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Analysis of the Yellow Bean Corridor in Tanzania

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Cover page photo credit: Noel Templer, Alliance-PABRA

Feed the Future Consortium Partners in the Feed the Future Global Supporting Seed Systems for Development activity:

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List of Acronyms

ASDP	Agriculture Sector Development Plan of Tanzania
AVISA	Accelerated Varietal Improvement and Seed Delivery of Legumes and Cereals in Africa
BHA	Bureau for Humanitarian Assistance
BMGF	Bill and Melinda Gates Foundation
BRFS	Bureau of Resilience and Food Security
CRS	Catholic Relief Services
DAPC	Discriminatory Analysis of Principal Components
DNA	Deoxyribonucleic acid
GAC	Global Affairs Canada
IBPMA	Improving Bean Production & Marketing in Africa
MAF	Minimum Allele Frequency
MoA	Ministry of Agriculture
MT	Metric Tonne
NARS	National Agricultural Research Systems
OFDA	Office of Foreign Disaster Assistance
PABRA	Pan-Africa Bean Research Alliance
PCA	Principal Component Analysis
PCoA	Principal Coordinates Analysis
QC	Quality Control
QDS	Quality Declared Seed
SDC	Swiss Agency for Development and Cooperation
SNP	Single Nucleotide Polymorphism
S34D	Supporting Seed Systems for Development
TARI	Tanzania Agricultural Research Institute
The Alliance	The Alliance of Bioversity International and CIAT
TOSCI	Tanzania Official Seed Certification Institute
TZS	Tanzanian Shilling

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EXECUTIVE SUMMARY

Common bean (*Phaseolus vulgaris*) plays a key role in the livelihoods of smallholder farmers in Tanzania as a food and nutrition security crop and a source of income for producers. It is the leading leguminous crop, accounting for 78% of cultivated legumes, while over 75% of rural households in Tanzania depend on beans for daily subsistence. Per capita bean consumption is estimated at 19.3 kg per person per year. With its estimated 1.2 million MT produced per year (2018), Tanzania is the top bean producer in Africa and seventh globally. More than a quarter of Tanzania's beans are exported to neighboring countries and beyond.

One of the most traded bean types is the yellow and its variants. However, there is limited information on its production and trade with potential implications on seed systems and other possible investments. Using the bean corridor framework of the Pan-Africa Bean Research Alliance (PABRA), the Alliance of Bioversity International and International Centre for Tropical Agriculture (the Alliance) in collaboration with Tanzania Agricultural Research Institute (TARI) and Catholic Relief Services (CRS), conducted a survey of the yellow bean value chain in Tanzania from July-August 2019 under the Feed the Future Global Supporting Seed Systems Development activity (S34D). CRS leads a consortium implementing S34D, a five-year Leader with Associates (LWA) Cooperative Agreement award, funded by the Feed the Future Initiative through the Bureau of Resilience and Food Security (RFS) and by USAID through the Bureau for Humanitarian Assistance (BHA).

The objective of the survey was to characterize and explore trade of yellow bean grain and potential seed. The survey collected data and grain samples from 298 grain traders (including wholesalers, exporters, aggregators, and retailers) and 64 potential seed traders (large and retail traders) from 12 regions across four administrative zones in Tanzania (Figure 1). The grain samples collected were for DNA analyses. Results show existence of an established yellow bean corridor across Tanzania and the region at large (Burundi, DRC, Kenya, Rwanda, Uganda, Zambia) and demonstrated a huge market pull in the Eastern and Southern Africa regions. There are also strong perceptions on the organoleptic quality of various yellow bean grains and varieties that are traced to their sources.

Yellow bean varieties are diverse and vary across the production hubs in the country, and this diversity is highest in the West (Kigoma) of the country. Moreover, the differentiated prices of these various grain qualities linked to varieties and sources further reflected differentiated products and responsive market demand. The Dar es Salaam and other markets preferred a yellow bean variety that is relatively large and round (referred to as '*Gololi,'* meaning round in shape). This is one of the released varieties that is known as *Selian 13*. Yellow beans from the Northern Zone and Tanga region are considered superior quality while those from Kagera are considered as low quality beans by market standards in Dar es Salaam. For that reason, no trader preferred selling mixed beans; rather, single varieties were mostly preferred as they fetched higher prices.

Sustaining supply of high-quality planting material is critical for the success of the yellow bean corridor. The seed supply system for the yellow bean corridor is largely informal, managed by grain traders, and is quite vibrant. These traders also double as seed suppliers and use numerous seed management techniques to improve the seed supply in the corridor.

DNA analysis/fingerprinting of the sub-sample of the traded yellow bean varieties show that traders were engaged in various yellow bean varieties that include landraces and improved varieties. A key result from the DNA analysis shows that about 50% of the traded varieties had been officially released in Tanzania (*Selian 13, Uyole 16,* and *Uyole 98*). The rest were either derived from neighboring countries or could not be clustered. In addition, the most traded varieties were also of the released types. Despite the diversity in yellow beans, there are clear preferences for particular varieties by traders and consumers.

According to traders, the peak selling periods (September to December) coincide with planting periods for beans when prices are also highest. The increased demand stems from use of the grains as planting materials. More than 50% of the traders reported being actively involved in selling grain used by farmers for planting. Women dominate the retail trade in the yellow bean, while men dominate export and aggregation businesses. Women sold closer to home within the district and mainly sourced grain close to their localities, while men tended to source and sell in distant regions or regional markets.

Additionally, discoloration of some of the beans when stored for longer periods posed a significant challenge to traders because beans which retained original color were preferred. Other key constraints are related to market organization and trade levies when moving grain internally from one district to another. Traceability in the yellow bean corridor is necessary, especially for potential seed supply but also for closer linkages between aggregators and grain producers — most — m traders expressed interest for support in this area as part of yellow bean corridor strengthening in Tanzania. Digital payment solutions via the system of aggregators is one such possibility to support the development of the value chains. Discussions have been initiated with some of the aggregators in Kagera and Kigoma regions to support the closer linkages. Even though the market pull for yellow varieties is strong, traders indicated inadequate supply to meet their demands.

Released varieties need to be disseminated through an efficient public-private partnerships based on the bean business platforms which bring together actors in value chain to reflect on and address constraints affecting the value chain. In addition, enablers of the policy environment, management and business training and support to traders, and enhancing the quality of the seeds in the current informal seed system in the wider yellow bean corridor are also areas that can substantially improve yellow bean supply in Tanzania.

1. INTRODUCTION

1.1. Importance of Common beans in Tanzania

The common bean (*Phaseolus vulgaris* L.) is an important legume produced and consumed worldwide for its edible grains and pods. Bean is a staple food in in Tanzania whose per capita consumption is about 19.3kg per person per year. Tanzania ranks 1st and 7th in Africa and globally, in common bean production respectively,.[1] Common beans provide dietary protein for over 200 million people in Africa, especially women and children living in rural areas and poorer urban communities. Beans and bean-based products are vital to livelihoods, delivering a range of benefits. These include inclusive economic growth through equitable wealth creation, women's empowerment, employment along the value chain (especially for youth), nutritional[2] benefits (especially for women of reproductive age and children) and health benefits. Further, beans contribute to sustainable agricultural systems, industrialization (i.e., to develop value added products like canning) and balance of payment through export earnings (i.e., expanding products for export markets). Common beans from Tanzania are for both domestic consumption and export to several neighbouring countries and beyond, particularly Burundi, DRC, Kenya, Malawi Rwanda, South Africa, Uganda and Zambia. Within Tanzania, 1.2 million hectares of beans are cultivated annually. The production is mainly by small-scale farmers of less than 2 hectares. Beans account for about 80% of total pulses produced in Tanzania. The production zones include Southern Highland Zone (Iringa, Mbeya, Rukwa, and Ruvuma regions), Western Zone (Kigoma region), Lake Zone (Kagera region) and Northern Zone (Arusha, Kilimanjaro, Manyara and Tanga regions).

1.2. The Bean Corridors

PABRA developed the commodity corridors[3] concept to intensify bean production, distribution and marketing and consumption activities (PABRA 2017). The corridor model aims to unclog production bottlenecks including access to quality seed of consumer demanded varieties and ultimately to satisfy the consumer demand. This model defines three hubs[4] in the bean value chain—production, distribution and consumption.

PABRA has defined nine bean corridors across Africa, based on major driving bean types. One of the bean types is the yellow bean that drives the yellow bean corridor, which is the focus of this study. Other bean corridors are illustrated in PABRA, 2017. The current study focuses on the trade flows of yellow bean varieties in Eastern Africa, with empirical evidence from Tanzania in order to identify opportunities to improve the 'yellow bean flow' and the corresponding influence on the seed sector.

[1] Although largely grown for subsistence, approximately 40% of production is marketed. Common beans contribute about 62% of all Tanzanian legume exports (the most exported Tanzania legume).

[2] Mineral elements are critical to the women and children in this category (e.g. iron and zinc).

[3] The corridors are based on PABRA's assessment of the bean trade in Africa, which has revealed major flows of the crop between areas of production and consumption, connected by distribution networks.

[4] **Production hubs** comprise the major bean production areas within the corridor, characterized by marketable volumes of produce. **Consumption hubs** comprise major market outlets and or processing units. They include open markets, supermarkets, bean processors that source from the relevant production hubs all linked to large pools of consumers in and out of a country. **Distribution hubs** connect production and consumption hubs. They comprise of product distribution centers, aggregation centers, warehouses and storage points, commodity exchanges and transportation.

