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Value creation and sorghum-based products: What synergetic actions are needed?

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Abstract- Sorghum is a crop of marginal and vulnerable areas that are highly susceptible to the changing climate. A firm-level survey was conducted to address the level of utilization of the sorghum grain, associated value creation and constraints in the agro-processing segment of the agrifood value chain. Results declare that wheat is the most popular and commercial crop that has been widely utilized for the manufacturing of different food products. Maize is the second potential grain while the large share more allocates to the manufacturing of feed and fortified food products. The grains of *teff*, rice, and sorghum are majorly restricted to traditional food products. To a very limited extent, the agro-processing utilization of sorghum is more attributed to the manufacturing of baby foods and feed products. The physical features and nutritional qualities of sorghum products, experience and awareness gaps, and consumer perceptions remain to be the major barriers that limit the competitiveness of sorghum. The complex nature of the system demands empirical research, agribusinesses, and development actors to join hands embarking on the enhancement of nutrition, capacity development, product innovations, and demand creation. Moreover, boosting up of farm productivity, promoting farmer-industry partnerships and backups to the infant agro-processing sector opens up the opportunities for the disconnected sorghum growers.

Keywords: Sorghum; value creation; products; competitiveness; demand; partnerships

1. Introduction

Smallholder farmers cultivate 96% of the total land and take the dominant share in the production of the major crops in Ethiopia (CSA, 2015). The country is the third-largest sorghum producer in Africa after Nigeria and Sudan (FAO, 2017). It accounts for 19% of the domestic cereal production and 20% of the total area under cereals (Demeke, Di Marcantonio, 2013). The crop also ranks third next to maize and *teff* for which the total annual production is estimated to be 4.75 million tonnes (CSA, 2017). Sorghum is widely grown in diverse climatic conditions and the major staple crop grown in the poorest and dry areas where other crops can survive least and food insecurity is widespread (Fetene et al., 2011; Jema et al., 2018). The crop is typically produced on marginal lands and predominantly based on traditional seeds with limited use of commercial fertilizer and pesticides (Fetene et al., 2011; Cavatassi et al., 2011). Its drought tolerance and adaptation attribute to adverse conditions named it a crop of the resource-poor farmers.

Sorghum is processed at a household level using traditional means, such as small grain-mills. The grain is consumed in various forms, including *enjera*, porridge, *nefro*, and local drinks such as *tella* and *arekie*. The principal use of sorghum is for *enjera* making either standalone product or by mixing with *teff*. Consumption of sorghum by the urban dwellers is partly explained by the availability and the market price of *teff*. This means that sorghum serves as a substitute for making *enjera* when the price of *teff* picks high (Demeke and Marcantonio, 2013; Adugna, 2104).

The fragmented nature of the marketing system and involvement of high transaction costs further discourage the commercialization of the crop. The susceptibility of the sorghum grain to post-harvest losses and lack of better storage facilities are posing a great challenge on the market. In view of this, sorghum has been put on a waiting list of the warehouse receipt system of the Ethiopian Commodity Exchange (ECX) market, which includes coffee, sesame, white pea beans, red kidney beans, mung beans, maize, and wheat (Pauw, 2017). The marketed quantity of sorghum estimated at 379,000 metric tons and this represents only 11.5% of the national sorghum production

(AATF, 2010; CSA, 2014). The crop is mainly produced for household consumption and the smaller portion of the national sorghum production is marketed.

The prevalence of inefficient input and output markets and weak value chains further impede the adoption of improved sorghum technologies and raising farm productivities. Investments to be made for the progression of market institutions, processing methods, and innovations that reduce marketing costs enhance the commercialization of the crop through the stimulation of consumer demand. This could be best achieved by embedding on the options for enhancing competitiveness and demand creation (i.e., including food and non-food uses). There is limited knowledge on the extent of utilization of sorghum and value creation in the agro-processing segment of the agrifood value chain in Ethiopia. Thus, the research strives to explore alternative uses, sorghum-based value-added products, and challenges for portraying important points of future interventions.

2. Literature Review

2.1 Sorghum Production, Marketing, and Trade

Sorghum is an important source of food and livestock feed, particularly for peoples that are dwelling in the arid and semi-arid climate (Duodu et al. 2003). Exposure to the recurrent drought risks is the prime cause of household food insecurity particularly in the most drier and vulnerable areas (Dercon et al., 2005; Doss et al., 2008). Despite the shock is transient, it has a persistent impact on household consumption and further pushes them into a trap of low productivity and sustained poverty (Dercon, 2004). The situation could be explained by the low investment in improved seeds, fertilizers, and related inputs for enhancement of crop intensification, commercialization, and value additions.

Pieces of the literature revealed that among the factors that influence technology adoption decisions, access to markets and social capital have important roles. Similarly, empirical findings of (Benin et al., 2006; Cavatassi et al., 2011) capitalized on the impacts of market access on producers' variety choice and access to good quality seeds. Despite continuous breeding and varietal development efforts undertaken for improving farm productivity and overcoming food insecurity, the adoption of modern varieties of sorghum is quite lower (Mulatu and Zelleke, 2002; Gebretsadik et al., 2014).

