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Implication of quality uncertainty on market exchange: The case of seed industry in Kilolo district, Tanzania. [version 3; peer review: 2 approved, 1 approved with reservations]

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Abstract

An increasing demand of agricultural intensification and value addition necessitates the use of improved inputs such as improved seed. Smallholder farmers contribute about 70% of agricultural production in Tanzania. Agriculture sector in Tanzania contributes about 24.1% of the GDP, 30% of exports and 65% of industrial raw materials. Thus, agriculture development, economic growth and industrialization are inseparable. Due to the nature of the product, smallholder farmers cannot judge the overall excellence of seed at the time of buying. This paper assessed quality uncertainty in maize and vegetable seed and its implication for market exchange between farmers and seed sellers in Kilolo district, Iringa Tanzania. The study used a random sample of 130 smallholder farmers and representatives from ten seed companies. Asymmetric information prevails between the two trading sides i.e. sellers and buyers leading into quality uncertainty. Moreover, product augmentation is profoundly overlooked whereby most of seed companies have not augmented their products. Because an improved seed is a quintessential example of an experience good, quality uncertainty of some crop varieties under field conditions favored some seed brands to be used more by farmers compared to others. This paper offers a thorough deduction on quality uncertainty under farmers' field condition and its implication on market exchange. It adds information in the body of knowledge on how an improved seed can contribute to sustainable production of food and industrial raw materials, which is a step towards desired industrialization agenda in Tanzania.




Keywords

Seed value chain, quality uncertainty, market exchange, agriculture intensification, industrialization in Tanzania

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REVISED Amendments from Version 2

The conceptual framework has been upgraded to allow easy understanding of interactions of deferent organizations in seed value chain with their respective functions. Figure 5 has been upgraded to define all tomato variety traits in the legend. Also, the conclusion has been reviewed to add relevance to the study.

Any further responses from the reviewers can be found at the end of the article

Introduction

The agriculture sector employs about 90 percent of Tanzanians (URT, 2014). It is the major supplier of industrial raw materials (65%) and contributes around 24.1 % of the GDP, 30 % of total exports and 65 % of industrial raw materials (URT, 2013). Cognizant of this, the Tanzanian government has paid due attention to build up this sector in its growth and transformation programs through Agricultural Sector Development Programs (ASDP I and II). Boosting the supply of quality agricultural inputs is thus of paramount importance and priority for the country.

Improved seed is one of the dimensions of agriculture intensification which particularly aims at improving crop productivity. Seed is defined as any part of plant that is used for reproduction, both generative (true seed) and vegetative parts (CABI, 2014). The role of seed as an agricultural input technology cannot be underestimated, as it is an indispensable input in any agricultural production system (Almekinders & Louwaars, 2008 and Miva *et al.*, 2017). It defines the quantity and quality to be realized on the farm produce (Kaguongo *et al.*, 2014). A quality seed is a result of research and development of appropriate and adapted products.

Like many other African countries, the seed value chain in Tanzania constitutes both the formal and informal systems. In the formal seed system: individuals, organizations and institutions are involved in specialized tasks connected to production, marketing and sales. On the other side, the informal seed system is made up of farmer selected, multiplied, processed, exchanged and retained seeds (Douglas, 1980). The National Agricultural Policy of 2013 highlighted the benefits of increasing access of quality seeds to farmers as the means of counteracting low productivity in Tanzania (URT, 2013). However, it takes multiple years before an improved variety is developed.

The process of seed product development starts with breeding in which genetic variation is created in order to allow for selection of plants with desirable traits (MacRobert, 2009). Within sub-Saharan Africa, the International Maize and Wheat Improvement Center (CIMMYT), the International Institute of Tropical Agriculture (IITA), World Vegetable Center (AVRDC) and National Agricultural Research (NARIs) provide public maize and vegetable germplasm to seed companies. On the other hand, some of private seed companies implement their own breeding programs to satisfy needs of their intended markets.

More than 80% of the population in Tanzania depends on maize for food as well as cash, in which 85% and 15% are produced by smallholder and large scale farmers respectively (Moshi, 1997).

Moreover, maize contributes about 61% of the total calories in people's diets (Kirway *et al.*, 2000) and is grown in more than 45% of the total cultivated area in Tanzania (URT, 2006). The significant importance of this crop instigated the government of Tanzania to establish the National Maize Research Programme (NMRP) which started in 1974 to provide road map for maize research including varietal development and management of maize research (Katinila *et al.*, 1998). Some open pollinated varieties such as Staha, Staha- St, Kilima, Kilima-St, Katumani, TMV-1, ICW and UCA are examples of varieties released by the NMRP. Higher yield, good plant standability, early maturity, medium maturity, large ears (cobs), streak tolerance and poundability are some key characteristics (quality traits) of maize varieties developed by research institutes and private companies for low, medium and high altitude areas of Tanzania (Kirway *et al.*, 2000 and Moshi, 1997).

Moreover, due to the potential of the horticulture sector in economic growth, Tanzania has also highlighted initiatives to develop horticultural value chain in the second phase of the Agricultural Sector Development Program (ASDP II). MAFSC (2012) reported generation of foreign exchange from the sub-sector to a tune of USD 46.7, 112.6 and 127.7 million per annum in 2006/07, 2008/09 and 2010/11 respectively. Captivatingly, the horticultural exports accounted for 61% and 48% of vegetables in 2013 and 2014 respectively (Match Maker Associates, 2017), thus it is worthy to promote intensification of vegetable production in Tanzania.

Quality traits in horticulture are many and diverse given that they are crop specific. For instance, heat tolerance, early blight resistance, high yield, and long shelf-life are some priority traits in tomato. Schreinemachers *et al.* (2014) and Ebert & Chou (2015) reported availability of more than 8300 accessions¹ each of tomato and pepper at the World Vegetable Centre (AVRDC) gene bank. Mamiro *et al.* (2014) report traits like high yielding, marketability, bulb size and storability as desirable characteristics among onion farmers in Kilosa district. Also, high yielding traits in improved tomato hybrid varieties has been reported by Msogoya & Mamiro (2016) as an essential parameter contributing to productivity and profitability of tomato growers in Morogoro region. In Tanzania, AVRDC develops new vegetable lines and release them as varieties in collaboration with public sector partners such as HORTI-Tengeru (Afari-Sefa *et al.*, 2013; Dinssa *et al.*, 2015). Due to the importance of market in signaling seed demand, scholars like Daniel & Adetumbi (2004) emphasize regular assessment of seed consumers' preferences for incorporation in breeding programs.

Problem statement

Smallholder farmers represent 80 percent of population in Africa and contribute up to 90 percent of agricultural production (Wiggins, 2009). In Sub-Saharan Africa, they are vulnerable to production risks triggered by climate change (Morton, 2007). They contribute about 70 % of agricultural production in Tanzania

¹Prolificacy refers to the ability of a maize variety to produce more than one ear per plant (Otegui, 1995). It is among maize traits highly considered by maize breeders

(URT, 2013). Therefore, promoting agriculture development is essential in improving livelihood of farmers thereby releasing capital, which can be used to non-agriculture enterprises hence, triggering industrialization (Lanjouw & Lanjouw, 2001).

Despite a conducive environment for crop production, Tanzania's agricultural productivity is still among the lowest in Sub-Saharan Africa (MAFAP, 2013). Maize yield under farmers' growing condition was reported to be 1.69 tons per hectare in South Pare Mountains which is significantly smaller than the national (Tanzania) estimated potential yield of 4–5 tons per hectare (Makurira *et al.*, 2007). Msuya *et al.* (2008) reported a very low average productivity (1.19 t/ha) of maize among smallholder farmers in Tanzania. Since maize is the main staple crop in Tanzania, its low productivity hampers food security. On the other hand, vegetable unit area production in Tanzania is still low. For instance, global tomato productivity was estimated to be at 33.6 tons per hectare (FAO, 2012) while in Lushoto Tanzania the estimated average yield stands at 11.3 tons per hectare (Bukola *et al.*, 2019)

Some researchers reported lack of disease-free seeds and planting materials as well as the absence of varieties suitable for climatic conditions present in Tanzania to be the major constraints in vegetable production (Shao *et al.*, 2002). Weinberger & Msuya (2004) pointed out the presence of insect pests and diseases, absence of efficient control measures and the lack of high-quality seeds as constraints in the cultivation of indigenous African vegetables in Tanzania. Moreover, drought, insect pests, diseases and lack of know-how are reported to be major challenges faced by maize smallholder farmers in Tanzania (Lyimo *et al.*, 2014).

Low profit, high cost of improved seed and availability of farmers preferred varieties have been reported to be limiting factors in adopting improved seeds (Haug *et al.*, 2016). Wilson & Lewis (2015) estimated maize seed demand in Tanzania to be over 70,000 Metric Tons while out of this 80% of seed used is farmers' recycled seed. Lack of Good Agricultural Practices (GAP) and access to high quality seed are major constraints affecting maize and vegetable production in Tanzania (Lyimo *et al.*, 2014; Mutayoba & Ngaruko, 2018 and Rajendran *et al.*, 2017). Moreover, Mutanyagwa *et al.* (2018) emphasized consideration of farmers' preference in development of improved maize seed. Variety performance of maize and vegetable seeds under farmers' local condition affects market exchange and adoption of this climate smart agricultural technology. A critical question to be addressed is how the market share of improved seeds (i.e. 20% for maize) meets expected quality under farmers' field conditions to trigger adaptation of this technology.

