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If technology is the answer, what does it take?

Ruth Haug, Joseph P. Hella, Susan Nchimbi-Msolla, Dismas L. Mwaseba, and Gry Synnevag

ABSTRACT

This article aims to assess why technology such as improved crop varieties has not taken off in Tanzania in spite of substantial efforts, and to consider what role policy plays in that regard. Few farmers use improved varieties due to reasons such as affordability in relation to the low profitability of farming; high risk, including fake seed in the market; and unpredictable policies and marketing opportunities. Effective governance is needed for agriculture to be transformed in the direction stated in national policy documents, but weak institutions and the collective interests of farmers not being sufficiently recognised hinder the likelihood of necessary technological changes happening.

Cet article cherche à évaluer pourquoi les technologies comme les variétés de cultures améliorées n'ont pas décollé en Tanzanie, malgré des efforts considérables, et à réfléchir au rôle que les politiques générales jouent à cet égard. Rares sont les agriculteurs qui ont utilisé les variétés améliorées, ce pour des raisons comme l'accessibilité par rapport à la faible rentabilité de l'agriculture ; les risques importants, y compris les fausses semences présentes sur le marché ; et des politiques et opportunités de commercialisation imprévisibles. Il faut une gouvernance efficace pour que l'agriculture puisse être transformée de la manière présentée dans les documents de politiques nationales, mais la faiblesse des institutions et le fait que les intérêts collectifs des agriculteurs ne sont pas suffisamment reconnus entravent la possibilité de changements technologiques suffisants.

El presente artículo propone valorar las razones por las cuales, a pesar de los importantes esfuerzos realizados, en Tanzania no ha sido adoptada la tecnología —por ejemplo, aquella que ha producido variedades mejoradas de cultivos. Asimismo, el artículo señala que es necesario comprender el papel que en este sentido desempeñan las políticas públicas. Se constata que muy pocos campesinos utilizan las variedades mejoradas, lo cual responde a diversas razones: la accesibilidad a las mismas en relación con la pobre rentabilidad que deja el cultivo; el alto riesgo generado por la incertidumbre en el mercado, donde se evidencia, por ejemplo, la existencia de semillas espurias; las impredecibles políticas públicas y oportunidades de venta. Por lo que, para transformar la agricultura en el sentido trazado por los documentos de políticas nacionales, se requiere contar con un gobierno efectivo. Sin embargo, la presencia de instituciones débiles y la poca atención prestada a los intereses colectivos de los campesinos disminuyen la probabilidad de impulsar las necesarias transformaciones tecnológicas.

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Introduction

During the last decade, Tanzania has done well as regards overall economic growth, but this growth has so far not contributed towards reducing the high frequency of rural poverty. The agricultural sector in Tanzania employs 70–80% of the working population and accounts for 25% of GDP (WB 2013; NBS 2014). Limited growth in agricultural productivity is regarded as an important reason why rural poverty remains high in the country (te Lintelo et al. 2014). However, Tanzania is more than self-sufficient in food, but food production has kept pace with population growth more due to the expansion of cultivated land than to an increase in productivity (Cooksey 2012). The average cereal yield per hectare has stayed at the same low level for the last 30 years and is estimated to be around 1300kg/ha (World Bank 2015). Small-scale farmers are responsible for around 90% of national rice and maize production, with farm sizes ranging from 0.5 to 2.0 ha (Mtengeti et al. 2014). Persisting rural poverty, chronic undernourishment, low productivity in agriculture, uncertainties around future impacts of climate change on food production, as well as huge unemployment, are challenges that the government is struggling to meet when formulating the country's agricultural policy.

The Tanzanian government is concerned about agriculture not performing according to strategic goals, and attributes poor performance to farmers' lack of access to technology such as farm inputs, mechanisation, and irrigation (URT/MAFC 2011; URT/MFEA 2011; URT/MAFC/NAP 2013). If lack of access to technology is a main reason for the lack of improved performance of the agricultural sector, it is important to understand why farmers are still not using technology such as improved crop varieties and fertiliser in spite of many years where such technology has been promoted in the country (Scones and Thompson 2011). The purpose of this article is to assess how different actors perceive issues in relation to adoption of improved varieties of different crops in Tanzania. We ask why relatively few farmers are using improved varieties (Sperling and McGuire 2010; Langyintuo et al. 2010; Cooksey 2012; Louwaars and de Boef 2012; URT/MAFC/Seed Unit 2012; Smale, Byerlee, and Jayne 2013; ASARECA/KIT 2014; Westengen and Brysting 2014), and what it might take to increase such use. In particular, we are interested in assessing the role of policy and an enabling environment in relation to uptake of technology such as improved crop varieties.