When it comes to the national grain flow balance, The UN COMTRADE data indicates that the country was a net exporter in the years 2005-07 while becoming a net importer during 2008-10. The volume of imports was relatively significant in 2008 and 2010 (113,000 metric tons), which is mainly associated with food aid imports from the US (Demeke and Di Marcantonio, 2013). Unlike crop failure during bad years and resultant demand for aid food, the grain of sorghum is traded to the neighboring countries. Sudan is one of the destinations for cross-border trade from Gondar, the major market center for the supplying areas in the north. Domestically, sorghum is more widely traded in the deficit, marginal and pastoral areas where transport and communication infrastructure are not well developed. The grain is transported to the deficit areas, such as Mekele, Asayita, Dire Dawa, Jijiga, Gode and Addis Ababa.

2.2 Nutritional Attributes

Several myths and discrepancies are existent in connection to the nutritional values of sorghum. Studies show that small differences do exist in terms of feed efficiency between sorghum and maize grains; however, it could be a substitute as far as the price justifies the use of more sorghum for supplying equivalent feed value (Rohrbach and Kiriwaggulu, 2007). Others indicate that sorghum gives a product with comparable nutritional value to maize. The typical scenario is that the nutrition characteristics have variability across locations and therefore, it remains to be the main source of ambiguity in acquiring the clear pictures and efforts of lessening undesirable reputations. As shown in the nutrient composition table below (FAO, 1995), the crop has more similarity with other cereals in terms of the different parameters indicated. The evidence at hand tells that the physical attributes and qualities of sorghum products seem to be more determinant than the nutritional attributes. Sorghum is a gluten-free cereal and consumption of the crop provides essential nutrients including carbohydrates, protein, vitamins and minerals, and nutraceuticals such as antioxidants, phenolics and cholesterol-lowering waxes (Taylor et al. 2006).

Table 1. Nutrient composition of cereal crops

Cereal type	Protein (g)	Fat (g)	Crude fiber (g)	Carbohydrate (g)	Energy (kcal)	Calcium (mg)	Iron (mg)
Rice (brown)	7.9	2.7	1.0	76.0	363	33	1.8
Wheat	11.6	2.0	2.0	71.0	348	30	3.5

Maize	9.2	4.6	2.8	73.0	358	26	2.7
Sorghum	10.4	3.1	2.0	70.7	329	25	5.4
Pearl millet	11.8	4.8	2.3	67.0	363	42	11.0
Finger millet	7.7	1.5	3.6	72.6	336	35	3.9

Source: FAO (1995)

2.3 Value Creation and Chain Upgrading

Value creation is broadly defined as the changes in current place, time and form on the basis of the consumer and market values (Anderson and Hanselka, 2009; Coltrain et al., 2000). A more narrow definition is the economic transformation of an agricultural product by processing it into a product desired by customers, for instance, wheat grain into flour. The concept is interchangeably used with value addition, which often is applicable in the analysis of the profitability of agricultural productions (Cucagna and Goldsmith, 2017). The biotechnological modification of crops, the engineering process of converting raw products to food, and the reorganization of the distribution system provide opportunities for adding value. Identifying the value-added activities that will support the necessary investment in research, processing, and marketing are important. Coltrain et al., (2000) distinguished two ways of value addition, i.e., an innovation that aims at improving existing processes, products and services or fabrication of new products whereas coordination centers on facilitation of the relationships among the actors in the supply chain.

The concept of upgrading is used to imply the shift from low-value-added to higher-value-added activities and comprises the components of production, technology, knowledge, and skills. The value chain development approaches have adopted Gary Gereffi's concepts of product upgrading, linked to innovation that involves product diversification or improvement of the final product (GIZ, 2007). Process upgrading refers to the enhancement of production and distribution components that aims at achieving overall efficiency. Functional upgrading targets on switching of the value chain functions among the operators, for instance, shifting of primary processing to farmers. Chain or inter-sectoral upgrading describes the situation when firms shift to new industries or more advanced technological chains (Gereffi, 2005; Gereffi and Fernandez, 2011; Gereffi, 2018). Generally, value-added is a measure for the value created in each stage of the chain while the aggregation represents the value generated in the economy at large. Value addition is the extra value generated or improved as a consequence of either of the upgrading strategies (GIZ, 2007).

2.4 Food Quality and Consumer Perceptions

Food quality is a multifaceted concept that is importantly determined by both perceived intrinsic and extrinsic quality cues available to the consumer (Acebrón and Dopico, 2000). The difference between the two product cues is the point of time at which consumers could make a judgment on the products. The extrinsic product attributes are not the inherent manifestations of the products, consumers used to make a decision with the help of observable information (e.g., brand, packaging, price, and labels). The physical characteristics and nutritional composition of a product affect the appearance, smell, taste, sound, and texture of the food. Intrinsic attributes are known to permit objective measurement of quality, sensory perceptions, and also drive buying intensions. Both extrinsic and intrinsic product attributes jointly determine the consumer responses and purchase decisions (Enneking et al., 2007; Brecic et al., 2017; Symmank, 2018).

