Maize from Push-Pull Technology (PPT): Can the produce be differentiated?

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Abstract

Maize is a major staple food in East Africa region with the potential to solve the region's food security and nutrition challenges. The crop is however faced with several biotic and abiotic stressors that resulting to pre and post-harvest losses. *Striga* weed is a critical biotic stressor that associated with poor soil fertility that leads to stunted growth, phytotoxicity, and reduced grain yields. Several solutions have been proffered. However, push-pull technology (PPT) stands out to be agro-ecologically beneficial for smallholder farmers. UPSCALE, is a Horizon 2020 project whose aim is to promote widespread adoption of Push-Pull technology through the trans-disciplinary engagement of multi-actors' communities of practice. This will ensure all relevant stakeholders are on board, ultimately enabling smallholder farmers to realize its associated benefits. This paper aims at reviewing existing scholarly literature, evaluating information from multi-actor communities (MACs) of practice constituted under the UPSCALE project, and the authors' experiences over time. To promote widespread adoption of PPT, it was established that MACs involvement in the maize value chain has achieved mapping and tracing of PPT maize produce and certify and Eco-labeling the produce to distinguish it from the rest. MAC involvement would also collaboratively price the produce at a premium to offer incentives towards realizing a transformative potential of PPT among farmers. However, this requires lobbying governments to ease the transfer of desmodium seeds within the region, waive duty, and sign common protocols on desmodium Quality Declared Seed (QDS) systems. The potential spinoffs identified include women and youth involvement as desmodium community seed merchants and seedling nurseries; SMEs trading in differentiated PPT maize in the region; and farmers trading carbon credits with widespread adoption. It is therefore recommended that PPT maize can be differentiated and promoted when stakeholders begin to reflect on its potential in the region. This will enable stakeholders to find adaptive and alternative PPT adoption pathways.

Keywords

Push-Pull technology (PPT), UPSCALE, multi-actor communities (MACs), Eco-labeling, PrAEctice, Stakeholders

Introduction

Maize is one of the essential crops in the East African region. Specifically, in Kenya, the crop is a staple food for most households. The crop is cultivated on an approximate area of 2.2 million hectares which is nearly 40 percent of Kenya's harvested crop area. The crop contributes approximately 12.65% of the agricultural annual GDP and 2.4% of the total GDP (DTMA, 2015). An estimate of about 103 kg of the crop is consumed per person annually. Regardless of crop necessity, productivity has generally stagnated in recent years (Jena *et al.*, 2021). The crop is faced with several biotic and abiotic stressors leading to massive pre-and post-harvest losses. This has led to persistent maize shortages with annual maize output often falling below the country's consumption (Barmao & Tarus, 2019). This has limited its capacity and the potential to address food security and nutrition challenges in the region. Among the factors that have significantly contributed to the decline in crop productivity is the low soil fertility instigated by land degradation from unsustainable agronomic practices, the severity of pests, weeds, and diseases in the region, and the effect of climate change (Ejigu *et al.*, 2021; Kogo *et al*., 2020; Mutea *et al*., 2020).

An important biotic stressor is the *Striga* weed associated with poor soils resulting in stunted growth, phytotoxicity, and reduced grain yield. To reduce these losses, intensive modern technologies have been recommended. For instance, the use of agrochemicals to reduce pests and weeds and the application of fertilizers to improve soil fertility. However, these interventions have not succeeded in promoting the cereal to the potential capacity of attaining food security instead, they have instigated land degradation and climate change thus widening the loss gap.

As a solution, several interventions have been initiated to promote conservation agricultural practices at the same time improve maize production. Organic farming has been able to protect the environment and sustain soil fertility. However, the problem of *Striga* weed has persistently remained a threat to these farming systems. Push-pull technology (PPT) was therefore developed by *icipe* and other partners to help in curbing such losses experienced by smallholder farmers

The Push-Pull technology can promote all the principles of conservation agriculture, cover cropping, diversification, and minimum soil distance among other benefits (ICIPE, 2011). PPT uses principles of chemical ecology where stem borer and moths are repelled from the maize plant intercropped (Push) plant, desmodium, and attracted by semi-chemicals produced by the border (pull) plant, Brachiaria (Gohole, 2003). Desmodium roots exude chemicals that encourage the germination of parasitic *Striga* weeds but prevent them from attaching to the maize root, as a result, this aids in the depletion of the *Striga* seed bank in push-pull systems (Khan *et al.,* 2011).

Currently, the UPSCALE project is promoting PPT in the region to empower smallholder maize farmers to produce maize with tradable surpluses by involving all multi-actor communities of practice (MACs) to aid in upscaling PPT among smallholder farmers. This will enable value addition and commercialization, thus creating employment through forage seed production, selling, and multi-functionality such as integration of livestock farming in the region. This will allow agricultural intensification and production of high-quality yield organically and in an economical way along the value chain. Therefore, there is a need to reflect on how to collaboratively differentiate the PPT maize as it enters the food chain to underscore its potential benefits to the community.