In general, the formal seed systems in Tanzania and elsewhere in sub-Saharan Africa are known for being inefficient in delivering seed, and the majority of sub-Saharan African farmers rely on informal seed systems for their seed supplies (Sperling and McGuire 2010; Louwaars and de Boef 2012; Smale, Byerlee, and Jayne 2013). It is difficult to give exact figures of the use of improved varieties in Tanzania. According to the Seed Unit in the Ministry of Agriculture, Food Security and Cooperatives (MAFC), the formal sector covers about 25% of the total cereal seed needs and less than 10% for the legume, oil crop, and vegetable seed needs of the country (URT/MAFC/Seed Unit, 2012). For maize, Langyintuo et al. (2010) indicate that 18% of the total area is planted by improved varieties. Other studies that include both improved maize varieties obtained from the formal seed system and quality seed of farm-saved improved open pollinated maize varieties, found that around 22 to 24% of planted maize is from improved varieties (Smale, Byerlee, and Jayne 2013; Westengen and Brysting 2014). A recent, larger study by ASARECA found that around 95% of all seed planted by Tanzanian farmers is obtained from the informal seed system (ASARECA/KIT 2014). The informal seed system includes farmer-saved seed, farmer-to-farmer seed exchange, community-based seed supply, and some open market and local seed business not guided by seed legislation (ASARECA/KIT 2014).

The Tanzanian government and donors have been promoting the use of improved varieties and fertiliser through the National Agricultural Input Voucher Scheme (NAIVS), which provides inputs for half price to selected smallholder farmers for 0.5 ha of maize/rice crops. NAIVS has stimulated the use of improved varieties in the country (URT/MAFC/Seed Unit 2012; Mtengeti et al. 2014). Quality declared seed (QDS), produced under minimum quality control for community use within the ward has also stimulated the use of improved varieties in the country (FAO 2006; URT/MAFC/Seed Unit 2012).

Objectives and approach

This article aims to assess why relatively few farmers are using improved crop varieties in Tanzania and what role policy and an enabling environment play in relation to such use. Qualitative approaches were used to address the objectives. Study locations were purposely selected based on dominant crops in the region and district. Ten different regions (Mbeya, Njombe, Iringa, Morogoro, Singida, Pwani, Dar es Salaam, Mtwara, Zanzibar, and Arisha) and 15 different districts (Mbeya rural, Njombe, Kilolo, Gairo, Morogoro urban, Kilosa, Singida, Kibaha, Temeke, Ilala, Mkuranga, Mtwara-Mikindani, Unguja, Meru, and Karatu) were selected for in-depth farm level data collection. Focus group interviews with eight to 16 men and women farmers were undertaken in one village in each of the 15 districts. Participants in the focus group interviews were selected based on gender, age, socio-economic diversity, and availability criteria. In addition, around 50 key informant interviews were undertaken with on-farm seed producers, agro-dealers, retailers and distributors, public and commercial seed producers and suppliers, the Agricultural Seed Agency (ASA), the Tanzania Official Seed Certification Institute (TOSCI), national and international research institutions, civil society organisations, and government officers at national, regional, and district levels such as Ministry of Agriculture, Food Security and Cooperatives (MAFC). It is not possible to generalise the empirical findings to the whole country, as the approach was qualitative. The fieldwork was undertaken during the first half of 2014.

