International Journal of Environment, Agriculture and Biotechnology
Vol-7, Issue-3; May-Jun, 2022

Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Peer Reviewed

A Review of options for speeding the adoption of climate smart varieties: what works and what does not work: Experiences from Tanzania

Atugonza Luta Bilaro[1], George M. Tryphone[2]

[1]Tanzania Agricultural Research Institute -IFAKARA Centre, Private Bag, Ifakara, Morogoro – Tanzania.
Email: Atugonza.bilaro@tari.go.tz
[2]Department of Crop Science and Horticulture, Sokoine University of Agriculture, P. O. Box 3005, Chuo Kikuu, Morogoro, Tanzania.
Email: muhamba@sua.ac.tz

Received: 11 May 2022; Received in revised form: 03 Jun 2022; Accepted: 08 Jun 2022; Available online: 13 Jun 2022

Abstract— *Given the efforts invested on addressing climate change adaptation particularly in agriculture, the adoption of climate smart varieties has not met the expectations. A number of crop varieties developed targeting drought prone areas largely remained un-adopted hence unknown to the majority of farmers or lack traits deemed special for adaptation to climate change in target areas. Variety adoption rate is highly dependent on its adaptation to particular environmental conditions including suitability to tolerate drought, salinity and acidity and ability to meet different livelihood needs such food, fodder and cash. Poor adoption emanates from lack of awareness and the volatility of the farming environment coupled with poor integration of seed business into private public partnership. Rapid adoption of climate smart varieties in Tanzania would require better policy intervention with a well-organized extension system and modifications in variety testing procedures, including the current guidelines for variety release. In this work the authors discuss some approaches that can be used to enhance the adoption of climate smart varieties in Tanzania and cite a few specific cases based on experience from Tanzania.*

Keywords— ***climate smart varieties, adoption, food security, drought***

I. INTRODUCTION

Climate smart varieties encompass crop varieties that are adapted to climate related challenges such as drought, salinity, flooding, pests and disease (World Bank, 2015). Apart from adaptation, these varieties are expected to produce reasonable yield under stress conditions. Lack or poor adoption of varieties adapted to these challenges result into low yields, which in turn leads to land degradation as farmers are forced to clear more land for food and household income. At the same time, agriculture in rainfall dependent areas, like Africa, is dominated by smallholder farmers who operate on small plots ranging between 0.5 and 5 acres (Kalungu et al., 2013). The majority of farmers use traditional varieties that are not adapted to climate change. As a result, food production is under threat due to increased incidences of drought caused by climate change (Khatri-Chehtri et al., 2017). Any attempt to sell food to meet other basic needs put further strains on household food budget and results in negative food balance (Connolly-Boutin and Smit, 2016).

While agriculture is regarded as the engine for poverty reduction in most of rural areas, in recent years, the growth of the agricultural sector has stagnated due to climate change worldwide (Readon and Zilbermann, 2017). Lack of crop varieties that can tolerate/resist to extreme conditions such as drought and flooding has resulted in increased number of households suffering frequent famine (Khtri-Chhetri et al., 2017). Low food production is aggravated by high population growth rate which limit the land available for farming (Muyanga and Jayne, 2014). At the same time

intensive land-use to meet food production results in severe land degradation particularly in marginal areas (FAO, 2014). One of the options for mitigating the climate change impacts in agriculture is the use of climate smart or resilient varieties. However, adoption of these varieties particularly in Africa is below the expectations (Pandey et al., 2012). For example, in the 2016, the alliance for green revolution for Africa (AGRA)'s country progress report, indicated that up to now there are over 251 released varieties out of which 205 are commercialized in East Africa; yet only 1,196 337 farmers are reported be using improved seeds. This shows that research efforts have not brought the desired results. Low adoption ability of the varieties suited to prone areas, suggests lack of awareness due to poor promotion or possible inefficiencies in seed delivery systems. In this paper, we examine the role of extension and government services in driving the adoption of new climate smart varieties using sunflower (*Helianthus annuus* L.) and pigeon pea (*Cajanus cajan* L.) in Tanzania. This will serve as a starting point towards formulating appropriate intervention in other regions and are discussed hereunder.

