RESEARCH ARTICLE

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

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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. Moreover, product augmentation is profoundly overlooked whereby most of seed companies have not augmented their products. Despite that genetic and environmental interaction sways crop performance, the paper offers a thorough deduction of the results and its implication on market exchange. This paper adds information in the body of knowledge on how an improved seed can intensify upsurge 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

This article is included in the Sustainable Food Systems gateway.

Open Peer Review

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Any reports and responses or comments on the article can be found at the end of the article.

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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). 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).

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.

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 ole rance 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 subsector 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 accessions[1] 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 (URT, 2013). Therefore, promoting agriculture development is

[1]Adverse 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.

[2]Prolificacy 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

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 tomatos 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).

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. Such a discriminate low use of improved seed impedes agricultural intensification and must be critically addressed. Research has reported low profit, high cost of improved seed and availability of farmers preferred varieties to be limiting factors in adopting improved seeds (Haug *et al.,* 2016). 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). Moreover, Mutanyagwa *et al.* (2018) emphasized consideration of farmers' preference in development of improved maize seed.

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 Akerlovian 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

Quality Differentiation and Market Mechanism. 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.

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.

Analogous to Akerlof (1970) study, it is fair to contend that presence of low quality seed at cheap prices will eventually lower the price of high quality seed which will be consciously sold at low prices by agro-dealers. Eventually, only seed of low quality will sell and those with high quality will no longer appeal to customers [Gresham's law where bad (low quality, low cost) products drive out good (high quality, high price) products] (Chown, 1994). For this reason, provision of quality seed and addressing asymmetric information between seed companies and customers/farmers is critical. 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).

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). According to Musadiq (2012), failure of the product performance to meet consumer expectation results into cognitive dissonance.

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).

Anderson *et al.* (1992) contend that product differentiation on quality, packaging, design, color, and style influence the consumer choice. 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). All these levels are crucial in planning market offerings entrenched in three basic elements at the center namely product features and quality, services mix and quality, and price.

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. Dirisu *et al.* (2013) emphasized on identifying meaningful product driven differentiators in gaining and sustaining a competitive advantage.

Quality uncertainty, information asymmetry and market exchange. 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). According to Akerlof (1970), if private and social interests differ, government interventions may increase the welfare of sellers and buyers. Furthermore, the presence of people who offer inferior goods in the market (lemons) tend to put the market out of existence. This is due to the inability of buyers to identify the quality of goods at the time of purchase.

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.

Akerlof (1970) suggests that, whenever there is adverse selection[1] there may be no possible market equilibrium at any price, in this case guarantee and brand-name good are proposed as means of counteracting quality uncertainty. Mudambi & Schuff (2010) identify 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) it.

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 theory of asymmetric information assumes that buyers know the average value of items on sale, which might not always be the case (Auronen, 2003). 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, Agriculture Research Institutes (ARIs), 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. In Tanzania, the Agricultural Seed Agency (ASA) is a public institution that has the mandate to multiply public bred varieties. On the other hand, Tanzania Official Seed Certifying Institute (TOSCI) that works under International Seed Testing Association (ISTA) standards has the mandate to assure quality of seed before they are sold to farmers. Quality assurance from TOSCI facilitates Market Exchange (ME) between companies, agro-dealers and farmers by guaranteeing identity preservation and quality of crop varieties to be sold on the market.