By *improved varieties* we mean a variety that has been formally released from a plant-breeding programme. Seed of an *improved variety* could be certified or not certified, as some farmers can keep seeds of improved varieties and continue to recycle the seed for several years. *Certified seed of improved varieties* has been produced according to standards set by the government in a quality assurance scheme and involves seed certification documents, for example, in relation to genetic purity and physical quality. By *quality declared seed* (QDS), we mean improved varieties that are produced under moderate quality assurance in accordance with MAFC guidelines for QDS (FAO 2006). We recognise that quality seed can also be produced in the informal seed system without being certified or only sometimes becoming certified. We also recognise that for self- and open-pollinated crops such as OPV maize, rice, wheat, and beans, farmers do not need to buy new improved varieties every year as they can re-use seed from previous seasons for a period, which varies according to the type of crop, without necessarily losing the qualities of the improved variety.

Farmers' perceptions on improved seed varieties in Tanzania

Seed affordability

The main finding from the focus group discussions with farmers was that in general, seed of improved varieties is too expensive for farmers to buy. However, there are clear differences when it comes to both type and intended use of crop and to geographic area. For example, in better-off areas, the use of improved varieties of hybrid maize is much higher than in other areas where maize is produced more for self-consumption than for the market. Regarding the type of crop, for example for vegetable and sesame seed, farmers complain less about the seed price and more about seed availability. However, in all locations, farmers underlined that the cost related to purchasing improved varieties was a problem. In Kiwambo village in Mkuranga district south of Dar es Salaam, the participants expressed that they would not buy seed for food crops such as maize, but instead use locally available seed. They stated that if they had the money, they could buy two kilos of hybrid maize seed for TZS 8000 (US\$3.70) and TZS 4000 (US\$1.85) for OPV maize at the agro-dealer, but that such prices were financially out of their reach. Sometimes, they might be able to afford a quarter or half a kilo of an improved maize variety, but would rather prefer to spend money on crops that they planned to sell. Even for many farmers receiving subsidised maize seed through the input subsidy programme (NAIVS) for half the market price, the improved varieties are still too expensive to buy. One reason for this is that, in order to get good yield

results from improved maize varieties, you also need to apply fertiliser, which adds to the input costs, although the input subsidy programme also provides fertiliser for half the market price. In addition, the subsidy vouchers are often delayed and do not arrive at the right time for planting, which might make the investment risky. Planting season is also a time of the year when farmers are desperately short of cash. For many farmers, it would be easier to purchase inputs after harvest time when cash is more available than at planting time. Misuse is a problem in the voucher system, as farmers cannot afford to use the vouchers and trade them cheaply for cash instead of getting the subsidised inputs. For self- and open-pollinated crops such as OPV maize, rice, wheat, and beans, it is important to underline that farmers can re-use improved variety seed from previous seasons for a certain time period without necessarily losing the qualities of the improved variety and hence, do not need to buy new improved varieties every year.

Another factor to take into consideration in relation to seed affordability is that varieties have often been handed out to farmers for free. Occasionally free handouts might decrease a farmer's willingness to pay for improved varieties. Farmers would like the government to distribute improved varieties free of charge. When this is not happening, farmers can easily rely on the informal seed system or in some cases the QDS system. QDS maize is about half the price of the OPV maize varieties provided by ASA. The QDS system appears to work successfully in some districts. For example, in Kongwa district we experienced a well-organised and appreciated QDS system that was supported by the district council and sold affordable quality seed even beyond the ward. Demand for QDS varies from place to place, for example, in the southern highlands there is higher demand for QDS seed. In other places, key informants stated that farmers would rather not buy seed from other farmers such as QDS, but preferred the more professional-looking seed packages marketed by private companies that they could buy from agro-dealers because they believed that this seed was of higher quality. For farmers producing and selling QDS, QDS is a good business if the demand is there. However, we were also told that funding for QDS was a problem as it was difficult to run the system without support from donors or the district council.

