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PROJECT TITLE: TRENDS IN THE RELEASE OF MAIZE SEED VARIETIES IN KENYA

INTRODUCTION

Climate change is rapidly exposing the vulnerability of our global food and agricultural systems more than ever. The exposure of food production to climate change presents a looming existential crisis that is bound to occur at the backdrop of a burgeoning human population. By the year 2050, the Food and Agriculture Organization (FAO) anticipates that the world needs to double its food production to satisfy a projected global population of 9.7 billion. From the onset, such a daunting task remains threatened by climate induced stress which is estimated to reduce agricultural production by 2% in every decade. Besides, FAO forecasts that by 2050, yields of major crops will experience an average decline of 8% for Africa and Asia. Of particular concern is that the climatic extremes will have the hardest impact on smallholder farmers in developing countries. While the livelihood of approximately 2 billion people globally is dependent on 500 million smallholder farmers, 80% of the food production by these smallholder farmers is consumed in Asia and sub-Saharan Africa. Of importance to this study is how access to farm inputs plays a fundamental role in food production. The focus of this report seeks to understand the impacts in the trends and development of seeds. Improved seed varieties have the power to deliver great impact to farmers including higher yields, disease and pest resistance, climate change adaptation and improved nutrition. This research report explores the variety release catalogues of the maize seed in Kenya and seeks to understand the trends in the development of improved maize seed varieties.

OBJECTIVES

While the projection of the global population is likely to hit 9 billion by 2050, the extremes of climate change are still altering food production with 925 million people going hungry on a daily basis. Much of this population relies on smallholder agriculture to redesign this narrative. For example, Sub-Saharan Africa is yet to experience a green revolution with 239 million people going hungry daily. It is clear that reimagining agriculture in this age of climate change is vital. The significance of this research project is to highlight how the availability and adoption of improved seed varieties is building resilience among smallholder farmers in Kenya at the wake of climate change. Based on the current cropping patterns, the adoption of improved seed varieties by Kenyan smallholder farmers has an existing potential market size that is anticipated to exceed $60 million. Apart from helping smallholder farmers to withstand the existential threat of climate change, improved seed varieties have the great potential to feed a rapidly growing population. Primarily, the impact of this research is to develop a case study that will provide insight to various agricultural stakeholders on the availability and adoption of improved maize seed varieties

- **Governments and policy makers -** This study hopes to encourage the government to prioritize and incentivize information access on improved seed varieites. Further, the project seeks to influence policy makers in shaping policies supporting the adoption of improved seed varieties.
- **Donors and development finance institutions -** With the advent of Sustainable Development Goals and blended finance, this project hopes to encourage donors and development finance institutions to allocate resources to the access and development of improved seed varieties
- **Investors -** The adoption of improved seed varieties in Kenya has robust market potential. This project seeks to leverage on the growth in climate finance to promote investment in the seed

development value chains.

- **Smallholder farmers -** This research project seeks to support the adoption of climate-smart agriculture among smallholder farmers by supporting information access to improved seed varieties.

METHODS

The report adopts a hybrid approach in understanding the trends in the variety release of maize seeds in Kenya. The report generates data from the official variety release catalogues from the Kenya Plant Health Inspectorate Service (KEPHIS). The variety release catalogues from KEPHIS covers seed varieties developed from 1970 to present day. The analysis of data from the variety release catalogues affords a wide horizon on which this study observes trends in the development of maize seed varieties. Further the wide scope of the variety release catalogues also allows this study to observe make comparisons in the various maize seed varieties with respect to trends in special breeding attributes as well as geographical and ecological characteristics. Beyond collecting data from KEPHIS variety release catalogues, the report also conducts a literature review on Kenya's seed sector and the breeding of maize seed varieties. Particularly, the report considers the annual reports of Kenya's seed sector published by The Africa Seed Access Index (TASAI) who is also a key informant of this research. Besides annual publication by TASAI, the literature review also covers scientific journals relevant to the study. Further, the literature review also involves studies from the Integrated Seed Sector Developement Africa program and the Seeds2B program by the Syngneta Foundation for Sustainable Agriculture.

LITERATURE REVIEW

Overview of Adopting Improved Seed as a Mitigation for Changing Climatic Conditions.