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

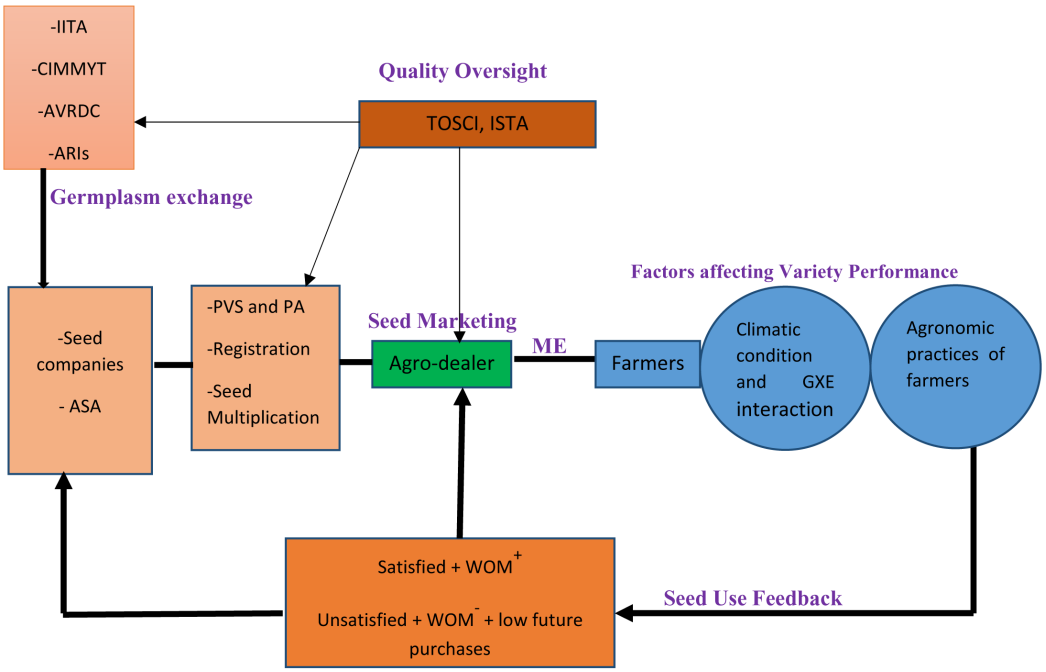

Figure 1. Conceptual framework of seed quality and market exchange. Source; author's construction from literature (Akerlof, 1970; Burman *et al.*, 2018; Langyintuo *et al.*, 2010 and Nieto *et al.*, 2014). IITA - International Institute of Tropical Agriculture, CIMMYT - International Maize and Wheat Improvement Center, AVRDC - World Vegetable Center, ARI - Agricultural Research Institute, TOSCI - Tanzania Official Seed Certifying Institute, ISTA - International Seed Testing Association, ASA - Agricultural Seed Agency, PVS - Participatory Variety Selection, PA – Product Advancement, WOM – Word-of-Mouth

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 enhancer 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 experience and the last farming practices between May 2018 and May 2019. The data for this study were collected between 1st and 30 th May 2019. A purposive sampling was used to select Mtitu and Kihesa Mgagao villages from Kilolo divison, 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 collects 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.

Farmers provided basic information on specific crop varieties that were planted in the 2018/2019 growing season. Since a seed is a typical example of experience good, farmers highlighted specific desirable traits that were expressed by maize and vegetable seed varieties under their growing conditions. Graphs were plotted to compare percentage expression of desirable traits of the crop variety of one brand compared to another brand.

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. 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. 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. Notes were developed to capture special information related to the study that resulted from interviews.

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 eight engendered members for each crop. 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 which "vital few" causes are responsible for most of the reported problems (Pareto, 1964). The implication of the 80/20 rule is that most efforts are not efficient and should be reduced. In 1940, Juran applied Pareto analysis to separate the "vital few" from the "trivial many" by assessing the most frequent reason for rejection of raw materials (Gittens *et al.*, 2005). In another study conducted by Perzyk (2007), the pareto chart shows that the staff in foundry industry should concentrate on reducing 'sand inclusions' and 'gas holes' defects, which constitute the majority (72 percent) of all defects. From the review above, it is fair to assert that Pareto analysis can also be used to identify what are the major issues of interest in a particular product by assessing frequency of occurrence. This study employed the concept of Pareto analysis for the aim of identifying core benefits (quality traits) of crop varieties most valued by farmers. This is contrary to its frequent use where it has been used to show high frequency of defects of systems of machines that need to be corrected (Pareto, 1964).

Frequencies of desirable traits of various crops were plotted based on farmers' ratings which emanates from their experience of using certain crop varieties. 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- 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)). Core benefits (desirable traits) of each seed brand variety are defined against the proportion of farmers (A_1) in Kilolo district who reported to use the variety in the 2018 growing season.

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

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

A_1= 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= tolerance 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

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	

A_1= 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

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	

A_1= 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	

A_1 = 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.

plays an indispensable role in positioning seed brands in the market.

