RUFORUM Working Document Series (ISSN 1607-9345) No. 14 (2) : 371- 379.
Available from *http://repository.ruforum.org*

Research Application Summary

Pathways to secure smallholder farmer seed security

Okori, P[1]., Charlie, H[1]., Munthali, W[1]., Kachulu, L[1]., Sichali, F[1]., Elirehema, S[2]., Soka, C[1]., Monyo, E.[3] & Siambi, M[3].
[1]International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), P. O. Box 1096 Lilongwe, Malawi.
[2]Agricultural Research Institute (ARI) Hombolo, P.O Box 299, Dodoma, Tanzania.
[3]International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), United Nations Avenue, P.O Box 39063-00623, Nairobi, Kenya.
Corresponding author: p.okori@cgiar.org

Abstract

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in partnership with several agencies in east and southern Africa have been testing and implementing different strategies to improve seed security of under invested dryland cereal and legume crops. ICRISAT's approach focuses on improving the functionality of seed systems and allied productivity knowledge. Seed systems in this case refer to individuals, networks, institutions and organizations involved in the breeding, multiplication, processing, storage, distribution and marketing of seeds. Investments target two forms of seed systems namely: (a) Formal systems generally managed by seed companies, and (b) Informal systems generally managed through community initiatives by farmer and or civil society led initiatives, supplying quality declared seed. In general, the efficiency of any seed system is influenced by functional linkages between breeding pipelines for locally-adapted and farmer-preferred varieties, efficiency of seed production and delivery systems and effective technology transfer. The ICRISAT models aim to, among others (i) Improve production and availability of improved legume and dryland cereal improved seed to farming communities, (ii) Empower smallholder farmers especially women farmers, to access, use and control productive seed resources and opportunities, and (iii) Harness productivity enhancing knowledge and innovations to unlock genetic potential of new varieties. This paper highlights key achievements from investments over the last five years that included, among others, a) Establishment of a viable public-private partnership model that produced and delivered 8,184 MT and 124 MT of groundnut and pigeonpea certified seed respectively to Governments' Farm Input Subsidy Program (over the period 2009-2014), and 54% of legume seed delivered by the private sector to farmers in Malawi, and b) Catalysing an eight-fold increase in early generation seed supply from 250 MT in 2009 to 2,000 MT in 2013; and produced 200 MT of pigeonpea certified seed for the first time for Malawi. In the two focus countries (Malawi and Tanzania), there has been overall strengthening of seed systems which has led to improved legume and cereal production and productivity, with wider benefits to smallholder farmers and the broader economy.

Key words: Dryland cereals, dryland legumes, ICRISAT, Malawi, seed systems, Tanzania

Resume

L'Institut International de la Recherche sur les cultures des zones tropicales semi-arides (ICRISAT), en partenariat avec plusieurs organismes en Afrique orientale et australe ont testé et mis en œuvre des différentes stratégies pour améliorer la sécurité des semences des céréales et des légumineuses des zones arides ayant reçu peu d'investissement. L'approche de l'ICRISAT se concentre sur l'amélioration de la fonctionnalité des systèmes semenciers et les connaissances connexes de la productivité. Les systèmes semenciers dans ce cas se réfèrent à des individus, des réseaux, institutions, et organisations impliqués dans la reproduction, la multiplication, la transformation, le stockage, la distribution, et la commercialisation des semences. Les investissements ciblent deux sortes de systèmes semenciers (a) les systèmes formels généralement gérés par des sociétés semencières (b) les systèmes informels généralement gérés à travers des initiatives communautaires gouvernées soit par les agriculteurs ou la société civile fournissant des semences déclarées de qualité (QDS). En général, l'efficacité de tout système semencier dépend des liens fonctionnels entre les canaux de reproduction des variétés adaptées aux conditions locales et préférées par les agriculteurs, l'efficacité de la production de semences et les systèmes de livraison, et de transfert de technologie efficace. Les modèles de l'ICRISAT visent, entre autres (i) l'amélioration de la production et la livraison des semences améliorées des légumineuses et des céréales auprès des communautés agricoles des zones arides, (ii) l'autonomisation des agriculteurs ayant de petites exploitations en particulier les femmes, tel qu'ils aient l'accès, l'utilisation, et le contrôle des opportunités et ressources semencières productives, iii) l'utilisation des connaissances visant le renforcement de la productivité et des innovations pour débloquer le potentiel génétique de nouvelles variétés. Ce document met en évidence les principales réalisations des investissements au cours des cinq dernières années, qui comprennent, entre autres, a) la mise en place d'un modèle de partenariat public-privé viable qui a produit et livré respectivement 8,184 tonnes et 124 tonnes de semences certifiées d'arachide et du petit pois aux programmes gouvernementaux de subvention d'intrants aux fermiers (sur la période 2009-2014), et dont 54% des semences de légumineuses étaient fournies par le secteur privé aux agriculteurs au Malawi, et b) la catalyse d'une augmentation de huit fois l'approvisionnement en semences de première génération à partir de 250 tonnes en 2009 à 2000 tonnes en 2013; et la production de 200 tonnes de semences certifiées du petit pois pour la première fois au Malawi. Dans les deux pays cibles (Malawi et Tanzanie), il y a eu un renforcement global des systèmes semenciers ce qui a permis d'améliorer la production et la productivité des légumineuses et des céréales, avec des avantages plus larges pour les agriculteurs à petite exploitation et l'économie en général.