Changing climatic circumstances offer an impending danger to the world food supply, particularly for small and medium-sized farmers. In light of the preceding, and as suggested by the research subject, Agri-researchers have worked to develop improved seed varieties to address the underlying climate dilemma. The same point of view has been upheld by (Walker & Alwang, 2015) as it states that Improved, climate-adapted seed distribution to farmers is a proactive adaptation method that is especially important in climate change hotspots. It has been demonstrated that enhanced seeds may raise productivity and profitability in low-income smallholder agricultural systems. It is generally known that adopting improved crop varieties in several sub-Saharan African states has considerably helped alleviate poverty in those nations. It was estimated that the deployment of improved agricultural varieties in sub-Saharan Africa boosted productivity by an average of 47% between 1980 and 2010. To understand the concept of improved seed, Raikwar (2020) defines the same as the fundamental approach for securing agricultural production in less favorable places. One of the most important contributions that can be made to assure better agricultural yields is the dissemination of high-quality seeds and adapted improved varieties. The above domain has gained repute, especially since the onset of the green revolution and the development of seed technology which, according to Taylor et al. (2021), is fundamentally a transdisciplinary study of several subjects. In its broadest sense, seed technology refers to all of the processes involved in the development of high-quality crop plant varieties, including their evaluation and release, as well as seed production, processing, storage, testing, certification, quality control, marketing, distribution, and sales, as well as research on seed physiology, seed production, and seed handling informed by modern botanical and agricultural sciences. A more accurate description of seed technology may read as seed

technology encompasses techniques of seed production, seed processing, seed storage, seed testing and certification, seed marketing and distribution, and research on these areas.

The reading by Cacho et al. (2020) further builds up on the idea of adoption of the improved seed technique as a means of ensuring food security by underlying the fact that Farmers in sub-Saharan Africa are already modifying planting dates and crop mixtures in reaction to the climatic change they perceive to be occurring. This form of unplanned adaptation may be reinforced with planned adaptation to reduce the negative consequences and costs of climate change. To achieve the objectives of the SDG2 indicators, however, a stronger preventative strategy is required. Since the adoption rates of better technology in sub-Saharan Africa have historically been significantly lower than anticipated because smallholders face significant barriers to access, there is an urgent need for deliberate and targeted interventions. Seed bulking facilities, better extension services, and input subsidy programs are just a few examples of the seed production and distribution expenditures required to achieve the goal of providing access to a larger population. Important interventions cannot be undertaken at the required rate and scope without specific policies. An integral approach for adaptation is the reduction of the current gap of up to 30 years between the breeding, delivery, and acceptance (BDA) of new crop varieties defined in (Challinor et al., 2016).

(Cho, 2013) highlights that currently, there are still 925 million people worldwide who are affected by hunger, despite the fact that the global population is expected to reach 9 billion by the year 2050, that climate change is causing more severe weather events, and that circumstances for agriculture are changing. To answer the problems presented here, scientists and agronomists are working around the clock to produce seeds that have a larger yield, are more nutritious, and are resistant to drought and climate. The majority of the existing enhanced seeds are created in the

manner that are defined as , open-pollinated refers to seeds produced by unintentional pollination. Historically, farmers would set aside the most promising seeds for future use. Through selective breeding, it is possible to develop hybrid seeds from two parent plants with desirable features. The resulting plants flourish during their first growing season but lose potency with each successive generation, requiring growers to acquire new seeds year. One or two genes encoding the desired characteristics are added to the plant's DNA to produce genetically modified seeds.

The Domain of Seed Improvement in Sub-Saharan Africa

Louwaars and De Boef (2012) paper brings forth the ISSD concept referred to in full at the Integrated seed sector development was first envisaged as a way to connect formal seed systems and farmers' seed systems on a technological and institutional level. Since then, the seed system has been implemented in the on-farm management of genetic resources, participatory plant breeding, seed security, and promoting on-farm seed production. The discussion of seed and variety laws has expanded to include integrated seed systems due to acknowledged institutional constraints. The statistics support the notion that maize is distinct from other crops. The adoption and annual purchase of formal quality maize hybrid seeds have increased as a result of public maize distribution systems (Ethiopia), a strong association between non-governmental organizations (NGOs) and private firms (Ghana), and publicly subsidized input programs (Malawi, Zambia). This increase is a result of significant market-driven measures that promote technology adoption. The maize model increases technology adoption by enforcing supportive institutional and governmental frameworks. Through international aid and charitable initiatives, the seed business has been encouraged to grow in a market-oriented direction. There are a number of countries where the maize model is incorporated into national subsidized input