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

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. Variation of variety performance is influenced by factors such as the genome of the variety, climatic conditions and management practices employed by farmers (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.

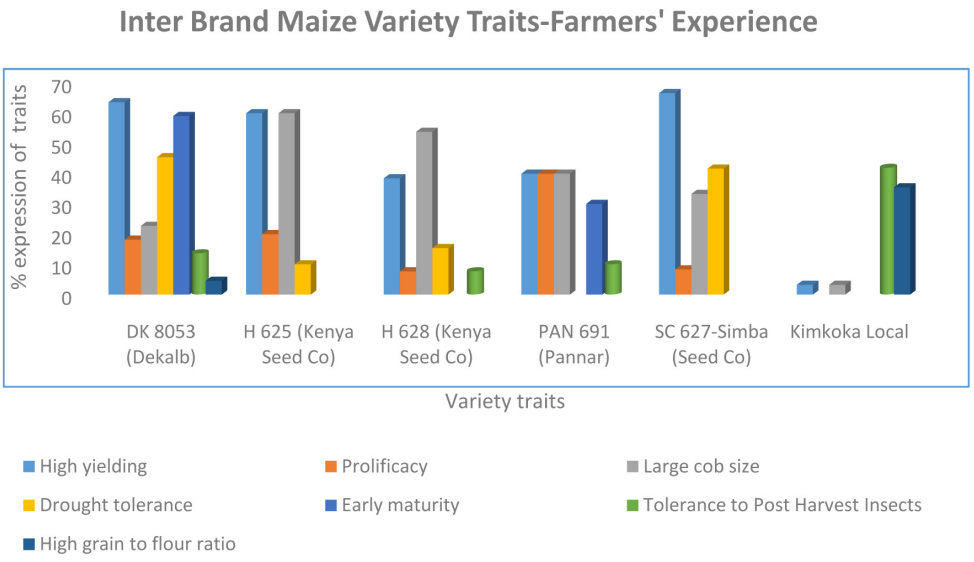

Figure 2. Quality traits of maize seed across seed brands in the study area.

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

A_1= Percentage of farmers that used the variety (2018/2019)

A_2= Percentage of farmers experienced the core benefit

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 famers 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. Reasons leading into this fortuitous mishap are still unknown. However, the designing and enforcement of marketing strategies that conform to localities 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 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. 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.

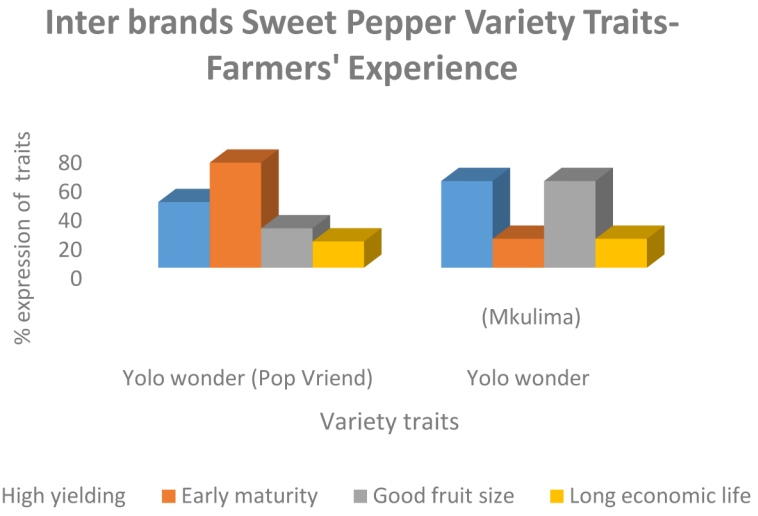

Figure 3. Quality traits of maize seed across seed brands in the study area.

