KNOWLEDGE AND PERCEPTIONS OF SMALL-SCALE FARMERS ON CLIMATE VARIABILITY IN MILLET AND SORGHUM-GROWING AREAS IN THARAKA NITHI, KENYA

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ABSTRACT

Climate variability is having a serious consequence on agriculture, especially for millet (*Pennisetum glaucum* (L.) R. Br.)) and sorghum (*Sorghum bicolor* (L.) Moench) since their production is influenced by the environmental variation. The objective of this study was to determine farmers' knowledge and perceptions of climate variability on millet and sorghum. The study was conducted in Tharaka North, Tharaka South, and Igambang'ombe sub-counties of Tharaka Nithi County. Stratified random sampling and systematic simple random sampling were employed to obtain a sample size of 399 respondents. Ten key informants, mainly from institutions, were selected using purposive sampling method. A significant number of millet and sorghum farmers had knowledge and perceived climate variability as a major cause of crop failure. This includes low and unpredictable rainfall, increased temperatures, excessive rainfall, prolonged cold, hot weather, rainy and dry seasons. Crops on farms wither and dry up. The indigenous knowledge that farmers used to rely on is no longer perfect, as rainfall can come too early or too late. The outbreak of many pests like locusts that attack both millet and sorghum, and the loss of permanent rivers during severe drought in some seasons are common. From this study, most (92.2%) of the famers already had the knowledge and they agreed (54.9%) that climate has been changing over the time . As a result, it was recommended that climate experts take the initiative of making climate variability preparedness available to small-scale farmers so that they can reduce future climate variability risks. The county and national governments need to ensure proper implementation of climate change mitigation measures so as to strengthen knowledge and perception that small-scale farmers already have.

Keywords: small scale farmers, climate variability, knowledge, perception, millet and sorghum farming

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INTRODUCTION

Climate variability has posed challenges to food security globally since it adversely affects the agricultural sector in one way or the other. For instance, erratic rainfall and increased temperatures have been influencing the physiological processes of food crops with direct negative effects (Abberton *et al.,* 2021). On the other hand, the indirect effect is that climate variability has an impact on crop development and production elements such as soil fertility and water supply, as well as pests and diseases. Besides that, droughts and floods cause significant crop loss and have a significant impact on revenue generation by small-scale farmers (Behailu *et al.,* 2021). In general, climate variability could have a negative impact on food crop production, accessibility, and availability for a large number of the population, especially in developing regions like Africa. This affects cereal crops like pearl millet which is an important food crop in West, Southern and Eastern Africa as well as semiarid and arid parts of India (Clotault *et al*., 2012).

Sorghum is an ancient African cereal crop that grows in the semiarid tropics of South and South East Asia, America, China, and Africa (Venkateswaran *et al.,* 2019). Davis *et al.* (2019) found that millet and sorghum farming methods have a lower carbon footprint than major staple crops that are grown with more agrochemicals. According to the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), over 90 million people in Asia and Africa rely primarily on millet as a cereal and staple crop, while sorghum is a staple food for about 0.5 million people in over 30 countries (Orr *et al.,* 2020). In addition, production of millet and sorghum contributes to the generation of income and also the improvement of food security. According to Davis *et al.* (2019), climate variability adversely affects millet and sorghum establishment, growth, development, and production. Climate variability compromises millet and sorghum production in most areas. This impacts general food crop production, including shifting of growing seasons, planting time, harvesting time and harvested area, as well as changes in production and yields (Defrance *et al.,* 2020).

The major negative effects that climate variability has on cereal crop production may include decreased quality and quantity produced, reduced soil fertility, drought incidences, destruction of lands as a result of frequent floods and prolonged droughts, the occurrence of pest and diseases, as well as high weed infestation incidences (Saediman *et al.,* 2020; Eccles, 2021; Baffour-Ata *et al.,* 2021). The lower Tharaka region, for example, is one of the most important areas for millet and sorghum cultivation. It was therefore necessary to conduct an appropriate assessment on small-scale farmers' knowledge and perceptions of climate variability (Makame & Shackleton, 2020). The understanding of climate variability is important since it would help in identifying and coming up with solutions for improving millet and sorghum production systems to be resilient and adaptive to climatic variability in the future. Therefore, the objective of this study was to determine the knowledge and perception of climate variability among small-scale farmers producing millet and sorghum in Tharaka Nithi County.

METHODOLOGY

Study site This study was conducted in Tharaka Nithi County, specifically in areas where millet and sorghum are widely grown, including Tharaka North, Tharaka South, and part of Igambang'ombe sub-counties. According to the 2019 census, Tharaka Nithi County has a population of 393,177 people (KNBS, 2019).