II. MECHANISMS OF ACCELERATING SPEEDY ADOPTION

2.1 Variety dissemination strategy and the role of extension services

Extension services play a great role in variety adoption by creating awareness The services act as a link between farmers and researchers by communicating their needs to research and demonstrating the innovations developed by research to them (farmers). Extension officers help to translate information and innovations generated by research into simple, user-friendly message suited to local circumstances. Better agricultural innovation services help farmer to make informed decision on the crop varieties to cope with climate variability (United Republic of Tanzania (URT), 2015). For it to be a better communication strategy, extension message must focus on aspects of content design, timing of the information and providing appropriate dissemination channels with consideration of different gender category (World Bank, 2015). The contents must be simple and easy to understand and follow with little external supervision taking into account of the education level of rural farmers. The time when the information is delivered should coincide with the crop calendar in target location i. e. time to establish demonstration plots. In addition, extension service must strive to reach large audience with less cost by choosing the right communication channel. In Kenya, for example, innovative ideas such as "Shamba Shape Up" (SSU), an agricultural reality TV show, have proved to be useful in disseminating new farming technologies and improved the crop agriculture. The TV and radio programmes in Tanzania also have been playing a vital role in the dissemination of improved cassava (Manihot esculenta Crantz) varieties. Similarly, the radio and TV programs are crucial especially in the areas where the number of extension personnel is very low but the famers need to be exposed to the technology. For a completely new technology adoption, demonstration plots are needed and must be designed in such a way that farmer participation is allowed so as to remove scientism and be able to get feedback before embarking on mass promotion (Paris et al., 2011).

2.2 The role of the government in variety adoption

In most cases, the traditional role of the state in the seed sector is regulatory, to ensure that standard procedures are followed. However, state monopoly in the seed business stifles competition and discourages private sector growth. The private sector involvement in seed business is important as it helps to reduce the inefficiencies resulted from government monopoly and therefore stimulate agricultural production (CTA, 2014; Mabaya, 2016). Therefore, the government should concentrate on creating an enabling environment for other actors along the seed value chain to function properly. For example, the governments need to revise variety release protocols by allowing quality declared seed (QDS) production scheme in remote areas. This exposes farmers to quality seed, which is a preliminary stage for formal seed systems (Langyintuo et al., 2008). In addition, governments must embrace policies that permit cross border seed trade through harmonization of seed policies (AFSA, 2017). Such initiatives when implemented better are likely to increase farmer access to improved seed and lower seed prices especially in countries with poorly developed seed system. Alternatively, farmers could be trained on seed purification and selection skills in areas where formal seed systems are lacking as in the case of beans in Uganda (Nasirumbi et al., 2008). Seed policies must support the growth and expansion of small seed companies operating at national level as in the case of Tanzania (International Trade Centre (ITC), 2016). Also policy incentives that will attract investment in the seed sector must be put in place. For example, policies that will improve access to credits as well as grain markets and retail networks are likely to improve variety deployment and its uptake due to assured markets (Langyintuo et al., 2009).

In Tanzania, an enabling environment to private sector has shown positive contribution in enhancing adoption of sunflower production in semi-arid regions where other tradition crops have been failing due to climate change. Sunflower in Tanzania is believed to grow well in almost all

regions including in drier areas of the central regions. Available data show that between 2000 and 2005 production was only 75000 to 100,000 tonnes but production has reached 2,995,500 tonnes in 2015/16 due to better policy intervention (Figure 1). Recent statistics from FAOSTAT show that, as of 2014 Tanzania is ranked 7th among the top sunflower seed producer in the world (FAO, 2014), as shown in Figure 1.

