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| RESEARCH ARTICLE

**Resilient Harvests: Unlocking the Potential of Drought-tolerant Orphan Crops in Kibwezi West Sub-county, Kenya – Production Trends, Farmer Practices and Challenges**

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| ABSTRACT

Food security remains a major challenge for smallholder farmers in Kenya's dryland regions, which are marked by low and erratic rainfall. However, amidst this challenge lies a glimmer of hope-orphan crops. This paper examines the production trends, farming practices, and challenges faced by smallholder farmers in growing orphan crops to combat food insecurity. The study was conducted in Kibwezi West Sub-County, which is in Makueni County in the eastern part of Kenya. Three orphan crops, namely sorghum, green grams, and pigeon peas, were investigated. Data was gleaned from over 200 questionnaires from smallholder farmers, Kibwezi West Sub-County agricultural office records (2014-2023), and interviews with key informants from the Department of Agriculture and NGO officers. The data was further supplemented with extensive one-on-one conversations, chama (village group) meetings, and nearly three months of in situ participant observation. Between 2014 and 2023, Sorghum and pigeon pea production decreased annually by 201.7MT and 1094.6MT, respectively, while green gram production increased by 124.4MT every year. The majority of smallholder farmers grew orphan crops during the short rainfall season (October to December), with ratooning common for sorghum and pigeon peas. Planting, weeding, and harvesting were done by hand, save for a few cases where oxen were used. Few farmers applied animal manure, and most did not use either manure or fertilizers. In all three orphan crops, the major constraints to production included low rainfall, pests and diseases, post-harvest losses from weevil infestation, soil degradation, weak seed distribution system, and unstructured marketing systems. Farmers can enhance the resilience of orphan crops by using integrated pest management strategies such as neem-based pesticides, adopting crop rotation and organic fertilizers to conserve soil, and setting up community-managed storage facilities. Additionally, establishing cooperatives and employing rainwater harvesting techniques will improve market accessibility and water management, respectively. To strengthen seed networks, community-based seed bulking and banking should be encouraged. By equipping farmers with this knowledge, the region's food security and the production of orphan crops will be greatly enhanced.

| KEYWORDS

Climate Change, Underutilized Crops, Food Security, Resilience

| ARTICLE INFORMATION

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**1. Introduction**

The main measure of food security is the availability and accessibility of nutritious and safe food for all human dietary needs. While food is extremely important for human development, this has not been the case for billions of people worldwide who are currently food insecure (Mohajan, 2022). Estimates show that out of 134 nations globally, 10.8% of the people in high-income nations face food insecurity, with 3.1% being severe, while 56.5% of people in

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low-income nations experience food insecurity, with 29.5% being severe food shortages (Samwel, 2021). Currently, the global population is estimated at 7 billion people, and projections show that by 2050, the number will have increased to around 9 billion (Solomon et al., 2021). Additionally, projections show that climate change is likely to cause a 20% decrease in agricultural production rates in developing countries by 2080 (Liaqat et al., 2022). With a growing global population and declining agricultural output, the future of food security remains extremely uncertain.

Orphan crops are those crops that either originate from a specific locality or have become indigenized through several years of growing natural selection, as well as farmer selection (Chongtham et al., 2022). The potential of orphan crops under water scarcity is crucial in global food security and may contribute to sustainable food systems amidst climate variability and change (Babele et al., 2022). The use of inexpensive, readily available, and climate-resilient orphan crops for local food system transformation is being investigated in many parts of the world (Borelli et al., 2020). For instance, farmers in India are now switching to millet farming after the water-guzzling paddy and wheat face tough challenges with the increasing temperatures and reduced rainfall threatening food security (Maitra, 2020).

Kenya is among the 49 countries listed by the Food Security Information Network as being in danger of famine (FSIN, 2018). The report further states that children, low-income households, the elderly, and marginalized populations, especially in arid and semi-arid lands (ASALs), are the most impacted by food insecurity in the country. Rainfall patterns are changing, thus posing a challenge to the agriculture sector, which depends significantly on rainfall (Kalele et al., 2021). Due to staple crops like maize and beans becoming overly sensitive to climate change, Kenya's situation of food insecurity has worsened, and it is anticipated that this will continue to negatively affect vulnerable individuals, mostly in ASALs (Kogo et al., 2021). According to Otara (2023), smallholder farmers in Kenya's ASAL regions are embracing drought-tolerant orphan crops like sorghum, green grams, and fast-maturing crop varieties to increase food security following climate change. Despite their vital role in enhancing food security in developing countries like Kenya, orphan or underutilized crops have received little attention from researchers and developers (Tadele, 2019). This study investigated the production trends, farming practices, and challenges faced by smallholder farmers in growing orphan crops to combat food insecurity.