2. STUDY METHODOLOGY

The purpose of the study is to use survey data from Tanzania to:

a. Characterize the yellow bean corridor;
b. Understand the distinct markets and flows of yellow bean grain and seed;
c. Show position of released varieties in the market;
d. Assess demand for yellow beans, and;
e. Guide public and private investments in the yellow and other bean corridors.

The study provides data and evidence on movements and flows of yellow bean grain and its connection with flow of 'potential seed' in Tanzania and the region at large. The study findings increase the understanding of the interface between bean grain trade and dissemination of potential seed. The study also sheds light on how to enhance quality in the informal seed sector as well as variety access in remote areas. Overall, the study establishes the contribution of informal seed systems to the yellow bean corridor in the country.

2.1. Yellow Bean Corridor Study Design

Under the PABRA framework, the Alliance in partnership with the Tanzania Agricultural Research Institute (TARI) conducted the yellow bean study which was supported by various PABRA projects mainly the Feed the Future S34D activity. Other contributing PABRA projects included Swiss Agency for Development and Cooperation (SDC) supported project, Improving Bean Production and Marketing in Africa (IBPMA) supported by the Global Affairs Canada (GAC), and Accelerated Varietal Improvement and Seed Delivery of Legumes and Cereals in Africa (AVISA) supported by the Bill and Melinda Gates Foundation (BMGF).

The major production hubs surveyed were Northern Zone (Arusha, Kilimanjaro and Manyara), Lake Zone (Kagera), Western Zone (Kigoma), and the Southern Highlands (Iringa, Mbeya, Njombe, Sumbawanga and Songwe). The major markets or consumption hubs evaluated included Arusha, Dar es Salaam and Shinyanga. The distribution hubs were mainly Kagera (Uganda border), Arusha/Kilimanjaro regions to Kenya and Tunduma en-route to DRC and Zambia. In the Northern zone, the hubs combine production, distribution and consumption.

Traders involved in both grain and potential seed (collectors, wholesalers and retailers) were interviewed in the survey conducted between July and August 2019. Identification of traders was by a listing of the traders in the districts of the target regions. The lists were acquired from market authorities in the survey locations (Figure 1). The report thus draws insights from a data set of 298 traders distributed according to age and sex. Women traders represented 41% of the sample, and about two-thirds of the traders were less than 45 years old (

Table 1).

Figure 1: Yellow bean Survey locations in Tanzania

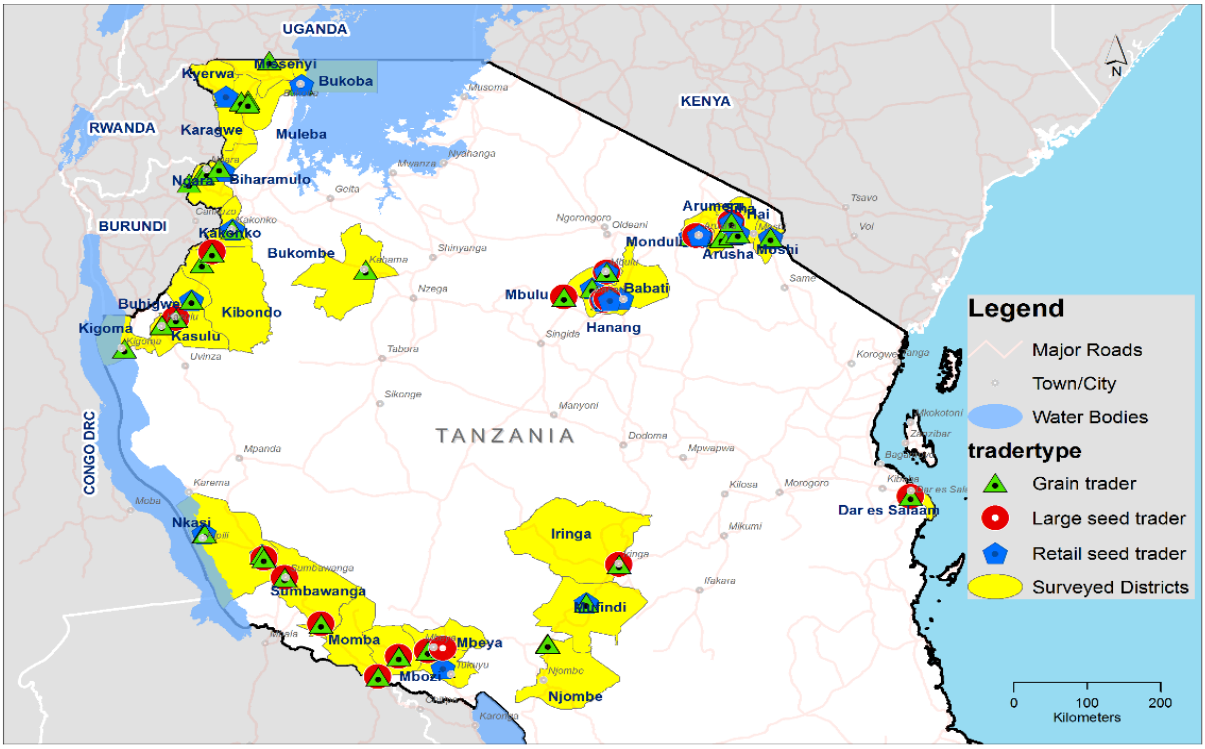


Table 1: Distribution of sampled yellow bean traders by age and sex.

Age	Female % (n=123)	Male % (n=175)	Total % (n=298)	Cumulative %
15 to 29	9.76	13.14	11.74	11.74
30 to 45	45.53	50.86	48.66	60.4
46 to 65	42.28	34.86	37.92	98.32
>66	2.44	1.14	1.68	100
Overall	41	59	100	

2.2. Yellow Bean Varieties Surveyed

The number of yellow bean variety observations[5] from the 298 traders were 444 (Table 2). 349 of 444 samples were collected for DNA analysis. The release status is also shown. The number of yellow bean varieties traded per trader ranged from one to four.

Selian 13 was the most traded yellow bean variety and comprised of 35% of varietal observations. *Uyole 16* (11%) followed this among released varieties. Other varieties that had at least 10% of the trade include *Njano Gololi* (10%). The rest were not clustered, or their release status was unknown.

[5] Each observation represents a separate variety, and thus a single trader could have multiple observations.

Table 2: Distribution among yellow bean varieties based on DNA identification

Variety	Year of formal release	Released	Non-released in Tanzania	Non-released	Not specified	Total	Key identifier
Selian 13	2018	153	0	0	0	153 (34.5%)	Medium, round oval, brown hilum
Uyole 16	2016	48	0	0	0	48 (10.8%)	Large Elongate, round, Brown hilum
Njano Gololi (Masindi yellow)		0	45	0	0	45 (10.1%)	Medium, Round oval, Brown hilum
Njano Uyole/ Uyole 98	2008/ 1998	16	0	0	0	16 (3.6%)	Large, Elongate, round
MOORE 88002		0	23	0	0	23 (5.2%)	Medium, Round oval, Brown hilum
Non-clustered		0	0	64	0	64 (14.4%)	
DNA not available		0	0	0	95	95 (21.4%)	
Total		217	68	64	95	444 (100%)	

Among the aforementioned varieties, formal releases were only *Selian 13, Uyole 16*, *Njano Uyole* and *Uyole 98*. All others are local varieties driven by local preferences and/or derived from neighboring countries. Figure 2 gives a snapshot of the variants of the yellow beans.

Figure 2: Snapshot of different variants of yellow bean

2.3. Locations of the Corridor Hubs

The survey focused on major production, distribution and consumption hubs of the Tanzanian yellow bean corridor. The major production hubs surveyed were in the Northern Zone (Arusha, Kilimanjaro, and Manyara), Lake Zone (Kagera), Western Zone (Kigoma), and the Southern Highlands (Mbeya, Iringa, Njombe, Songwe, and Sumbawanga). The major markets (consumption hubs) assessed included Arusha, Dar es Salaam, Geita and Shinyanga. Some distribution hubs were located in the production hubs such as Kagera (Uganda border), Arusha/Kilimanjaro regions to Kenya and Tunduma en-route to DRC and Zambia (details in

Table 3).

Table 3: Distribution of yellow bean traders and transactions in the hubs (by region)

Region	Number of traders	Number of bean observations
Dar es Salaam	38	47
Kagera	30	58
Geita/Shinyanga	10	22
Arusha	38	47
Kilimanjaro	31	45
Manyara	26	34
Iringa	18	20
Mbeya	22	34
Njombe	6	13
Rukwa	29	43
Songwe	14	33
Kigoma	36	48
Total	298	444

2.4. Types of Bean Trading Businesses

The majority of surveyed businesses were retail and wholesale. About 7575% of female traders were engaged in retail business, compared to 45% for male traders. On the other hand, 35% of females were involved in wholesale business compared to 57% of male traders (see Table 4). This is indicative of more women participating in smaller retailer businesses, while men are more focused on the larger wholesale trade (chi=42.35; p=0.000).

Table 4: Type of bean trade *businesses.*

	Females			Males			Total		
	Number of responses	**% of responses**	**% of female traders**	**Number of responses**	**% of responses**	**% of males traders**	**Number of responses**	**% of responses**	**% of traders**
Retailer	92	56.4	74.8	78	31.6	44.6	170	41.5	57.1
Collector/aggregator/broker	22	13.5	17.9	52	21.1	29.7	74	18.1	24.8
Wholesaler	43	26.4	35.0	99	40.1	56.6	142	34.6	47.7
Producer-trader	5	3.1	4.1	15	6.1	8.6	20	4.9	6.7
Exporter	0	0.0	0.0	2	0.8	1.1	2	0.5	0.7
Others	1	0.6	0.8	1	0.4	0.6	2	0.5	0.7
Total	163*	100.0		247*	100.0		410*	100.0	

**Multiple responses were allowed; hence total number of responses exceeds the respective sample size for females, males and total.*

3. YELLOW BEAN GRAIN FINDINGS

3.1. Yellow bean trade volume

During the period of assessment, the 443 yellow bean transactions generated 40,645 MT of grain sold by the traders. Varieties such as *Uyole 16*, *Selian 13* and *Njano Uyole* had relatively higher volumes of beans traded (see Table 5 below).