2.5 Food Fortification

Fortification of food products is a value creation process that evolved through the growth stages of conventional food processing and innovation. It is defined as the practice of deliberately enhancing the nutritional quality of the food supply and minimization of health risks with the addition of essential micronutrients (i.e., vitamins and minerals). Market-driven fortification targets increasing sales and profitability of the company within a specified regulatory framework, whereas mass fortification is augmentation through the addition of micronutrients to foods commonly consumed by the general public, such as cereals, condiments and milk (Allen et al., 2006). A different paradigm in the enhancement of food quality is introducing the micronutrient density into staple crops through the techniques of genetic modification or biofortification (Horton, 2006). Value addition in life science redefines the role of creating and capturing value through genetics and processing. In this regard, the application of biotechnology alters the intrinsic attributes of crop commodities for the purpose of fitting specific traits for food, industrial, and medicinal uses (Coltrain et al., 2000).

2.6 Sorghum-Based Products

The crop of sorghum largely has subsistence uses, however, experience justifies that utilizations by the food, feed, and beverage industries are existent in African and Asian countries. In India for instance, there is substantial exploitation of sorghum for dairy and poultry feed products (Kleih et al., 2007). The utilization of sorghum for commercial malting in South Africa is among the practices to be mentioned. Partial processing of sorghum that is targeted for traditional and household products such as, Maltabella, Morvite (sorghum instant soft porridge), and a shelf-stable opaque beer are among the commercial products available in South Africa. The companies supply the sorghum malt for household uses and making of the traditional opaque beer for special festivals, weddings, and occasions. Beer powders containing pregelatinized maize grits, sorghum malt, and yeast are products that help in reducing the time for the preparation of traditional beverages. Estimations indicate that the volume of sorghum malt used for the home-based drinks is more than twice of the modern brewery. Opaque beer was the first product of the large-scale industrial processing of sorghum in Africa and currently is among the commercial beers in southern, central, and eastern Africa (Taylor, 2003; Waniska et al., 2016).

In Nigeria, policy instrument has induced a reduction of imports of malted barley, which then enhanced the opportunities for the domestically produced sorghum value chains. The products from the sorghum breweries include the lager beer, stout and non-alcoholic malt-based beer (Taylor et al., 2013; Rohrbach and Kiriwaggulu, 2007; Léder, 2004; INTSORMIL, 2008; Rohrbach, 2003). Drinks of malt and cocoa, powder-based drinks such as Milo, a Nestlé product are discussed. Similarly, sorghum becomes the best alternative crop in Uganda by replacing barley where the utilization of this crop is uneconomical (Taylor, 2003). The world-famous and Chinese Maotai and Fen liquors are sorghum-based products. For the growing beer industry, sorghum is a new potential and alternative substitute for barley or rice, which also derived more economic benefits (FAO, 2013).

Lots of opportunities are revealed for value creation in the agro-processing sector and deliver value-added sorghum products that could be served as manifold dishes, recipes, bakery products, noodles and pasta, extruded products, syrup (FAO, 2013; Ratnavathi and Patil, 2013). Existing literature also tells that in China, about 40 kinds of sorghum foods are widely known (FAO, 2013).

The utilization of sorghum for the purposes of manufacturing relief foods has been well recognized besides the commercial products. For instance, soy-fortified sorghum grits is a good alternative in emergency programs where populations are at risk for both protein and micronutrient deficiencies. The micronutrient enriched soy-fortified sorghum is 85% grain sorghum grits and 15% soybeans i.e., cracked, defatted, and roasted. The protein content of 100 gm of commodity sorghum grits, soy-fortified is 17.3% compared to 11.3% for commodity sorghum (Rooney et al., 2010).

3. Research Methods and Design

It is estimated that nearly 4.57 million smallholders situated in the eastern and northwest parts of the country are cultivating the sorghum crop (CSA, 2019). Looking at the geographical spread of production, the share becomes 39.9% for Oromia, 38.7% for Amhara, 11.8% for Tigray and 4.4% for the SNNPN region. This implies that the major sorghum producing regions, Oromia and Amhara accounting for nearly 80% of the total production. Specifically, the leading sorghum producing zones are East and West Hararge in Oromia and North Gondar and North Shoa in Amhara (Demeke and Di Marcantonio, 2013).

According to the Mistry of Industry and Oromia Region Industry Development Office, the agro-processing industries are clustering in the central part of the country, mainly in the capital city of Addis Ababa and vicinities. Addis Ababa, neighboring cities (Sebeta, Gelan, and Burayu), Bishoftu and Adama remain to be the prioritized hubs for industrial expansion in general. Such industrial concentration is obviously much linked to proximities to the final product markets, differences in infrastructural facilities and the relative institutional service qualities. However, the recent industrial parks development strategy more or less privileged the agroindustry input corridors. The National Growth and Development Plan (GTP-I) indicated that the establishment of industrial zones is the strategic direction taken to promote industrial development in different corners of the country.