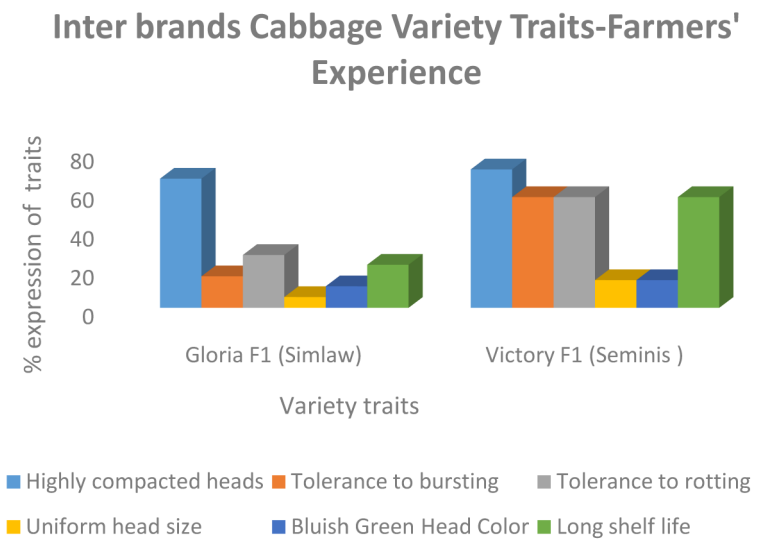

Figure 4. Quality traits of maize seed across seed brands in the study area.

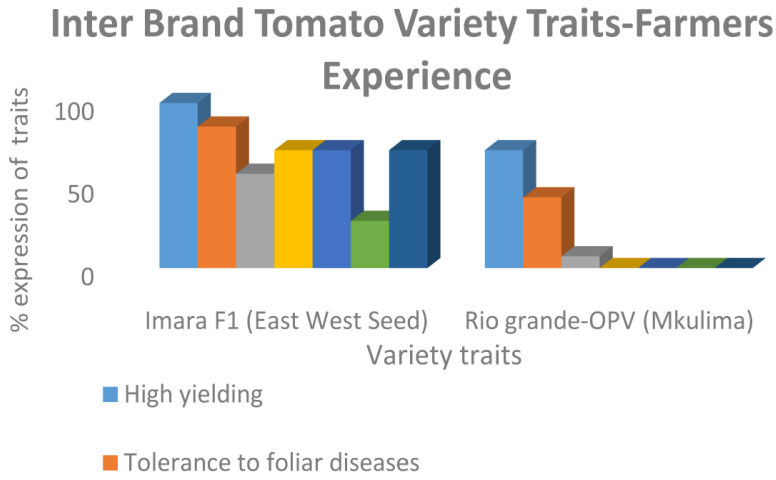

Figure 5. Quality traits of maize seed across seed brands in the study area.

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). 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.

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 performance. 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 exposed several core benefits of different crop varieties of maize, tomato, cabbage and sweet pepper. However, farmers' experiences on defined core benefits of most crop varieties were modest. Existing information asymmetry between seed companies and farmers presents a loophole for seed quality uncertainty. 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 provides a room for existence of an Akerlovian market. 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. This kind of adverse selection may push some seed brands out of existence and limit adoption of improved varieties.

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. Moreover, inter-brand variety comparison favored some varieties over others due to high frequencies of expression of variety traits. This insinuates that, Participatory Variety Selection is essential in order to facilitate release of varieties live up to local growing conditions. On the other hand, some varieties of seed brands such as Royal seed, Kibo Seed, Seminis and Syngenta had similar traits to the above varieties but they were used by a small proportion of farmers in the study area. Strategic marketing management becomes a matter of priority on promoting variety adoption, which is achieved by development of crop varieties with desirable traits.

Given the existing information asymmetry in the seed sector, capacity building of practitioners on Climate Smart Agriculture in the agricultural sector is imperative. Policies to prompt adoption of improved maize and vegetable seed are required for sustainable crop intensification. Also, preservation of landraces to conserve biodiversity for future crop improvement programs is of paramount importance. This research is indirectly calling for effective Public Private Partnership on intensifying agriculture as a bridge to industrialization in Tanzania. 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. Participatory variety development is also imperative to ensure that the traits of crop varieties supplied in the market appeal to all stakeholders along the value chain.

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). This paper suggests further researches on partnerships along seed value chain, Participatory Variety Development and appropriate seed marketing campaigns. This will foster dissemination of improved seed technology that will foster production, processing and exports of crops for the desired agriculture development and industrialization in Tanzania.

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 characteristis from seed brabds.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)

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