## 2. The setting

This article is based on research done in Kibwezi West Sub-County, which is located in Makueni County in the eastern part of Kenya. The Sub-County covers an area of 3,985.7 square kilometers and has a population of approximately 248,704 people (KNBS, 2019). It is located between latitudes 2°14' and 2°41' South and longitudes 37°51' and 37°97' East. The entire sub-county is located in an ASAL region (GoK, 2014; GoMC, 2019), which is distinguished by low-lying terrain. However, the steep region of Chyulu Hills punctuates the area. The Sub-County experiences bimodal rainfall, with the long rains falling between March and April and the short rains between November and December. With an average of 500mm, annual rainfall is unpredictable and erratic (Odikor, 2023). The short rains constitute the primary crop growing season, and rain-fed agriculture is the main source of livelihood for the inhabitants. Although Kibwezi West Sub-County has six wards, this study was specifically focused on Kikumbulyu North and Kikumbulyu South wards. The two wards were purposively sampled due to the acute food shortages reported in the region (Makueni County Integrated Development Plan, 2023) and the growing trend of farmers turning to drought-tolerant orphan crops to guarantee food security amidst climate change.

## 3. Materials and Methods

For this study, three orphan crops, namely sorghum, green grams, and pigeon pea, were investigated. The data presented in this paper is gleaned from over 200 questionnaires filled out by smallholder farmers in the Kikumbulyu North and Kikumbulyu South wards. Additionally, the Kibwezi West Sub-County agricultural office provided data on the annual yields of the three orphan crops for the period spanning from 2014 to 2023. Formal interviews were also conducted with key informants from the Makueni County Department of Agriculture and officers from an NGO dealing with agriculture, food, and nutrition (Biovision Africa Trust) in Kibwezi West Sub-County. The data collected from key informant interviews, questionnaires, and the county agricultural office was further enriched by extensive one-on-one conversations with smallholder farmers and nearly six months of *in situ* participant observation, including active engagement in *chama* (village group) meetings. The author used simple random sampling to select

interlocutors for the study. Formal interviews were conducted in English, while informal conversations were done in the local *Swahili* language. Notes from interviews and participant observation were well kept by the author and coded by hand. To analyze trends in orphan crop production, linear regression analysis was applied to the annual yield data obtained from the sub-county agricultural office.