Risks and uncertainty

There are substantial degrees of uncertainties related to farming regarding weather, pests, market access, and farm gate prices. For farmers to invest in agro-inputs, such risks are important considerations. Profitability of farming and input affordability are closely linked. Expected returns from investment are important for the use of agricultural inputs such as improved varieties. There is more willingness to invest in improved vegetable varieties such as tomatoes and onions, where market opportunities and the returns on investment are more predictable than for maize and rice. Unpredictable agricultural prices and marketing policies have contributed to uncertainties around marketing, prices, and profitability of farming in Tanzania. For example, on and off export bans on maize have led to farm gate maize prices dropping drastically. The East African Community estimated that maize prices dropped from TZS 45,000 (US\$20.80) to 30,000 (US\$13.86) for a 100kg bag because of the export ban that was introduced in July 2011 (EAC 2012). Haug and Hella (2013) found that in Matai village in the Rukwa region, farm gate prices dropped from TZS 35–38,000 per bag of maize to TZS 20,000 per bag following the same ban. Similarly, import of cheap rice has hurt the domestic rice producers and led to falling rice prices (Haug and Hella 2013). According to a Daily News report "Rice Prices Up as Supply of Illegal Cheap Imports Fall" (2014), cheap rice imports from Thailand and Pakistan have been haunting local rice farmers since 2013 when a permit to import 60,000MT led prices to plunge by more than 50%. In surplus years with bumper maize harvests such as 2014, farmers faced huge problems when it came to selling their maize at a reasonable price. In general, there is a lack of trust towards the government in relation to its ability to create a conducive and stable price and marketing environment for investing in agriculture.

In addition to risk in relation to weather and market-related factors, there are also uncertainties as regards the quality of the seed. The quality of the improved varieties offered in the market is not

always up to standard. Some seed dealers take advantage of the high demand for improved varieties and deliberately sell seed that is fake or not up to standard. Fake and low quality seed might take different forms. The seed might not be real varieties at all; the labels might be fake and give the wrong date of expiration; the germination rate might be low, for example because seed varieties produced by contract farmers have been mixed with ordinary grain for the producer to be able to meet the volume of the contract; and the seed might also be unclean due to insufficient sorting. Fake and low quality seed in the market contribute towards a lack of trust and scepticism in relation to the purchase of improved varieties. Farmers who have purchased improved varieties that have been fake or of low quality become less willing to do so again. If farmers lose the first rain due to poor germination, which is common for fake varieties, the consequence could be food shortages in the household throughout the year. According to key informants, the public seed quality control institution, TOSCI, lacks staff and resources to fulfil its control role. Nobody appears to be reinforcing the law when it comes to the sale of fake varieties. TOSCI complains that the police are not doing anything about fake seed sellers even when TOSCI brings these sellers to the police for them to take action. Another risk is theft of crops in the field. Farmers in some places complained that they had to guard their fields and stores to protect their crop.

Awareness of possible benefits of improved varieties

For farmers to be willing to purchase improved varieties, they need to be aware of the possible benefits in relation to yield increases due to improved varieties. Some farmers lack knowledge of the possible benefits of using improved varieties, but most farmers appear to be well aware of their potential. Thus, lack of awareness does not seem to be an important reason for not using improved varieties. However, as the quality and characteristics of newly released varieties will change over time and possibly improve, it is an ongoing effort to make farmers aware of these changes and improvements. Every year, new improved varieties are released and farmers need continuously to be made aware of what the market has to offer. Accordingly, both farmers and extension officers would like more demonstration fields to learn about improved varieties. Farmers tended to say that they get seed information from neighbours and that they would like more active extension officers. The activity level of the public extension services vary from district to district. Some districts have seed demonstration plots and are active in distributing seed. In some districts, there are also private agro-dealers that provide advice on the use and possible benefits of improved varieties, as well as civil society organisations that work in the seed sector.

Seed availability, access, and preferences

The availability of improved varieties of some crops such as hybrid maize has improved in recent years, but in remote areas, farmers and key informants stated that it is still difficult to access improved varieties. There are regional variations in availability and distance to an agro-dealer. Distance to agro-dealer is an important factor to consider regarding physical seed accessibility. Some farmers in Masasi illustrated the problem of accessibility by saying that if bus tickets and other travel costs were considered, the price of improved varieties for one to two hectares doubled as compared to the cost of improved varieties at the agro-dealer. There are also variations in the availability of QDS as the production of QDS is very low. QDS is not supposed to be sold outside of the ward, hence when QDS is available the distance might not be a problem in relation to accessibility.