The Match Maker Associates (2017) and Iringa Region (2013) reports have highlighted the good climatic conditions and long term potential for agricultural growth in the southern highlands' districts (Kilolo districts inclusive). There is scarcity of studies assessing quality of agriculture inputs in Africa and Tanzania in particular. It is also a fact that inability to determine and verify the pedigree and quality of goods at the time of purchase will lead to development of Akerlofian market (Akerlof, 1970) on any marketed good. It is from this standpoint that circumvention of quality uncertainty in the Tanzanian seed industry is a matter

of priority. This paper assesses seed quality for maize, tomato, cabbage and sweet pepper in Kilolo district. These crops are of economic importance and contributes to the welfare of the society, which has prompted concentration of seed business of these crops in Kilolo district. It establishes insights and avenues for the discussion on implication of prevailing seed quality uncertainty for market exchange between farmers (buyers) and seed companies (sellers), and anticipated agricultural intensification in the study area and beyond.

Literature review and theoretical framework

Seed Quality Differentiation. Seed quality is the most pressing matter in seed business as it determines the overall yield and the market value of the final product (Louwaars & De Boef, 2012). Seed quality can be defined as a “standard of excellence in certain characters or attributes that will determine the performance of the seed when sown or stored” (Hampton, 2002). Roner (2014) highlighted the physical purity, physiological vigour, genetic potential and the health of the seed as important parameters of seed quality. Moreover, Hampton (2002) asserted that the quality attributes of a seed include its health, genetic and analytical purity. In any market, a consumer evaluates products and buys after being satisfied. However, seed buyers face challenges as they cannot measure genetic potential and other quality attributes of seed at the time of purchase while seed suppliers are well informed of variety traits in their product portfolio.

Kotler *et al.* (2008) defined product as some good or service for sale that a company offers on the market. On the other hand, product differentiation is defined as the business strategy whereby firms attempt to gain competitive advantage by increasing the perceived value of their products or services relative to the perceived value of other firms' products or services (Barnley & Hesterly, 2008; Murphy *et al.*, 2007 and Rahman, 2011). Kotler (1991) identified three product levels, the core value of the product, the actual product and the augmented product in terms of features, benefits and quality. The core value is the problem solving benefit provided by the product to the consumer and actual product is a product's parts, level of quality, design, features, brand name, packaging and extra features combined to deliver the core benefits. On the other hand, the augmented product adds value to the core product, usually aimed at exceeding customers' expectations (Kotler, 1991 and Kotler & Keller, 2012). Contemporary product classification has highlighted five levels of product differentiation namely core product, generic product, expected product, augmented product and potential product (Kotler & Keller, 2012).

Mudambi & Schuff (2010) identified two product types in the market place i.e. a “search” good whose quality can be assessed easily before purchase and an experience goods which entails a purchaser to evaluate its quality after use. In this connotation, seed becomes a quintessential example of an “experience” good in the agriculture sector, because farmers evaluate field performance of crop varieties after sowing (using) them. On the other hand, Murphy *et al.* (2007) highlighted three aspects for successful product differentiation by arguing that, any successful product differentiation should command a premium price for a product, increase sales because of additional buyers acquainted to the differentiated products and increases buyer

loyalty to its brand. It is vital to identify meaningful product driven differentiators in gaining and sustaining a competitive advantage in any market (Dirisu *et al.*, 2013). Thus, product driven differentiators are fundamental in planning market offerings for various market segments in seed business.

Asymmetric information and market mechanism. Failure of seed suppliers to communicate and guarantee attributes of seed quality to farmers during seed purchase hampers market exchange. This asymmetric information between seed buyers and sellers leads to quality uncertainty since buyers are not certain of the quality of seed. Akerlof (1970) reported quality uncertainty on his paper titled “The Market for Lemons: Quality Uncertainty and the Market Mechanism” in the automobile market. In this market there are good and bad (lemons) cars which sell at the same price since the buyer cannot tell the difference. According to Akerlof (1970), this leads to operation of Gresham’s law in the market place whereby lemons sell more and drive out good cars in a market with quality uncertainty. Since Akerlof highlighted that the automobile market (cars) was used for its concreteness and easy for understanding rather than for its importance and realism, this phenomenon is applicable in seed business as well.

Izquierdo & Izquierdo (2007) reported that failure of uninformed buyer (or more generally market) to distinguish quality of products could result into same price for high and low quality products. Eventually, profit margin from low quality product will result into floods of low quality products in the market lowering average quality of products in the market and buyers’ quality expectations. Due to quality differences, Stiglitz (1975) proposed screening and defined it as the process of identifying important differences in the qualities of goods, individuals, brands and other items. Moreover, Spence (1973) uses the concept of signaling in assessing applicants’ capabilities as a means of reducing asymmetric information between job applicants and employers.

Due to the importance of information at the time of purchase, asymmetric information has gained reputation in many real markets as one of the paradigms underlying the economics of information (Stiglitz, 2000). The effect of quality uncertainty under asymmetric information and its implication for market exchange has been contributed by number of authors (Akerlof, 1970; Spence, 1973 and Stiglitz, 2000). The theory of asymmetric information assumes that buyers know the average value of items on sale, which might not always be the case (Auronen, 2003). Akerlof (1970) suggests that, whenever there is adverse selection² there may be no possible market equilibrium at any price, in this case guarantee and brand-name good are

²Adverse selection is a circumstance when the buyer or seller has the information which the other group does not have about some aspect of product quality. Akerlof noted a similarity between his model where bad cars drive out the good cars and Gresham’s law, in this case the process of worse individuals (cars) starting to dominate the market is called adverse selection. In market exchange adverse selection may lead corporates to do business in less profitable market segments as a result of having less information on market preferences. However, buyers are at high risks to suffer in the transaction process by buying low quality products as the result of being less informed.

proposed as means of counteracting quality uncertainty. In the cost of dishonest under quality uncertainty, it is not only the buyer/consumer who is cheated but also there is a cost incurred in the loss of driving legitimate business out of existence as consumer will curtail future purchase (Akerlof, 1970). Generally, the concept of information asymmetry is also applicable in the seed industry, making reputation (which is normally fostered through company brand names) an important coordinating mechanism for the market exchange in the sub-sector.

Conceptual framework. The Conceptual Framework (Figure 1; (Edson & Akyoo, 2020a)) below provides a landscape for discussion of seed quality uncertainty and market exchange. Seed companies, Tanzania Agricultural Research Institute (TARI), CIMMYT and AVRDC are principal variety developers in Tanzania. However, development of a vibrant seed system would normally be possible if closer involvement of agricultural stakeholders is observed e.g. adopting a Participatory Variety Selection (PVS) approach during trait screening and Product Advancement (PA) (Burman *et al.*, 2018 and Trouche *et al.*, 2011).

Seed multiplication needs to match the demand in a timely manner. Private seed companies which are key players in the formal seed system in Tanzania have a colossal role to assure timely availability of quality seeds. Also, the Agricultural Seed Agency (ASA) which is a government agency in URT has the mandate to multiply public bred varieties. On the other hand, Tanzania Official Seed Certifying Institute (TOSCI) that abide by International Seed Testing Association (ISTA) standards has the mandate to assure quality of seed before they are sold to farmers. TOSCI guarantee identity and quality of crop varieties to be sold on the market and thus facilitates Market Exchange (ME) process between companies, agro-dealers and farmers.

Variety performance is influenced by factors like climate, genetic (G) and environmental (E) interaction and agronomic practices employed by farmers (Atkinson *et al.*, 2013; Langyintuo *et al.*, 2010). Since variety performance is a function of the aforementioned factors, variation in any of those may result in poor crop yield. Thus, improved seed provision must consider a whole gamut of factors affecting variety performance. Since buyers’ trust between themselves is stronger than with sellers (Nieto *et al.*, 2014), farmers’ satisfaction after using certain crop varieties drives positive Word-of-Mouth (WOM+) which eventually increases the customer base. On the other hand, unsatisfied farmers are a source of negative Word-of-Mouth (WOM-) obliging farmers to curtail future seed purchases exacerbating negative brand image. This study evokes a holistic approach of understanding and counteracting quality uncertainty in maize and vegetable seed in a bid to enhance efficient market exchange in a sub-sector which is pivotal for the anticipated agricultural transformation in Tanzania.