Methodology

As a reflection on ongoing discussions at trans-disciplinary multi-actor communities (MACs) of practice was constituted under the UPSCALE project in East Africa. MACs included UPSCALE partners, seed producers and marketers, NGOs, farmers and farmer organization, extension personnel, aggregators, processors, credit providers, marketers and consumers of maize. Through several meetings with stakeholders, reviews of literature as well as the authors' reflections and experiences over time, many farmers have been able to access information concerning the existence of push-pull technology. Therefore, there is a great need to focus on how the multi-actors can be engaged in promoting PPT among the farmers. UPSCALE is about realizing the transformative potential of PPT by expanding its scope and applicability. As many adopters, researchers, and agronomic experts advocate for the necessity of this technology, the main questions of focus are whether the maize produced from PPT can be differentiated, who are the actors and their roles in promoting PPT, what are the hindrances to stakeholders' engagement in promoting PPT and what are the potential outcomes of effective stakeholders' engagement in promoting PPT?

Results and Discussions

Multi-actors' communities of practice (MACs) refer to all the actors in the community that supports agricultural activities and development such as KEPHIS, financial institutions, insurance companies, research, extension, policymakers, farmers' organizations/cooperatives, agro-dealers, higher education institutions, NGOs, seed companies and government agencies.

In the UPSCALE project, multi-actors communities of practice (MACs) have been a key pillar of success. MACs are critical for creating an enabling environment for an efficient and effective foundation for transdisciplinary research and technology innovation. It has been greatly involved in the mapping and tracing of PPT maize producers in the region. The mapping of maize producers is key as it lays out a visual representation of all the maize producers in the project and how they are connected. Mapping enables the project to know the priorities of the farmers in terms of the inputs, keeping a track of areas of operation, the level of adoption of the technology, changes facing old members of the project, expectations of the new members, the trends in terms of productivity of the members, locating areas to initiate the project, know the needs of farmers, identify new products to offer to farmers, and evaluate the impact of a project through monitoring and evaluation. It is also easy to target a specific group of farmers, or a section of the community through mapping to offer additional projects or establish demonstration plots as it aids in disseminating agricultural technologies to diversified farming communities for adoption. Through the mapping of the maize producers, MACs operate in the community to support agricultural activities and innovations for increased food productivity through the provision of inputs, credit, knowledge, market, or access to advice by extension.

MACs in the UPSCALE project have advocated for certifying of various products to be accepted at both regional and international markets. Desmodium seed is one product that it has pushed to ensure that it is tradable and farmers can easily access it across the borders to promote PPT. Currently, the seeds are produced in Ethiopia in admirable quantities and through the MACs effort, they will be commercialized once it is certified across the borders.

MACs also have promoted Eco labeling for the products. This is an effort to educate and increase consumer awareness of the environmental impact of PPT products. This is to enhance environmental protection by encouraging consumers to buy organic products that are from a low environmental impact production process. This is one of the ways to reduce agrochemical usage, and promote PPT as an environmental and organic farming system.

MACs have also engaged in providing farmers with incentives in form of inputs through demonstration plots such as desmodium seeds to lower the pricing of the product. The low prices stimulate the demand for the products scaling up the PPT technology among the farmers. In addition, credit incentives, and training farmers for better production method is a ways of improving efficiency can help to scale up the number of adopters. According to (Rogers, 1995), farmers are likely to be persuaded by dissemination pathways that are reliable, simple, and credible. According to Murage et al. (2010), who evaluates different pathways used in the adoption of PPT, advocate for adequate information dissemination to the farmers and interaction with the researchers. Silva (2016) explains that to counter the negative effects of technology adoption among farmers as a result of illiteracy, access to extension services has to be upheld.

Despite the achievements that MACs have provided in the scaling up PPT, it greatly needs the government support in terms of national and regional policy formulation. The government is required to ease trading activities, especially in agricultural commodities across borders. Currently, products such as desmodium seeds are facing the challenge of being commercialized in a different country or it could be bureaucratic to import or subjected to many regulations. Most countries are experiencing a deficit in desmodium seeds which is a hindrance in upscaling of PPT. To remove these obstacle, the government should waive duty and sign common protocols on desmodium Quality Declared Seed (QDS) systems. This will promote commercialization raising income among women and youth involvement as desmodium community seed merchants and seedling nurseries.

Consequently, a simultaneous increase will be realized among farmers practicing PPT maize production as the soils will improve in fertility, pests will be controlled, and *Striga* weed eliminated organically. The overall production cost will be low, the quality of the product will be high as the crop is freed from diseases as the, and weeds will not have any effect on it, organic product in nature free from agrochemicals and high nutritional value. In addition, farmers trading carbon credits can lower their production costs as the effect on the environment is minimized through PPT farming. Equally, it will be a mitigation to the climate change affecting the SSA region.

Conclusion and Recommendations

Push-Pull technology maize can be differentiated and promoted when stakeholders begin to reflect on its potential in the region. Produce from the PPT production system are organically produced, the genetic composition of the product is not altered by any external agrochemicals, the production process does not affect the environment and the quality of the seed is high and acceptable to international markets. Ultimately, more adopters justify the need to differentiate PPT maize in the region. Therefore, as stakeholder's find adaptive and alternative PPT adoption pathways, it is imperative to begin discussions on differentiating PPT maize in the region.

This calls for the stakeholder's engagement on how to help consumers to differentiate PPT maize at the market level to create demand for the product which will in turn call for a greater supply trapping more farmers in PPT production and promoting a sustainable farming system where the ecosystem is protected, soil fertility improved, livestock feeds produced, increase in productivity, increase in the tradable surplus, income and improved livelihood for the women and the youth.

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