In this area, the hottest months are January and February, as well as September and October, but the average temperature ranges between 17 ˚C and 35 ˚C (MoALF, 2017). The study area experiences annual precipitation ranging from 2100 to 2500 mm in a bimodal pattern ranging from 250mm to 1200mm. The long rains occur between March and May, while the short rains occur between October and December. According to Wawire *et al.,* (2021), the predominant soils in Tharaka Nithi County which are prone to erosion and compaction are ferralsols, Alfisols (Acrisols, luvisols), and vertisols. . The soils are generally coarse textured, have low organic matter, and are shallow, resulting in low crop yield (Wawire *et al.,* (2021). Majority of the people in the study area are small-scale farmers who grow food crops for subsistence, with very few large-scale commercial farmers (King-Okumu *et al*., 2018).

Data collection

Data was collected from July to August 2021 using interviews, questionnaires, focus group discussions, and observations. Stratified random sampling and systematic simple random sampling were employed to obtain a sample of 399 respondents. This sample size was obtained by use of formula adopted from Yamane (1967). The semi-structured questionnaires were used to assess both demographic and socioeconomic characteristics, small-scale farmers' knowledge of climate variability, the climate variability impacts, and the perception of small-scale farmers on climate variability. For qualitative data, the researcher used an interview guideline to conduct eight focus group discussion on the wide topics of climate variability and its impacts on millet and sorghum farming as well as opinions towards solutions to climate variability. Each of the focus group discussions was composed of seven small-scale farmers that grow millet and sorghum in the study area. In addition, interviews were carried out with 3 officers in charge of agriculture in Tharaka North, Tharaka South, and part of Igambang'ombe sub-counties.

Data analysis

The data were analysed using descriptive statistics. Perception responses were designed to be reported on a 5-point Likert scale, where strongly agree, agree, neutral, disagree,strongly disagree were 5, 4, 3, 2 and 1 respectively (Chimi and Russell, 2009). The responses to the questions were categorized based on their mean scores.

RESULTS AND DISCUSSION

Characteristics of respondents

From this study, it was revealed that the interviewed composed of 69.7% male and 30.3% female farmers (Table I). The majority of the respondents were between the ages of 41–50 (29.6%) and 51–60 (24.8%) while a few respondents were between the ages of 21–30 (5.3%). These are the groups that are actively involved in farming and other productive economic activities.

Most of the respondents were married (92.0%). Among the respondents who participated in this study, 37.6% had acquired knowledge up to primary education, while 27.6% were educated up to secondary education level 13.6% had tertiary education, and 21.1% had no formal education.

TABLE I- FARMERS' CHARACTERIZATION (n=399)

Variables		Percent
Gender	Male	69.7
	Female	30.3
Age	21-30	5.3
	31-40	18.3
	41-50	29.6
	51-60	24.8
	61-70	14.3
	71-80	6.5
	81-90	1.3
Education	Primary	37.6
	Secondary	27.6
	Tertiary	13.8
	Did not attend school	21.1
Married	Yes	92.0
	No	8.0
Training	Yes	37.9
	No	62.1
Employed	Yes	34.8
	No	65.2
Land size	Below 1 hectare	36.1
	1-3 hectares	27.8
	4-5 hectares	23.1
	Above 5 hectares	11

A higher percentage of 62.1% of the respondents had never attended any training in agriculture, with only 37.9% indicating they had attended . Only 34.8% of the farmers were employed while 65.2% were not employed. The total averageland size grown with crops was below 1 hectare (36.1%), 1-3 hectares (27.8%), 4-5 hectares (23.1%), and above 5 hectare (11%)

Knowledge on climate variability

The findings showed that 92.2% of the respondents already had knowledge and 89.2% of them had heard about climate variability (Table II). The results further showed that 82.5% of the small-scale farmers got information on climate variability from mass media sources such as television, radio, newspapers, and social media.

Other sources of information on climate variability mentioned included agro-dealers (76.4%), County and government extension officers (24.6%), non-governmental organization officers (39.1%), church and village elders, friends, fellow farmers (49.4%), personal experience and observation (74.9%) and agricultural seminars (14.8%).

The results further indicated that climate variability was in form of increased temperatures (74.2%), prolonged dry spells/droughts (73.9%), floods (12.4%), indigenous knowledge becoming unreliable (76.7%), unpredictable rainfall (95.2%), increased millet and sorghum pests and diseases (87%), and drying of permanent rivers (63.2%).

