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Production and genetic conservation of quality protein maize (QPM) seeds by smallholder farmers in Karamoja sub-region, Uganda

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Abstract

The need for improving availability and access to pure quality maize seeds of protein content by small holder farmers instigated the commencement of a scheme for production and conservation of longe5 seeds in the dry land farming system. Longe5 is a maize variety with two amino acids called *tryptophan* and *lucine* coding protein synthesis. This study aimed at creating a multi stakeholder innovation platform for commercial production of pure quality Longe5 maize seeds; equipping farmers with sustainable knowledge of production, genetic conservation and quality control of Longe5 maize seeds; increasing seed volume through farmer–farmer block production. Methodically, four seed grower groups were formed and commenced seed production using longe5 foundation seed stock for 3seasons applying half-sib pollination technique. Comparatively QPM seed scheme were established, functionalized and operationalized; and 60% of seed growers trained in production, conservation, marketing and consumption of QPM maize; 79.9% of farmers adopted and applied half-sib method for genetic purity conservation. 100MT of QPM maize seeds were produced. Currently growers are knowledgeable of the values, benefits of longe5 seed production with ease of seed access and availability.

Introduction

Production of maize (Zea mays) is essential and better when yield is high and food products are nutritive to consumers for improved livelihood. In Uganda maize is one of the main cultivated crops after banana and cassava and globally ranked 4th to sugarcane, rice and wheat (Molnes, 2014). In Uganda, maize in predominantly grown by smallholder farmers with longe5 variety most preferred for high yield (2.7MT/Ha) and protein content coded from synthesis of two essential amino acids (*Tryptophan* and *Lysine*) in grains (Kassahun *et. al.*, 2004). Increasing maize productivity is largely based on sustainable use of pure quality seeds under ideal farming management. However, yield can be better if the majority smallholder farmers genetically conserve seeds purity during production and for ease of access especially at planting time. In Karamoja dry-land productivity of maize is low (1.6MT/Ha) during the main rain season (700mm) (*Akiporo*) and further reduces (0.8MT/Ha) in the second micro-rain season called *akamu*. Causes to poor productivity were attributed to drought stress and lack of pure quality maize seeds especially in areas with bimodal rains and where irrigation was practiced at semi-intensive mode. But with changing climate for more intensive rains and water conservation for irrigation during drought stress, pure quality seed production and conservation remained the most pressing need to enhancing increased maize productivity and food availability to the increasing population for better livelihood. The comparative advantage of protein content also remained vital in improving the dietary nutrition for young ones in particular. Maize growers were and still remain interested in maize productivity but lacked knowledge on values and benefits for quality

seeds production and genetic conservation. Protein drifting and genetic purity are often realized when quality in compromised especially during outcrossing with unknown mixed seed races at pollination level. This study therefore concentrated on edifying growers with sustainable techniques of producing maize seeds of pure quality with genetic purity conservation for the next cropping season, and grain protein content for dietary nutritional boost among consumers. Successes were achieved through a dynamic system of multi stakeholder innovation platform formation for enhancing production of pure quality Longe5 maize seeds; training and equipping farmers with practical knowledge for seed growing and genetic purity conservation; quality control and marketing of pure quality Longe5 seeds in a sustainable venture; and increasing longe5 seed availability through farmer–farmer block production.

Material and Methods

Successes were achieved through formation of seed grower groups (four) each with 30 smallholder farmers (50% gender). Production of quality seeds commenced with use of var. Longe5 foundation maize seed stock, cultivated for 3 seasons. Selected plants were bulked and applied half-sib pollination technique (Peiris, 2001) for enhancing pure quality and protein seeds conservation. Applied methodologies included formation and functionalization of the platform (Adekunle *et. al.* 2014) for sourcing QPM seeds production and marketing information; Introduction and production of seeds using farmer field school (FFS) perspective for practical grower training (Braun *et. al.,* 2000); Seed fields isolation by distance and time of planting for genetic purity conservation (MacRobert J.F., 2009); and block fields cultivation for seed production.

Results and Discussion

Successes in this study were achieved with creation and comprehensive engagement of stakeholder innovation platform (fig.1) through broad interface and networking with seed agro-stakeholders. The platform coordinated and offered guidance and knowledge of producing quality longe5 maize seeds, projecting seed market information and practices of genetic traits conservation. The platform successfully followed a networking approach identified by Adekunle (2014) as integrated Agricultural Research for development (IAR4D) useful in interlinking crop grower stakeholders with agricultural research technology implementation. Currently seed growers are in full recognition and utilization of the platform roles and services for seed venture.