Although some improved crop varieties might be available at the nearest agro-dealer, the seed might not be the crop or variety that the farmer prefers, as reported by farmers to be the case for maize. The most popular improved maize varieties might be sold out or never make it to the local agro-dealer. In addition, the districts might not necessarily get the improved maize varieties they ask for through the input subsidy programme. The types of improved varieties distributed to the districts through NAIVS are decided centrally. Some district key informants said they get what they want,

while others do not. For crops other than maize such as wheat, rice, cassava, banana, beans, sesame, and vegetables, the availability is limited, although this varies from location to location and from season to season. Some of the improved varieties in the market have qualities that the farmers dislike, such as improved maize varieties that are regarded to not store as well as local maize. Limited seed availability for preferred crops and preferred crop variety appears to be a challenge. In this regard, it is important to underline that farmers' demand for seed might change from year to year depending upon, for example, climatic conditions and market opportunities.

Perceptions by farmers and key informants on possible policy measures to increase the use of improved varieties

As shown above, the reasons why relatively few farmers are using improved varieties are explained in relation to affordability of seed and low profitability of farming, risks and uncertainty, fake seed or questionable quality of improved varieties in the market, limited availability of improved varieties in particular in remote areas, and limited availability of preferred varieties or crops. For the Tanzanian government and international actors to succeed in their efforts towards modernisation of the agricultural sector through increased use of technology such as improved varieties, farmers and key informants gave the following suggestions on what it would take to increase such use.

How to make improved varieties more affordable to farmers

Measures that were suggested for cutting seed prices include shortening the seed value chain by making the certification system more efficient by reducing the number of components and promoting more direct sales to farmers – directly from research if possible. In addition, if farmers were better organised in groups, they could access cheaper seed. QDS could be expanded as it is in general half the price of ASA varieties, and the packaging could be improved, as second-rate packaging makes farmers believe that the seed is also second-class. More subsidies and free seed handouts were suggested by some, but at the same time underlining the challenge of sustainability and that seed markets could suffer from free seed handouts. Better infrastructure could also make seed distribution cheaper and possibly reduce seed prices.

There were also many suggestions for how to improve the institutional set-up for seed production and distribution. Several key informants underlined the need for more resources to be allocated to ASA and TOSCI to better fulfil their mandate, for example, the need for ASA to increase its production of foundation seed to better meet demand and improve seed distribution in remote areas where the private sector does not deliver. Private seed companies were concerned about competition from ASA and suggested that ASA play a more complementary role to the private sector than currently. However, it was also noted by some that competition might be good for keeping prices down. In relation to the role of the districts, it was suggested that the districts should use more of their tax revenue to produce and distribute improved varieties, and possibly provide direct support to QDS seed producers and support farmers' own seed systems, to increase the quality of the seed in the local markets as local seed are much more affordable to farmers. Getting rid of corruption in the input subsidy programme was also highlighted as a role that the district could take on. It was suggested that improved varieties or seed coupons should be available just after harvest time when farmers had money and not only at planting time when many of them had no money. Credit was not necessarily regarded as a way forward as the profitability of farming in relation to ability to pay back might be a problem.

How to ensure it is profitable for farmers to buy improved varieties

The enabling environment for farming is important, as it makes it profitable for farmers to purchase improved varieties. Farming involves high risk both from weather and pests, but policy interventions

can also change conditions in ways that have huge impacts on farm gate prices. Key informants stressed the need to establish efficient and predictable marketing systems and price policies. Farmers need to be able to trust that the government will not change the rules of the game between planting to harvest time. For planning purposes, these rules should preferably be stable throughout many seasons. Fortunately, 2014 was a year of bumper harvest, but many farmers faced difficulty selling their maize at a decent price. All national storage structures were full, and export was difficult to organise, although World Food Program (WFP) helped by purchasing some maize. Reducing the risky nature of farming in relation to weather and climatic conditions could be addressed by having responsive seed systems that could provide more relevant seed options to farmers such as early maturing varieties.