Methods

Data collection and sampling design

Household interviews. A cross-sectional survey design was employed in this study. Household Heads (HH) were interviewed about quality traits of seeds varieties based on their long term

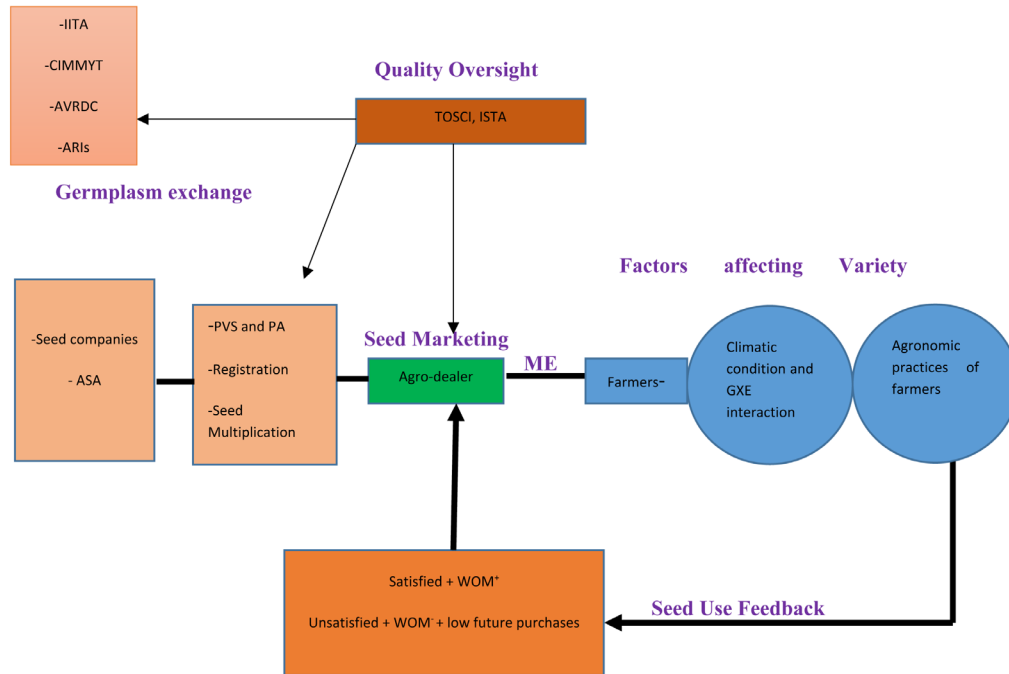


Figure 1. Conceptual framework of seed quality and market exchange. Source; author’s construction from literature (Akerlof, 1970; Burman *et al.*, 2018; Langyintuo *et al.*, 2010 and Nieto *et al.*, 2014). IITA - International Institute of Tropical Agriculture; It develops high yielding, disease and pest-resistant and nutritionally enhanced maize varieties that are adapted to the growing conditions in SSA. CIMMYT - International Maize and Wheat Improvement Center; It increases the resilience of agri-food systems, and maize and wheat varieties, to the impact of climate change, pests and diseases. AVRDC - World Vegetable Center; It develops improved vegetable cultivars to help farmers cope with increasing climate variability. TARI- Tanzania Agricultural Research Institute; It is a public institute which conducts research to develop improved crop varieties as well as strengthening genetic resource conservation in Tanzania. TOSCI - Tanzania Official Seed Certifying Institute; It is a public institute responsible for verification of new crop varieties for official release and certification of seeds produced for sale in Tanzania. ISTA - International Seed Testing Association; It is an independent international organization supported by the non-profit cooperation of experienced seed scientists and analysts which develops seed testing methods since 1924. ASA - Agricultural Seed Agency; It is a public seed agency in Tanzania which was established under the Executive Agencies Act [Cap.245 R.E. 2002] to ensure high quality agricultural seeds are available to farmers at affordable price. PVS - Participatory Variety Selection, PA – Product Advancement, WOM – Word-of-Mouth.

experience and the last farming practices between May 2018 and May 2019. The data for this study were collected between 1st and 30th May 2019. A purposive sampling was used to select Mtitu and Kihsa Mgagao villages from Kilolo division, Mazombe and Ikokoto villages from Mazombe division and Ruaha Mbuyuni village from Mahenge division. This sampling was aided by the list of villages in the study area obtained from Kilolo District Council. Primary information from experts in the department of agricultural extension at the district council and the Southern Agricultural Corridor of Tanzania (SAGCOT) expedited selection of these villages. The aim of purposive selection of villages was to obtain representativeness of climatic and ecological diversity for maize and vegetable growing areas across high, medium and low altitude areas. Also, the sampling aimed at selecting areas with virtuous exposure to improved seeds in which a sample of farmers with sufficient information on the quality of crop varieties can be drawn.

In addition, the study employed a random sampling technique. A random sampling technique was used to select farmers from each of the village involved in this study. Due to homogeneity of smallholder farmers’ population, a random selection of 26

maize and vegetable smallholder farmers was selected from each village to make a total sample of 130 subjects that was considered adequate for analysis (Bailey, 1998). Village registers of farmers were used as sampling frame in each village. The village executive secretaries provided access to village guides who directed two enumerators and the principal investigator to the households of sampled respondents where interviews were conducted. Researchers performed face validity to make sure that the questionnaire is geared to collect the intended data. Data were collected through a pre-tested questionnaire (see extended data; (Edson & Akyoo, 2020b)). Ten maize and vegetable smallholder farmers in Mlali village in Morogoro region were involved in the pretest. Inter-rater reliability was then conducted whereby researchers and enumerators agreed on how to record desirable traits of various crops. The questionnaire was then improved based on the feedback from the field in order to increase its efficiency of collecting information of interest for the study.

The household survey provided fundamental information for this study on specific crop varieties that were planted in the 2018/2019 growing season. This included the core benefits

(quality traits) of crop varieties from various brands which were most valued by farmers. Based on their farming experience, farmers highlighted specific desirable traits that were expressed by maize and vegetable seed varieties under their growing conditions.

Sales representatives' interviews and data from secondary sources. The study assessed quality status of maize and vegetable seeds that are sold in Kilolo district. The assessment involved obtaining details of key seed brands at play in the study area from official seed distributors, agro-shops and the district agricultural extension officers. Sales representatives and secondary sources were used to collect information on core benefits (desired variety traits), climatic adaptability, and augmented products of respective operating seed companies in the study area.

This included local, regional and international seed companies. Meru Agro-Tours and Consultants Co. Ltd was the only local seed company involved in this study due to its high accessibility of maize varieties for sale to farmers. Regional (Africa) seed companies included Kibo Seed Company, Kenya Seed Company, Simlaw, Royal Seeds and Seed Co. On the other hand International seed companies included East West Seed (with its local named Mkulima brand), Monsanto (DeKalb and Seminis), Pannar, Pop Vriend and Syngenta. Sales representatives' interviews and secondary sources were used to acquire information on the perspective of seed companies on maize and vegetable seed varieties sold to farmers in the study area. This will enhance better understanding on the quality of maize and vegetable seeds sold to farmers in the study area. Notes were developed to capture special information related to the study that resulted from interviews. On the other hand, the government of Tanzania enforced a mechanism for production, processing and distribution of Quality Declared Seed (QDS) of different crops in order to increase access of quality seeds within districts. However, QDS of maize and vegetables were not sold in the study area and thus not included in this study.

The interviews of sales representatives from seed companies and secondary sources (brochures and websites) aimed at gaining more knowledge on the quality of crop varieties supplied in the study area in order to allow triangulation of data. The aim of research was introduced to the interviewees, which was to explore scientific evidences on the quality of desirable traits of desirable variety traits on the perspective of farmers under their growing conditions. The subject matter in this research was elaborated to sales representatives thereby seeking their consent of participating in this research. Face to face interviews were conducted with sales representatives in different locations in Iringa town based on their availabilities. On the other hand, phone calls were used to interview sales representatives who were not present in the study area at the time of conducting research.

A checklist was used to facilitate data collection from sales representatives (see extended data; (Edson & Akyoo, 2020b)). Information from companies' websites, brochures and product catalogues were used to supplement the data required for this study. It was elucidated that results will be disseminated to the

stakeholders for the aim of finding plausible ways of improving the performance of the seed industry in Tanzania.

Focus group discussion. Two focus group discussions (FGDs) were conducted to enhance availability of data from which inferences of the study is made. Each focus group was conducted for 45 minutes. Purposive sampling was used to select participants based on the knowledge on improved seed and farming experience as suggested by Khan & Manderson (1992). Formation of FGDs considered socio-economic variation of participants and geographical variations. They were comprised of 8 engendered members for each group. One FGD was conducted in the highland/ cool climate and another FGD was conducted in the low land area. FGDs were conducted in the last week of May 2019 at Kihesa Mgagao and Ruaha Mbuyuni villages, which represented highland and low land areas respectively.

The moderator ensured adherence to the theme of discussion and planned time (45 minutes) in order to explore in detail the issues in discussion. A checklist was used to guide the discussion (see extended data; (Edson & Akyoo, 2020b)). It guided famers to discuss the desirable quality traits in maize and vegetable seeds suitable for their growing conditions compared to the quality of seed supplied by seed companies. Timely availability of quality seed in their pristine state was the priority during the discussion. Moreover, they discussed the potential roles of agro-dealers in supporting delivery of quality seed.

Data analysis

Descriptive statistics was used to analyze the level of product quality differentiation with the aid of SPSS version 20 and Microsoft Excel (2016). The concept of Pareto analysis was used to establish frequencies of core benefits sold by seed companies (brands) in the study area. Pareto analysis is a statistical procedure that seeks to discover from an analysis of defect reports or customer complaints in which "vital few" causes are responsible for most of the reported problems (Pareto, 1964). However, according to Powell & Sammut-Bonnici (2014) a caveat when applying this concept is that the 80/20 ratio should not be taken literally as it is an indicative that the majority of results are often derived from a minority of inputs. Despite that, this concept has not been utilized in agribusiness research, desirable variety traits (the minority) which drives the overall expected variety performance in seed business can be presented through the Pareto analysis as suggested by Powell & Sammut-Bonnici (2014).

Some studies adopted Pareto principle to investigate the prevalence of quality factors and success factors in design firms and software engineering (Kado & Bala, 2015; Mahboob *et al.*, 2015 and Kado *et al.*, 2016). These studies identified key quality/success factors which to the large extent influence performance of aforementioned industries. For the same reason, this study adopted the concept of Pareto analysis for the aim of identifying vital factors (quality traits) of crop varieties most valued by farmers. In other words, as the Pareto principle has been used to separate the 'vital few' from 'trivial many' in quality management research, it can also be used to delineate prevalence of quality

factors on crop varieties as experienced by farmers. Farmers' ratings on the frequencies of expression of desirable traits of various crop varieties were used to express the percentage of farmers asserted to experience core benefit(s) of a named variety trait. Moreover, graphs were plotted based on the percentage of experience of farmers on certain variety traits that were found to be common across brands. Most valued traits were represented by the tallest bars reflecting the most valuable core benefit of a crop in question. This process facilitated analysis of product differentiation and inter-brand product comparison based on the core benefits provided by similar crop categories.