programs aimed at national food security and enterprise development; however, in Malawi and Zambia, these programs consume a significant portion of the government's agricultural budget, indicating that they are not sustainable over the long term. Critics of the maize model question its economic and institutional viability and assert that it is inapplicable to other seed systems and food crops (Lunduka et al., 2013). New strategies are required, such as strengthening fragile public breeding and seed systems, investing in and encouraging small seed businesses, and fortifying national seed companies. A major emphasis on maize exemplifies the narrow perspective that dominates seed sector development, varietal replacement, and acceptance of current varieties in sub-Saharan Africa; it only addresses a small portion of the complex food and seed markets there.

Among the clear advancements in improved seeds is initiating the Improved maize for African soils project (IMAS). According to International Maize and Wheat Improvement Center (2022), The Improved Maize for African Soils (IMAS) Project develops maize varieties that make more efficient use of the nitrogen they absorb, and the limited quantities of fertilizer African farmers can afford. As a result of this initiative, nitrogen loss will be reduced, improving food security in Sub-Saharan Africa. Participants will utilize modern biotechnology tools such as molecular markers and DNA signposts for traits of interest and transgenic approaches to develop varieties with yields that are 30–50% greater than current varieties, with the same amount of nitrogen fertilizer applied, or when grown on poorer soils a concept that is brought forth in (Pixley et al., 2013). It will be feasible to reach this objective while employing less nitrogen fertilizer and cultivating the crop on less fertile soils. In the next four years, farmers in Africa will have access to IMAS varieties created by conventional breeding if the results of further research are any indication. The desired yield improvement over present cultivars is at least 20%. Varieties

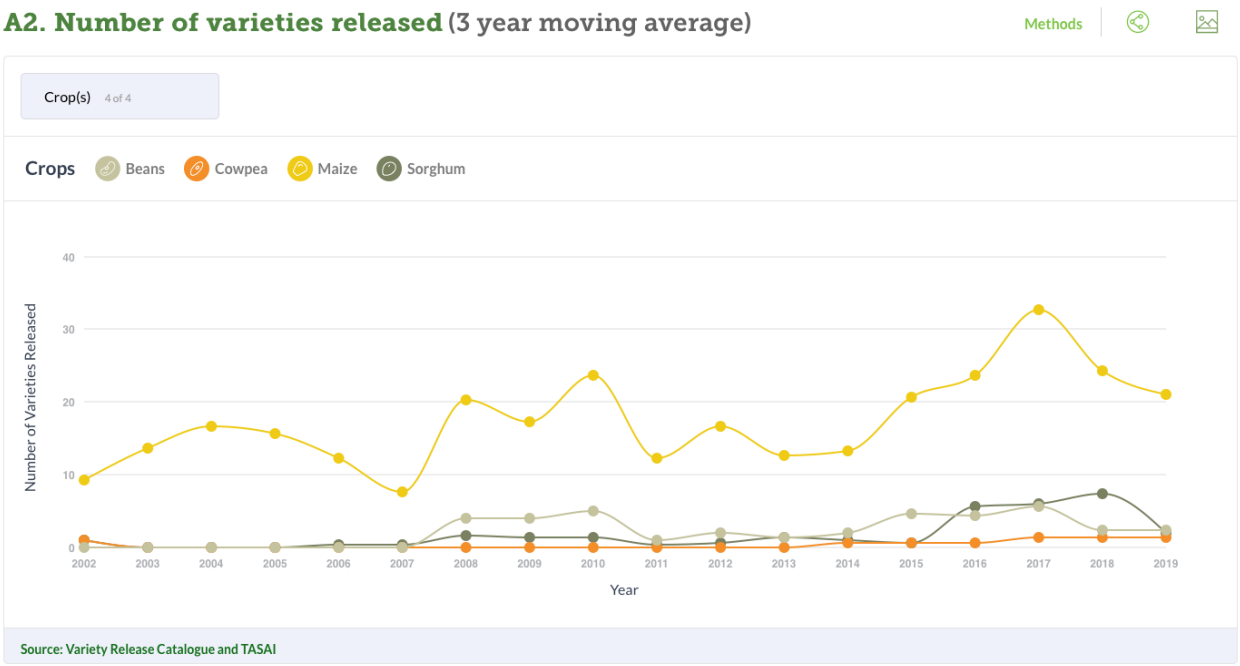
harboring transgenic features are anticipated to be commercially accessible in about ten years, depending on product performance and regulatory clearances by national regulatory and scientific agencies in compliance with each country's laws and regulatory procedures.