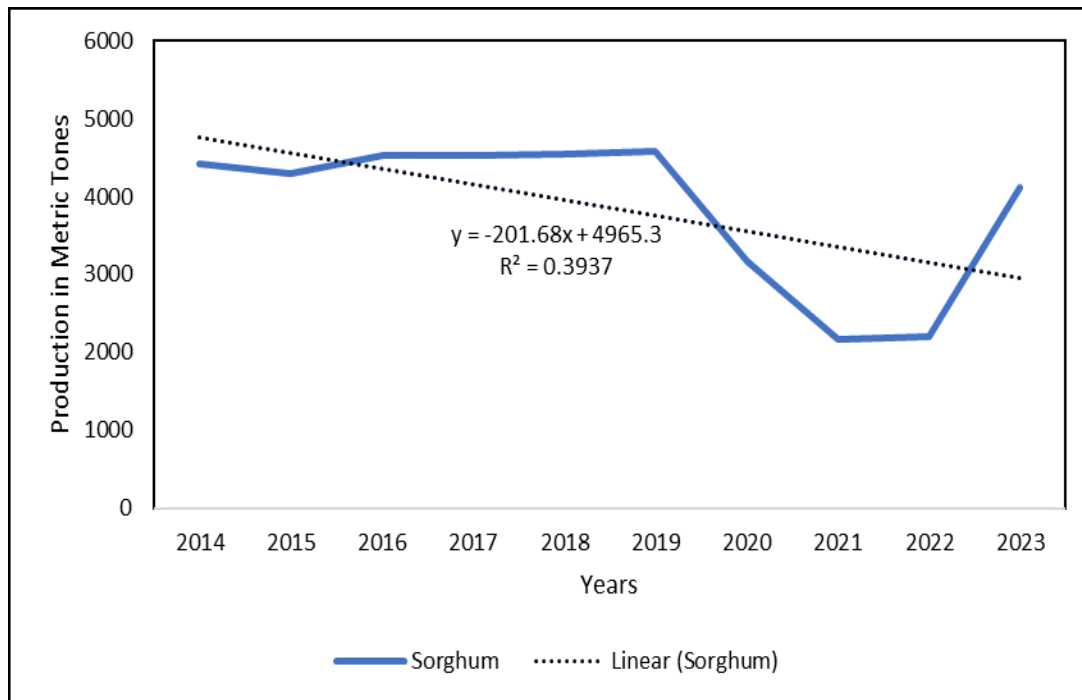
#### **4. Limitations of the Study**

Limitations of a study refer to the flaws that emanate from the research design and methodology. One of the significant challenges of this study was the availability of data on orphan crop yields from the Sub-County agricultural office. Given their neglected and underutilized nature, data on annual yields especially for the last three decades (1993-2023) become a challenge to get. The limited temporal scope can be a great challenge in research with the likely consequences of biased results, conclusions, and inaccurate decision-making. The researchers chose to work with the available data, which was for the last ten years (2014-2023). The study also focused on Kibwezi West Sub-County, which may not represent broader agricultural trends in other regions of Kenya or sub-Saharan Africa. Local environmental, economic, and cultural conditions could limit the generalizability of the findings.

### **5. Results and discussions**

#### **5.1 Sorghum**

The production trend of sorghum was analyzed, and the findings are presented in Figure 1.



**Figure 1.** Annual Yields Trend for Sorghum

Sorghum production increased between 2014 and 2019 before a sharp drop between 2020 and 2022 (Figure 1). The increase was attributed to a support program by the County government where farmers were occasionally issued with free certified seeds (Makueni County Development Plan, 2023). This led to an increase in the acreage under sorghum production in the County, thus increasing productivity. According to the farmers, the drop in production between 2020 and 2022 was due to low rainfall. The year 2021 recorded the least production due to the severe drought that the County experienced between 2020 and 2021, leading to massive crop failure (Makueni County Development Plan, 2023). While underpinning the effects of drought on sorghum production, Ondiko and Recha (2022) indicated that drought stress reduces leaf size, panicle length and height, panicle exertion, and sorghum height, which significantly reduce yields. The high short rains experienced in 2023 led to an increase in sorghum production, as confirmed by 75% of the farmers growing the crop. Overall, linear regression analysis revealed that

sorghum production was decreasing at the rate of 201.7 metric tons per year. The main cause for this decline, according to key informants, was a negative perception of sorghum as food for the poor and animals.

### 5.1.1 Farmer Practices and Challenges

The majority of the farmers practiced a one-season cropping system, with a few allowing for re-growth (ratooning). Farmers observed that apart from producing low yields, the ratoon crop transferred diseases to the next growing season, explaining why the majority did not allow re-growth. The crop was mainly grown during the short rains because the season experienced higher rainfall amounts. Planting was done at the onset of the rains with the common varieties grown, including Seredo, Gadam and Kari Mtama 1. Additionally, it was intercropped with maize, green grams, or pigeon peas, and very few cases of monocropping were reported. In one of the field surveys, I met Mutinda, a smallholder sorghum farmer at his farm in Kikumbulyu South Ward. He practiced mono-cropping, and as we spoke, he shared the reasoning behind his farming method and the benefits he had observed:

*"I grow my sorghum on a separate piece of land from other crops since this strategy significantly boosts yields. By minimizing competition for water and nutrients the sorghum can thrive with less stress, ensuring healthier growth and a more abundant harvest"*

Mutinda's approach speaks to a larger truth: minimizing competition for water and nutrients can sometimes lead to better crop productivity, particularly in areas with unpredictable rainfall patterns like Kibwezi West Sub-County. Nonetheless, Kagwiria et al. (2019) established that mono-cropping and failure to plant leguminous crops are among the poor farming techniques causing a decrease in soil zinc and nitrogen content. The resulting poor soils negatively influence sorghum yields. Figure 2 shows a mono-cropped sorghum farm in Kikumbulyu South Ward.



