week of May in all the three decades.

The trends in average diurnal rainfall cessation for the second rainy (SON)season is shown in the last two weeks of November as illustrated in Figure 8. Generally, average diurnal rainfall amounts displayed an increased trend especially in the recent two decades.

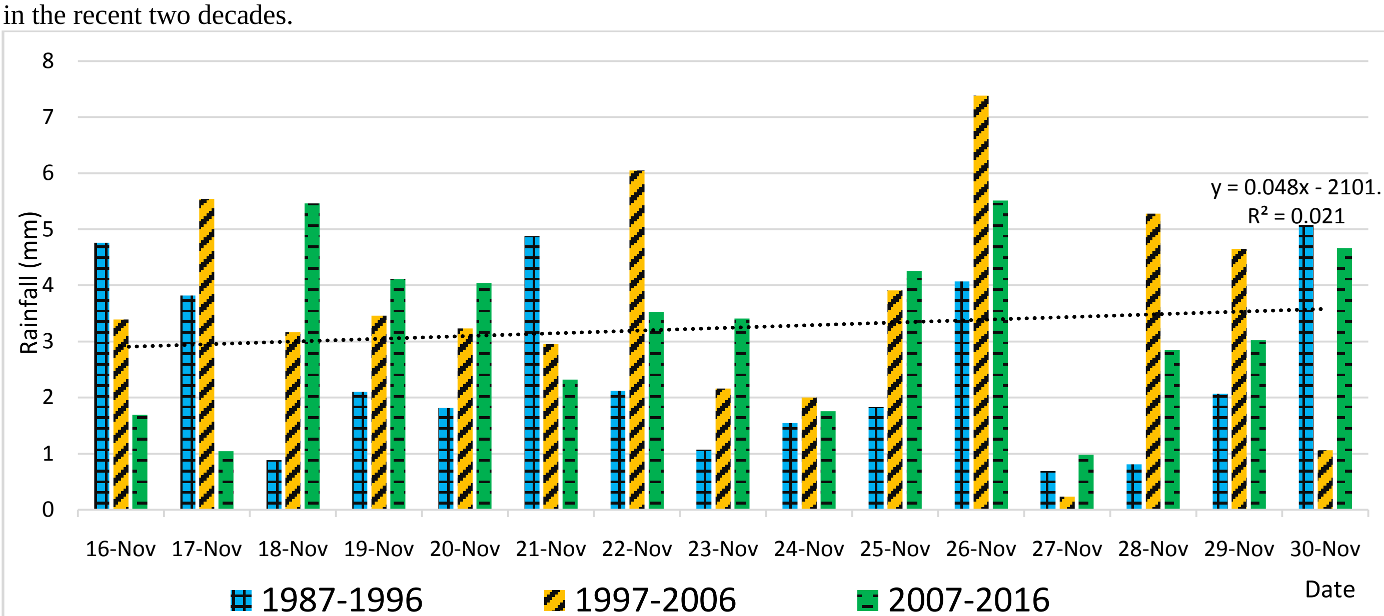

Figure 8: Shows the average decadal daily rainfall amounts for the last 15 days of the month of November.

In the 1987-1996 decade, rainfall cessation started as early as 18th November although the lowest average dailyrainfall amounts (0.7mm) were recorded on 27th November. The average dailyrainfall amounts in 1987 – 1996 decade were generally below 2.5mm throughout the last two weeks of November although the dailyamount (5.1mm) was recorded on 30th November. As regards to 197 – 2006 decade, average diurnal rainfall amounts were generally above 2mm with the highest average diurnal rainfall amount (7.4mm) recorded on 26th November subsequently followed by the lowest average diurnal rainfall amounts (0.2mm and 1.1mm) on 27th and 30th November respectively. For the case of 2007 – 2016 decade, average diurnal rainfall amounts in the last two weeks of November were generally above 2mm although the lowest rainfall amounts (0.9mm, 1.0mm and 1.7mm) were recorded on 27th, 17th and 16th November which signifies that rainfall cessation also started early.

The increasing trend of diurnal rainfall amount towards the end of second rainy season in November is because the rains in the second season do not subsequently subside upon onset of the second dry (DJF) season. The rains rather continue through to December as well depicted in Figure 9 where average monthly rainfall amount of December was 81mm and yet December is the month where dry season is expected to start. This was not the case in the onset month (June) of the first dry season although average rainfall amount of June was 52mm. This recent readjustment of the seasons is a possible manifestation of climate change and climate variability which has implications on the community livelihoods and specifically on farmer's calendar since majority practice rain-fed agriculture and have been following indigenous knowledge systems (Nyakaisiki et al., 2019).