Ethics and consent

This study was conducted under a research project for the partial fulfillment of the requirements for the degree of Master of Business Administration (MBA-Agribusiness). The duration of the research was between July 2018 and June 2019. Thus, it followed all ethical issues and approval from the senate of SUA. On the other hand, authorities of Kilolo district council provided a written approval of this study.

A written consent was prepared and presented to the respondents not only to introduce the aim and benefits of the study but also expressing the fact that participation was purely on one's free will (see extended data; (Edson & Akyoo, 2020b)). An approval from the district council was used to introduce the team of researchers to the village authorities and consequently to the respondents. Written consent were obtained from some sales representatives who conducted face to face interviews. On the other hand, phone calls were used to interview sales representatives who were not around the study area at the time of conducting the research due to large geographical coverage of their duties. In this case, the consent was recorded by writing down the name of the sales representative who consented, the date they consented and what they were told at the time of consent.

The enumerator (s) used a written consent in local language (Swahili) where a farmer had to write down a name, date of giving the consent and signature. In case of the farmers who can't read or write the consent was read to him/her and a thumbprint was used instead of the signature. Due to limited awareness and knowledge on research ethics to farmers, some of them were ready to participate in the study but they - reluctant to sign the consent forms. Under these circumstances, participation was thus an implied consent on the part of interviewees. The implied consent was recorded by writing down the name of the respondent who consented, the date they consented and what they were told at the time of consent and the local authorities in the study area agreed it.

Results and discussion

Quality differentiation of maize and vegetables seed brands in Kilolo district- Seed brands' definitions

Seed brands' defined traits of maize, tomato, cabbage and sweet pepper are presented in the tables below (Table 1, Table 2, Table 3, and Table 4; (Edson & Akyoo, 2020a)). Table 1, Table 2, Table 3 and Table 4 presents results from sales

Table 1. Seed brands' defined traits for maize varieties in Kilolo district.

Seed Brand	Variety	Core Benefits/ Desirable traits	A ₁
Dekalb	DK 777	a,b,c,d,e,f	2.31
	DK 8053	a,f,g,h	16.92
	DK 8031	a,c,i	
	DK 9089	a,b,j	
Kenya Seed Co	H 614	a,b,c,f,h,k	
	H 625	a,b,l,m	7.69
	H 628	a,b,l,n	10
MATC	HB 513	a,e,f,h,m,p,q,r	4.62
	HB 613	a,h,k,l,q,r	
Pannar	PAN 691	a,k,l,q,u	7.69
Seed Co	SC 627	a,j,u,t	9.23
	SC 719	a,h,r,u,f	
Local	Kimkoka	g,h,w,k	23.85

A₁= Percentage of farmers that used the variety

a=High yield

b=Prolificacy

c= Early maturity

d=Early to medium maturity

e=Drought tolerant

f=Wider adaptation (medium to high altitude areas)

g=Tolerance to post harvest pest infestation

h=High grain to flour ratio

i=Adapted to low altitude

j= Adapted to medium altitude

k=Heavy grains

l= Adapted to high altitude

m= Medium maturity

n= Resistant to lodging

p=light feeder

q= Tolerant to rust

r=Tolerant to cob rot

s= Large cobs

t= White shiny grains

u= Tolerant to Grey Leaf Spot (GLS)

v= Good taste

w=Big grain size

representatives' interviews and data from secondary sources. It shows the core benefits/desirable traits of crop varieties, promoted by seed companies to farmers. This delves the range

Table 2. Seed brands' defined traits for tomato varieties in Kilolo district.

Seed Brand	Variety	Core Benefits/ Desirable traits	A ₁
East West Seed	Imara F1	a,b,c,d,e,f,i	5.38
Mkulima	Rio grande	a,e	10.77
Kibo Seed	Mwanga	a,b,c,e	0.77
	Rio grande	b,c,j	
Royal Seed	Strike F1	a,j,g,h	0.77
	Rambo F1	a,b,c,g,h	
	Terminator F1	b,c,g,h,k	
Seminis	Assila F1	a,b,c,d,l,p	4.62
	Eden F1	a,b,m	0.77
	Firenze F1	a,b,m	0.77
Syngenta	Tilika F1	a,c,g	
	Kilele F1	a,g,k,n, m	

A₁= Percentage of farmers that used the variety

a=High yielding

b=Firm fruits

c=Long economic life

d=Tolerant to early and late blights

e= Good fruit shape

f= Adaptability to rain and dry seasons.

g=Tolerance to Fusarium wilt (Fol 1, 2)

h=Tolerance to Verticillium wilt (Vd and Va)

i= Long shelf life

j=Big fruit size

k= Tolerance to bacterial wilt

l=Tolerance to high temperature

m= Tolerance to foliar diseases

n=Early maturity

p= Tolerance to Tomato Yellow Leaf Curly Virus (TYLCV)

of diversity of traits in crop varieties available for sell to farmers in the study area. Core benefits (desirable traits) of each seed brand variety are defined against the proportion of farmers (A₁) in Kilolo district who reported to use the variety in the 2018 growing season. Some varieties which included DK 8053, DK 8031, DK 9089, H 614, HB 613, SC 719, Rio grande, Rambo F1, Terminator F1, Tilika F1, Kilele F1, Pretoria F1, Indra F1, Victory F1 and Indra F1 were not reported to be used by any of the interviewed farmers in the study area despite that sales representatives of respective companies proclaimed to promote these varieties.

Product differentiation provides the basis for market segmentation and offers business entities a pathway to gain strategic

Table 3. Seed brands' defined traits of cabbage varieties in Kilolo district.

Seed Brand	Variety	Core Benefits/ Desirable traits	A ₁
Seminis	Victory F1	c,f,d,l	5.35
Simlaw	Gloria F1	a,b,c,d,e,g	13.85
Royal seed	Pretoria f1	g, h,i,j,k	

A₁= Percentage of farmers that used the variety

a= Uniform heads at maturity

b= Long shelf life

c=Sweet taste

d=Good head shape (globe)

e=Tolerant to bacterial diseases

f=compacted heads

g=high yield

h=excellent field holding capacity

i=Dark green colored heads

j=Heat tolerant

k= Good head size

l=Early maturity

Table 4. Seed brands' defined traits of Sweet pepper varieties in Kilolo district.

Seed Brand	Variety	Core Benefits/ Desirable traits	A ₁
Pop Vriend	Yolo wonder	a,b	8.46
Mkulima	Yolo wonder Improved	a,b,c	3.85
Kibo Seed	California wonder	a,e,h	2.31
	Indra F1	a,b,c,d,e	
	Victory F1.	a,d,f,g,h	
Syngenta	Indra F1	a,b,c,d,e	

A₁ = Percentage of farmers that used the variety

a=High yielding **b**= Early maturity **c**=Long economic life

d=Long shelf life **e**= Deep green colored fruits **f**=Red colored fruits after maturity **g**=Big fruit size **h**= Medium maturity.

competitive advantage (Barnley & Hesterly, 2008). Rivalry through product differentiation as one of the Porters Five Forces of competition applies in the seed industry as well. Seed companies in the study area have differentiated their products to offer distinct customer value in different markets. Most quality traits (core benefits) of maize varieties (Table 1 and Figure 2; (Edson & Akyoo, 2020a)) sold by seed companies in Kilolo district are similar to traits of maize varieties reported by

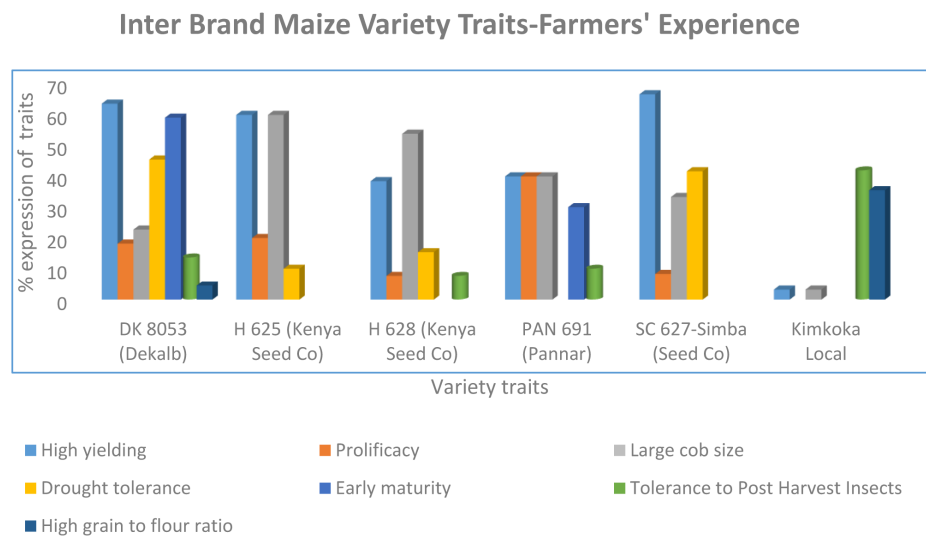


Figure 2. Quality traits of maize varieties across seed brands in the study area.