**Figure 2.** Sorghum crops in the Farm

Notably, a majority of the farmers grew the crop on very small portions of land and, in many cases, as few strips along the farm edges. While admitting this observation, Kagwiria et al. (2019) noted that apart from farmers' wrong perception of sorghum, low commercialization and the lack of well-established marketing channels that consider value addition were other reasons for the small area of land allocated to the crop. Weeding was done twice, from the time of planting to the time of harvesting, using hand hoes. Women were the most involved in growing this crop for sale or for chicken feed. Farmers observed that the crop was harvested by hand by cutting the panicle with a sickle and then sun-dried (Figure 3) before threshing, winnowing, and storage.



**Figure 3.** Sun drying sorghum Panicles after harvesting in Kikumbulyu North Ward

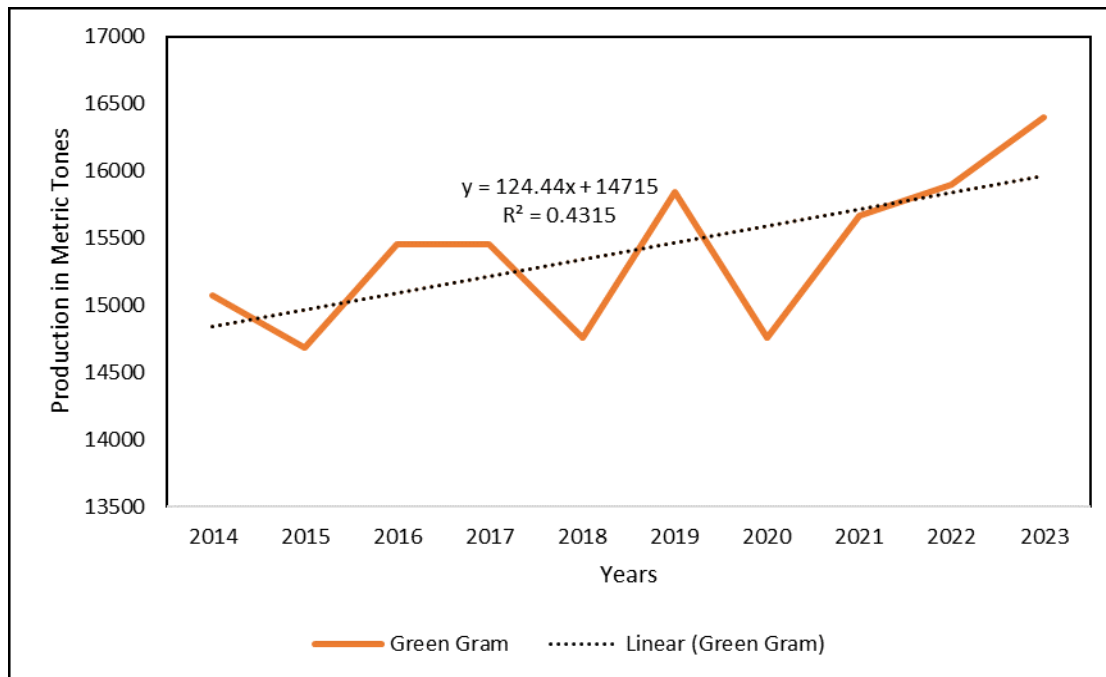
The major constraint to sorghum production, according to farmers, was bird damage. In one of the *chama* meetings in Kikumbulyu South Ward, smallholder farmers noted with a lot of concern that bird damage was devastating in sorghum production, sometimes leading to a 100% loss of the crop. I raised this concern in one of the interview sessions with the Makueni County Director of Agriculture, and she noted the following:

*"It is true that birds cause significant damage to sorghum crops, which is why we have developed a new variety that birds don't eat. While we have been actively encouraging farmers to adopt this new strain, we face an uphill battle. Many are hesitant due to its striking deep red color which starkly contrasts with the traditional varieties they are accustomed to. As a result, the market demand for this new variety remains low leaving farmers reluctant to grow it."*

Apart from bird damage, other pests and diseases affecting sorghum production included head smut disease and stalk borer. While underscoring the destructive nature of pests and diseases, Begna (2021) notes that diseases like head smut and pests such as wireworm greatly destroy sorghum, causing huge losses to farmers in Ethiopia.