Table 5: Estimated volumes (MT) of yellow bean sold between July 2018 - July 2019 for major yellow bean varieties

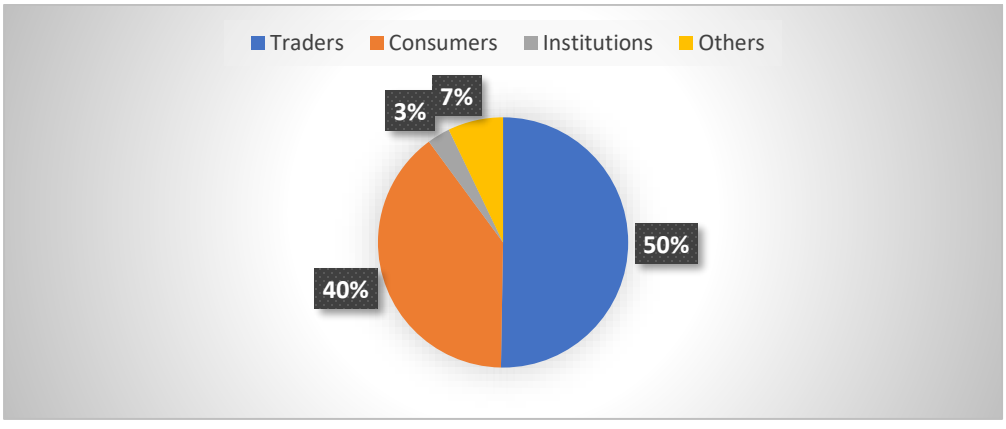
Variety	Mean	Std dev	Median	Min	Max	n	Total tonnage
Selian 13	39.8	148.2	5	0.1	1,450	153	6,084
Uyole 16	359.8	1,543.7	5.5	0.2	10,000	48	17,272
Njano Gololi (Masindi yellow)	114.7	384.7	6.5	0.12	2,000	44	5,049
Njano Uyole/ Uyole 98	57.7	138.6	6.5	0.2	550	16	923
MOORE 88002	102.7	239.7	10	0.1	1,080	23	2,363
Non-clustered	57.6	238.5	4	0.1	1,560	64	3,686
DNA not taken	55.5	128.1	10	0.1	1,020	95	5,268
Total							40,645

In terms of the volumes traded by gender, more male than female traders handled larger grain quantities except for *Uyole 16* and *Uyole 98* varieties. On average, male traders were handling a mean quantity of 105 MT for each variety sold, while women were handling 73 MT per variety resulting in an average of 92 MT per variety per trader. The differences in magnitude are clear for *Njano Gololi/Soya Njano,* Similarly, the volumes traded in mixed yellow bean also followed the same trend. Some of the differences in the volumes may be due to market destinations of the varieties, especially to more distant markets such as Dar es Salaam. It could also be due to exports to neighboring countries like Kenya, where men were more likely to sell compared to women.

3.2. Main Buyers

Yellow bean sales were mainly to other traders, consumers and institutions (schools, hospitals, government agencies, among others). **Error! Reference source not found.** shows the average proportion of volume sold to each buyer type. In general, 50% of the yellow beans traded were sold to traders, while the traders sold 40% to consumers.

Figure 3: Proportion of sales volumes to various buyer types



Sales to institutions were relatively low i.e., with only 40 out of 444 variety level observations being partial or full sales. The main institutions that bought the yellow beans were schools, colleges and other learning institutions accounting for 65% of the responses. There were a handful of sales to hotels and in the catering industry.

3.3. Yellow Bean Prices

Table 6 presents yellow bean prices by variety, type of buyer and type of business i.e. retail or wholesale. For example, consumers paid a slightly higher price than institutions and traders. There is a variety price differentiation e.g., Selian 13 fetches better price than the rest of the varieties. Comparisons of prices received by women and men traders did not show significant differences.

Production hubs in Mbeya, Njombe, Rukwa, Songwe and Kigoma have lowest prices at Tanzanian Shilling (TZS) 1,400 (approx. US $0.60) per kg for any given variety. Regions such as Dar es Salaam, Geita, and Shinyanga are mainly consumption hubs, with higher prices. The Northern zone regions such as Arusha and Kilimanjaro are also major transit routes for beans to major markets. Similarly, Kagera also has major transit routes for the beans. This explains their price fluctuations between the lows in the mainly production hubs and high in the mainly consumption hubs.

Table 6: Average bean prices by different buyer types and by variety in TZS/kg (1USD=TZS 2295.7).

Variety	Sale price to consumers		Sale price to institutions		Sale price to traders	
	Mean	n	Mean	n	Mean	n
Selian 13	1,854	105	1,875	10	1,689	94
Uyole 16	1,725	28	1,650	4	1,559	32
Njano GololiG (Masindi yellow)	1,496	25	1,800	1	1,373	30
Njano Uyole/Uyole 98	1,525	6	1,700	1	1,317	13
MOORE 88002	1,658	13	1,640	5	1,458	15
Non-clustered	1,604	37	1,560	10	1,531	35
DNA not taken	1,769	54	1,867	9	1,597	64
Total	1,739	268	1,736	40	1,571	283

There were some price differences for varieties traded by female and male traders: women received higher prices in five varieties while men received higher prices in three varieties. In some of the varieties, the difference in prices is significant, such as Selian 13 and Uyole 16 (Table 7).

Table 7: Yellow bean sale price (TZS/kg) per variety by sex of trader.

Variety	Female		Male	
	Mean	n	Mean	n
Selian 13	1,779	63	1,680	89
Uyole 16	1,540	23	1,631	26
Njano Gololi (GMasindi yellow)	1,375	14	1,380	30
Njano Uyole/Uyole 98	1,364	11	1,325	5
MOORE 88002	1,546	9	1,586	14
Non-clustered	1,446	28	1,515	36
DNA not taken	1,635	33	1,593	62
Total	1,603	181	1,586	262

The distribution of prices across the regional hubs confirms higher prices in key consumption hubs (markets) such as Dar es Salaam, but also by bean variety ((Table 8).). Some bean varieties were not sold in certain markets, for example, Manyara, Kilimanjaro, Kagera and Kigoma. These markets also had more varieties.

Table 8: The price (TZS/kg) of common bean varieties across the regional hubs.

Region	Selian 13	Uyole 16	Njano goloi (Masindi yellow)	Njano Uyole/ Uyole 98	MOORE 88002	Non-clustered	DNA missing
Dar es Salaam	1,976	1,950			1,750	2,050	1,913
Geita			1,900		2,000	1,650	2,500
Kagera	1,638	1,600	1,417		1,583	1,656	1,556
Shinyanga	1,667	1,867			1,750		1,588
Arusha	1,844	1,960	1,344	1,650		1,850	1,729
Kilimanjaro	1,989	2,122	1,688	1,350	1,750	1,463	1,870
Manyara	1,836	1,600	1,900			1,434	1,650
Iringa	1,631	1,650	1,700			1,900	1,760
Mbeya	1,471	1,263	1,125	1,356		1,192	1,085
Njombe	1,500	1,275		1,600	1,750	1,375	
Rukwa	1,334		1,286	1,383	1,350	1,294	1,461
Songwe	1,355	1,300	1,211	1,170	1,488	1,067	1,112
Kigoma	1,215	1,286	1,385		1,259	1,529	1,471

3.4. Yellow Bean Sales

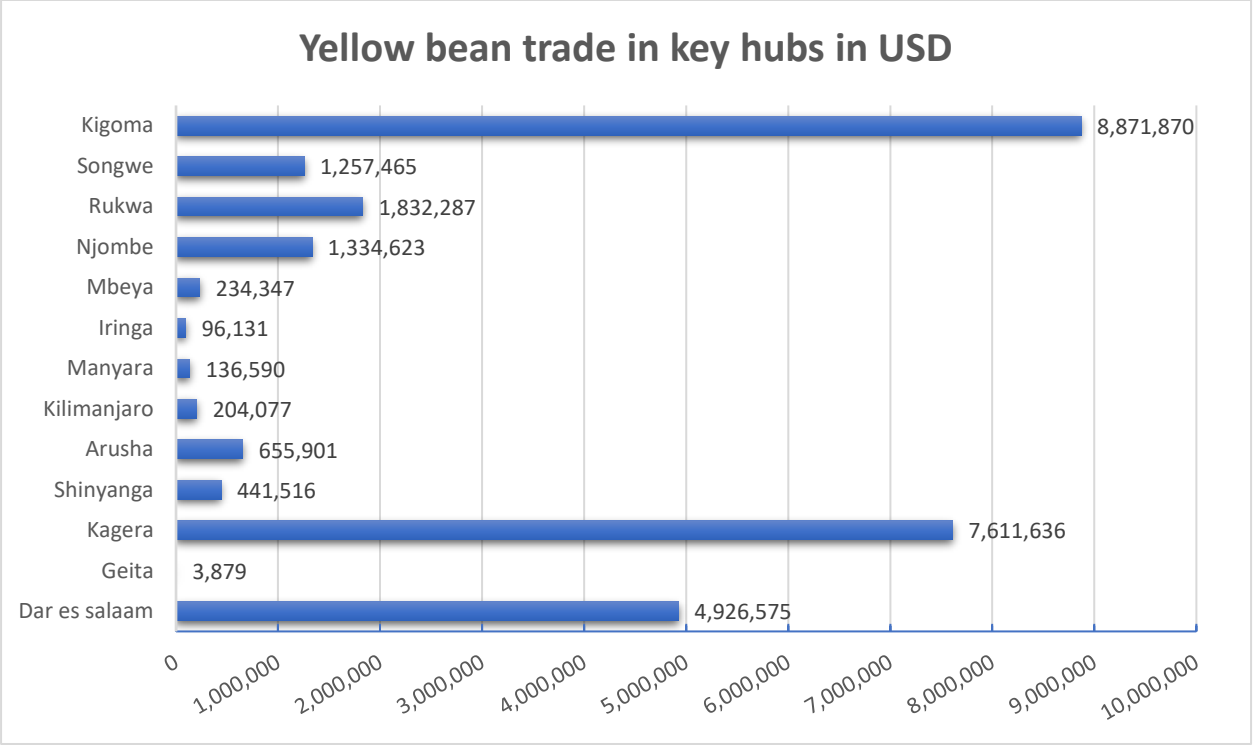
The average highest and lowest price recorded for the period July 2018 – July 2019 and for each observation enabled computation of the value of bean trade by multiplying it with the volume of beans sold. About **USD 27.6 million** worth of yellow bean was traded in the period under study (Table 9).