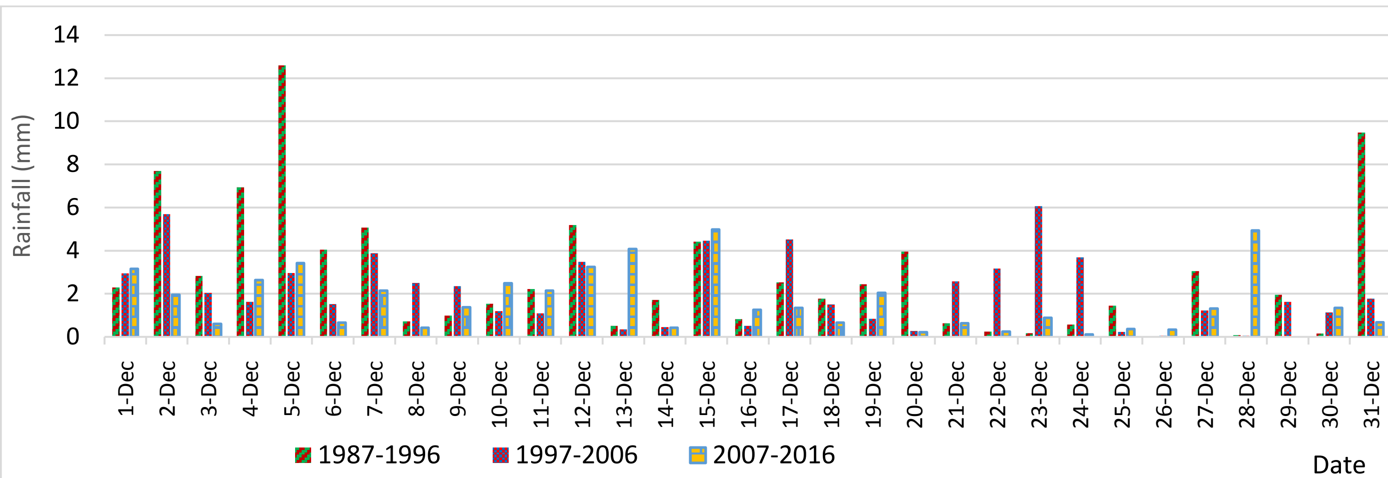

Figure 9:Shows the average decadal daily rainfall for the month of December and for the three decades.

3.2.1 Rainfall variability implications

Figure 10 shows the current implications of rainfall variability on community livelihoods according to the respondents in Kamwenge District.

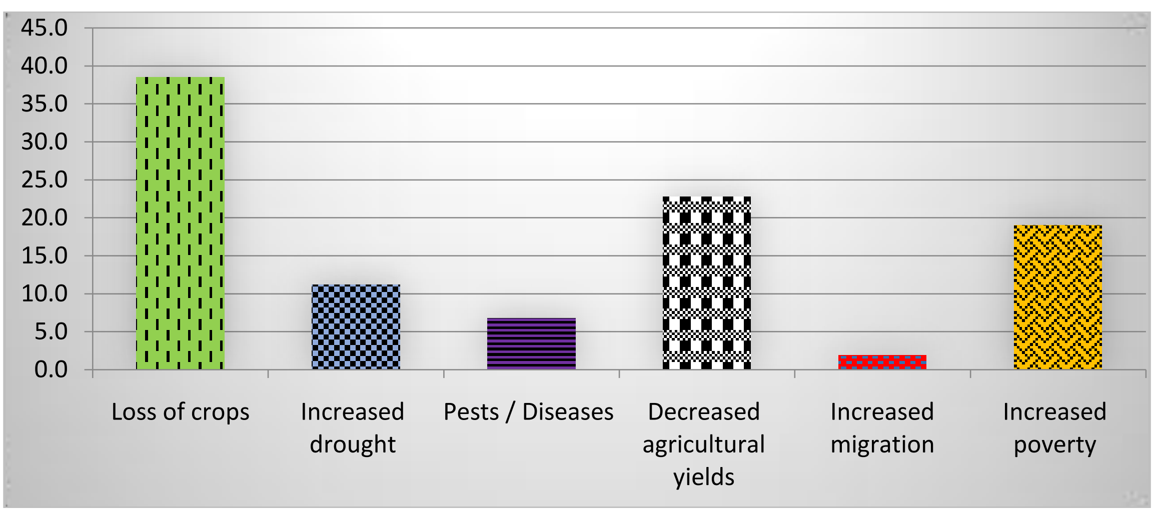

Figure 10: The effects of rainfall variability on bee farmers' livelihoods in Kamwenge District.