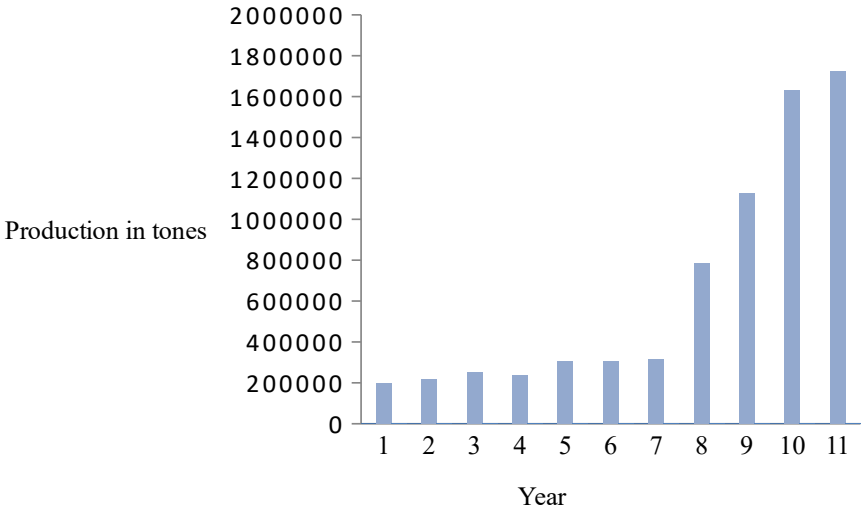

Fig.1: Sunflower seed production trends for Tanzania (2004 – 2014)

2.3 Factors for successful adoption of climate smart varieties

Sunflower was introduced in Tanzania many years ago but it has remained unpopular despite the huge market potential of edible oil in Tanzania. As a result, Tanzania has continued to import a large portion of edible oil due to poor local production. High incidences of drought forced the government to adopt a number of policy interventions to promote sunflower production in semi-arid areas of Tanzania. First the government initiated and supported the production of quality declared seed (QDS) at village level to ensure timely availability and at an affordable price. Also, agricultural reforms such as agricultural sector development programme (ASDP) ensured increased participation of private sector by providing start-up capital for the establishment of agro industries. For example, the government introduced the industrial development support loan with subsidized interest to promote local investment for agro-processing industries through the Tanzania Investment Bank (TIB) in partnership with Rural Livelihood Development Cooperation (RLDC). The government also initiated credit guarantee scheme for agro-processing and agro-business sector through small industry development organization (SIDO). Such incentives increased the participation of NGOs and other financial institutions such as RLDC working with government to increase the profit among sunflower producers (SARECA/KIT, 2014). RLDC also helps sunflower farmers to gain access to agro inputs and reliable markets and processors by supporting contract farming where processor association works with 300 to 700 farmers. The voucher system and warehouse receipt system supported by RLDC enable farmers to deposit sunflower seed in the warehouse and sell later when the prices are better; while stored seed serves as a guarantee for the RLDC business partners to give credits to farmers. As a result, currently in Singida region alone, central Tanzania there are more than 64 small scale sunflower oil processing factories and one (1) large scale processing factory. Sunflower production is rapidly spreading to new regions such as Morogoro (South-east) and Tabora (North-west) where new small oil mills are also being established involving women and youth groups which are supported through district development fund. Following these successes in sunflower adoption the number of foreign seed companies dealing with seed business has been increasing Market opportunities also act as an incentive in the adoption of drought tolerant (DT) varieties. Guaranteed market has been a driving force in the adoption of Pigeon peas in Tanzania. Using this model Tanzania has been able to increase the production of pigeon pea production thus overtaking Malawi as the third world leading producer (Table 1).