Mot Clés : les céréales des zones arides, les légumineuses des zones arides, les systèmes de semences, l'ICRISAT, le Malawi, la Tanzanie

Background

The goal of agricultural development in Africa is to achieve sustainable intensification through adoption of new technologies that use inputs such as improved seed and other yield enhancing technologies to increase land and labour productivity (Reardon, 1998; Dorward *et al.,* 2009). Thus, improved seed becomes a crucial input to productivity increase, being a repository of many years of selection and crop breeding. Availability, access and utilization of improved quality seed is essential for agricultural communities to increase their land and labour productivity as they strive to expand their livelihood opportunity. Seed security, the availability, access and utilisation therefore underpins food and income security improvement. In Malawi for example, recent groundnut productivity improvement from a national average of 500 kg ha^{-1} in 2005 to 820 kg ha^{-1} in 2009 then to 1,200 kg ha^{-1} in 2014, is mainly due to increased adoption of modern varieties and allied technologies. In Tanzania, the area under groundnut is growing at 4.63% per annum, albeit with relatively low yield hovering between 545 – 723 kg ha^{-1} and a yield gap of >50%. In most of Africa's groundnut producer countries, productivity is generally compromised by a multiple of stresses (biotic and abiotic), as well as continual use of obsolete varieties. Improving access to modern technologies could unlock productivity with immense opportunities for farming communities and economies. The CGIAR has been instrumental in development of new varieties, accounting by and large for most of the cropped area under modern varieties that have been released in partnership with the National Agricultural Research Systems (NARS) (Fuglie and Rada, 2013).

Productivity of most legume, dryland cereals and other under invested crops in most of sub-Saharan Africa (SSA) cropping systems, is low with yield gaps of over 50%. These crops have not benefited much from the resurgence in growth of the agriculture sector that has averaged 6% over the last 15 years. A key driver of the low productivity is the continued use of obsolete varieties that are burdened with genetic erosion of superior traits and consequent susceptibility to biotic and abiotic stresses and low yield. Equally important is their incongruence to new market opportunities. The high seed insecurity of many of SSA's well adapted crops has a strangle-hold on many planned productivity-increase targeted investments of the continent. Seed insecurity is asymmetric, being favourable for commercial crops. For example, between 2001 and 2005, the share of new maize varieties in SSA's crop area was (40.4%) compared to (16%) for sorghum. Among the legumes and oil crops a similar trend was observed over the same period, i.e., cotton (30%), groundnut (4.3%), cowpea (15.6%), pigeonpea (1.4%) and soybean (18.1%). For these under invested crops many of which provide livelihood opportunities strengthening availability, access and utilization of improved seed provides a new window of opportunity to catalyse productivity increase. Consequently, ICRISAT efforts are directed at developing and increasing access to improved seed. This paper focuses on work being done in Malawi and Tanzania to increase availability of groundnut and pigeonpea seed to business and farming communities in the two countries.

Literature summary

The recent gains in total factor productivity of Africa's Agriculture is mostly due to gains in factor use efficiency rather than adoption of new technologies such as new varieties (Liu and Benin, 2011). For the most part, access to improved innovations especially seed and allied technologies has been weak. This has led to intensified efforts to strengthen breeding programmes especially in SSA by the Alliance for Green Revolution in Africa (AGRA) led Scaling Seeds and Technologies Partnership in Africa (SSTP), Pan Africa Bean Research Alliance (PABRA), CGIAR led Scaling Seed Technologies in West, East and Southern Africa, Malawi Seed Industry Development Project, Tropical Legumes III, Harnessing Opportunities for Productivity Enhancement (HOPE) of Sorghum and Millets in Sub-Saharan Africa and South Asia (HOPE II), N2 Africa, among others. All these investments are underpinned by strategic CGIAR-NARS partnerships to improve functionality of seed value chains involving formal and informal seed sector actors. In general, the efficiency of any seed system is influenced by functional linkages between breeding pipelines for locally-adapted and farmer-preferred varieties, efficiency of seed production and delivery systems and effective technology transfer (McGuire and Sperling, 2015).