Application of the Concept Seed Improvement Within Kenya

In Kenya, for example, there have been continuous efforts towards curating maize seeds suitable to the country's makeup to potentially increase yields seeing as in recent times, even with increased land mass use, the production rates have significantly dropped. A research endeavor spearheaded by *FEED THE FUTURE*, the United States Global Hunger and food security, highlighted that Kenya Seed, a government-backed enterprise, dominates most of the Kenyan seed industry. The randomized controlled study employed hybrid maize manufactured by the commercial firm Western Seed. The company has developed a type of seed thrives in Kenya's intermediate altitudes (1,000-1,500m). These regions often have a warmer climate and a shorter growing season than those at higher elevations. It was an underlying fact that an effective breeding program must include genetic material that accounts for all of the limits farmers face. Tegemeo and the AMA Innovation Lab determined what prevented farmers from planting Western Seed's hybrid maize. In addition, they examined how the elimination of fertilizer purchasing limits and the use of soil analysis to identify the optimal fertilizer combinations influenced crop production. Significantly, we discovered that crop yields improved by almost 40 percent among the sample of western farmers located in mid-latitude regions. This increased the range and amount of meals consumed in private homes (Russell, 2017). Even though only 25% of these farmers' revenue came from corn, household income improved. Eighty to ninety percent was the average increase in production for farmers who routinely employed hybrid seed. In around nine of the previous ten growing seasons, farmers in the central region utilized enhanced

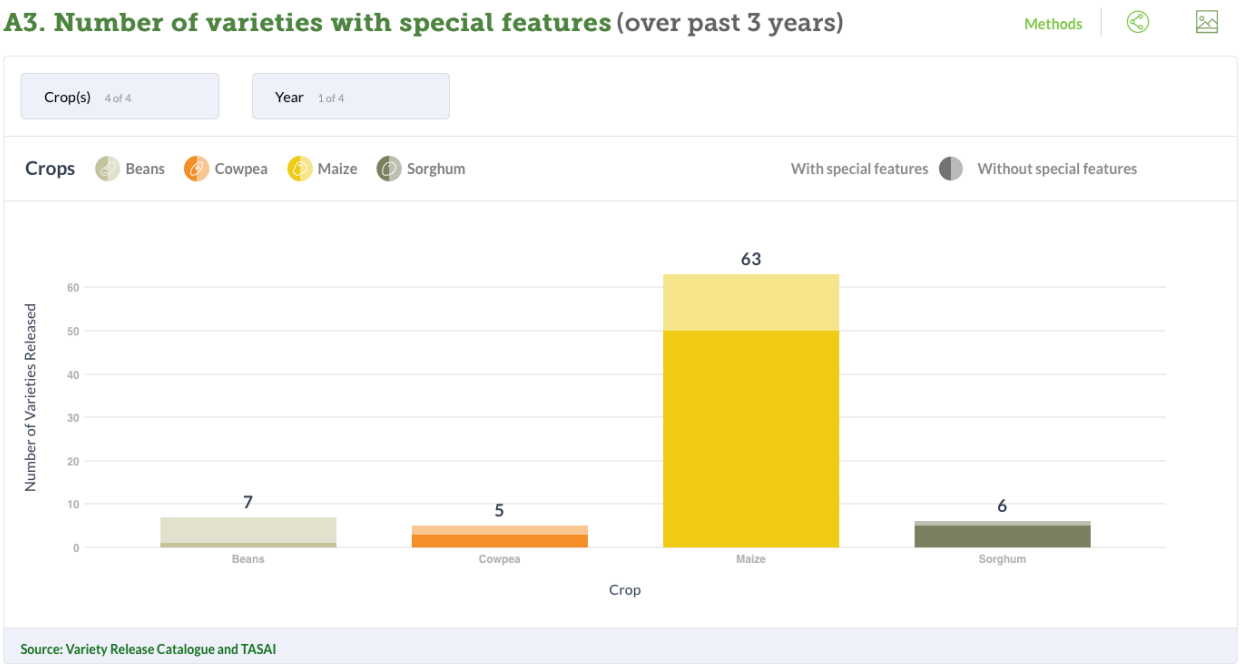
seed and fertilizer, but in the western region, only about one-fourth of those instances happened. Thus, this is a significant advancement in the research on this subject.