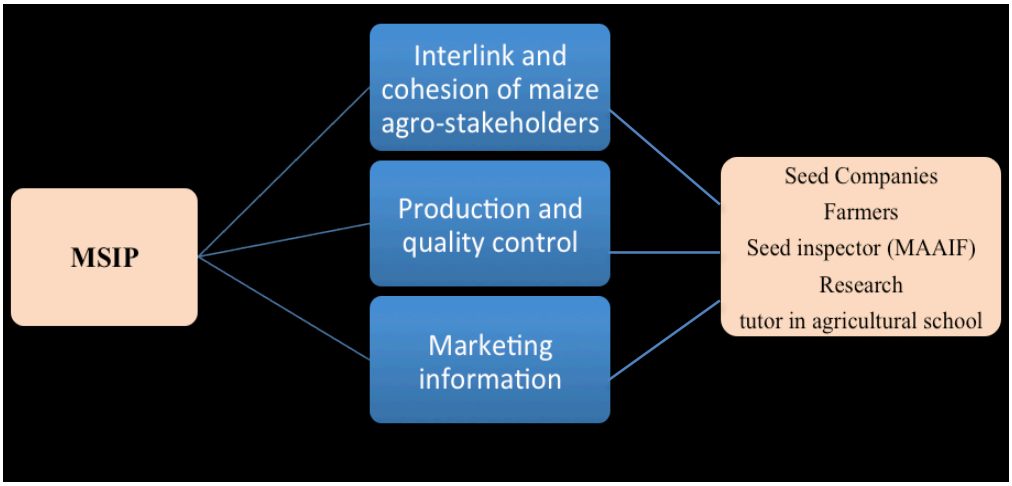

Figure 1: MSIP formed for participatory production and marketing of QP maize

Crop growers were trained to become diversified farmers with engagement into quality maize seed production especially the protein content type to help narrow the gap of seed access and

availability and general nourishment of people with quality protein maize (fig. 4) for human nutritional improvement. Throughout the study, 79% of growers were cumulatively trained (tab.1) and equipped with practical knowledge of quality seed production and genetic purity conservation using the adopted farmer field school approach described by Elske *et. al.* (2000) and Braun *et.al*. (2000) as important imparting practical skills. Trainings were participatory from identification of ideal field for seed production to a series of activities involving trial establishment, crop agronomy, pest and disease control, field phytosanitary management, post harvest, seed processing control and marketing. Adoption rate of trained farmers were above 90% typically attributed to the grower interest and need for improving their productivity through quality seed production in particular.

Table 1: *Farmers trained and adopted QPM seeds production technology*

		Cropping years		
Season	Trained Farmers	2017	2016	2015
A	200	160 (80%)	30 (15%)	10 (15%)
B	90	70 (77.8%)	10 (11.1%)	10 (11.1%)
A	120	90 (75%)	20 (16.7%)	10 (8.3%)
B	75	50 (66.7%)	15 (20%)	10 (13.3%)
A	240	205 (85.4%)	25 (10.4%)	10 (4.2%)
B	86	61 (70.9%)	15 (17.4%)	10 (11.6%)
A	268	238 (88.8%)	20 (7.5%)	10 (3.7%)
B	90	60 (66.7%)	20 (22.2%)	10 (11.1%)
Total	1169	934 (79.9%)	366 (31.3%)	325 (27.8%)

Figure 2: *Maize genetic purity conservation by a farmer in Naitakwai, Moroto District*

Similarly, farmer training were enriched with scientific applications of genetic purity conservation especially the trait purity control and protein maintenance. Half sib technology as described and suggested in earlier studies by Peiris (2001), were adopted and used in trait conservation. Growers collected pollinated silks (fig. 2) of selected plants for source of need for the next cropping season and sale of surplus through the venture cooperative group. Other purity controls adopted include isolation (distance and time) (fig. 3) based on the ease of materials acquisition for use in genetic control and the land tenure system enhancing 400m fields isolation potential from maize field with other maize varieties. The success of this technology enhanced growers to own implement the half sib technology where 98% of pollinated plants produced pure quality seeds hence preferred as quality declared seed (QDS). Similarly maize fields isolated at 400m from other maize plots were found uniform in tassel and silk structural appearance hence conformation of morphological plant purity, and harvested cobs appeared uniform hence purity assurance. The achieved results of genetic purity were in correlation with observation of MacRobert (2009) on maintaining and production of breeder seed of self-pollinated maize crops.