Compared to legumes, seed systems for cereals are relatively more secure mainly due to complementary policy support (Fuglie and Rada, 2013). In most developing countries of SSA, certified legume seed is being routed via a relatively small proportion of transactions, i.e., 2.4% overall and in no case higher than 17.4% by private sector companies (McGuire and Sperling, 2015). Informal seed systems underpin most legume and dryland cereal cropping systems with certified seed accounting for less than 1% of volumes sown. Indeed, a seed security assessment conducted in the southern districts of Malawi in 2011 indicated that legume based cropping systems experience acute seed shortage (CIAT, 2011). This report and others show that the supply of diverse and sought after legume varieties, particularly, groundnut and pigeonpea is limited (Ng'ambi and Maliro, 2004). Yet farmers in southern Malawi, in general, are very responsive to adoption of new high yielding varieties, with 71% of them adopting new varieties over a five-year period, between 2006 and 2011. A similar trend is expected across the country and other smallholder based production systems in Africa.

In both formal and informal seed systems, seed flows influence the pattern and dynamics of materials that farmers access, exchange and deploy in their farms. Indeed, by clarifying seed flow dynamics, growth opportunities expand. Using Malawi as a case study, it is noted that the relatively weak supply systems of legume seed value chains compromises seed security. Between 2005 and 2012, for example, no new groundnut variety was released in Malawi. However between 2012 and 2015, 12 new varieties were released, seven coming from Malawi, introducing production and productivity enhancing groundnut varieties. However, availability of new varieties alone does not necessarily solve the problem. For example, the popular groundnut variety CG 7 (ICGV-SM 83708), first

released in Malawi in 1990 only got to farmer's fields over a decade later due to intensive investments that strengthened supply of early generations of seed. An impact assessment commissioned by ICRISAT in 2013 showed that over 80% of cropped area under improved groundnut varieties is under CG7 and Nsingiro (ICGV-SM 90704), another improved variety. These results corroborate earlier seed security assessments conducted in 2011, in southern Malawi that showed that maize accounted for 78% of new varieties distributed due to functional seed systems. Thus limited production of early generations of seed (breeder and foundation) is a major issue in the supply of legume seed. Building on lessons learnt over the years, CGIAR institutes in partnership with the NARS (National Agricultural Research Systems) are producing early generations of seed and working to improve functionality of seed systems. In order to improve targeting and impact orientation, a systematic scenario analysis of target seed systems to inform design and implementation of interventions is critical to improve access to modern varieties. This process when integrated to grain markets, provides workable and sustainable solutions for seed security.

Approach to improving production and delivery of improved seed

For countries with small economies, capacities and resources for agricultural infrastructure and research and development systems are scarce. In such economies, CGIAR bred varieties predominate crop area under improved varieties (Evenson and Gollin, 2003; Liu and Benin, 2013). However, the dichotomy in net benefits of CGIAR varieties, i.e., 2% total factor productivity growth per year in South Asia, compared to 1% for SSA, all developing economies, calls for strategic Research for Development (R4D) processes that leverage the current and emerging strategies to improve production and delivery of improved seed and allied innovations. Using Malawi and Tanzania as case studies we note that lack of awareness and limited or no access to quality seed due to consistent failure of the public sector to supply early generations of modern varieties in desired quantities has diminished growth in productivity. ICRISAT and partners are implementing investments and research to enhance impact delivery, while at the same time, informing the science of delivery. These programmes are underpinned by plant breeding programmes that must of necessity focus on contextual/regional release of modern varieties that are supported by effective seed production to delivery systems. ICRISAT's activities have thus focused on strengthening of formal and informal systems by improving production and delivery of improved seed through both formal and informal systems. This nexus of informal and formal seed systems conceivably improves access to modern varieties by small holder farmers. The team involves researchers from NARS and CGIAR, private and public sector seed companies, civil society and farmer organisations and relevant government departments and agencies.