Table 9: Mean and median value of beans traded (USD) per variety per trader, July 2018 – July 2019.

Variety	Mean	Median	Std dev	Min	Max	n	Total value
Selian 13	31,170	3,929	126,787	53	1,306,593	152	4,737,843
Uyole 16	222,896	5,275	910,374	145	5,714,286	49	10,921,894
Njano GololiG (Masindi Yellow)	75,376	3,599	252,416	73	1,274,725	44	3,316,540
Njano Uyole/Uyole 98	42,281	4,055	114,362	119	459,341	16	676,500
MOORE 88002	72,543	6,374	181,956	77	830,769	23	1,668,493
Non-clustered	41,477	2,231	184,264	49	1,302,857	64	2,654,553
DNA not taken	38,222	8,077	95,842	40	829,451	95	3,631,070
All varieties (total)	62,318	4,308	337,631	40	5,714,286	443	27,606,896

The major contributors to this value are *Uyole 16, Selian 13* and *Uyole 98*. Significant volumes were also contributed by the non-released varieties. In Figure 4, sales are aggregated for each region or hub. The value of bean sales is highest in Kigoma[6], followed by Kagera (both are production hubs) and Dar es Salaam (a consumption hub). Thus, the major production hubs (and largest consumption hubs) accounted for the majority of yellow bean trade.

Figure 4: Traded volumes across the hubs.



The annual mean value of bean sales for women was worth **USD 65,992** per trader, while the men had **USD 113,422,** almost 2 times that of the women (Table 10).

Table 10: Value of bean sales for the period July 2018- July 2019, USD per trader, by sex of trader.

Group	Obs	Mean	Min	Max
Female	121	65,992	92	5,828,571
Male	173	113,422	154	4,351,648
Combined	294	93,901	92	5,828,571

**When extra-large values or outliers are included, the difference is not statistically significant.*

In cases where a trader sold more than one variety of the same market class (market description of bean type classified by color, size and share),) a sum of the volumes gave the total sold for the market class per trader. In all the bean varieties, men dominated in terms of mean quantities handled per trader. This means that women handled relatively smaller quantities than men did. This is consistent with the fact that there was a higher proportion of women in retail business than men (they dominate both wholesale and export business).

In some cases, there were more women trading more than one variety even though they handled smaller volumes. This present potential to grow women's revenues from sales. Data also shows that bean sales to different buyers

[6] Kigoma focuses mainly on yellow beans, almost 90% of the market comprises yellow bean compared to other production hubs that grow various types.

by sex of the trader were varied. The results indicated that female traders would sell relatively larger mean quantities to consumers than men.

3.4.1. Regional Export Markets for Yellow Beans

Out of the 444 variety level observations, 49 (11%) involved export of the yellow beans outside Tanzania (Table 11). The proportion of sales volume exported ranged from 10% to 74% in a few cases where some large traders, mainly the exporters, have designated varieties for export. The main export countries for yellow beans were Burundi, DR Congo, Kenya, Malawi, Rwanda, South Africa, Uganda, and Zambia. This survey recorded eight yellow bean varieties being exported, and there could be more varieties not captured in this survey.

Table 11: Proportion of the yellow beans exported outside Tanzania

Yellow bean variety	Number of observations involving export (% in brackets)	Proportion (%) of sales volume exported for specific variety/bean types
Selian 13	13 (8.6%)	26.7%
Uyole 16	7 (14.3%)	73.6%
Njano Gololi (Masindi yellow)	5 (11.1%)	40.7%
Njano Uyole/Uyole 98	1 (6.3%)	10.0%
MOORE 88002	4 (17.4%)	40.0%
Non-clustered	7 (10.9%)	54.7%
DNA not taken	12 (12.6%)	49.5%
Total	49 (11.0%)	45.5%

In terms of yellow bean export volumes, an average of more than 400 MT was exported. The value of the exported yellow beans was about USD 11 million. The exporters were mainly men with almost no women involved (Table 12).

Table 12: Volume and value of yellow beans exported (Mean MT, USD per variety observation).

Variable	Obs	Mean	Std. dev	Min	Max
Volume exported (MT)	42*	412.4	1377.811	0.135	8,000
Value of exported beans (USD)	42*	263,197.2	836299.9	81.59341	4,571,429

**Seven observations with bean exports have missing data on volumes because the question of proportion of sales exported was introduced after the start of data collection*

The distribution of exports by variety are shown in Table 13. About 40 traders exported more than 17,000 MT (seven varieties reported exports).

Table 13: Volume (MT) of yellow beans exported per variety.

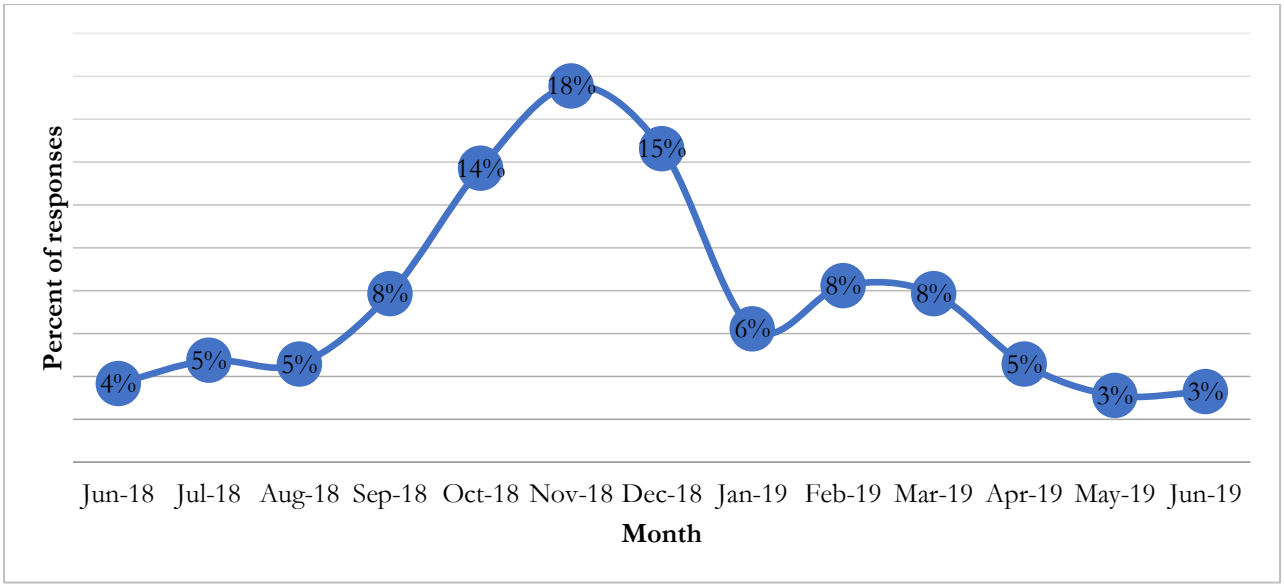
Variety	Mean (MT)	n	Total (MT)
Selian 13	21	12	247
Uyole 16	2,018	7	14,126*
Njano GololiG (Masindi yellow)	536	3	1,608
Njano Uyole/Uyole 98	9	1	9
MOORE 88002	72	3	216
Non-clustered	97	6	585
DNA not taken	53	10	530
Mean/Total	412-	42	17,322

*****One large trader handled 10,000 MT of Uyole 16 of which 8000MT were exported*

3.4.2. Peak Sale Months

The study captured variations in peak selling times for the yellow beans ((Figure 5). For the case of grain, the peak selling months were in the period between September and December of each year. This period coincides with post-harvest consumption and planting time. The planting period could be driving the overall selling price since traders often did not distinguish between prices of grain and seeds (though a few did make this distinction).