Kirway *et al.* (2000); Moshi (1997); Nkonya *et al.* (1998)) and TOSCA (2001) to be sold in different parts of Tanzania. High yielding, as one of the valuable quality trait of tomato varieties reported by smallholder farmers in this study (Table 2; (Edson & Akyoo, 2020a)), was also reported in a study by Msogoya & Mamiro (2016) which was conducted in Morogoro region. This denotes that, development of products that live up to the market needs in the seed sub-sector in Tanzania plays an indispensable role in positioning seed brands in the market.

Seed quality traits for maize and vegetables in Kilolo district - farmers' experience

Results from the farmers' survey showed that quality traits of most varieties sold by seed companies in the study area were less expressed under farmers' growing conditions resulting into uncertainty on the quality of seed. Only variety traits in Table 5 (Edson & Akyoo, 2020a) were expressed under growing conditions of at least 50% of farmers who used the variety in question. However, genome of the variety, climatic conditions and management practices employed by farmers are known to influence variety performance (Atkinson *et al.*, 2013; Langyintuo *et al.*, 2010 and Pandey *et al.*, 2015). Variation in performance of these varieties call for interventions in order to increase likelihoods that would guarantee expression of seed quality attributes under farmers' growing conditions.

The majority of the farmers in FGDs asserted that, in most cases they do not experience variety performance as defined by seed sellers. They claimed that, some seeds sold to them are not of the quality expected and are sold at high prices by agro-dealers. Results in Table 5 (Edson & Akyoo, 2020a) above supports the assertion of farmers as some desirable traits of crop varieties which were defined by seed companies (Table 1, Table 2, Table 3 and Table 4; (Edson & Akyoo, 2020a)) were not expressed under farmers' growing conditions. However, several factors are believed to influence variety performance and

henceforth a holistic approach to enhance variety performance is critical among seed value chain actors. Moreover, farmers complained about not receiving feedback when they present complaints about seed quality to seed sellers (Seed companies and agro-dealers).

On the other hand, farmers in FGDs asserted that crop varieties are introduced into the market with limited involvement of farmers and materials to guide them on proper management of improved varieties. This might have manipulated variety performance since farmers' knowledge on GAP plays an enormous role on variety performance (Atkinson *et al.*, 2013; Langyintuo *et al.*, 2010).

Crop varieties from some companies did not appear in the variety list grown by farmers in the study area. For instance, core benefits of maize varieties SY 634 and SY 644 from Syngenta are more or less the same with those provided by other seed companies, a case which is also applicable to vegetable varieties sold by this company. None of the interviewed farmers in the study area reported to use any variety from this company. However, the designing and enforcement of marketing strategies that conform to localities (Kotler & Keller, 2012) may be the principal reason affecting variety dissemination and hence the market share of Syngenta Company in the study area and Tanzania seed industry in particular.

The market for OPVs is open for all seed companies to multiply or procure seeds in bulk and distribute to the market under their brand names but with the same variety name (e.g. Yolo Wonder, Rio-grande). Factors that determine brand preferences for the market of OPVs are still unknown. For instance, Rio-grande (Mkulima brand) was used by 10.77% of the respondents while none of the interviewed farmers used Rio-grande from Kibo seed brand. Yolo Wonder (Pop Vriend seed brand) was used by 8.46% of smallholder farmers while only 2.3% of

Table 5. Distribution of crop core traits by variety and seed brand (n=130).

Crop	Seed Brand	Variety	Trait/Core benefits	A ₁	A ₂
Maize	DeKalb	DK 8053(n=22)	High yielding	16.92	63.64
			Early maturity		59.09
	Kenya Seed Co	H 625 (n=10)	High yield	7.69	60
			Big cob/ear size		60
		H 628(n=13)	Good for grilling/fresh market	10	69.23
			Big cob/ear size		53.85
	Seed Co	SC 627/Simba(n=12)	High yield	9.23	66.67
Tomato	East West Seed	Imara F1(n=7)	High yielding	5.38	100
			Tolerant to foliar disease		85.71
			Firm fruits		71.43
			Good fruit shape		71.43
			Good fruit size		57.14
			Long shelf life		71.43
			Wide environmental adaptability		71.43
	Mkulima	Rio-grande(OPV) (n=14)	High yield	10.77	71.43
Sweet pepper	Pop Vriend	Yolo wonder(OPV) (n=11)	Early maturity	8.46	72.73
Cabbage	Seminis	Victory F1(n=7)	Highly compacted heads	5.38	71.43
			Tolerant to bursting		71.43
			Tolerant to rotting		71.43
			Long shelf life		57.14
	Simlaw	Gloria F1(n=18)	Highly compacted heads	13.85	66.67

A₁= Percentage of farmers that used the variety (2018/2019)

A₂= Percentage of farmers experienced the core benefit

farmers used Yolo Wonder from Mkulima brand. This situation suggests that, there are some variations in the quality of OPVs among seed brands which guide farmers to prefer one seed brand over the other.

Intercompany/Brand Quality Outlook of Maize and Vegetable Seed Varieties

Despite the fact that crop varieties are distinct, uniform and stable (DUS), some quality traits appear to be in common across varieties under the same crop. This study evaluated inter-company differences of seed quality attributes that appeared to be common in some varieties. Results in [Figure 2](#), [Figure 3](#), [Figure 4](#) and [Figure 5](#) (Edson & Akyoo, 2020a) show variation of farmers' experience on some common variety quality traits across companies/brands. Inter-company/brand variations in expression of crop variety traits under farmers' growing conditions provide the impetus for farmers' preference on some crop varieties over others. It is clear that, farmers will be influenced to buy those varieties with virtuous expression of desirable traits under their

growing conditions ([Figure 2](#), [Figure 3](#), [Figure 4](#) and [Figure 5](#); (Edson & Akyoo, 2020a)).

On the other hand, a local variety "Kimkoka" ([Figure 2](#); (Edson & Akyoo, 2020a)) was found to be favoured on tolerance to post harvest insect pests and high grain to flour ratio over improved varieties. Maize breeders are prompted to feature these traits in their breeding programs and communicate efficiently to stakeholders in the maize value chain.

Akerlof (1970) highlighted guarantee and brand name goods to be among principal institutions counteracting product quality uncertainty. Seed companies emphasize desirable traits of respective varieties when they promote crop varieties to famers. It is through seed marketing communication farmer acquire specific information on variety traits and thus they are aided to choose varieties according to their needs. In this case, smallholder farmers purchase seeds expecting some normal expected quality (Kotler & Keller, 2012) including the expected core benefits

Inter brands Sweet Pepper Variety Traits- Farmers' Experience

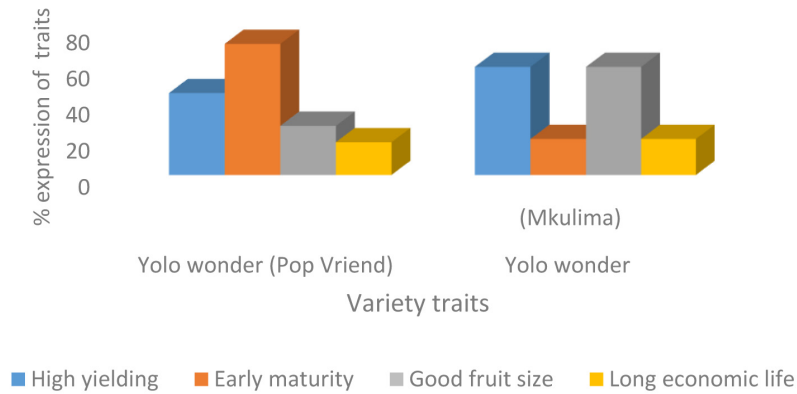


Figure 3. Quality traits of sweet pepper varieties across seed brands in the study area.

Inter brands Cabbage Variety Traits-Farmers' Experience

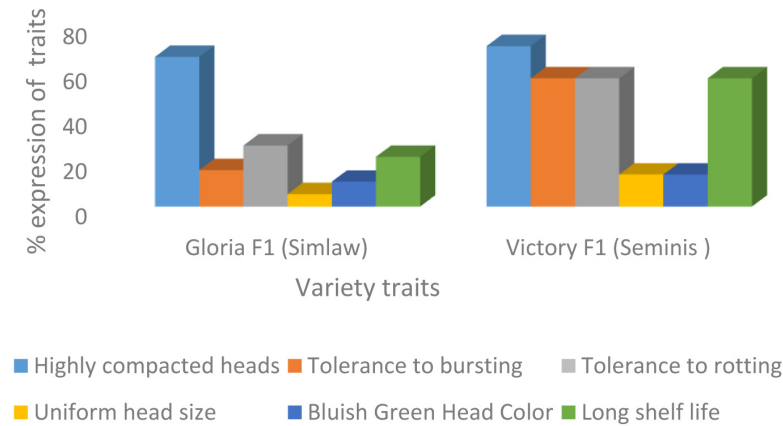


Figure 4. Quality traits of cabbage varieties across seed brands in the study area.

(company’s defined variety traits). In situations where core benefits of crop varieties are indefinite and the market value of farm produce is unstable, Gresham’s law may operate forcing smallholder farmers to opt for low quality/recycled seeds which affects productivity and market exchange. Uncertainty in variety performance (Figure 2, Figure 3, Figure 4 and Figure 5; (Edson & Akyoo, 2020a)) insinuates that some Seed Companies may suffer as farmers will eschew future seed purchases from brands that failed to meet their needs. According to Musadiq (2012), the failure of the product performance to meet consumer expectation results into cognitive dissonance. In this connotation, quality uncertainty of some crop varieties exacerbates retaliation of farmers to purchase seed from certain brands and thus affecting market exchange between seed companies and farmers.