The results showed that small-scale farmers in Tharaka Nithi County appeared to be knowledgeable about the effects of climate variability (Table II). These impacts adversely the production of millet and sorghum. This finding goes hand in hand with that of Kirema (2020), who pointed out that the Thanantu river, which acts as a source of water for the majority of Tharaka North, goes dry during the dry seasons, especially when prolonged droughts strike. Its flow had altered so much that in recent years it had reached the point of becoming a seasonal river. However, floods were least mentioned, and this could be due to the fact that most of the areas have relatively hilly terrain that does not retain water for flooding. The few numbers that indicated floods as a problem were those who have settled or had farmlands near or along the Tana River, which floods during very heavy rainy seasons and tends to sweep most of the crops and settlements.

TABLE II- KNOWLEDGE OF RESPONDENTS ON CLIMATE VARIABILITY (n=399)

Questions	Response	%
Do you know about climate variability?	Yes	92.2
	No	7.8
Have you ever heard of climate variability?	Yes	89.2
	No	10.8
Where do you get information on climate variability from?	Mass media, eg; Television, Radio, Newspapers, Social Media	82.5
	County and government extension officers	24.6
	Non-governmental organization officers	39.1
	Agro dealers	76.4
	Church and village elders, friends, fellow famers	49.4
	Personal experience and observation	74.9
	Agricultural seminars	14.8
Which impacts do you think climate variability has?	Increased temperatures	74.2
	Prolonged dry spells/droughts	73.9
	Floods	12.4
	indigenous knowledge no longer works as before	76.7
	Unpredictable rainfall	95.2
	Increased millet and sorghum pests and diseases e.g. locusts that attack both millet and sorghum	87.0
	Loss of permanent rivers	63.2

Perception of climate variability

The findings indicated that millet and sorghum farmers in the study area had a strong perception of climate variability (Table III). Likert scale questions were asked to determine the various aspects of the climate that could influence farming. From the responses, 48.9% agreed that seasons and weather had changed in the last 30 years, 54.9% agreed that climate had changed in the area compared to 30 years ago, and 47.6% strongly agreed that other factors had contributed to low crop production rather than climate variability. These findings agree with that of Hoy *et al.* (2020), who explained how climate variability affect the Northern Hemisphere's seasons and the agriculture sector. In their studies, they revealed that the length of the summer dry season had increased while the length of the cold season had reduced, so seasons and weather patterns have shifted.

On the other hand, 49.5% of the farmers strongly disagreed with the fact that climate variability did not affect millet and sorghum production, 40.4% of the farmers strongly disagreed that climate variability was not likely to affect crop production, 18.1% of the farmers strongly disagreed that there was no climate variability in the area and 36.1% of the farmers were neutral that climate variability would adversely affect crop production in the future. From the responses, 48.9% agreed that seasons and weather had changed. Agesa *et al.* (2019) and Behailu *et al.* (2021) observed that temperature rises can harm millet and sorghum yields' quantitative and qualitative characteristics, such as establishment, growth, development, and grain quality.

TABLE III. - FARMERS' PERCEPTION OF CLIMATE VARIABILITY

Climate Variability	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Seasons and weather have changed in the last 30 years	0.8	1.8	7.3	48.9	41.4
Climate is changing in this area compared to 30yrs ago	1.3	0.8	5.5	54.9	37.6
Climate variability does not affect millet and sorghum production	49.1	34.8	5.0	16.8	4.3
Climate variability is not likely to affect crop production	40.4	33.3	5.0	19.3	2.0
There are other factors contributing to low crop production rather than climate variability	0.3	0.8	4.0	47.4	47.6
There is no climate variability in the area	18.1	36.8	6.0	16.0	3.0
Climate variability will adversely affect crop production in future not now	15.8	20.8	36.1	20.8	6.5

CONCLUSIONS AND RECOMMENDATIONS

Small-scale millet and sorghum farmers had good knowledge of climate variability and the respective changes in the environment and production in the past thirty years. Small-scale farmers' perceptions of the climate variability impacts included unpredictable rainfall, increased temperatures, the shrinking of some permanent rivers, indigenous knowledge not working anymore, and prolonged droughts. In addition, seasons and weather had changed in the last 30 years, and climate variability had adversely affected millet and sorghum production. Farmers associated climate variability with increased millet and sorghum pests and diseases. For instance, the locusts and Fall Army worms that attacked millet and sorghum in 2019 may have been as a result of climate variability. However, flood incidences were the least mentioned. It is recommended that climate experts take the initiative to come up with various ways of educating small-scale farmers on climate variability, especially for the farmers that practice millet and sorghum cultivation. This will allow them to gain a better knowledge and perception of climate variability as well as the adaptation strategies that could be employed, thereby increase and promote millet and sorghum production in the area.

ACKNOWLEDGMENTS

Gratitude go to area agricultural extension workers from Tharaka Nithi County for organising, meetings and discussions with millet and sorghum small scale farmers. Special thanks to Kenya Climate Smart Agriculture Project Management for financial support.

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