Graphical representation of the variety released between year 2002 - year 2019



The graph above is a visualization of the counts in variety release for beans, maize, cow pea and sorghum as presented by The Africa Seed Access Index. While there is an increase in seed varieties for the crop represented in the graph above, Maize appears to have the highest release count over the years. From the graph, it can be deduced that on average at least 10 new varieties of maize have been released every year. Perhaps, maize being a staple food in Kenya may explain why there is increase in maize variety release every year. The increased development of maize varieties could be an effort towards bolstering food production to keep Kenya food secure.

Graphical representation of the variety released with special features between years 2002 - 2019



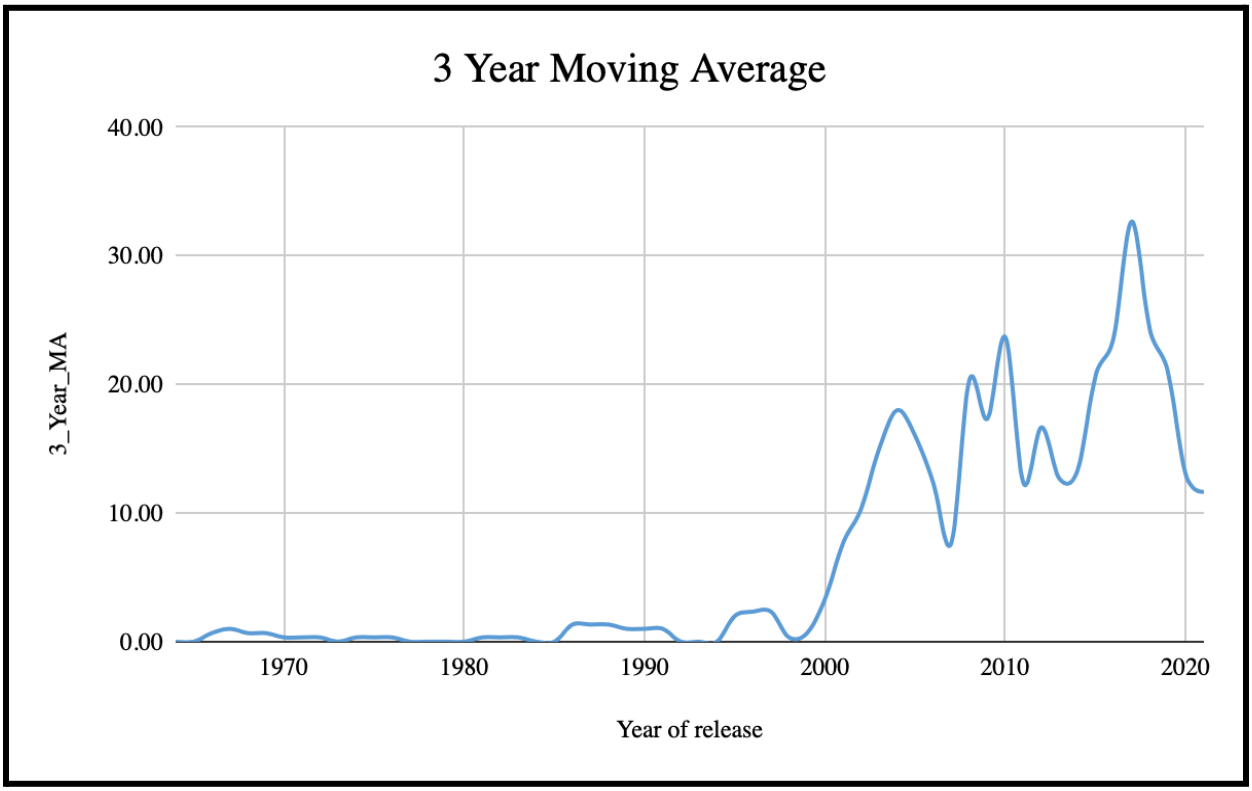
The graph above is a visualization of seeds varieties of various crop released with special features that include resistance to harsh climatic conditions, increased nutritional value, resistance to pests and diseases and ease in cooking. Just like in the variety release counts, maize seeds lead in the varieties released with the special features. Of the 63 maize seed varieties released over the last three years, 50 are attributed to have special features.