How to ensure that the improved varieties in the market are of high quality

Key informants stressed the importance of prioritising removing fake seed from the market and had several suggestions on how this problem should be addressed. First, TOSCI should get more resources to be able to perform their control role more efficiently and be empowered to work closely with police in enforcing the law, for example by fining dealers of fake seed. It was also suggested that TOSCI become an independent entity outside of MAFC, similar to the sister institution in Kenya (Kenya Plant Health Inspectorate Service (KEPHIS)). Second, awareness campaigns should be carried out in collaboration with media, to inform about possible fake seed (included fake labels) in the market as well as how dealers offering these will be punished. Third, more seed producers should be trained and better controlled, and their improved varieties should be inspected, to ensure that seed producers do not mix grain with seed to be able to meet their contract obligations. Fourth, QDS should be expanded, and the quality of QDS should be improved by providing more resources and more frequent controls. Fifth, the districts should be made accountable for possible fake seed in their districts, in collaboration with TOSCI and by empowering seed inspectors. Sixth, farmers who have bought fake seed or low germination seed should be compensated for their loss. Lastly, better integration of improved varieties, QDS, and local seed markets could contribute towards better seed quality overall.

How to ensure available improved varieties and crops are according to the farmer's preference

The diversity available in the formal system is limited compared to the informal system, regarding both different crops and varieties. It is difficult for the formal sector to meet the demand for preferred crops and varieties. Key informants claimed that it is not a lack of released varieties, for instance in maize, but more a problem of distribution and attracting private sector interest in crops other than hybrid maize. The private seed sector focus on one crop, which is hybrid maize, where there is a profit to make. Other important cereals as rice and sorghum, legumes, and vegetative planting material have been neglected both by the private sector because of lack of profitability, and by the public sector because of lack of resources. The private seed sector faces bottlenecks such as the high cost of establishing a seed company and poor infrastructure in the value chain (retail networks and sale points). The QDS system has been established which allows improved seed to be available at village and ward levels for the open pollinated varieties and other crops, which big seed companies are not interested in.

Actors and institutions of relevance to the formal seed system in Tanzania

In order to address the suggestions for how to increase the use of improved varieties, we need to look at relevant actors and institutional capacity. In Tanzania, the Seed Policy Guidelines of 1994, the Seed Act of 2003, and the Seed Regulations of 2007 direct the seed system. In addition, there is Protection

of New Plant Varieties (Plant Breeders' Rights) Act of 2002 and Plant Breeders' Rights Regulations (2008). The agricultural policy supports the development of a seed industry in the country with both national and international seed companies, as well as a public seed institution that produces and distributes certified seed of improved varieties and QDS seed produced under minimum quality control for community use within the ward. The key players and their relations in the formal seed system are shown in [Figure 1](#).

The Ministry of Agriculture, Food Security and Cooperatives (MAFC) formulates seed policy and legislation, and the general agricultural policy in the country. Farmers and farmer groups select, store, produce, exchange, and sometimes sell seed in the local seed systems. Operating at district, ward, and sometimes local level are agro-dealers. The country has 1,500 to 2,000 active and registered agro-dealers (USAID/EAT 2013). The input subsidy programme has been important for the establishment of agro-dealers. Also, some agro-dealers have received loans from credit institutions to establish their shops. According to key informants, the agro-dealers survive on input vouchers and would collapse without them.

Local governments at district level are, to varying degrees, involved in seed production and distribution through the district office; for example, in Singida the local government is running seed farms, and in Mtwara it is responsible for seed fares. The district level is also involved in distributing input subsidy vouchers. Decentralisation has given local governments multiple responsibilities. About 80% of local governments' income comes from agriculture, and several key informants pointed out that more of this income should go back to agriculture. The private sector both distributes improved varieties through agro-dealers and has their own shops. In 2012, there were 65 registered national and international seed companies in Tanzania (40 national and 25 international) (URT/MAFC/Seed Unit 2012). By 2014, the number of registered companies had increased to over 90. Some companies deal with both imported and locally produced improved varieties. Examples of national seed companies are Tanseed International Ltd, Suba Agro, and Southern Highland brokers. Key informants reported that some seed companies have quite a lot of carry-over seed that makes business risky