## **5.2 Green Gram**

The production trend for green gram was analyzed, and the findings are presented in Figure 4.



**Figure 4.** Annual Yields Trend for Green Gram

Green gram production increased over the years at the rate of 124.44 metric tons per year (Figure 4). According to the farmers, green gram was a favorite crop because of its fast maturity and high tolerance to many tropical pests and diseases, thus thriving well under ASAL conditions. These findings are consistent with those of Mulika (2022), who noted that green gram was Kenya's second preferred grain after maize because of its drought tolerance characteristics and high yields. Another reason given by farmers was that demand was ever high, and the market price was the highest of the three crops. As a result, the majority of the farmers grew the crop purposely for sale with a small quantity left for household consumption. The increasing trend was also linked to a subsidized input support program by the Makueni County government in collaboration with the Kenya Cereal Enhancement Program Climate Resilient Agricultural Livelihoods Window (KCEP-CRAL), where farmers were occasionally supported with certified green gram seeds (Makueni County Development Plan, 2023). As a result, this led to an increase in the crop's acreage from 19200HA in 2014 to 22385HA in 2023, consequently increasing its production in the County.

However, in the years 2015, 2018, and 2020, drops in production were recorded. Key informants from the Department of Agriculture attributed the decline to low rainfall received in 2015 and 2020, while in 2018, the higher-than-normal rains lowered yields. This was confirmed by the farmers, who stated that very low rainfall lowered yields while excessive rain, especially during the flowering stage, caused flower abortion, making the crop bushy with no pods. Similar observations were made by Mugure et al. (2023), who established that a 1% rise in rainfall and temperature during the growing season led to a 13.2% decline in green gram yields in Tharaka South Sub-County, Kenya. While acknowledging the effects of excess rainfall on green gram production, Wambua et al. (2017) conclude that rainfall above 500mm results in increased vegetative growth with reduced pod setting and development significantly lowering yields.

### **5.2.1 Farmer Practices and Challenges**

Green gram was mostly grown during the short rains. Farmers noted that the long rains were extremely low and, hence, less promising. Planting was done at the onset of the short rains, and varieties like the N26, KS20, Biashara, Karembo, and other informal seeds were commonly grown. Farmers alternated between planting certified seed varieties and planting informal seeds, with a majority planting locally saved informal seeds. According to Muchomba et al. (2023), although informal seeds are well adapted to the local growing conditions, they are associated with small seeds, low yields, and many stony seeds. One old man, in particular, stood out: Mutua, a

father of five and grandfather of two. I interviewed Mutua at his farm in Kikumbulyu North Ward as he prepared to sow the green gram seeds that he had saved from the previous harvest. With a deep sense of frustration, Mutua explained to me why he saved his own seeds instead of buying certified seeds from the nearby agro-vet shops.