Firm-level survey and desk research methods were involved for the purpose of grasping the competitiveness of sorghum in the agro-processing industry and concluding important strategies of change. Thus, the study involved the survey of the agro-processing businesses that are mainly engaged in the manufacturing of food, feed, and beverage products. The firms were further stratified into the categories of small, medium and large-scale on the grounds of the scale of operation as defined by the size of capital and the number of workers. The firms were contacted based on the information obtained from the Ministry of Industry, Addis Ababa City Small and Micro Enterprises Development Office and Oromia Region Industry Office. Besides, the snowball sampling technique was opted to

locate any firm that has been involved in sorghum value addition. Key informant interviews were held with the selected firms based on the pre-designed survey instrument. Data analysis is limited to simple descriptive and qualitative analysis due to the rareness of the study population (i.e., quite a few sorghum value-adding medium to large-scale firms were found).

4. Results and Discussion

4.1 Grain Supply and Food Market Channels

The Ethiopian Grain Trade Enterprise (EGTE) is found to be the major supplier of wheat for the agro-processing firms that 36.8% acquired the grain input through this channel. Due to the limited supply of wheat by smallholder farmers, domestic production could not fulfill the demand by the medium and large-scale processing firms. As a result, there is much relying on imports of wheat from abroad to come up with the existing supply gaps. For instance, in 2011/12, EGTE imported 750,000 MT of wheat mainly from Russia and Argentina, and 300,000 MT through food aid mainly from the United States (USDA, 2013). Until recently, it remained one of the major sectors where the government subsidy goes with the aspiration of protecting urban consumers. Much of the demand by the food industries will be met through this arrangement, apportioned on a quota basis by giving more privileges to specific product categories.

Next to EGTE, traders have the largest share in reaching the locally produced grain with a pie of 35.6%. The direct vertical coordination among farmers or farmer cooperatives and agro-industries is quite smaller. The supply of grain by the individual farmers or cooperatives comprises 2.9% and 7.3%, respectively. It is also observed that 6.5% of the firms get grains from their own farms and the situation often characterizes the feed milling industries. Industry-industry linkage as a source of secondary inputs is recognized for 10.9% of the firms.

The market channel through which the processed products and by-products delivered is dominated by traders, among which wholesalers are taking the largest 36.6% of the share. Industries involve multi-stages where the primary inputs undergo earlier stages of processing to be used for the subsequent production, and this comprised 26.7%. The direct linkage of the firms with that of consumers is found to be 11.3%. The UN organizations, such as the WFP and UNICEF also have roles that for 14.1% of the agro-processing firms, the supplementary food products are geared toward the victims through them. Public institutions are also the customers in purchasing the processed products (i.e., hotels and universities) make up about 11.4%.

4.2 Grain Utilization and Product Portfolio

The volume of utilization of a specific grain crop designates the extent of value addition prevalent within the agro-processing business and competitiveness of value chains. The result shows that wheat is the most commercial and popular grain for the agro-processing sector followed by maize in terms of both the number of firms and the total volume in demand. Accordingly, the leading grain inputs for the agro-processing firms include, wheat (60.0%), maize (26.7%), soya bean- (16.7%), and barely (6.7%). Soybean ranks third in terms of the number of firms that have utilized the crop but fourth when it comes to the total volume. Out of the total volume of barley in use, 82.6 percent is for that of malting purposes (Table 2).

Table 2. Grain inputs, value-added products, and volume of utilization (metric tons- MT) (N=60)

Grain Inputs	Value-added products	% of firms utilized the grain	Annual total grain utilized (MT)*	Grain allocation by the value-added product (MT)*
Wheat	Packed floor	60.0	1269367.2	1123360.0
	Bread			19361.9
	Snack foods			123141.5
	Baby food			3392.0
	Relief and health food			94.5
	Injera[1]			7.3
	Feed			10.0
Maize	Relief and health food	26.7	86350.2	64290.0
	Injera			60.2
	Feed (dairy, poultry, beef)			22000.0
Barley	Bread	6.7	43629.8	3600.0
	Snack foods			20.0
	Baby food			9.8
	Malt			40000.0
Soybean	Snack foods	16.7	30900.4	0.2
	Relief and health food (CSB)[2]			20534.0
	Feed			10366.2
Teff	Packed floor	16.7	3787.5	2520.0
	Injera			1267.5
Sorghum	Feed	6.7	22.7	8.9
	Injera			13.8
Rice	Injera	6.7	87.2	87.2
Peanut	Relief and health food	1.7	1800.0	1800.0
Chick pea	Baby food	3.3	27.6	8.6
	Relief and health food			19.0
Haricot bean	Feed	1.7	8.2	8.2
Barley-malt	Beer, draft beer and non-alcoholic Malta drinks	3.3	44900.0	44900.0
Spent grain	Feed	6.7	3226.9	3226.9
Byproducts	Feed	11.7	28468.0	28468.0

* *Grain utilizations are estimated from the firm-level survey*

There is growing commercialization of the wheat and malt barley crops where the domestic supply could be able to exploit the underlying opportunities in the agro-processing sector. Exceptionally, the potentials of the wheat and barley malt are not the sole representation of the internal agrifood value chain because of the fact that the agro-industries access a portion of these inputs from international markets. To close the supply gaps, the government would like to redirect the attention to irrigated and commercial wheat production farms in the widely uncultivated lowlands of the country. For that of malt barley, promotion of partnerships among breweries and farmers for improving the access to seeds of preferred malting-quality varieties and market contracting is the progress

[1] Thin bread prepared locally from *teff* floor after fermentation with yeast.
[2] CSB represents Corn-Soya-Blended food targeted for overcoming nutritional problems and health risks

underway. The issues of complying with the grain quality and mixtures are the challenges for effective coordination in the farmer-brewery model.