Table 1: World's Pigeon pea production - India and its main suppliers 2009-11

Country	2009		2010		2011	
	Production (Mt)	Proportion of world supply (%)	Production (Mt)	Proportion of world supply (%)	Production (Mt)	Proportion of world supply (%)
India	2,270,000	64.1	2,460,000	63.9	2,860,000	64.9
Kenya	46,474	1.3	103,324	2.7	84,313	1.9
Malawi	184,156	5.2	193,005	5.0	195,516	4.4
Burma	765,000	21.6	772,999	20.1	837,385	19.0
Uganda	91,000	2.6	93,000	2.4	94,861	2.2
Tanzania	**120,870**	**3.4**	**166,130**	**4.3**	**272,608**	**6.2**
Total India and suppliers	3,477,500	98.2	3,788,458	98.3	4,344,683	98.6
Total World Production	3,542,598	100.0	3,852,110	100.0	4,405,984	100.0

Source: FAOSTAT (2014)

Pigeon pea is a drought tolerant crop that is currently widely grown in northern regions of Tanzania. It is an important source of income among farmers in Arusha, and Manyara regions (North-east) with market opportunities in Kenya, the Middle East and the European Union (Mponda et al., 2013; ICT, 2016). About 70 percent of Pigeon pea produced in Tanzania is exported (Mponda et al., 2013). Originally, Pigeon pea production was confined to high rainfall areas due to lack of early maturing and drought tolerant varieties (Mussa et al., 2012). The assurance in market has increased the number of farmers growing the crop. As a result, Pigeon pea production is rapidly spreading in other semi-arid areas particularly Dodoma, Morogoro (central) and southern regions such as Mtwara and Lindi. Availability of better varieties with short duration maturity and farmer preferred traits such as high grain yield, intercropping compatibility, photoperiod insensitivity and maturity, high yield potential during ratoon and climate resilience have contributed to increase Pigeon pea production (Figure 2).

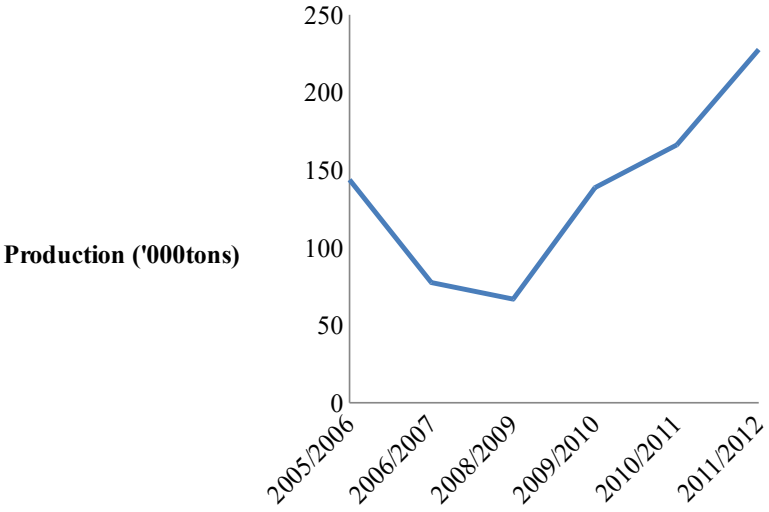

Fig.2: Pigeon pea production in Tanzania 2005/06 – 2011/12

In Northern Tanzania, varieties such as ICEAP 00040 and ICEAP 00053 which carry most of these traits have a reported adoption rate of above 60% (Mponda et al., 2013). Currently there are 16 released varieties in with production estimated at 300,000 MT per year (Mponda et al., 2013). Seeds are obtained mainly from National Agricultural Research Institutes (ARIs) through Community based organization (CBOs) and QDS schemes. Further, Catholic

Relief Service (CRC) works in collaboration with Technoserve, a non-profit organisation and TARI_Selian to help farmers to form cooperatives and providing training so as to meet European requirements for export. Reliable market opportunities and good partnership between government and private sector have been the driving force in the adoption.

III. CONCLUSION

In order to enhance adoption of climate smart varieties, the choice of a crop for promotion must take into consideration the traits that meet people's livelihood needs such as food or cash. At the same time the government need to put in place seed policies that will attract investment in different aspects of the seed value chain. A package of incentive that include lowering tariff on agricultural inputs and agro-processing machinery adds value and that farmers get premium prices on their produce, this in turn enhance adoption. Also, extension services help in making the right decision with regards to the choice of right variety and the best management practices for better results and is prerequisite for adoption.

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