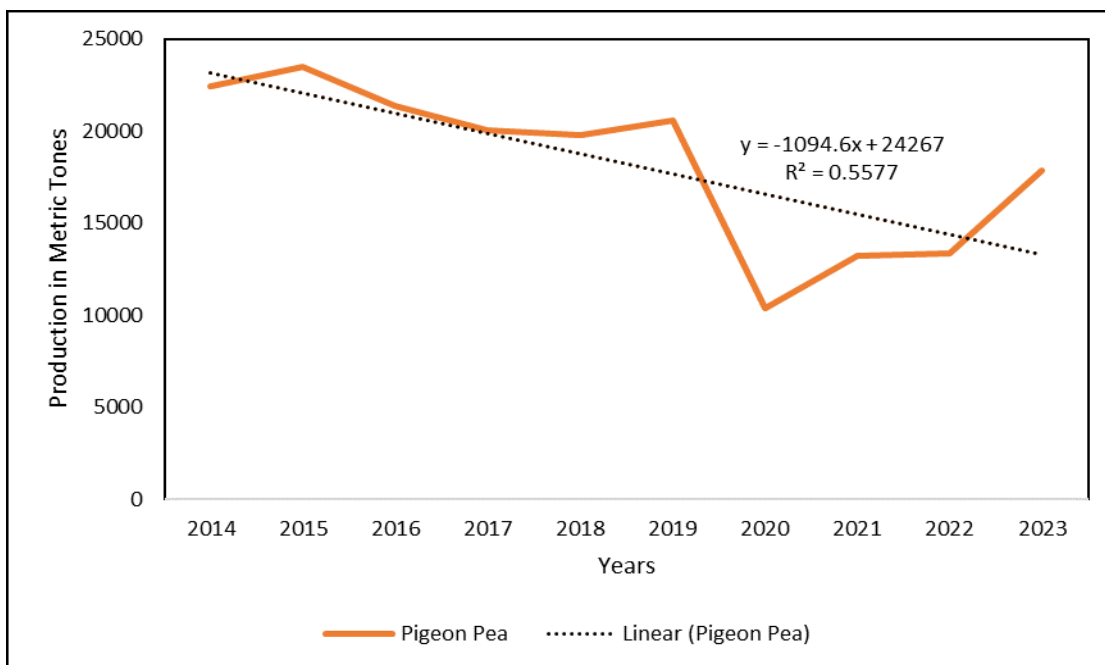
*“These improved seed varieties are not only expensive, but they also need much higher rainfall to produce better yields. On top of that, they are far more susceptible to pests and diseases. When you plant them and the rains don’t come as expected, you suffer huge losses. It is like taking a huge risk with your crops and livelihood.”*

A report by Greenpeace Africa (2022) indicates that indigenous seeds are more tolerant to drought, pests, and diseases and can be used in numerous seasons, unlike the improved varieties. The report further faults the Kenya Government’s Seed and Plant Varieties Act of 2012, which outlawed the exchanging, sharing, or selling of unregistered and uncertified seeds, stating that more than 80% of smallholder farmers in Kenya depend on indigenous seeds and prohibiting their use would lead to low food production triggering food insecurity. Most farmers practiced intercropping with grain crops such as sorghum, cassava, maize, cowpea, and pigeon peas.

None of the interviewed farmers used fertilizer when growing orphan crops. Instead, a few used animal manure, and the rest used neither manure nor fertilizers. To the farmers, fertilizers harden the soil, burn crops, or destroy soil fertility, and this explains their reservations about the use of fertilizers. Similar findings were noted by Kerina et al. (2017), who observed that only 2% of farmers in Makueni County used inorganic fertilizers despite continuous cropping without external inputs, which has lowered soil fertility and decreased crop productivity. Weeding was done twice from the time of planting to the time of harvesting, using hand hoes and, in some cases, oxen. According to the farmers, timely harvesting was vital to preventing losses through shattering of the pods or bird damage. The harvested pods were then sun-dried before threshing, winnowing, and storage. A myriad of factors, such as pests and diseases (Pod borers, aphids, rust, and mildew), erratic rains, soil degradation, and unstructured marketing systems constrained the production of the crop. Post-harvest losses through weevil infestation also remained a major challenge to the farmers.

### 5.3 Pigeon Pea

The production trend for pigeon peas was analyzed, and the findings are presented in Figure 5.



**Figure 5.** Annual Yields Trend for Pigeon Pea

Out of the three orphan crops, pigeon peas had the highest decline of 1,094.6 metric tons per year (Figure 5). Farmers blamed this on several factors, key among them being the low rain experienced during the long rainfall season. It is worth noting that although the primary crop growing season was the short rainfall season, pigeon pea was a one-season crop whose flowering period coincided with the long rains. As a result, the long rains were vital in ensuring high production. Similar findings were observed by Ojwang (2023), who reports that low rains during the long rainfall season sporadically could not sustain the crop during the flowering stage, leading to low yields. This was also confirmed by the NGO officers, who noted that low rainfall during the long rainy seasons was a major constraint to pigeon pea production, which often led to flower abortion and, consequently, low yields.