Wheat grain is predominantly used for the production of packed flour, bread, biscuits, and other snack foods. There is a huge dependence on wheat for the manufacturing of most commercial food products. The utilization of maize by the large-scale commercial food processors is limited but it is often processed to feeds, relief foods, and *enjera*. The largest share of maize utilization allocates to the feeds and relief foods manufacturing. The blending of the maize and soya floor is common practice with the relief food programs. Maize value addition for the commercial products of packed floor, snacks, bread and baby foods is uncommon.

Teff, rice, and sorghum were utilized majorly for *enjera* making by the small-scale firms. One medium-sized processor, which is located in Addis Ababa has commercialized the *teff* grain into packed *teff* flour while on the rest, the potential uses of the grain are limited to the small-scale firms and less diversified products. Food barley is also found to be converted to baby foods, bread, and snack foods. Barley-based malt is the most preferred and popular ingredient for the Ethiopian breweries. Soya bean and spent grains are devoted to the manufacturing of various feed products. Spent grain is a by-product after the brewery process (Adugna et al., 2012) and includes the husk of malt barley, pericarp, and endosperm (Öztürk et al., 2002).

The utilization of maize grain is estimated to be 3867 metric tons for the medium and large-sized firms while it is estimated at 5.6 metric tons of the total volume for the small-sized firms. Taking the case of sorghum, just two feed manufacturers within the medium and large-scale category are found in converting the grain into animal feed products. It indicates that the utilization of sorghum by large and medium-sized firms is negligible. In total, only about 22.7 metric tons of sorghum grain is being utilized including the small-scale firms. Blended with *teff*, the higher volume of sorghum is traditionally utilized for making *enjera* by the small-sized agribusiness firms. Rice is becoming popular for making *enjera* nowadays as the mixture enhances the preferred color of the product. It is observed that even more rice of about 87.2 metric tons is used in comparison where both are mixed with the *teff* flour. The evidence demonstrates that sorghum remains the most traditional crop among cereals with limited value creation practices and insignificant industrial alternative uses. Sorghum-based products, such as snack foods, cakes, bread, packed floor, relief foods, and beer are totally unaccustomed in Ethiopia.

4.3 Food Products

When it comes to the manufactured and delivered products, commercial foods, such as packed floor and snacks foods remain to be the dominant ones. The snack foods category includes different processed types of creamy, dry, and flavored biscuits, and sweet cakes. Shoa Bakery and Floor is the first agro-processor that commercialized the barley floor at a larger scale and promoted barley- bread. New snack food products have already been delivered and Faffa Foods is the first company that introduced specialized snack food products such as corn flakes and ball snacks. The products from baby food manufacturing include *Serifam, Faffa, Dube Duket* and Barley Mix (fortified foods), *Abay* Milk and Soya Milk. The company also manufactures diversified and fortified products with the utilization of maize, chickpea, barley, oats, and soybean. Despite the recent emergence of many manufacturers, the baby food-processing sector is underdeveloped and there is much dependence on imported products (Table 3).

Table 3. Value-added products and annual quantity of productions

Product Type	Annual production (MT)	Percent of firms (N=60)
Commercial floor	216,000	38.3
Snack foods	35,000	23.3
Bread	14,000	15.0
Baby food	13,800	1.7
Relief and health food	68,300	10.0
Enjera	12,200	16.7
Malt	35,558	1.7
Byproducts and feed	94,500	61.7
Beer[3]	1,611,000	3.3

** Estimated from the firm-level survey*

The relief food (aid food) and health food products are aimed to serve vulnerable people who are victims of food shortages, drought, and migration. Faffa foods, Nourish Business and SHS Floor are the major processors engaged in the manufacturing of large quantity relief foods, respectively. The relief food manufacturers deliver products such as maize flour, soya bean floor and fortified food- *Famix* (CSB). The company named Hilina Enriched Foods P.L.C manufactures *Plumpy* Nut in its Amharic name, "*Nefis Aden*" or "life saver" which is mainly devoted to children under sever mal-nutrition. Supplementary *Plumpy* Nut and Peanut Butter are other products that targeted both children and pregnant women. The products are directly supplied to the World Food Program (WFP) and United Nations International Children's Emergency Fund (UNICEF).

4.4 Feed Products

The introduction of modern feed resources and intensive feeding practices do provide good opportunities for the urban and semi-urban enterprises that are engaged in productions of poultry, dairy, and beef. According to the information from the Ethiopian Feed Association (EFA), the major feed manufacturers are concentrated in the central part of the country. There are twenty feed processors that are members of the feed association. The feed millers or mixers reported that the small-scale farmers do not have the interest to buy manufactured feed products. The potential markets for them are businesses that are engaged in fattening, dairy, poultry production and pig in some cases.