KEY FINDINGS

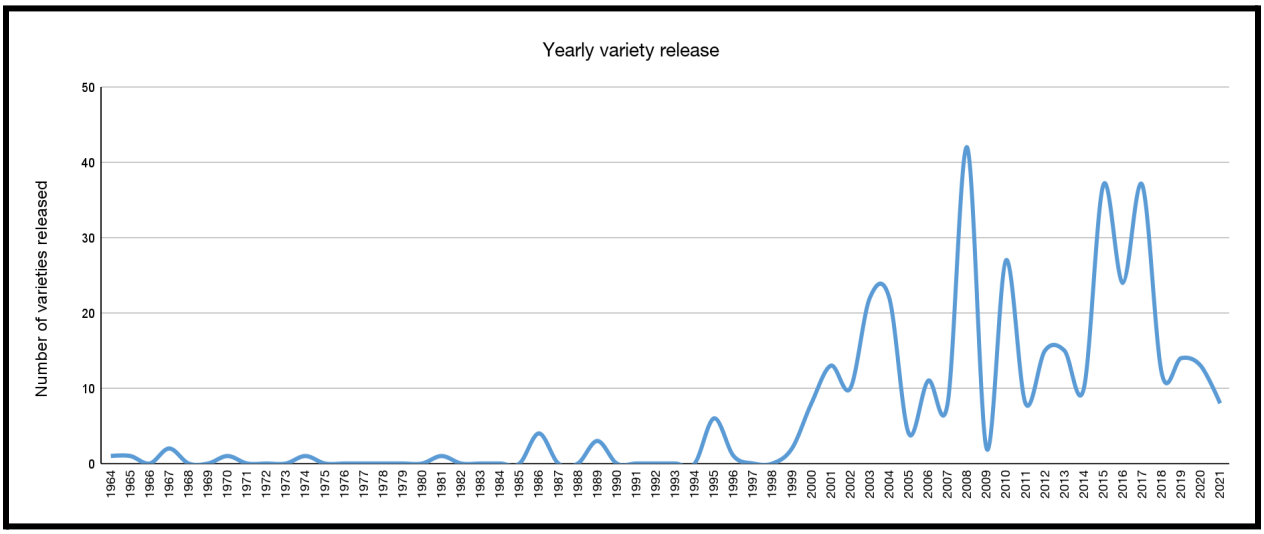
Below are visualization of the analysis from the data collected from the variety release catalogues from the Kenya Plant Health Inspectorate Service. Primarily the visualizations below seeks to provide a snap shot of the progress and advances made in the release of maize seed varieites from the 1960s to the year 2021. The graphical representations below, seek to observe

through a quantitative lens, how the variety release of maize seeds spans over intervals of 1 year, 5 years and a decade since the year 1964.