Research application

Dual systems to deliver improved seed. Private seed companies and civil society took the lead in acquiring Foundation Seed for further seed increase and dissemination. Most of the farmers rely on self-saved seed and access to seed of improved varieties either through

informal networks. In both countries, we find two seed supply systems, namely informal, usually non-market based and the quasi-formal, mainly market-based seed supply systems. Informal seed supply sources include own-saved seed; gifts from family and friends, farmer-to-farmer seed exchanges and others. The importance of quasi-formal seems to increase formal release of new farmer and market-preferred varieties, helps in augments seed demand and seed markets for superior varieties.

A public and private sector partnership for strengthening seed systems developed. A viable public-private partnership model has produced and delivered 8,184 tons and 124 tons of groundnut and pigeonpea certified seed over the period 2009-2014. In Malawi, investments reduced the supply gap of groundnut certified seed, catalysing eight-fold growth from 250 MT in the first year of implementation (2009) to an annual average of about 1,000 MT by 2015. In the case of pigeonpea, production of certified seed gradually increased from negligibly low volumes before the strategic interventions, to about 200 MT in 2015. In Tanzania, similar actions for pigeonpea have drastically increased cultivated area by 180%. In Ethiopia, PABRA unlocked opportunity for sugar bean and canned bean grain production for export by strengthening the seed systems. Figure 1 gives an illustration of the increases in production of these commodities over the last few years.

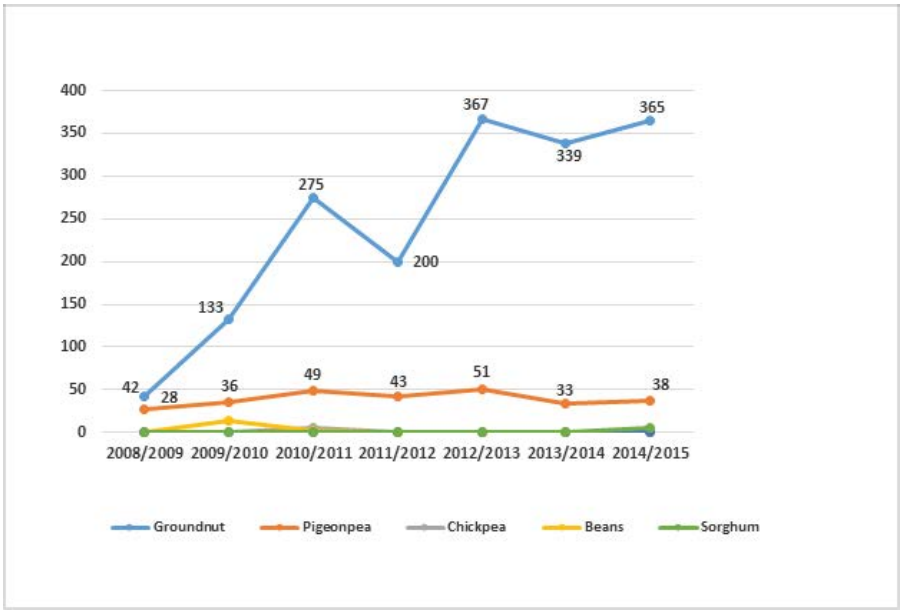

Figure 1. Foundation seed production trends for selected grain legumes and sorghum in Malawi

Created a seed business incubation platform – Malawi Seed Alliance (MASA). A seed business incubation mechanism, MASA was created for young seed companies to provide quality assurance with traceability and branding for market penetration. MASA now has 10 local seed company incubatees, that accounts for 44% of the seed companies in the

country.

Accessing seed via informal seed systems. In Malawi and Tanzania, 60 community seed banks have been established directly reaching 15,000 farmers and indirectly reaching 33,000 farmers over a three-year period. In Malawi, from an initial 7.5 tons of basic seed investment for groundnut varieties: Nsinjiro, Kakoma, CG 7 and Chitala was infused to community seed banks for farmer access in Mchinji, Mzimba and Nkhotakota. This system produced 65 tons of Quality Declared Seed (QDS), expanding coverage of target improved groundnut varieties to over 70% under (Nsinjiro, CG 7 and JL 24), compared to about 26% in 2009 the baseline year. Results also indicate that improved seed of these varieties reached a total of 33,000 non-collaborating farmers in the three districts. The use of such systems can thus invariably increase access to and use of modern crop varieties.

Table 1. Illustrative growth in productivity of groundnut seed produced by community seed banks in Malawi.