The increasing price of the feed ingredients and depreciation of exchange rates on imported inputs becomes a huge obstacle for the feed processors. It is apparent that it raises the cost of production for the processors and eventually skyrockets the price of feed on the market. Most of the poultry producers and fattening firms less encouraged as it becomes less profitable for them (Adugna et al., 2012). Hence, many of urban and peri-urban dairy and fattening farmers rely on factory by-products as manufactured feed gets much unaffordable. The most commonly marketed agro-industrial by-products include wheat bran, wheat middling, and the seed cakes of linseed, cotton, and *noug* as spinoffs from food manufacturing. Wheat bran is supplied as fine, coarse, and mixed types (Gebremedhin et al., 2009). The by-products used for feeding purposes contain the remains of husk and fined endosperm after food processing (Adugna et al., 2012). Cognizant of the pertinent problems, poor livestock feeding practices, and low farm productivities, exemption from the import tax levy specifically to the feed-related ingredients is the remarkable policy intervention that has taken place very recently during this year.

The survey of the feed mixers and millers indicates that feed of poultry, dairy, and beef, respectively are the major products in terms of volume of production. Alema Koudijs located in Debrezeit (Bishoftu) is the leading

[3] With an exception to beer, the unit used for the annual production is hectoliter. One hectoliter is equivalent to 100 liters.

manufacturer of a range of animal feeds including for pigs. Kaliti Animal Feed Enterprise (established in 1978) and Akaki Animal Feed (established in 1980) are the oldest feed industries located in Addis Ababa. Despite constrained by the availability and the higher price of sorghum, Akaki Animal Feed Enterprise has got long-established experience in the utilization of sorghum and manufacturing of feed products. Currently, the firm has abandoned sorghum due to the aforementioned problems. The sorghum surplus producing areas are far located from Addis Ababa and inefficient marketing system less favors sorghum to compete with the maize grain, which could be sufficiently available in the central market.

4.5 Beverage Products

The Heineken Group and *Brasseries et Glacières Internationales* (BGI Ethiopia) are the two international brewery industries consulted on the potential utilization of sorghum. In Africa, the Dutch originated Heineken Beer also operates in Nigeria and the experience tells that the crop is a good alternative for the industry. Alcoholic beer, other alcohols, non-alcoholic drinks (Malta), commercial malt, and beer powder are among the potential uses for the beverage products. Ipso facto, malt is the main ingredient in this respect that it is the major raw material (about 90% of the total raw material cost) for beer production (USDA, 2013). Besides preference by consumers, the utilization of sorghum by the beverage industries depends on the availability of sorghum-malt. Nevertheless, the malting industry in Ethiopia solely utilizes the barley grain, which is potentially available in the vicinity of the plants. The actual practice tells that sorghum is neither an alternative crop for both of the breweries and the malting industry in Ethiopia.

4.6 Malt Products

A single government-owned malting factory remained to be the only supplier of the product for many years; however, very recently another industry has emerged in North Ethiopia. A Belgian company named as, Boortmalt, is a new firm that is involved in industrial malting around the Debrebirhan city. The report of the Ministry of Agriculture indicates that only about 40 percent of the domestic demand for malt has been fulfilled with the local processing firm, Asella Malt Factory. According to (USDA, 2013), the total estimated demand for malt barley in 2012/13 was 72,000 tons of which only 35 percent can be supplied by the local barley farms. The remaining amount of malt barley is imported from Belgium and France. During the survey, the two interviewed breweries also indicated that they imported 44,900 metric tons of malt from Germany, France, and Belgium.

4.7 Awareness and Product Development

The level of awareness and the innovation tendency of the agro-processing firms significantly determine product diversification and attempts of testing of sorghum-based products. Based on the existing experiences, different potential sorghum products were listed and the key informants indicated their awareness and perceptions. On the food category (packed floor, bread, snake foods, baby food, sweetener), the beverage uses (commercial malt, beer powder, alcoholic beer, non-alcoholic Malta drinks), and feed types (dairy, poultry feeds, fattening) were included. As shown, 33% of the agro-processors are not aware of any food recipe that could be manufactured from the sorghum grain. Similarly, general awareness seems to be the worst for the beverage and feed products (Table 4).

Table 4. Awareness of the firms towards the alternative uses of sorghum

Products	No product	One product	Two or more products
Foods	33.33	35.00	31.67
Beverages	68.34	18.33	13.33
Feeds	48.33	40.00	11.67

** Awareness evaluated using firm survey*

It is generally observed that ‘‘business as usual’’ is the best strategy in the infant agro-processing segment with little emphasis on research and product development on the basis of the loop of feedback. The firms that conducted a feasibility study on sorghum prototype products are only 6.7% while on the other side, those who did a market test are about 11.7%. It is also true that among the firms that conducted market tests, 85.5% are successful on the market. Even though the attempts are not very ample, there is no such high risk of market failure or lack of demand for the products they have delivered provided that sufficient testing is performed. Accordingly, the food and feed

manufacturing businesses are the potential areas for sorghum value addition. As constrained by other factors, most of the firms are not using currently, except for the feed milling industry.