Figure 5: Peak selling months for yellow bean grain

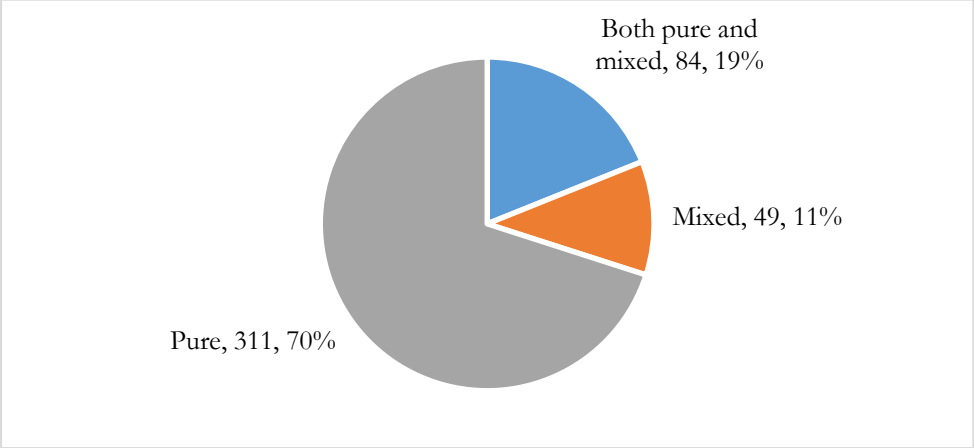


The peak selling month for seed begins in October and ends in December. A sharp curve matches the planting dates. The impression here is that yellow beans are mostly planted in November and December as the main season in Tanzania.

3.4.3. Grain Quality: Issues and Preferences

Most of the yellow beans were sold as single variety in (70%) of the observations. This means the traders did not prefer mixing varieties to the best of their knowledge ((Figure 6). About 11% were sold as mixed varieties while 19% sold both as mixed and single yellow varieties. Mixed varieties involved a mix of different yellow varieties or yellow and white varieties, and other colors.

Figure 6: Proportion of observations of yellow bean varieties sold as pure (non-mixed) or mixed with other varieties



Mixed varieties were relatively cheaper and preferred by some consumers such as schools and other institutions and some export destinations. Burundi, Kenya and Rwanda were indicated as preferring mixed yellow beans (some would eventually sort them back into single varieties for premium pricing). Thus, both farmers and traders rarely deliberately mix yellow beans.

3.4.4. Consumer's preferred traits

Table 14 shows the key traits that traders reported buyers searching for in yellow beans. Taste or palatability came up as a highly preferred trait in 39% of the yellow bean variety transactions. The second was short cooking time with 31% of the variety transactions. In addition, in 8% of the transactions, low flatulence was also a major trait highlighted. Other traits did not come out strongly. This study confirms the importance of consumers traits that were also detailed by the study on consumer acceptance and willingness pay for high iron beans (Rubyogo et al. 2019b).

Table 14: Yellow bean consumer trait preferences.

Trait	Number of responses	% responses
Taste /palatable/delicious	356	39.0
Cooks faster	281	30.7
No gas (flatulence)	71	7.8
Readily available	46	5.0
Good price	46	5.0
Cheap	34	3.7
Large size	19	2.1
High yield	15	1.6
Disease resistant	4	0.4

3.4.5. Gender Preferences

An analysis of the gender preferences of yellow beans in

Table 15 shows that 82% of the traders indicated that there is no preference by gender for the yellow bean varieties. About 13% of traders indicated, about 13% of yellow bean varieties were more preferred by women. However, this could indicate that traders do not pay much attention to the gender differentiated preferences of buyers.

Table 15: Gender preference for yellow bean varieties as indicated by traders.

Variety	No gendered preference (%)	Preferred by men (%)	Preferred by women (%)
Selian 13 (n=117)	81.2	6.8	12.0
Uyole 16 (n=44)	79.6	4.6	15.9
Njano GololiG/Masindi yellow (n=41)	80.5	7.3	12.2
Njano Uyole/Uyole 98 (n=14)	85.7	14.3	0.0
MOORE 88002 (n=23)	69.6	8.7	21.7
Non-clustered (n=59)	79.7	3.4	17.0
DNA not taken (n=82)	87.8	4.9	7.3
Total (n=380)*)*	81.6	6.1	12.4

**Some observations had missing data because the question was introduced after the start of data collection*

3.5. Yellow Bean Flows in the Tanzania Corridors

This section discusses bean trade flows in the yellow bean corridor in Tanzania. It focuses on where the grain was sourced from and where it was sold. Based on the survey data, indicative trade flows of yellow bean grains were analyzed.

3.5.1. Production Locations/Hubs

The major production hubs are mainly the Western and Lake Zones, the Southern Highlands and the Northern Zone. The major yellow bean consumption areas are around Arusha, Shinyanga and significantly Dar es Salaam and Zanzibar and Pemba. Another major market for yellow bean is Nairobi in Kenya, with other countries in the region (Burundi, DRC, Rwanda, Uganda, Zambia) also being export destinations. The majority of the yellow bean was sourced from locations within the district where the traders operate (about 50%). On the other hand, 30% and 19% were sourced from other districts within the region and other regions, respectively (Table 16). Only 1.5% indicated that they import some of the yellow bean grain from outside the country.

Table 16: Grain sources by location of trader.

Region where trader is located	Variety sources				No. of observations
	Within district (%)	Other districts within region (%)	Other regions in Tanzania (%)	Neighboring countries in ESA (%)	
Dar s Salaam	34.04	23.4	74.47	4.26	64
Geita	20	0	80	0	5
Kagera	51.72	77.59	5.17	8.62	83
Shinyanga	0	0	100	0	17
Arusha	72.73	15.15	36.36	0	41
Kilimanjaro	77.14	22.86	20	0	42
Manyara	88.24	17.65	2.94	0	37
Iringa	60	50	15	0	25
Mbeya	67.65	61.76	14.71	0	49
Njombe	38.46	61.54	38.46	0	18
Rukwa	69.77	32.56	2.33	2.33	46
Songwe	81.82	39.39	27.27	0	49
Kigoma	85.42	35.42	0	0	58
Total (n=534)	**49.8**	**29.6**	**19.1**	**1.5**	**534**

***Note**: Row responses involve multiple grain sources with multiple responses (adds to >100%).*

***Note**: Row Total is normalized to 100% traders in Dar es Salaam and Geita mostly source their yellow bean grain from other regions in Tanzania. This comprised 74% and 80% of the variety level observations, respectively for Dar es Salam and Geita. Kagera, Mbeya and Njombe mainly sourced from other districts within their regions. In the case of traders located in the production hubs, the scenario reverses with more incidence of grain sourcing from within the district and other neighboring districts within the same region where the respective trader is located. This is in Arusha, Kilimanjaro, Manyara, Mbeya, Songwe, Rukwa and Kigoma. All the data from Shinyanga indicates the source of yellow bean grain as other regions in Tanzania.*

Figure 7: Bean market indicating bean prices of various varieties, Tandika Market, Dar es Salaam.

3.5.2. Sale/Destination Locations (Distribution and Consumption Hubs)

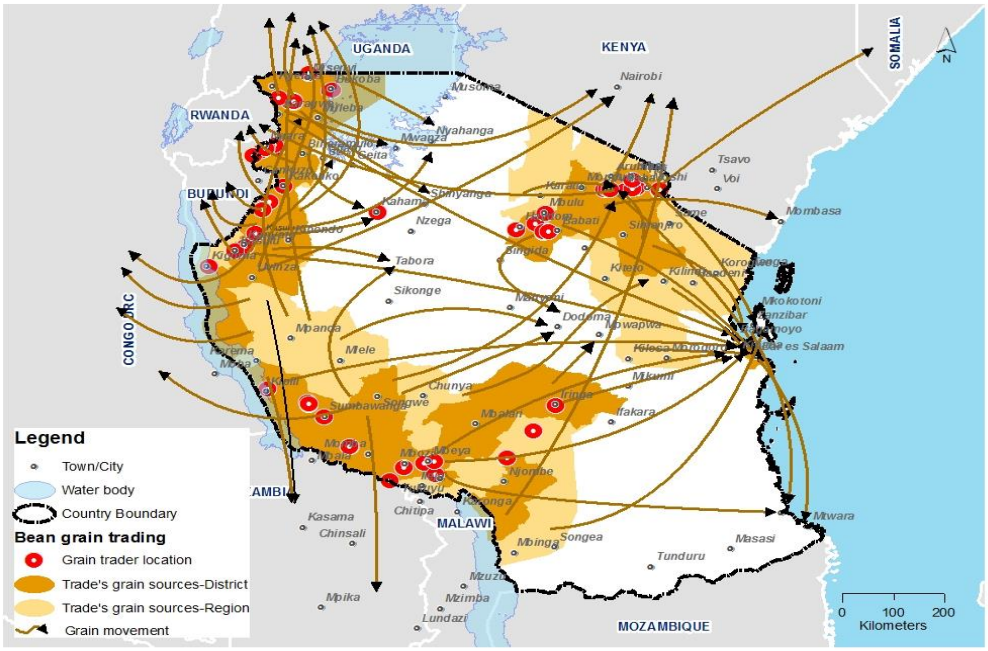
Areas within the districts where traders are located were the major destination of grain traded (40%) (Table 17). More often traders were selling to other regions in Tanzania (28%) and other districts within the same region (24%). About 8% of the yellow bean was exported to other countries. In terms of grain sale locations, traders in the production hubs mostly sold yellow bean to regions outside their location — these include Njombe, Rukwa, Songwe, and Kigoma where consistently more than 60% of the beans were taken to other regions in Tanzania (Table 17). This indicates that the regions are production and distribution hubs.