However, not only seed companies will be victims but also farmers and the agricultural sector will be haunted by low productivity and poor livelihood of farming societies. Thus for the market exchange process to advance smoothly, seed companies must intervene to ensure that varieties they supply in the market meet minimum expected quality under farmers field conditions.

Moreover, under ecological diversity an improved seed need to be coupled with other inputs such as pesticides and fertilizers along with Good Agricultural Practice (GAP) in order to produce optimum results. Thus, access to other complementing agri-inputs (pesticides and fertilizers), availability of variety information and technical expertise of farmers are essential to reassure variety

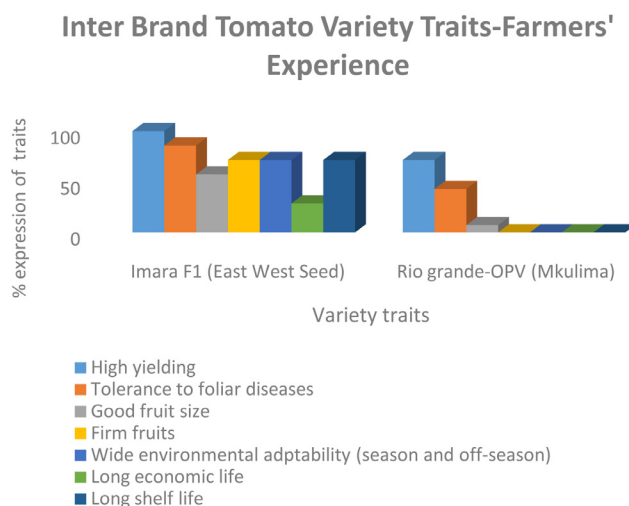


Figure 5. Quality traits of tomato varieties across seed brands in the study area.

performance. This implies that, under farmers' management some varieties failed to express the desirable traits that were proclaimed by seed sellers during variety promotions. The perceived quality of crop varieties experienced by farmers might have influenced choices (market exchange) of farmers as some varieties tended to be used more than others. Thus, an existing information asymmetry between some seed sellers and farmers insinuated farmers to opt more for the varieties that met minimum expected quality under their field conditions.

In addition, product augmentation in the study area seem to be ignored. There is little or no added value to the core benefit provided in crop varieties sold by seed companies. Kotler & Keller (2012) reported little involvement of augmented benefit in developing and emerging markets, which is also the case in the seed industry in the study area. Consequently, seed quality uncertainty perpetuates low productivity that affects sustainability in production of food and industrial raw materials.

Conclusion

This study has uncovered several core benefits of different crop varieties of maize, tomato, cabbage and sweet pepper sold by seed companies to farmers in the study area. However, farmers' experiences on defined core benefits of most crop varieties were meager. Despite that, all seed companies promoted their products to farmers, the final decision on which varieties to use was made by farmers during seed purchases. Some crop varieties such as DK 8053, H 628, SC 627/Simba, Imara F1, Rio-grande (Mkulima) Yolo wonder (Pop Vriend) and Gloria F1 (Simlaw) were used by a slightly higher proportion of farmers. In addition, some of their core benefits/traits were experienced by more than 50% of farmers who used the variety. However, in most cases farmers' experience on maize and vegetable seed varieties were not promising compared to the core benefits of varieties as defined by seed companies. This information asymmetry between seed companies and farmers presents a loophole for seed quality

uncertainty. It provides a room for existence of an Akerlovia market which affects the market exchange process. Further research is needed to expose empirical data in order to explain the reasons for quality differences of improved seed varieties under farmers' field conditions versus those promoted by seed companies.

If resource constrained farmers invest in improved seed while being subjected continuously to low variety performance, Gresham's law may operate since high quality seeds would no longer appeal to farmers. Inter-brand variety comparison favored some varieties over others due to high frequencies of expression of variety traits under farmers' field condition. The implication for this adverse selection in market exchange is that legacies of some seed brands in some crops will be threatened and adoption of improved varieties will be restricted. For seed brands whose varieties had similar traits compared to the most used varieties in this study, strategic marketing management becomes a matter of priority to ensure that market exchange is enhanced between the two trading parts.

Given the existing information asymmetry on crop variety traits, capacity building of practitioners on Climate Smart Agriculture in the agricultural sector is imperative. Enhancing Good Agricultural Practice (GAP) suitable to different Agro-ecological zones (AEZ) of Tanzania is important since farmers' skills and knowledge can affect variety performance. Moreover, policies to prompt knowledge transfer on GAPs must be emphasized for sustainable crop intensification which is the bridge to industrialization. Participatory variety development must be emphasized to ensure that the traits of crop varieties supplied in the market appeal to local growing conditions and to all stakeholders along the value chains. On the other hand, preservation of landraces such as "Kimkoka" to conserve biodiversity for future crop improvement programs is of paramount importance.

Notwithstanding, TOSCI as a public institution signaling seed quality should collaborate with other agriculture stakeholders to make sure that seed sold in the market are of the required quality. Taking into account the existing information asymmetry and quality uncertainty, innovations to trace seed sources must be emphasized. For instance, scratch vouchers associated with seed packages may be useful to confirm the seed source and if the seed source is authenticated through text messages (SMS).

Data availability

Underlying data

Figshare: Raw data from farmers' survey under a research study titled "Implication of quality uncertainty on market exchange: The case of seed industry in Kilolo district, Tanzania". <https://doi.org/10.6084/m9.figshare.12110733> (Edson & Akyoo, 2020a)

This project contains the following underlying data:

- Sales representatives survey and secondary data (brochures and websites) of variety characteristics from seed providers.xlsx (Data collected from sales representatives and secondary sources from seed companies)
- Raw data from farmers' survey.sav (Raw data from farmers)

Extended data

Figshare: Extended data (Checklists and questionnaire) for the study titled "Implication of quality uncertainty on market exchange: The case of seed industry in Kilolo district, Tanzania". <https://doi.org/10.6084/m9.figshare.12110745> (Edson & Akyoo, 2020b)

This project contains the following extended data:

- Checklist for Seed company representatives.docx (Checklist used in discussion with sales representatives)
- Checklist for FGDs.docx (Checklist for focus group discussions)
- CONSENT FORM.pdf (consent form)
- Questionnaire for smallholder farmers in Kilolo district.docx (study questionnaire)
- Inter-company or brand variety performance (Core Benefits) as experienced by SHFs.xlsx (Intercompany and brand performance as reported by farmers)

Data are available under the terms of the [Creative Commons Zero "No rights reserved" data waiver](#) (CC0 1.0 Public domain dedication).

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Open Peer Review

Current Peer Review Status: ? ✓ ✓

Version 3

Reviewer Report 16 June 2021

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✓ **Ola Westengen** 

Department of International Environment and Development Studies/Noragric, Faculty of Landscape and Society, Norwegian University of Life Sciences (NMBU), Ås, Norway

I find the revisions appropriate. I have no further comments to the manuscript.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Crop science, crop diversity, seed systems

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 2

Reviewer Report 02 March 2021

<https://doi.org/10.21956/emeraldopenres.14989.r27362>

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? **Ola Westengen** 

Department of International Environment and Development Studies/Noragric, Faculty of Landscape and Society, Norwegian University of Life Sciences (NMBU), Ås, Norway

As stated in the abstract this paper "assessed quality uncertainty in maize and vegetable seed and its implication for market exchange between farmers and seed sellers in Kilolo district, Iringa

Tanzania." It presents an original and interesting perspective on the use and non-use of commercially available crop varieties in the case study area. The economic theories used are useful and helps shedding light on aspects of the seed market and its transactions. This study appears well designed and thought through and the weaknesses of the study are associated with its presentation. The paper would benefit from a thorough revision for consistency in argument, structure and figure design/explanations.

The conceptual framework presented in figure 1 should be elaborated. It is very useful with an overview of the organizations involved in the seed system, but the figure should make it clearer what role the different organizations (and activities) plays in ensuring seed quality in the formal seed system. The mention of PVS seems out of place unless it is tied to specific actors. In the conclusion the following is stated:

"However, in most cases farmers' experience on maize and vegetable seed varieties were not promising compared to the core benefits of varieties as defined by seed companies. This information asymmetry between seed companies and farmers presents a loophole for seed quality uncertainty. It provides a room for existence of an Akerlovian market which affects the market exchange process. In this undertone, quality uncertainty of some varieties under farmers' field condition favored some varieties to be used more than others.» At an earlier point this statement is made: "Lack of Good Agricultural Practices (GAP) and access to high quality seed are major constraints affecting maize and vegetable production in Tanzania (...)" From these statements one can get the impression that the authors consider the seed companies' version as the factual situation while farmers' perceptions are less valuable/true. The study does not present empirical data that can support such an assessment of the reason for the asymmetry.

The next point is well taken:

"If resource constrained farmers invest in improved seed while being subjected continuously to low variety performance, Gresham's law may operate since high quality seeds would no longer appeal to farmers."

The reference to the situation with no farmers growing particular varieties from particular companies as a "fortuitous mishap" is strange.

Some of the figures also appears incomplete. For example figure 5: Only two out of seven trait categories assessed appear in the legends.