4.8 SWOT Analysis

The SWOT analysis helps to understand the internal and external forces that determine the value creation process. It enables us to examine the most important limitations in the utilization of the grain and underlying opportunities to be exploited further. This serves as a road mapping means of designing the required and key sorghum value chain interventions from the varietal development to demand creation stages. In consultation with the experts in the food, feed, and beer industries, the major constraints, opportunities, strengths, and weaknesses are identified (Table 5).

Table 5. SWOT Analysis Matrix

Strength	**Weakness**
• Good for health (diabetics) in contrast to higher sugar grains (e.g., bread wheat) • Blended products • Potential for fortified foods and nutrition intervention • Experience and potential for baby foods • Be used for traditional foods and drinks • Sweet sorghum for snack foods • Experience in feed milling • Drought tolerance	• Limited awareness of sorghum products • Lack of experience in processing technique • The need for separate machines and difficulty of processing • The short shelf life of the grain • The short shelf life of *enjera* (drying problem) • Nutritional and physical qualities for bread and other products • Less preferred taste, color, and flavor for biscuits and bread (compared to wheat) • Lack of grain for specific product and variety
Opportunities	**Threats**
• Conducive for growing diverse grains • Develop products for a specific market niche • Utilizations for relief foods • Shortage of wheat and teff crops • Increased demand for baby food • Emerging demand for feed and lower price of biomass (fodder) • Shortage of feed material • Growing brewery industries	• Limited testing and uncertain market demand • Risk of loss and profitability problem • Lack of technical support on processing • Shortage and inconsistency of supply • Availability problem of other ingredients • Consumers perception (culture) and preference • Inadequate know-how on food values • Lower demand for sorghum beer • The high price of sorghum (central market)

4.8.1 Strengths

There is a possibility to exploit the sorghum grain for industrial processing through augmenting the physical characteristics of the product (i.e., appearance, taste, color, and flavor) and the nutritional values. The products could be further enriched by blending with the well-accustomed grains and food innovation that advances the less desirable attributes. Wheat-blended sorghum products, such as bread and snack foods are mentioned to be potential deliverables to the market. The sweet sorghum varieties could best serve for manufacturing of snacks and cakes. The sorghum grain has got merits of utilizations for better health in contrast to grains with a higher composition of sugar, for example, bread wheat. For the reason, sorghum will be more preferable particularly for diabetic people. There is an option to utilize sorghum for baby food and feed product manufacturing as the experience indicates. The packed floor of sorghum could be targeted for fermented and homemade traditional drinks, bread, and porridge. Sorghum is also a good alternative for the formulation of fortified food products.

4.8.2 Weaknesses

The agro-processing firms themselves have limited awareness about the alternative uses of sorghum. Lack of technical skills and experience on sorghum value creation are among the weaknesses mentioned. Different grain inputs require separate machines and techniques so that there will be a need for plant expansion and extra investment. The grain relatively has got shorter shelf life since sorghum could easily be damaged by storage pests.

Besides, sorghum products may receive less preference and be less competent in terms of taste, flavor, and color. Besides, sorghum-based bread, cake, and *enjera* will dry soon and palatability will be affected.

The processing firms raised concerns about the intrinsic characteristics of the grain, much allied with the nutritional features where sorghum will be less competitive for the manufacturing of standalone products. Similarly, the gluten content often enhances the bread-making quality and the low gluten composition of sorghum affects the intrinsic characteristics, such as flavor, texture, and color of the products. Furthermore, the availability of grain that meets specific qualities and lack of varieties that are suitable for specific purposes also determine product development process and acceptability by consumers.

4.8.3 Opportunities

Sorghum is produced in different parts of the country and suitability for diverse grain types gives the chances of fulfilling the needs of the agro-processors and consumers. There is the opportunity to develop sorghum products for specific market niche (e.g., low-income groups, peoples already consuming the crops and diabetic peoples). Targeting and testing of potential markets ascertain the likely acceptance for the new products. Sorghum products could further be utilized for making traditional foods and drinks, such as *tella, arekie,* and porridge. Partial processing reduces the burden and time spent on household food preparation so that it will be compatible with the modern way of living. The lower price of sorghum offers an opportunity to utilize for teff blended *enjera* and wheat-based products. Nowadays, the market is in short of wheat and teff supplies, the situation triggers the adoption of different alternatives.

The other potential of sorghum is for the manufacturing of relief foods, for instance, a Sorghum-Soya-Blended (SSB) product could be delivered. This draws the attention of nutrition intervention programs to consider sorghum as an alternative mix. The brewery industry is growing fast, however, due to high preference for barley, the opportunities could be partial uses, such as adjunct sorghum. The demand for feed products is also rising particularly in the urban centers, this gives the chance of utilization of sorghum.