Traders in Arusha are among the highest exporters with almost 25% of the bean transactions going into export. Therefore, making the city a major distribution hub. Conversely, Shinyanga had traders who mostly sold yellow beans only within the district where they operated (94% of cases), an indication that the region is a consumption hub. The bean flows are visualized in Figure 8. Traders are mostly located close to production hubs. Yellow beans did not flow into most of the production hubs unless the production hubs acted as distribution hubs too. This is the case for Kagera, Arusha, Kilimanjaro and Dar es Salaam.

Table 17: Yellow grain sale/destination locations by location of trader.

Region where trader is located	Percent (%) of variety level observations indicating sales to destination				
	Within district	Other districts within region	Other regions in Tanzania	Exports to neighboring countries in ESA	No. of observations
Dar Es salaam	70.21	74.47	10.64	0	73
Geita	100	0	0	0	5
Kagera	48.28	39.66	50	18.97	91
Shinyanga	94.12	29.41	5.88	0	22
Arusha	63.64	30.3	36.36	24.24	51
Kilimanjaro	82.86	22.86	5.71	2.86	40
Manyara	70.59	17.65	32.35	11.76	45
Iringa	75	35	10	0	24
Mbeya	70.59	50	23.53	2.94	50
Njombe	53.85	38.46	69.23	15.38	23
Rukwa	34.88	23.26	60.47	6.98	54
Songwe	27.27	36.36	81.82	15.15	53
Kigoma	43.75	20.83	79.17	22.92	80
Total (n=611)	**40.1**	**24.3**	**28**	**7.6**	**611**

Figure 8: Tanzania yellow bean corridor: linking production to consumption hubs for yellow beans



3.6. Challenges and Opportunities in Yellow Bean Trade

Table 18 presents a summary of key constraints and opportunities traders expressed could contribute to improvement of their bean trade. One of the major constraints that affected traders was lack of stable market reported by 59% of female and 44% of male traders (beans are often informally traded), poor bean grain quality or grading, inadequate supply and demand, low prices and high levies. Men and women traders experienced these constraints differently. However, it is apparent that more men than women mentioned constraints of categories

(except for market reliability and delayed payments). Overall, the yellow beans were in higher demand than supply, especially of the more preferred varieties.

Table 18: Challenges and opportunities by sex.

Constraint	Female		Male		Total	
	Frequency responses	% of traders (n=123)	Frequency responses	% of traders (n=175)	Frequency responses	% of traders (n=298)
Lack of a stable market	73	59.4	77	44.0	150	50.3
Poor Grading	45	36.6	66	37.7	111	37.3
Others (storage pests, poor quality)	36	29.3	54	30.9	90	30.2
Inadequate supply	27	22.0	42	24.0	69	23.2
Inadequate Demand	24	19.5	28	16.0	52	17.5
Low Prices	18	14.6	31	17.7	49	16.4
High Taxes/Levies	16	13.0	32	18.3	48	16.1
Inadequate/Poor Storage	13	10.6	24	13.7	37	12.4
Inadequate market information	13	10.6	17	9.7	30	10.1
Credit constraints	13	10.6	13	7.4	26	8.7
Costly &/or Inadequate transportation	10	8.1	15	8.6	25	8.4
Mixed beans	6	4.9	9	5.1	15	5.0
Buyers are not trust worthy	5	4.1	7	4.0	12	4.0
Weather/climate related challenges ee.g. rains	4	3.3	7	4.0	11	3.7
Road condition	2	1.6	9	5.1	11	3.7
Delayed payments	5	4.1	4	2.3	9	3.0
Thefts	3	2.4	0	0.0	3	1.0
Security	1	0.8	0	0.0	1	0.3
Cultural factors	1	0.8	0	0.0	1	0.3
Total responses	315		435		750	

4. YELLOW BEAN 'POTENTIAL SEED' ANALYSIS

This section focuses on the seed component of yellow bean, recognizing that seed is a key driver for grain production—escalating both its scale and improving its quality. It complements the grain trader analyses grain trader analyses in section 3.. In terms of the yellow bean value chain, seed (planting materials) are drawn from the informal sector, thus the term 'potential seed' is used to distinguish it from certified or Quality Declared Seed (QDS).

For those unfamiliar with the term 'potential seed', this refers to grain sourced from local markets that can be used for planting and which is often expressly purchased for seed. Such material is perceived to be adapted and with acceptable quality—as judged by the buyer. Traders (the suppliers) also see such seed as a distinct revenue stream and it may be actively managed as 'potential seed' as distinct from routine grain (see below for more refined potential seed management discussion).

4.1. Sampling Potential Seed Traders

The insights below draw mainly from a dataset of 23 larger 'potential seed' traders and 41 'potential seed retailers'. It also draws from the larger grain traders' dataset (N=298). It is key to emphasize that these researcher-designated divisions (grain vs. seed trader)) proved incorrect when verified on the ground. So-called potential seed traders always also sell grain, and most grain traders (over 50% of the sample) recognize that their customers are also buying seed — especially just prior to and during peak sowing time. So, the distinct label divisions of 'potential seed' and grain traders should be considered only to identify which sample datasets are being used. (Based on this important finding, future investigations examining bean-linked trade corridors will focus on grain and potential seed in one combined instrument).

The tables below ((Table 19, Table 20, Table 21 and Table 22) give more detail on the larger trader and retailer potential seed sellers. For both, the majority of the traders and sellers were between 30 and 65 years old. Women and men had good representation in both, with women more visible at the retail level and men as larger traders. In terms of the zones, the northern zone and southern highlands were given greater emphasis.

Table 19: Age of potential seed large traders (percentage) (N=23).

Age	Female (n = 8)	Male (n = 15)	Total (N = 23)	Cumulative %
15 – 29	12.5%	13.3%	13.0%	13.0%
30 – 45	37.5%	60.0%	52.2%	65.2%
46 – 65	50.0%	26.7%	34.8%	100.0%
66 and above	0.0%	0.0%	0.0%	0.0%

Table 20: Age of potential seed retailers (percentage) (N=41).

Age	Female (n = 24)	Male (n = 17)	Total (N = 41)	Cumulative %
15 – 29	16.7%	29.4%	22.0%	22.0%
30 – 45	41.7%	41.2%	41.5%	63.4%
46 – 65	33.3%	29.4%	31.7%	95.1%
66 and above	8.3%	0.0%	4.9%	100.0%

Table 21: Distribution of yellow bean large potential seed traders and transactions by zone.

Region	# of Traders	%	# of Transactions	%
Southern Highlands	12	52%	30	64%
Northern	8	35%	13	28%
Western	2	9%	3	6%
Coastal	1	4%	1	2%
TOTAL	23	100%	47	100%

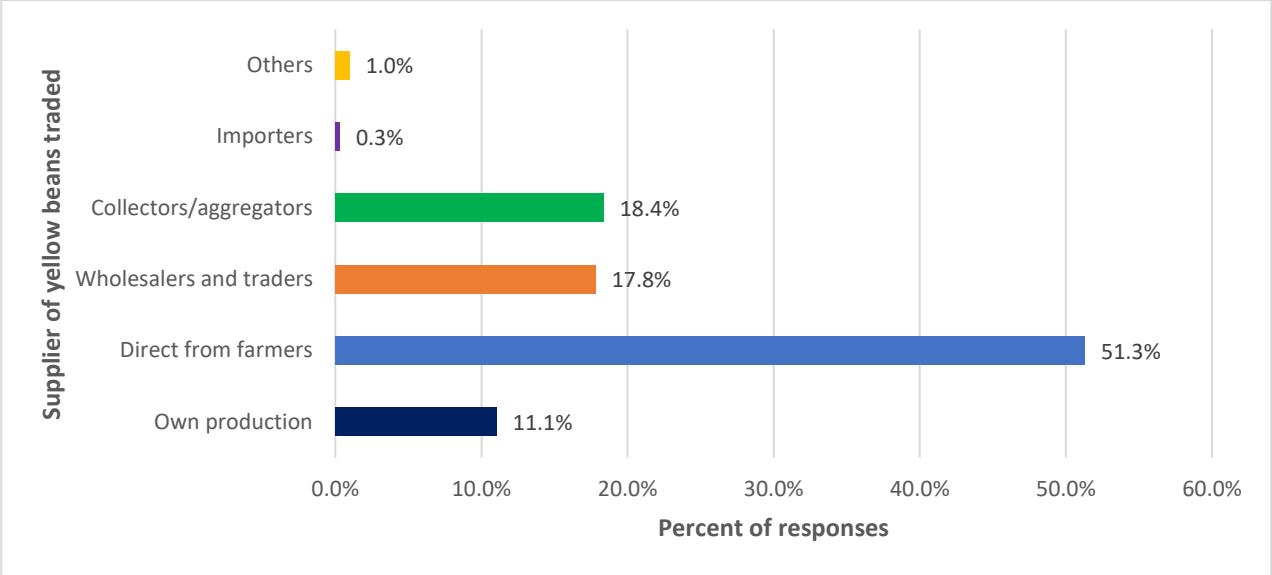
Table 22: Distribution of yellow bean potential seed retailers and transactions by zone.