In the statement: "The seed companies included East West Seed (T) Ltd (Mkulima brand), Kibo Seed Company (T) Ltd, Kenya Seed Company, Meru Agro-Tours and Consultants Co. Ltd, Monsanto (Dekalb and Seminis), Simlaw, Pannar, Pop Vriend (T) Ltd, Royal Seeds Co Ltd, Seed Co Tanzania Ltd, and Syngenta." it could be useful to indicate which seed companies are national and which are international. Also: Are there no local companies / farmer groups selling QDS seeds in the area? If such organizations indeed operate it would be interesting to know how they perform and eventually why they are not included in this study.

Overall, this is an interesting and original study with merit for passing peer review following revisions.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Is the argument information presented in such a way that it can be understood by a non-academic audience?

Partly

Does the piece present solutions to actual real world challenges?

Partly

Is real-world evidence provided to support any conclusions made?

Partly

Could any solutions being offered be effectively implemented in practice?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Crop science, crop diversity, seed systems

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 29 Apr 2021

saadan edson, Sokoine University of Agriculture, Morogoro, United Republic Of Tanzania

I would like to thank Prof. Ola Westengen for his outstanding comments to improve this article. All comments were taken and they have been incorporated in the new version of this article which has been submitted to Emerald production team for publication.

Competing Interests: No any competing interest

Reviewer Report 14 December 2020

<https://doi.org/10.21956/emeraldopenres.14989.r27094>

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Conny J.M. Almekinders

Knowledge, Technology and Innovation Group, Wageningen University & Research, Wageningen, Netherlands

I appreciate the rebuttle of the authors. I can however not see if or how they changed the manuscript. I can only conclude that it has become more readable. In the following a number of queries and comments. The authors and editor should take into account that I'm not a marketing specialist and am unfamiliar with the way authors are using some concepts (especially the lemons and cars example of Akerlof remains vague for me.

I do not not understand how the authors compare variety claims made by the companies and those by farmers.

- The data sit in different tables (companies) and figures (farmers).
- It is unclear why inter-company comparisons are used for the farmers claims.

In the text it is in many places authors need to clarify what crop they refer to. For example, on p.10 bottom left I think I read information on maize, then authors then jump to OPVs, but apparently of a vegetable?

I do not see the data as evidence that farmers are unclear and uncertain about the quality of seeds. Nor that the situation of different perceptions constrain the farmers in seed investments. Also, I cannot see the difference between quality claims made by the seed companies and the farmers experiences with these varieties as a situation of information asymmetry. Probably I do not understand the Akerlofian concepts. The conclusions on top right on p.13 are unclear to me.

Authors in several paces base their conclusions on literature sources rather than on interpretation of their own data.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

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Are the conclusions drawn adequately supported by the results?

Partly

Is the argument information presented in such a way that it can be understood by a non-academic audience?

Partly

Does the piece present solutions to actual real world challenges?

Partly

Is real-world evidence provided to support any conclusions made?

Partly

Could any solutions being offered be effectively implemented in practice?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Seed systems and genetic resources, social sciences

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 22 September 2020

<https://doi.org/10.21956/emeraldopenres.14989.r27095>

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Monica K. Kansiime 

CABI, Nairobi, Kenya

I have read the revised paper and most of the comments raised have been addressed or clarified by the authors. I don't have further comments.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Is the argument information presented in such a way that it can be understood by a non-academic audience?

Partly

Does the piece present solutions to actual real world challenges?

Partly

Is real-world evidence provided to support any conclusions made?

Partly

Could any solutions being offered be effectively implemented in practice?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Seed systems, adoption studies, impact assessments, climate change adaptation, and value chain development.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 20 July 2020

<https://doi.org/10.21956/emeraldopenres.14517.r26948>

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Monica K. Kansiime 

CABI, Nairobi, Kenya

The study is novel, investigating implications of quality uncertainty on market exchange. The literature and conceptual frameworks are adequate. Some flaws are observed in the manuscript, that if improved, this would be a great paper.

1. Methods - 2FGSs were conducted - how many farmers participated? It seems subsequently most of the results are based on FGDs.
2. Methods - data collection - it is not clear what exact data were gathered from farmers and how this data were analysed. The last paragraph under HH survey the authors indicates "*.. Graphs were plotted to compare percentage expression of desirable traits of the crop variety of one brand compared to another brand*". This should be presented under data analysis and presentation.
3. Data analysis - The authors refer to use of Pareto analysis. This approach, as they mention has not been utilised in agricultural projects, and has been used by companies based on customer feedback. In this study, they used the method based on consumers' perceptions of desirable attributes. I am not sure it plays out the same. The authors need to provide literature on where it has been used based on customers/consumers survey.
4. Data analysis - most of the literature under this section is not needed. This section should tell us how data was transformed, what variables were analysed, how the statistics were conducted. Much of what is included is more about model specification. This need to be re-worked.
5. Results - Table 1. 82.3% of farmers (I am imagining this is from HH survey) used the various varieties. The balance of farmers are not accounted for. Some varieties e.g DK8031 have benefit traits analysed but not the users.
6. Results - Does the style of the journal allow authors to reference the work presented in results. Ok, this confused me.
7. Conclusion - I was keen to see the extent to which quality uncertainty affected/influenced market exchange functions. This question is rather not answered. If there was information asymmetry, how did this influence farmers decisions on varieties to use? For those varieties where more farmers used, was it because of their own perceived quality or experience, or did it have to do with the seller doing something extra eg marketing, participatory selection etc (cf conclusion paragraph 2). For the varieties farmers use, and the benefits they mention, did they know about them before? what informed their decision to select those varieties? as the data is, they are only rating the attributes but has nothing to do with their decision making processes based on prior information about the variety.
8. Conclusion (last paragraph), the authors write "*Given the existing information asymmetry in the seed sector, capacity building of practitioners on Climate Smart Agriculture in the agricultural sector is imperative*". I thought the information asymmetry referred to earlier related to information between seed sellers and seed users. There is need to substantiate, what asymmetry in this context means.

9. General comment: The authors provide a wide literature on differentiation, quality uncertainty and conceptual framework. While this is important literature, it has overshadowed the research methods and results which are more important in this case. There is need to reduce this section, and keep only the literature that is relevant to the problem and analytical framework.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

No

Are all the source data underlying the results available to ensure full reproducibility?

No

Are the conclusions drawn adequately supported by the results?

No

Is the argument information presented in such a way that it can be understood by a non-academic audience?

No

Does the piece present solutions to actual real world challenges?

No

Is real-world evidence provided to support any conclusions made?

No

Could any solutions being offered be effectively implemented in practice?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Seed systems, adoption studies, impact assessments, climate change adaptation, and value chain development.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 19 June 2020

<https://doi.org/10.21956/emeraldopenres.14517.r26837>

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✗ Conny J.M. Almekinders 

Knowledge, Technology and Innovation Group, Wageningen University & Research, Wageningen, Netherlands

The manuscript (ms) deals with an important topic: how farmers know and understand seed quality of a number of important crops in Tanzania.

The ms starts off in an interesting presentation of marketing concepts. As a seed person I have some queries, but overall this fresh look at seed issues can really make a contribution. However, later on, as a reviewer, I got stuck and I finally have lost the thread: could not grasp the discussion and conclusion section anymore. It may well be that for business and economy experts this is a valuable publication; I cannot judge, this is not my field. However, I consider it hard to understand for seed people. Because I think the authors have valuable data for seed people, I hope the authors find my comments useful and I suggest they try to find a colleague with expertise in "seeds" to develop this ms in a valuable publication for seed people. The english writing is excellent.

The manuscript (ms) deals with an important topic: how farmers know and understand seed quality of a number of important crops in Tanzania.

The ms starts off in an interesting presentation of marketing concepts. As a seed person I have some queries, but overall this fresh look at seed issues can really make a contribution. However, later on, as a reviewer, I got stuck and I finally have lost the thread: could not grasp the discussion and conclusion section anymore. It may well be that for business and economy experts this is a valuable publication; I cannot judge, this is not my field. However, I consider it hard to understand for seed people. Because I think the authors have valuable data for seed people, I hope the authors find my comments useful and I suggest they try to find a colleague with expertise in "seeds" to develop this ms in a valuable publication for seed people. The english writing is excellent.

There is no space to add all my comments. Available on request. The most important one:

At random selection of farmers: even at random has a way of doing it: pulling names out of a pot, otherwise?

FGDs: there were two, but it is not clear how many participants there were per FGD.

Table 1, 2, 3 and 4: is it information from the questionnaires or FGDs? How was the information on the core benefits collected? Did authors use open question or were traits pre-defined? How many observations/mentions for each of the traits?

Figure 2, 3, 4 and 5: it is not clear how the authors collected the data, how they processed them and what the meaning of the data is. They make further reading/understanding for me

impossible.

The authors refer to Akerlof and a market phenomenon with an example for lemons and cars (?). It would be interesting and necessary for the authors to reflect on the question if this model also applies for seeds. Seeds are not just "a good": it can also be provisioned by farmers themselves by saving part of last seasons harvest for next planting. Also: how would "branding" (for lemon, cars, or seeds) affect this phenomenon. There are still very expensive Mercedes cars for sale, next to cheaper Skoda s and Dacia s? Also, for seeds it makes quite a difference when we talk hybrid seed or open pollinated, and if we are talking maize, tomato or another vegetable.

In general, in the result section, in many places it is not clear when the authors jump from maize to another crop. F.e. top right column on p 11. In Figure 3 the title says sweet pepper, the other title says sweet pepper.

In the text on the results, authors come at places with concluding comment (i.e. "it is clear that....) which I do not understand AND/ALSO BECAUSE they referring to 4 figures together. F.e. Forelast paragraph bottom left p 11.