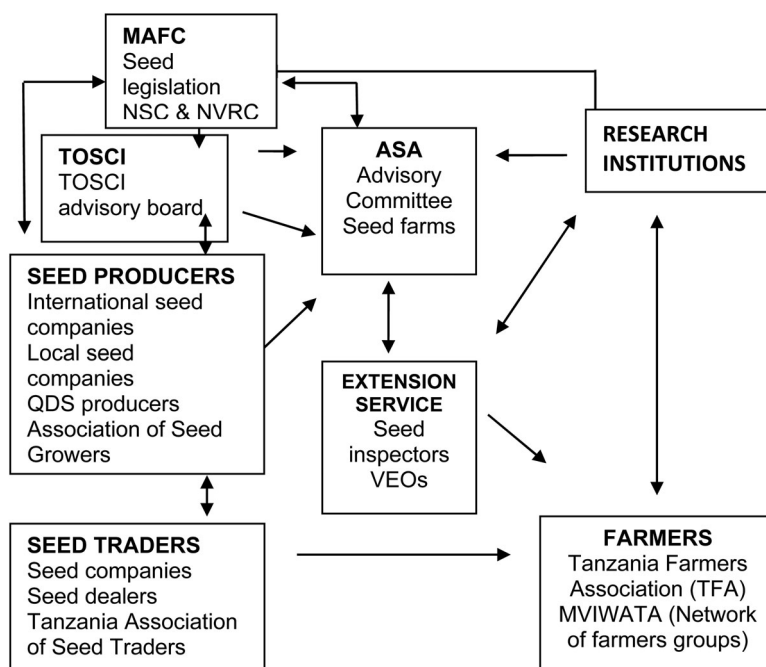


Figure 1. The formal seed system in Tanzania: key players and relationships.

and difficult to break even. National seed companies experienced problematic competition from international companies, as the international companies had more resources for marketing and for handling possible losses.

The public Agricultural Seed Agency (ASA) was launched in June 2006 as a semi-autonomous body under MAFC (ASA 2014). ASA was established to ensure that high quality agricultural seed of improved varieties is available to farmers at affordable prices through both production and distribution by ASA. ASA is also responsible for the promotion of increased private sector involvement in the seed sector through the establishment of public–private partnerships or joint ventures in seed production and distribution (ASA 2014). ASA is not supposed to compete with the private sector but rather complement private seed companies by producing and making improved varieties available around the country, through agro-dealers. However, seed companies often perceive ASA as a competitor and would like ASA to stay away from profitable maize seed business in easily accessible and better off areas of the country. One key informant underlined ASA's important role in producing certified rice varieties that companies are not interested in doing, since rice is self-pollinating and thereby not profitable for seed companies. However, during our fieldwork, agro-dealers reported that there was no demand for rice varieties because of the low rice prices due to the import of cheap rice in 2013.

Tanzania Official Seed Certification Institute (TOSCI) is responsible for field and seed inspection, sampling, testing, variety evaluation and verification through distinctness, uniformity and stability tests (DUS), and control plot testing (TOSCI 2014). The control function of TOSCI is of crucial importance in relation to the quality of seed offered in the market, for example in relation to fake seed. However, TOSCI lacks human and monetary resources to fulfil its mandate. Information from the Chief Executive Officer suggested that currently only 44 people are employed, 35% of the estimated number required. Coupled with financial limitations, seed quality assurance for the whole country is almost impossible. On paper, there should be seed inspectors in each district to undertake the control functions, as well as QDS inspections. In some of the districts we visited, for example in Singida, the seed inspectors seem to work well. Other places, the seed inspectors had taken on other responsibilities outside of seed-related tasks. District seed inspectors, who were trained by TOSCI, did not even have identity cards to substantiate their mandate. Some of the extension staff inspectors had conflicts of interest, since they are supposed to perform quality control of their own input shops.

Research is an important factor in the formal seed system. National research such as the national agriculture research institutions (NARI) including Sokoine University of Agriculture (SUA), and international agricultural research, CGIAR centres, are both responsible for producing basic seed material. In exceptional cases, for example Uyole Research Station in Mbeya region (Southern Highland), research institutes have been given permits to provide or sell improved crop varieties directly to farmers. According to a key informant, NARI gets about 95% of its genetic material from CGIAR. In addition, companies benefit from CGIAR, for example Tanseed International gets seed material directly from International Maize and Wheat Improvement Centre (CIMMYT) for release in Tanzania.

Discussion: if technology is the answer, what does it take?