Zone	# of Traders	%	# of Transactions	%
Northern	22	54%	26	41%
Southern Highlands	10	24%	25	39%
Lake	4	10%	8	13%
Western	5	12%	5	8%
TOTAL	41	100%	64	100%

4.2. Major Findings

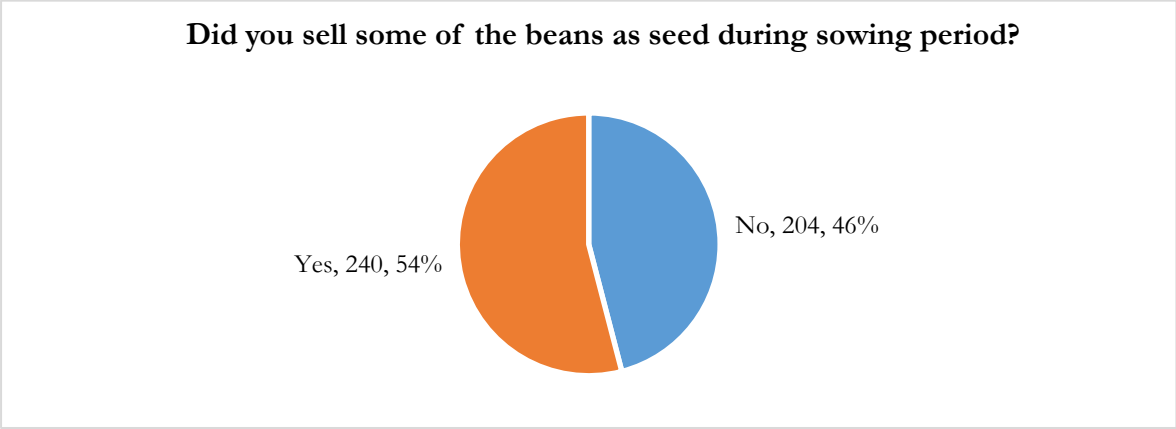
Traders sourced their yellow bean varieties directly from farmers, with about 51% of the traders drawing in full or partly from this source. However, some traders also produced their own yellow bean seed (11%) and/or sourced from other traders (18%) and collectors (24%).

Figure 9: Suppliers of yellow bean seed traded as percentage of the volume.



The main findings related to potential seed are listed below, with the accompanying data following. They draw from extensive qualitative as well as quantitative datasets and are complemented by GIS mapping data of the source areas and sale areas for both seed and grain. Figure 10 indicates that 54% of the traders (those interviewed as mainly grain traders, not seed sellers per se) involved sale of grain as planting material (informal seed). This form of seed material, hereafter referred to as 'potential seed' appears common among grain traders, especially during sowing period. This large proportion of variety seed transactions has implications for dissemination of the yellow bean seeds in the production hubs.

Figure 10: Incidence of potential seed sales by grain traders



In terms of quantities of yellow beans sold as seed, the average was 2.7 MT per variety per trader; this overshadows the amount of formal seed sales and underlines the importance of the grain market as a major source of seed planted by producers. In many countries, the formal seed sector accounts for about 5% of the beans used for production, while the rest comes from farmer saved seed and/or the grain market (from grain traders). Available data shows that about 4,000 MT of formal seed (certified and quality declared) were available to producers in 2017-18 period for all varieties (yellow and non-yellow). This is a small fraction of the effective demand for planting materials or seeds, with the balance largely supplied by informal supplies.

The section hereunder highlights eight areas based on findings from the analysis. They are discussed in detail afterward.

a) In terms of this yellow bean corridor analysis, 100% of the seed for all yellow bean varieties marketed by traders was drawn from the informal sector.
b) Traders conduct trade in both grain and potential seed.
c) While grain sourcing and sale dominates, seed sourcing and sale is recognized as an important part of the business.
d) Sources for seed and grain are similar for both the larger traders and the retailers, and sources are restricted to four main bases.
e) The geographic sourcing of seed and grain is quite distinct — potential seed source and sale tends to be local. For grain, source and especially sale is much more far-reaching
f) There are very clear practices used by traders to manage and anticipate potential seed.
g) When buying, farmers give clear signals that they are looking for seed.
h) Potential seed traders have clear concerns, which could also be seen as opportunities.

I. In terms of this yellow bean corridor analysis, 100% of the seed for all yellow bean varieties was drawn from the informal sector.

a. For the larger seed traders, none drew from or traded in stocks of certified seed; only one knew about QDS (but did not use it);
b. For the retailers, the trend was similar, none drew from or traded in either certified or QDS.
c. In contrast to (a) and (b) above, almost 40% of larger traders and 20% of retailers indicated that they had traded in modern varieties. Hence, *variety innovations are entering informal seed systems* – even if formal quality seed is not being accessed (Table 23). *(This could be an important point for strengthening the yellow bean trade.)*

Table 23: Potential seed traders' sale of modern varieties

Trader category	# of Traders	# yes	% yes *
Potential seed retailers	41	7	17
Potential seed larger traders	23	9	39

**There were also missing values of 'don't know'.*

II. Traders conduct trade in both grain and potential seed.

Both grain and seed bring traders' revenue. This forms part of the seasonal cycles of business. For the large grain traders of yellow bean, (298 traders, 453 variety observations), 55% state that some of their sales are used for local seeds but the proportion of seed/grain are not specified further. More than 50% recognized that they also sell seed. Conversely, of the 64 seeds-linked traders, big and retailer, there was only one participant (in Karagwe/Kyerwa) who indicated he only sold seed (and this was explicitly dressed with pesticides in July, for eventual seed sale in October). There are also clear, direct interactions between seed and grain, often deliberately planned. Some examples collected from the field:

- Traders describe supplying farmers with potential seed from whom they want to buy back grain later.
- Traders, anticipating seed, ask farmers not to mix different grain types at harvest.

This means that grain and seed are generally intermixed business and that effort to improve seed markets and overall trade can work to support both grain and seed trade.

III. While grain sourcing and sale dominates, seed sourcing and sale is recognized as an important part of the business.

a. For the larger seed traders (N=23), the seed business occupies about a third of their business during sowing periods, and 1/7 during non-sowing periods (Table 24).

Table 24: Large potential seed trader — seed and grain business proportions (percentage volumes).

Calculation	Total volume (MT)	Non-sowing period		Sowing period	
		% grain	% seed	% grain	% seed
Total volume	2,116.6				
Simple average	48.1	84.1%	15.9%	66.4%	33.6%
Weighted average	-	87.1%	12.9%	69.0%	31.0%

b. For the retailers (N=41), the potential seed business is recognized as even more important, as they often have direct interface with farmer-buyers. At peak, it almost 40% during sowing, and 20% during non-sowing periods (Table 25).

Table 25: Potential seed retailer —— seed and grain business proportions (percentage volumes).

Calculation	Total volume (MT)	Non-sowing period		Sowing period	
		% grain	% seed	% grain	% seed
Total volume	295.3				
Simple average	4.6	80.5%	19.5%	61.2%	38.8%
Weighted average		85.8%	14.2%	63.6%	36.4%

While the 'seed' business is markedly seasonal, when total volumes of sale are compared, it is also partly year-round. For instance, as described by a large trader in Arusha (selling 2,300 MT annually of yellow bean), he recently put aside seed for his own use, some 4 MT of potential seed as soon as the grain shipment came in. The trader indicated the quality was 'very good.' Conversely, farmers may buy seed year-round, such as when they come across a special variety that may become scarce later on as the sowing period approaches.

IV. Sources for seed and grain are similar for both the larger traders and the retailers, and sources are restricted to four main bases.

These four sources for seed and grain include directly from farmers, from collectors, from small and middle-level farmers and from their own production (Table 26). The order of importance differs slightly between the larger traders and retailers. Larger traders rely more on collectors and other traders, while the retailers may interact relatively more with farmers directly. Of particular note is the degree to which larger traders also bulk non- certified seed of improved varieties for sale. The relative absence of grain or seed sourcing from wholesalers, seed companies, QDS producers or National Agricultural Research Systems (NARS) is evidence of this informal self-production.

Table 26: Potential seed traders' sources of grain and seed.