Is the work clearly and accurately presented and does it cite the current literature?

No

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?

No

Are the conclusions drawn adequately supported by the results?

Partly

Is the argument information presented in such a way that it can be understood by a non-academic audience?

Partly

Does the piece present solutions to actual real world challenges?

Partly

Is real-world evidence provided to support any conclusions made?

Partly

Could any solutions being offered be effectively implemented in practice?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Seed systems and genetic resources, social sciences

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 30 Jun 2020

saadan edson, Sokoine University of Agriculture, Morogoro, United Republic Of Tanzania

We would like to thank the reviewer for the time taken to come up with useful comments.

We appreciate that the reviewer has recognized that our manuscript deals with an important topic: "how farmers know and understand seed quality of a number of important crops in Tanzania as well as an interesting presentation of marketing concepts". The reviewer highlighted that this may be valuable publication for business and economy experts. However, our intention goes further to seed quality regulators as well as not for profit agriculture development practitioners. Moreover, the author showed we have valuable data for seed people and appreciated the English writing. We appreciate the time spent to come up with valuable comments.

Our study employed a simple random sampling technique. Record books used to enroll farmers in villages (Village registers of farmers) were used as sampling frames. A random number generator was used to pick 26 numbers (equivalent to number of farmers) in every village from each farmers' register in the study area.

In the methodology section under **Focus group discussion**, our study stipulated that each FGD comprised eight engendered members for each crop. In order to capture climatic diversity in the study area, one FGD was conducted in the highland/ cool climate and another FGD was conducted in the low land area.

Information in Tables 1, 2,3 and 4 are the information from seed sellers (Seed companies). A checklist was used to collect information from representatives of seed companies that were involved in this study. Open ended questions were used which enabled traits of different crop varieties to be defined as in tables 1,2,3 and 4. In addition, brochures and product catalogs of some companies were used to complement information collected through the checklist. After defining traits based on information given by seed companies, this study-examined framers' experience of the same crop varieties under field condition.

On the other hand, information on Figures 2, 3,4 and 5 and Table 5 were collected through the questionnaire administered to farmers. Figures 2, 3, 4 and 5 shows the summary of the

number of mentions (%percentage expression of traits stated by farmers) for each trait observed by farmers across brands. Table 5 {Distribution of crop core traits by variety and seed brand (n=130)} shows the most expressed traits in each crop variety of used seed brands as well as the number of farmers observed the traits (equals to the number of mentions of traits) . To extend implication of the information collected from farmers, this study compared the number of mentions of each traits, which were common to across seed brands. By doing so , a reader can clearly observe the highest number of mentions of a particular trait which is also common to other varieties. For instance, drought tolerance as the trait experienced/mentioned by farmers the highest number of mentions is in the sequence of DK 8053 (45.45%), SC 627 (41.67%), H 628 (15.38%) and H 625 (10%)

This study referred a paper by Akerlof (1970) since it related quality and uncertainty due to existence of goods of many qualities in the markets. This model applies as well for seed business because if farmers buy seeds from a certain brand, the brand name signifies quality and gives consumers means of retaliation if the quality does not meet expectations. Since seed quality can't be verified at the time of purchase, this study avers on the importance of trust in order to avoid driving legitimate seed business out of existence. In his paper, Akerlof concluded that informal unwritten guarantee are preconditions for trade and production, which is even more than the case in seed business. In this case, seed companies have gone further by promoting varieties with written promotional materials (brochures, leaflets) of which sometimes, farmers buy seeds at agro-shops/dealers without attesting the identity of varieties. Moreover, Akerlof highlighted that the automobile market (cars) was used for its concreteness and easy for understanding rather than for its importance and realism. Therefore, his thoughts are applicable in seed business as well. The following sentences from this study highlights on some covered issues from the Akerlofian model that are applicable in seed business as well.

1. It is also a fact that inability to determine and verify the pedigree and quality of goods at the time of purchase will lead to development of Akerlofian market (Akerlof, 1970) on any marketed good.
1. Akerlof (1970) highlighted guarantee and brand name goods to be among principal institutions counteracting product quality uncertainty. In this case, smallholder farmers purchase seeds expecting some normal expected quality (Kotler & Keller, 2012) including the expected core benefits (company's defined variety traits).
1. In the cost of dishonest under quality uncertainty, it is not only the buyer/consumer who is cheated but also there is a cost incurred in the loss of driving legitimate business out of existence as consumer will curtail future purchase (Akerlof, 1970)

This study has highlighted several challenges of using low quality seeds compared to improved seeds. The following sentences are quoted from our paper to verify this.

1. Some researchers reported lack of disease-free seeds and planting materials as well as the absence of varieties suitable for climatic conditions present in Tanzania to be the major constraints in vegetable production (Shao *et al.*, 2002).
2. Weinberger & Msuya (2004) pointed out the presence of insect pests and diseases,

absence of efficient control measures and the lack of high-quality seeds as constraints in the cultivation of indigenous African vegetables in Tanzania. Moreover, drought, insect pests, diseases and lack of know-how are reported to be major challenges faced by maize smallholder farmers in Tanzania (Lyimo *et al.*, 2014).

3. Lack of Good Agricultural Practices (GAP) and access to high quality seed are major constraints affecting maize and vegetable production in Tanzania (Lyimo *et al.*, 2014 and Mutayoba & Ngaruko, 2018; Rajendran *et al.*, 2017).

In addition, the use of recycled seeds has been elaborated in some paragraphs. The study did not ignore local recycled seeds as they are important in conserving biodiversity and in breeding programs as it has presented some desirable traits from a local variety, "Kimkoka". The following are some sentences highlighting the status of recycled seeds in the Tanzanian seed system

1. Wilson & Lewis (2015) estimated maize seed demand in Tanzania to be over 70,000 Metric Tons while out of this 80% of seed used is farmers' recycled seed from previous season.
2. On the other hand, a local variety "Kimkoka" (Figure 2; (Edson & Akyoo, 2020a)) was found to be favoured on tolerance to post harvest insect pests and high grain to flour ratio over improved varieties. Maize breeders are prompted to feature these traits in their breeding programs and communicate efficiently to stakeholders in the maize value chain.

The study has explained the importance of using improved seeds in order to counteract some challenges highlighted in the paragraphs above. However, the importance of recycled seeds has been insisted as well in conserving the biodiversity and suggested using some local varieties such as Kimkoka in breeding programs, as it was favored on tolerance to post harvest insect pests and high grain to flour ratio over improved varieties. Branding will apply only in improved seed business and its effect on the market will be influenced by farmers experience on using a given seed varieties. For example, if farmers are interested on drought tolerant maize varieties {the market share of brands selling these varieties will be affected respectively-DK 8053 (45.45%), SC 627 (41.67%), H 628 (15.38%) and H 625 (10%)}. Varieties that were more observed by farmers (high percentage of observations) to be drought tolerant will sell more. However, if farmers buy improved seeds with hopes of experiencing certain levels of quality/traits and fail to realize their benefits the agriculture sector will suffer. A sentence below from the manuscript addresses this phenomenon

1. In situations where core benefits of crop varieties are indefinite and the market value of farm produce is unstable, Gresham's law may operate forcing smallholder farmers to opt for low quality/recycled seeds. Uncertainty in variety performance (Figure 2, Figure 3, Figure 4 and Figure 5; (Edson & Akyoo, 2020a)) insinuates that some Seed Companies may suffer as farmers will eschew future seed purchases from brands that failed to meet their needs. However, not only seed companies will be victims but also farmers and the agricultural sector will be haunted by low productivity.

This study has highlighted desirable traits of hybrid varieties (F1) and open pollinated varieties. Further, it highlighted how the market for open Pollinated Varieties (OPV)

operates. As the reviewers has highlighted that it make a difference when we talk maize, tomato or another vegetable, we understand that each crop has some unique desirable traits and that is why they were analyzed and presented separately in tables and figures 2, 3,4 and 5 and tables 1,2,3,4 and 5. However, we will put forth more description on differences between hybrid and open pollinated varieties to facilitate easy understanding of the concepts for readers.

The reviewers was concerned about titles of some figures. Some title of figures were duplicated, the following are the right titles on how figure must be named in the paper.

Figure 2. Quality traits of maize varieties across seed brands in the study area.

Figure 3. Quality traits of sweet pepper varieties across seed brands in the study area.

Figure 4. Quality traits of cabbage varieties across seed brands in the study area.

Figure 5. Quality traits of tomato varieties across seed brands in the study area.

Figures 2, 3, 4 and 5 shows desired quality traits of maize sweet peeper, cabbage and tomato seeds respectively across seed brands in the study area. Since some researchers highlighted in our study (Haug *et al.*, 2016 and Mutanyagwa *et al.* (2018)) expressed limited availability of farmers' preferred seeds (fore last paragraph bottom right pg 4), we thought it is fair to say, "It is clear that, farmers will be influenced to buy those varieties with virtuous expression of desirable traits under their growing conditions. This is because, traits of maize sweet peeper, cabbage and tomato plotted in figures 2, 3, 4 and 5 respectively are the desirable traits mentioned by farmers and hence they will continue to buy varieties that have virtuously expressed the desirable traits.

We are looking forward to get more comments to improve quality of the manuscript as the reviewer said they are available upon request. In addition, we are working to update the literature cited, methodology, analysis and conclusion as suggested by the reviewer.

We would like to thank the reviewer for constructive comments and we hope that the reply to the comments will give a new outlook on the first and further review of the paper.

Competing Interests: No competing interests were disclosed.