The year 2020 had the highest decline in production. According to the farmers, this was attributed to the low rains experienced that year. These findings concur with the Makueni County government's report that prolonged droughts in 2020 led to a sharp decline in pigeon pea production in many parts of the County (Makueni County Development Plan, 2023). However, between 2021 and 2023, the production trend was increasing. This increase was attributed to the introduction of a new variety of pigeon pea (ICEAP 01552 nicknamed "M-PESA" by the locals), which was more drought and disease-tolerant, fast-maturing, and high-yielding, thus improving farmer's income through sale. The new variety matured within 4 to 5 months, unlike the local varieties, which took 9 to 11 months to mature, as noted by key informants from the County Department of Agriculture.

### **5.3.1 Farmer Practices and Challenges**

Pigeon pea was a one-season crop planted during the short rainfall season only. Cheboi et al. (2017) note that the crop is grown during the short rains due to its long maturity period, with some varieties taking up to ten months to produce. The crop was planted at the onset of the short rains, and common varieties were grown, including Mbaazi 1, M-PESA, and KAT 60/8. Nearly half of the farmers planted certified seeds, with the rest relying on self-saved informal seeds. According to the farmers, improved seeds were more expensive, and this explains why more than half of them used their own saved informal seeds. Similar findings were reported by Ojwang (2023), who established that although improved pigeon pea seeds are accessible, some farmers prefer local seeds, which are cheaper. All the farmers intercropped pigeon peas with other crops such as Maize (Figure 6), cow peas, green grams, and sorghum. This confirms the findings by Sarkar et al. (2020), who acknowledge that pigeon peas are mostly intercropped with other crops and, in very few instances, grown as a sole.



**Figure 6.** Pigeon Peas intercropped with Maize

Weeding was done using hand hoes and, in some cases, oxen-drawn ploughs. When ripe, most of the green pigeon pea was consumed at the household level, with the rest sold at the nearby markets (Figure 7).



**Figure 7.** A Trader Selling Green Pigeon Peas at Kibwezi Market

After drying while on the farm, pigeon pea pods were harvested by hand picking and sun-dried further (Figure 8) before threshing, winnowing, and storage. I observed that after harvesting, some farmers did not uproot the plant as is the common practice in the area; instead, they left it standing or cut it at the stem level. I asked Mutua why this was the case, and he went on at some length.

*"We sometimes don't uproot the pigeon pea plants after harvest unless they are infested by pests and diseases. This is to allow them to regrow for the next season. This way, we can harvest the crop twice a year. It saves on seeds and labor, and the plants help prevent soil erosion more so during the dry season. Most importantly, it boosts our household food security as harvesting twice a year means a more reliable food supply for the family."*



**Figure 8.** Sun Drying Pigeon Pea Pods after Harvesting

According to the farmers, the major constraints to pigeon pea production were low rainfall, especially during the long rainfall season, and pests and diseases. The major pests include aphids, thrips, pod borers, wilt, and weevil infestation after harvesting.

## 6. Conclusion

While orphan crops are essential for ensuring food security in Kibwezi West Sub-County, smallholder farmers face a series of challenges that hinder their productivity and sustainability. These challenges include low rainfall, pests and diseases, soil degradation, weak seed distribution systems, and inadequate marketing structures. This research underscores the need for targeted interventions to address these challenges. To overcome this, farmers should adopt a multifaceted approach to enhance productivity and resilience. First, integrating pest management strategies such as neem-based pesticides can significantly reduce crop losses due to pests and diseases. Additionally, establishing community-managed storage facilities will help minimize post-harvest losses, reducing the risk of food shortages. To combat soil degradation, practices like crop rotation and the use of organic fertilizers should be prioritized to enrich the soil and sustain long-term yields. Forming cooperatives will empower farmers to collectively access better markets and improve bargaining power. To strengthen seed networks, community-based seed bulking and banking should be encouraged, especially for the underutilized high-value traditional crops. Lastly, adopting water conservation methods such as rainwater harvesting should be encouraged to enhance crop resilience by ensuring a more reliable water supply during dry spells. By adopting these strategies, farmers will not only tackle the current challenges but also build a more sustainable and food-secure future.

### 6.1 Recommendations

Research is required on the suitability of different orphan crops during the long and short rainfall seasons in Kibwezi West Sub-County. Research is also required on the effects of soil and socioeconomic factors on orphan crop production in the area.

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