In order for technology to be the answer, we concur with Sumberg and Thompson (2012) in highlighting the need for political agronomy analysis, as well as Scones and Thompson (2011) in underlining the importance of not treating improved crop varieties as strictly technocratic and delinked from the political economy of agrarian change. To encourage the adoption of new technology, it is necessary to provide a conducive and predictable environment for such investment to take place. In Tanzania, unpredictable policy changes and lack of an enabling environment for farming, have contributed towards unexpected decreases in farm gate prices and diminishing trust towards the government (Haug and Hella 2013). In order to increase the use of improved varieties in Tanzania, first, there is a need to ensure that the interests of the small-scale farmers are better taken into

account in general policy formulation and implementation so that it becomes worth both the effort and risk for small-scale farmers to invest in new technology.

Second, we would argue that changing the current seed policy, including the present pluralistic seed system, would probably not make much of a difference in relation to increased adoption of improved varieties. We would rather recommend that the current seed policy is effectively implemented. According to Cooksey (2012), policy failure is not only a question of formulating the so-called right policy, but in the Tanzanian case more an inability to formulate policies that the state has the human and financial resources to implement. Policies, well formulated or not, do not necessarily make a difference in relation to action and results, if they are not being implemented. Moreover, institutional failure appears to be a challenge in relation to the poor performance of the formal seed system. The main seed quality control organs, TOSCI and the district seed inspectors, need to be strengthened to address the problem of low quality and fake seed in the market. The government should strengthen TOSCI's ability to perform its control role and be willing to reinforce the law in relation to the sale of fake seed. In Kenya, the media has played an active role in addressing the problem of fake seed, through campaigns with slogans such as "we cannot fight hunger if we cannot protect farmers against fake seed" (Amugune 2014). In addition, corruption, for example in relation to the input subsidy programme (NAIVS), undermines official policies intended to deliver public or private goods to the population (Cooksey 2012; Pan and Christiansen 2012; Aloyce, Gabagambi, and Hella 2014) and should be forcefully addressed.

Third, in our study we found that many farmers do not use improved varieties because they cannot afford the cost in relation to the risky nature of agriculture, including the probability of low profitability. This finding indicates that farmer adoption of improved varieties goes beyond providing rural credit, as farmers have to be in a position to repay their loans. Either farming has to become less risky and more profitable, or improved varieties have to become cheaper and more accessible. As Lipper, Anderson, and Dalton (2010) found, farmers can make higher returns by recycling seed of improved varieties over several seasons and thereby avoid buying new improved varieties every year. A way forward could be to focus on cost-cutting measures in variety release procedures, seed production, certification, and distribution of improved varieties as well as ensuring stable availability of popular improved crop varieties over time. Expanding QDS is one way of increasing availability of cheaper, but still quality declared, seed.

Fourth, taking into account Tanzania's pluralistic seed system, better integration of the formal and informal systems, including QDS, might be one way to increasing use of quality seed in Tanzania. ASARECA/KIT (2014) suggest going for a strategy that acknowledges system diversity and where different seed systems are considered as complementary, and that interactions between such systems should be strengthened. Open pollinated varieties are often more suitable in Tanzania as such varieties can be farm-stored and recycled. OPV improved maize varieties have made their way into local seed systems, and provide an example on how local systems could be used to improve small-scale farmers' access to quality seed (Westengen and Brysting 2014). Possibly, local agro-dealers could collaborate with actors in the informal seed systems to make agro-dealer shops more economically viable and provide a wider range of quality seeds in accordance with local preferences and at different prices.

Conclusion

This article assessed why technology such as improved varieties has not taken off in Tanzania in spite of substantial national and international efforts, and what role policy and an enabling environment play in that regard. We posed the question, if technology is the answer – what does it take? Our findings indicate that, for small-scale farmers to invest in new technology, the political economy has to change and become more conducive to make such investments worth the effort. Few farmers use technology such as improved varieties because of reasons related to affordability of inputs in relation to low profitability of farming and the level of risks and uncertainties involved, including fake seed in

the market, unpredictable policies, and marketing opportunities. Effective governance is needed for agriculture to be transformed in the direction stated in national policy documents, but weak institutions and the collective interests of farmers not being sufficiently recognised hinder the likelihood of necessary technological changes happening.

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