4.8.4 Threats

In dealing with sorghum products, poor consumer taste and perceptions about the new products remain to be the major barrier as foresighted by the agro-processing firms. This is explained by the culture, reputations and inadequate consumer knowledge on food values of sorghum. With limited efforts of research and product development experience, most of the firms are uncertain about the demand and later on the return from such an investment. Until now, products are also not well promoted to consumers in order to evaluate and make decisions to utilize or not. Even when the agro-processors would like to use sorghum particularly for the manufacturing of feeds, the supply is not consistent and much reliable. The supply shortage in the central part of the country arises due to the reasons of drought risks and market constraints.

According to the feedback from the beer industry, there is an untapped potential of malt barley in Ethiopia. Despite the high potential for the production of malt barley, a large amount of the malt product is imported from abroad. There is a good opportunity for malt barley value chain since the increasing number of beer factories nowadays are interested to support and focus in this direction. The aid-to-trade paradigm of the innovative development approach enrooted within the strategies of the NGOs necessitated the subcontracting of value chain activities (Abera et al., 2018). The contract farming model of the giant Heineken beer and the barley farmers positively impacted the access to improved seeds, price premiums, and income of the farmers.

Barley is the most preferable grain in Ethiopia among cereals that could be utilized by breweries, such as rice, maize, and sorghum. Apparently, the breweries are afraid that there will be less acceptance for sorghum-based beer in contrast to the barley products. As the experience in the beer industry verifies, what befell the new brand beer was a loss of market due to the fact that consumers have less preference for the maize-based beer products. The industries have the same expectations on the fate of the brewed-sorghum products.

The agro-processing businesses have a concern that the higher price of sorghum will be the major barrier for its utilization, particularly for the feed products. Processing of sorghum for feed purposes could be the better opportunity provided that the price situation and availability in the non-producing industrial hubs become more encouraging. Furthermore, access to the processing techniques and related ingredients are questionable due to unfamiliarity with the practice.

5. Conclusions

Smallholder sorghum production in Ethiopia is described by the high dependence on the landrace varieties, limited commercialization and weak value chains due to lack of value addition opportunities. A number of factors do interact and influence the production, consumption, and marketing behavior of the farmers. Enhancing the productivity of sorghum to meet the increasing demand for food and building the resilience of the farmers in response to the negative impacts of climate change are the challenges ahead. For this, pursuing the opportunities of the agro-processing uses of sorghum and improving smallholder farmers' access to remunerative markets dictates back farm productions. The complexity of the agrifood system due to the interrelated challenges necessitate holistic value chain development for the sorghum commodity and remains to be an important intervention that requires synergetic efforts to be pledged. The major concern for the agro-processing businesses is the issue of the market as there is no sufficient experience, research, and testing so that the investors prefer to avert the probable risks. Business as usual trend strongly limits the notion of understanding consumer perceptions, prototype development, and food innovation. This is partly explained by the undeveloped stage of the agro-processing industry in general and that of the consumption habits towards the industrial products. Despite emerging consumption shifts due to the push-pull impacts of globalization, the traditional way of food processing is overriding in any of the diets. It further hinders the innovation endeavors of the industries and they prefer to stick to well-known products or markets.

Based on the actual circumstances in Ethiopia, empirical investigation on the nutrition aspects, consumer perceptions, and product development are important areas of value chain interventions. Likewise, the development of food recipes and beverages for the specific market niches on the arena of societal cultures, income status, and population group is pinpointed. The intrinsic product attributes such as gluten composition, indigestibility problem, texture, flavor, and color could be identified and improved through blending and food fortification. Furthermore, the need for quality-based research and targeting of crop varietal developments for meeting the specific product attribute is the issue to be considered. The sorghum surplus producing areas are far located from the agro-processing center, which results in a high price gap between the markets. Switching in the current value creation scenario requires improving the marketing system, facilitation of partnerships among farmers and industry and policy support to the agro-processing industries, such as tax incentives on imported inputs and machines. Enhancing farm productivity and the marketable surplus to come up with the inconsistency of supply is crucial for the sustained competitiveness in the agrifood system.

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About the Authors

Exploration and development of improved market strategies for improving the adoption of technologies is among the intents of the project, Harnessing Opportunities for Productivity Enhancement (HOPE) in sub-Saharan Africa and South Asia. The authors are researchers in the Agricultural Economics Division at Melkassa Agricultural Research Center and they executed the assessment work within the realm of this component. The first author pursued his MSc study and specialization in Development Economics. The second author had a specialization in Environmental Economics and Natural Resources. Both of the authors pursued their postgraduate studies at Wageningen University of The Netherlands. Currently, the authors are involved in the research themes of the value chain and market analysis, agricultural technology adoption, impact evaluations, production economics (farm power and production efficiency).

Public Interest Statement

The low level of adoptions of the released short maturing and drought-tolerant modern varieties remained a long worry that compels the proposition of strategic mechanisms for changing the status quo. Studies revealed that sorghum is the least commercialized commodity whereas substantial resources have been devoted to the production of the crop. Research and development actors often have a keen interest in value chain development and intervene in the introduction of innovative sorghum products spotlighting on the competitiveness of sorghum. The issue is about the understanding of producers' choices, the supply side hiccups, and foresight for uncovering the black box of consumer behavior. Thus, the assessment study sheds light on the extent of sorghum value addition, constraints and the required redressing measures by the public and private actors.