The majority (38%) of the respondents reported to have lost crops whereas 23% reported general decline in agricultural yields, 19% disclosed increase in poverty while 11% reported increased drought, 9% acknowledged increased prevalence in pests and diseases and 2% reported increased migration pattern. These effects of rainfall variability have significant implications not only to bee farmers but all the community members' livelihoods.

3.2.2 Coping strategies to Rainfall variability

When interviewed on coping strategies to the challenges brought about by rainfall variability, bee farmers had varying opinions as presented inFigure11. Of the total percentage, 42% of the respondents disclosed the need to emphasize afforestation and agro-forestry practices while 31% of the respondents emphasized environmental conservation activities, 17% of the respondents stressed the need to establish dams as water collection / preservation points for not only for livestock but also to provide water for crop irrigation especially during dry season.

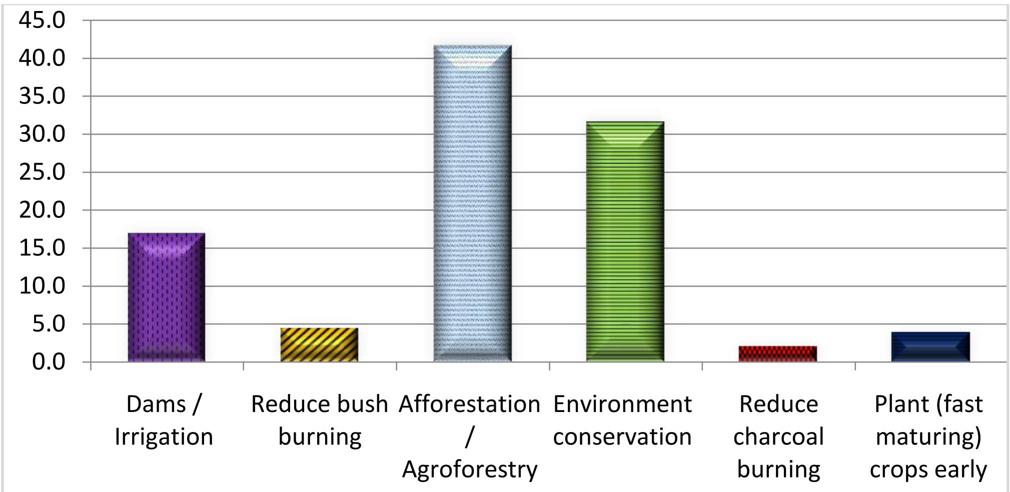

Figure 11: The farmers' perception of coping strategies to the rainfall variability effects on community livelihoods.

However, small percentages (4%, 4% and 2%) of the respondents acknowledged the need to specifically plant fast maturing crops, reduce (eliminate if possible) bush burning and charcoal burning.

4.0 Conclusion and Recommendation

4.1 Conclusion

The results revealed that 76% and 16% of the respondents perceived reduced and significantly reduced rainfall in recent decades. While 90% of the famers reported that rainfall significantly delay and 88% lamented its cessation was significantly early. The primary findings were in agreement with the secondary data from UNMA. We noted that there's evident change in the rainfall season with rains starting slightly late especially for the MAM rainfall season and withdrawing early. The implications of rainfall variability included increased drought and increased prevalence in pests and diseases that led to loss of crops, decrease in agricultural yields and persistent poverty. Coping strategies were: afforestation, agroforestry, environmental conservation, establishment of dams to conserve water for livestock and irrigation of crops. Planting fast maturing crops and reducing bush burning and charcoal production were also suggested.

4.2 Recommendations

The paper recommends that the District Local Government through the department of Natural Resources and in collaboration with Agricultural Production should encourage afforestation, environmental conservation and agroforestry while emphasizing bee farming.

This is because the first three will go a long way in providing forage for the bees and also improving the micro-climate of the district. The trees also act as wind brakes which will go a long way in reducing the effect wind that has constantly felled bananas. In this regard, it is recommended that gravelia and Ficusnatalensis should be planted on the boundaries of banana gardens. In reference to reduction in use of charcoal, it is recommended that with increased hydropower production in the country, the ministry of energy should accelerate the connection of customers on the national grid. This is because the charcoal produced is mainly for sell to the urban areas. The feasible method of reducing use of charcoal is provision of cheaper alternative of power.

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