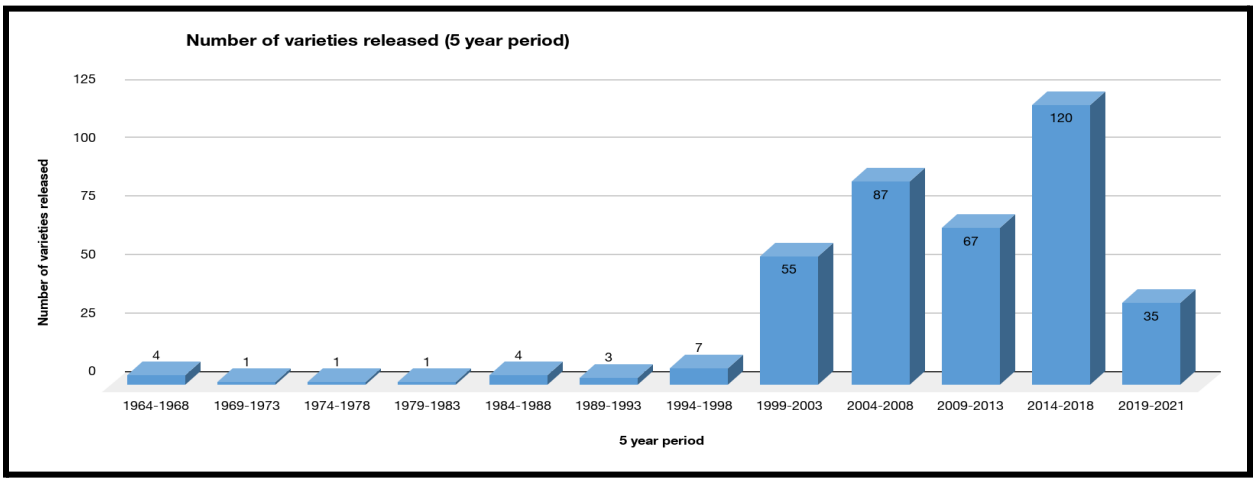
A graphical representation of the release of maize varieties on a three year moving average.



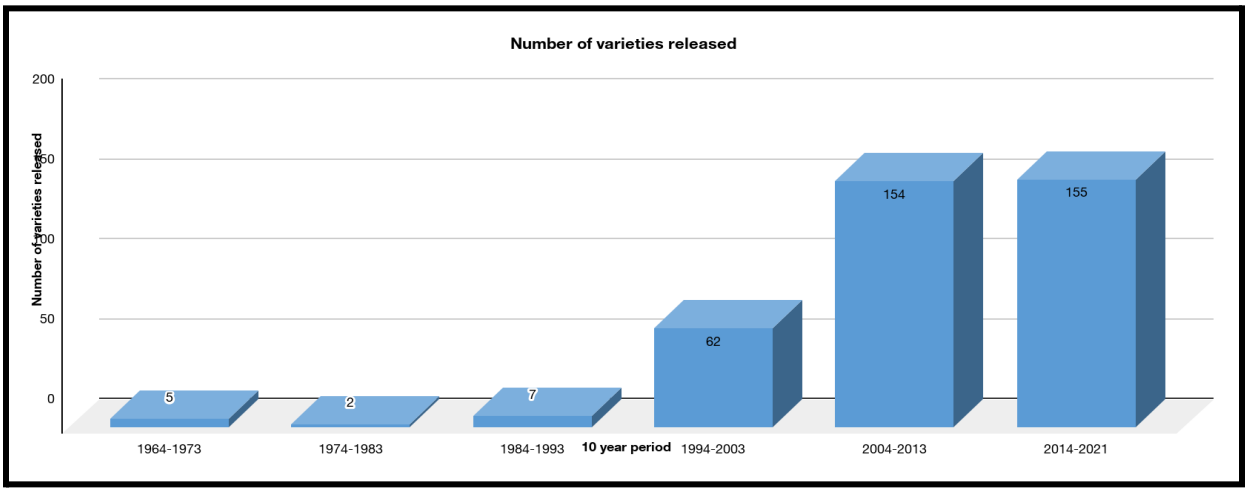
A graphical representation of the yearly release of maize seed varieties.



A graphical representation of the release of maize seed varieties on a 5-year interval.



A graphical representation of the release of maize seed varieties on a 10-year interval.



CONCLUSIONS

The analysis from the the variety release catalogues as graphically presented in the key findings above shows that there has been tremendous progress in the development of maize seed varieties. However, for Kenya to scale it food production, in particular maize, there is need to bridge the gap between farmers and the information on improved seed varieties as and when they are developed. The next phase of this research seeks to understand the extent of the gap between agricultural stakeholders, particularly farmers, and their access to information on improved maize seed varieties.