District	Area	Seed Provided (Kg)	Harvested seed (Kg)	Seed recovery (Kg)	New members Recruited in 2013-14	Number of Seed banks/ (old +new)
Mchinji	Mikundi	1000	10,000	1900	190	39
Mzimba	Champhira	2500	20,000	4980	332	54
Mzimba	Ekwendeni	2000	12,000	3500	350	45
Nkhotakota	Linga	1000	10,000	1850	185	36
	Total	6,500	52,000	12, 230	1,057	174

Conclusion

Overall, historically, seed-based technologies have been easier to implement with most farmers being anxious to experiment with new varieties. However, plant reproductive biology and seed flows influence the scale of success. By elucidating seed flows, to inform seed production and delivery systems, and when complemented with participatory variety selection, assures relevance and adoption. The examples from Malawi and Tanzania show that while access to seed of open-pollinated crops at scale still remains a challenge, strategic strengthening of early generation seed production can reverse the trend. Greater success is however possible if both grain and seed production are supported by functional markets, institutions, policies and agroecological factors among others. The approach adopted by ICRISAT to increase farmer access to quality seed has led to:

1. Establishment of a viable public-private partnership model that produced and delivered 8,184 MT and 124 MT of groundnut and pigeonpea certified seed respectively to Governments' Farm Input Subsidy Program (over the period 2009-2014), and 54% of legume seed delivered by the private sector to farmers in Malawi.
2. Catalysing an eight-fold growth increase in early generation seed supply from 250 MT in 2009 to 2,000 MT in 2013; and produced 200 MT of pigeonpea certified seed

for the first time for the country.

3. Created a seed business incubation platform (MASA) for young seed companies providing quality assurance with traceability and branding for market penetration.
4. Unlocked potential of on-the-shelf varieties that had not been accessible to farmers e.g. CG7 and Nsinjiro (groundnut), Mwaiwathualimi, Chitedze 1 (pigeonpea) and these now account for over 60% of cultivated area under improved varieties.
5. Improved capacity for seed certification by statutory agencies by developing seed management and information system at Government's Seed Services Unit (SSU), capital equipment replacements, and para seed inspectors trained for increased surveillance and inspection, seed certification.
6. Promoted productivity enhancing technologies such as the double-row system that triggered a 2.4 fold increase in groundnut productivity from 500 kg ha^{-1} to 1,200 kg ha^{-1} in Malawi.
7. Increased equal opportunity for women farmers with participation threshold of 45% women participation, unlocking opportunities for women farmers and directly contributing to improvement in their income, overall household nutrition and livelihood opportunities.
8. In Tanzania and Malawi, farmer research groups have been established and engaged in participatory variety selection, on-farm research and promotion activities. These groups annually host over 60 communal seed banks established.

Acknowledgement

The work reported herein has been generously supported by IrishAid, USAID, Bill and Melinda Gates Foundation, McKnight Foundation, AFRICA RISING and host Governments of Malawi and Tanzania. This paper is a contribution to the 2016 Fifth African Higher Education Week and RUFORUM Biennial Conference.

References

Fuglie, K.O. and Rada, N.E. 2013. Resources, policies, and agricultural productivity in sub-saharan Africa, ERR-145, United States Department of Agriculture. Economic Research Service, February 2013.

CIAT, WALA, CRC and Government of Malawi. 2011. Seed system ssecurity assessment, Southern Malawi. October 2011. Blantyre, Malawi: CRS and Internal center for tropical agriculture. Supported by United States Agency for International Development/ US Office of Foreign Disaster Assistance.

Dorward, A.R., Kirsten, J.F., Were-Omamo, S., Poulton, C. and Vink, N. 2009. Institutional Economics Perspectives on African Agricultural Development. International Food Policy Research Institute Washington, D.C. U.S.A. DOI: 10.2499 /9780896297814BK.

Liu, Y. and Benin, S. 2013. Options and Priorities for raising and maintaining high agricultural productivity in Africa. Regional strategic analysis and knowledge support system. (ReSAKSS) IFPRI, Issue Note number 20.

McGuire, S. and Sperling, L. 2016. Seed systems smallholder farmers use. *Food Security* 8: 179. doi:10.1007/s12571-015-0528-8.

Ministry of Agriculture Food Security and Cooperatives. 2011. Proceedings of the seed industry stakeholders' workshop held on 3rd June, 2011 at Naura Springs Hotel, Arusha, Tanzania.

Ng'ambi, F. and Maliro, M.F.A. 2004. Seed security in Malawi with emphasis on food crops. Africa Biodiversity Network (ABN), Malawi Economic Justice Network (MEJN).

Reardon, T. 1998. African agriculture: Productivity and sustainability issues. In: International agricultural development. Eicher, C.K. and J. Staatz, J. (Eds.). Baltimore: Johns Hopkins University Press.