The need for enhancing sustainable application of seed production technology, the idea of commercialization was considered and therefore through the MSIP interface, seed marketing were implemented to improve the economic income and grower livelihood. The seed produced and considered as quality declared seeds were marketed under umbrella of cooperative to individual farmers, non-government organizations (NGOs), seed companies and government parastatals engaged in agro-activities. Approximately 42.2MT of pure quality protein maize seed were produced (fig. 5) but more pronounced in the final project year 2017 (20.4MT).

Figure 3: *Pure quality protein maize seed in production*

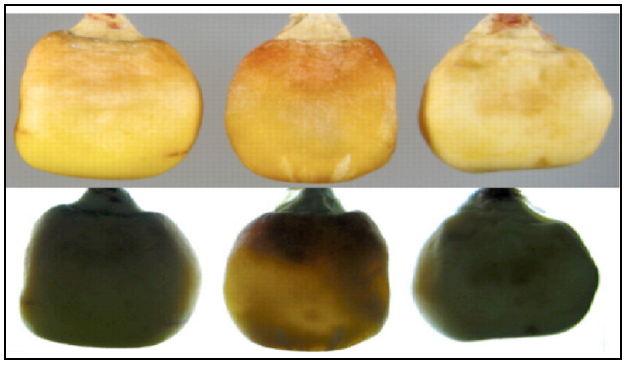

Figure 4: *Quality protein maize grains (Opaque 2)*

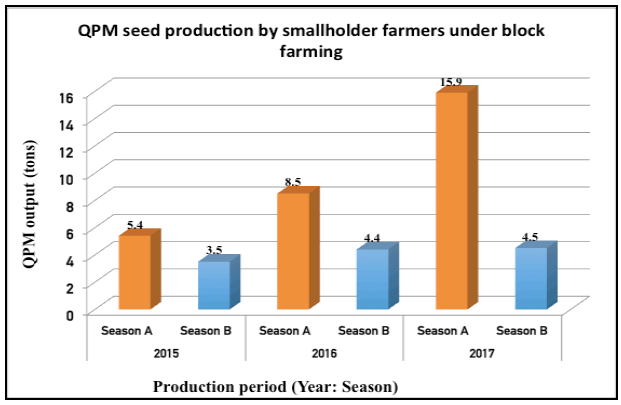

Figure 5: *Seed productivity by smallholder farmers*

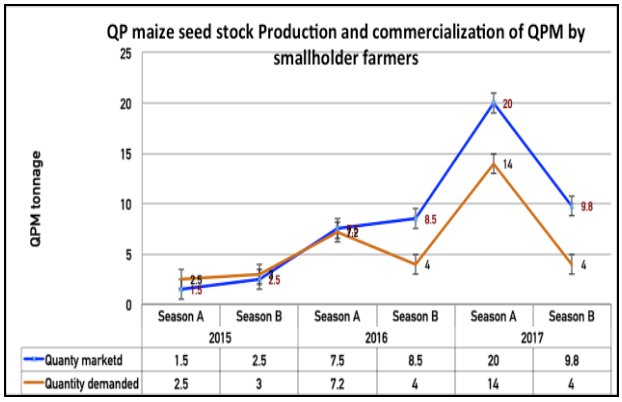

Figure 6: *Seed stock produced and commercialized*

Seed marketing gained prominence and solvency by the year with the highest in 2017 typically due to more awareness of the group seed production venture and the proof of the seed quality and availability for ease of access. Seed demand is persistently increasing (fig. 6) by the effectiveness in purity maintenance and productivity. Due to more productivity realized 15% of the seeds were offered on credit through the voucher scheme to all increased in demand and potential income for the growers.

Conclusion and outlook

Project success was and still remains attributed to the determination and comprehensive engagement of growers in realizing their potential and ability to bridge the gap of poor productivity with pure quality seed production and conservation for availability and ease of access at planting time. Use of pure quality seeds is the most correlated form of enhancing increased productivity and income especially among smallholder farmers. Currently growers possess good knowledge of seed production technology. Thus effective functioning of developed MSIP, smallholder farmer are in position to sustainably produce pure quality maize seeds with protein trait maintenance hence stimuli for increase food production and nutritional improvement in Karamoja. Intensive seed system development is anticipated to stimulate more demand hence enhancing commercialization and ultimately leading to improved livelihood.

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