REFERENCES

Cacho, O. J., Moss, J., Thornton, P. K., Herrero, M., Henderson, B., Bodirsky, B. L., . . . Lipper, L. (2020). The value of climate-resilient seeds for smallholder adaptation in sub-Saharan Africa. *Climatic Change*, *162*(3), 1213-1229. https://link.springer.com/article/10.1007/s10584-020-02817-z

Challinor, A. J., Koehler, A.-K., Ramirez-Villegas, J., Whitfield, S., & Das, B. (2016). Current warming will reduce yields unless maize breeding and seed systems adapt immediately. *Nature Climate Change*, *6*(10), 954-958. https://www.nature.com/articles/nclimate3061

Cho, R. (2013). *Improving Seeds to Meet Future Challenges*. https://news.climate.columbia.edu/2013/02/08/improving-seeds-to-meet-future-challenges/

International Maize and Wheat Improvement Center. (2022). *Improved Maize for African Soils (IMAS)*. https://www.cimmyt.org/projects/improved-maize-for-african-soils-imas/

Louwaars, N. P., & De Boef, W. S. (2012). Integrated seed sector development in Africa: a conceptual framework for creating coherence between practices, programs, and policies. *Journal of Crop Improvement*, *26*(1), 39-59. https://www.researchgate.net/publication/249644277_Integrated_Seed_Sector_Development_in_Africa_A_Basis_for_Seed_Policy_and_Law

Lunduka, R., Ricker‐Gilbert, J., & Fisher, M. (2013). What are the farm‐level impacts of Malawi's farm input subsidy program? A critical review. *Agricultural Economics*, *44*(6), 563-579. https://onlinelibrary.wiley.com/doi/pdf/10.1111/agec.12074?casa_token=yg6fg8JsWqwAAAAA:tVoVZGxuKXRMj9bFmjCTieP-VFMTXORc2DH-MvlRKEXcXYbeq6wXxxOqVtN6nta2syNiycU4lqVrJQ

Mabaya, E., Mburu J., Waithaka, M., Mugoya, M., Kanyenji, G., Tihanyi, K., 2021. Kenya 2020 Country Study - The African Seed Access Index (version September 2021). https://www.tasai.org/en/products/country-reports/

Pixley, K., Rojas, N. P., Babu, R., Mutale, R., Surles, R., & Simpungwe, E. (2013). Biofortification of maize with provitamin A carotenoids. In *Carotenoids and human health* (pp. 271-292). Springer. https://d1wqtxts1xzle7.cloudfront.net/67206156/Biofortification_of_Maize_with_Provitami20210505-17070-bde6bc-with-cover-page-v2.pdf?Expires=1661812051&Signature=a0i4gSsUEffOkNsM9einRN9NKbGvbcEFOs7MqFip2yo3cH0~Prx4Q2wfkt9ntl7PiqWfllI7pG9Qq66mY8bphVyLG9gGi63XrSb47dS1gG39Xx79s3poD5p3ccslp~0Dez~rgYEVFKLOiyEYGqHUePL6A3pv8-Ad3Q~wo9bT6noLca9wxngqr5MzexR5lWaELqCx4Cq3EkD-i4bmY5fF7JvW5O4n4H8VLX6txe-mbTz8WURH6cPPnb~Qh1tJvdUibmwRYH-jCRp93YpImvnrBQIdQ0A1CRTPs2OISCdP4L4GOPnlo4gUU5t0ARoyQcERoHv5inAu06I7rxAxrR9sdA__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

Raikwar, R. S. (2020). PRINCIPLES OF SEED TECHNOLOGY. http://www.jnkvv.org/PDF/30032020194456Principles_of_Seed_Technology_Dr_Rudrasen_Singh.pdf

Russell, A. (2017). *Event Highlights Challenges And Opportunities For Increasing Maize Productivity In Kenya*. https://basis.ucdavis.edu/sites/g/files/dgvnsk466/files/inline-files/AMA%20News-Tegemeo%20conference.pdf

Taylor, A. G., Amirkhani, M., & Hill, H. (2021). Modern seed technology. In (Vol. 11, pp. 630): MDPI.

Walker, T. S., & Alwang, J. (2015). *Crop improvement, adoption and impact of improved varieties in food crops in sub-Saharan Africa*. Cabi. https://vtechworks.lib.vt.edu/bitstream/handle/10919/81300/Walker_Binder.pdf?sequence=1