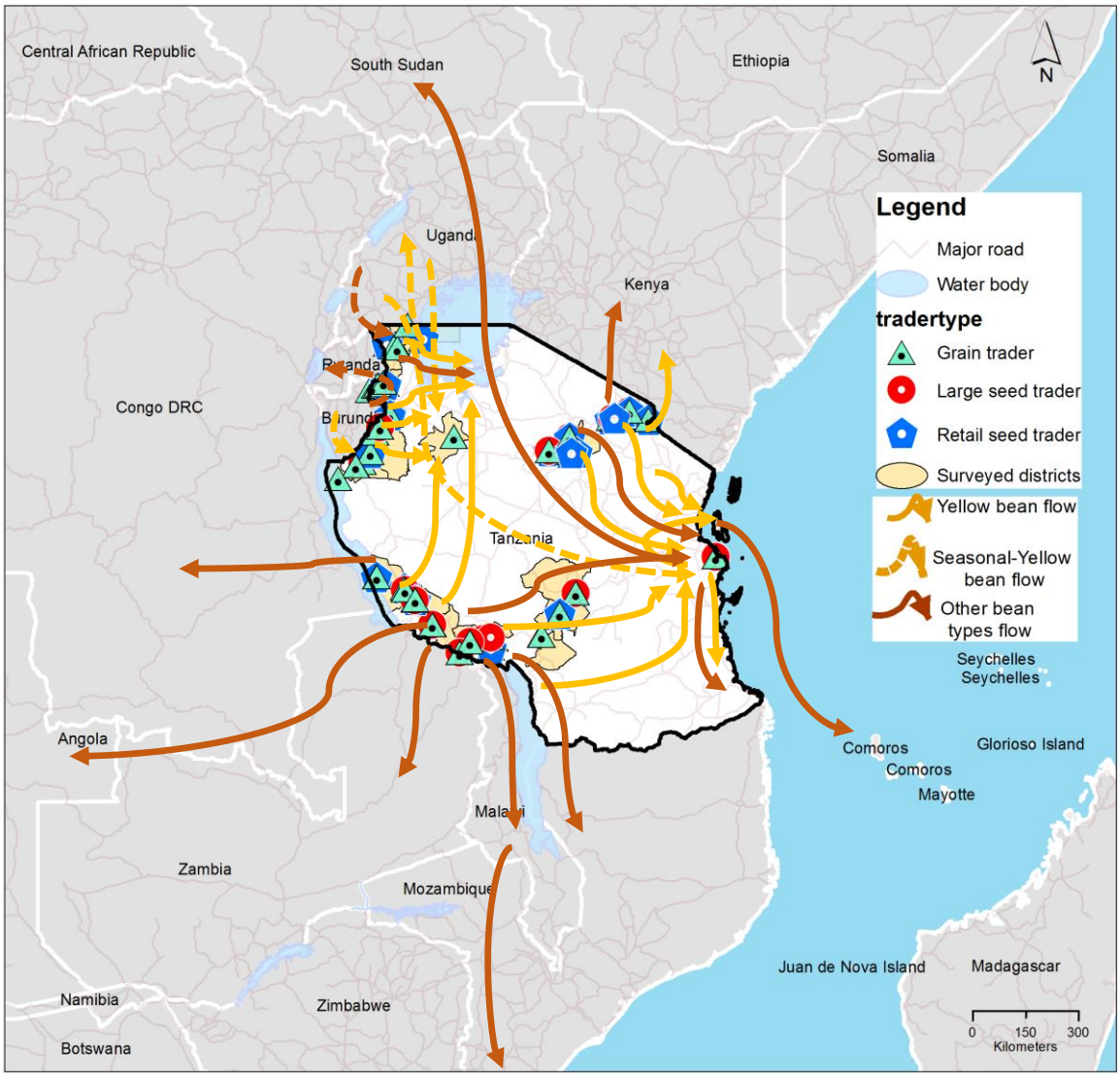
	% of larger traders	Local Seed Sources								
		Self-production	Farmers directly	Collectors (who source from farmers)	Other traders, small and middle level	Wholesalers	Seed Companies	QDS producers	Research / NARS	Other
Grain sources	Self-production	26.1%	23.9%	13.0%	13.0%	0.0%	0.0%	0.0%	0.0%	2.2%
	Farmers directly	23.9%	65.2%	50.0%	26.1%	0.0%	0.0%	0.0%	0.0%	6.5%
	Collectors (who source from farmers)	19.6%	54.3%	52.2%	30.4%	0.0%	0.0%	0.0%	0.0%	10.9%
	Other traders, small and middle level	10.9%	32.6%	30.4%	34.8%	0.0%	0.0%	0.0%	0.0%	4.3%
	Wholesalers	2.2%	0.0%	0.0%	2.2%	0.0%	0.0%	0.0%	0.0%	2.2%
	Seed Companies	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	QDS producers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Research / NARS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Note: The higher the tone/shade at the intersection, the more important the source was for the trader (for either grain and/or seed).

	% of retail traders	Local Seed Sources								
		Self-production	Farmers directly	Collectors (who source from farmers)	Other traders, small and middle level	Wholesalers	Seed Companies	QDS producers	Research / NARS	Other
Grain sources	Self-production	9.4%	7.8%	6.3%	4.7%	0.0%	0.0%	0.0%	0.0%	0.0%
	Farmers directly	9.4%	53.1%	20.3%	12.5%	1.6%	0.0%	0.0%	0.0%	1.6%
	Collectors	6.3%	15.6%	28.1%	15.6%	1.6%	0.0%	0.0%	0.0%	0.0%
	Other traders	4.7%	7.8%	15.6%	14.1%	1.6%	0.0%	0.0%	0.0%	1.6%
	Wholesalers	0.0%	0.0%	1.6%	1.6%	1.6%	0.0%	0.0%	0.0%	0.0%
	Seed Companies	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	QDS producers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Research / NARS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Other	0.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

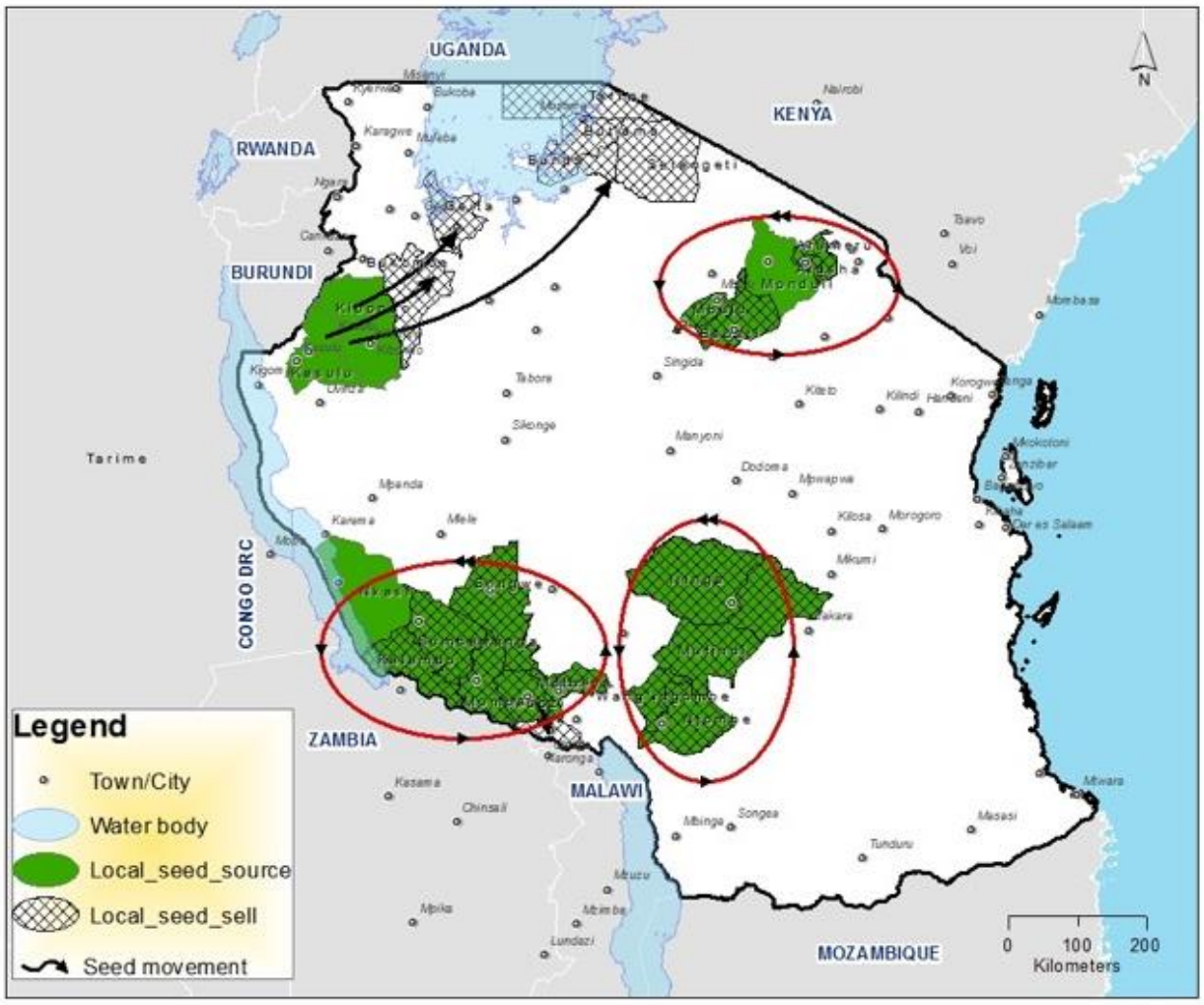
V. The geographic sourcing of seed and grain is quite distinct

Figure 9: Overview of trader (all sample types) seed and grain flows.



Potential seed source and sale tends to be local. For grain, source and especially sale is much more far-reaching (Figure 9). The local (within region) circulation of seed is particularly striking when maps of seed flow alone are charted (see Figure 10, following page). Seed typically stays within the region.

Figure 10: Zones of sourcing and selling of potential seed (larger and retailer potential seed traders combined).



VI. There are very clear practices used by traders to manage and anticipate potential seed.

Research identified a series of practices that traders in many Africa sites use to manage seed (Sperling and McGuire 2010). Both larger potential seed traders and retailers were queried about these at all sites. Of the 12 possible practices, larger traders used on average 6.7 of them. Moreover, the retailers, on average used 5.5 practices. The majority routinely use a cluster of practices. These are keeping the varieties pure: sorting out the waste, like dust and pebbles; sorting out bad and immature grains; and, keeping freshly harvested stocks apart. In addition, a fair number of traders sell seed and grain separately, at different prices. In contrast, very few do germination tests (see Table 27, Table 28).

Table 27: Large potential seed traders (N=23) management practices – relating to potential seed.

a. Number of practices

Minimum # practices used (out of 12)	3
Maximum # practices used (out of 12)	9
Range	3.7
Average practices used (out of 12)	6.7

b. Type of practice

Type of Practice	# yes	% yes
Get grain from specific regions, with similar adaptation	9	39
Seek out specific varieties to buy (which can be planted)?	17	74
Buy from specific growers who are known for high quality seed?	7	30
Ask growers (ahead of time) to multiply select varieties	0	0
Keep each variety pure—as single variety?	18	78
Keep freshly harvested stocks apart?	21	91
Grade stocks (which grain/which seed)?	16	70
Do germination tests?	0	0
Have special storage conditions (to help with seed viability)?	11	48
Sort out 'waste' (pebbles, dirt, dust)?	19	83
Sort out 'bad grains/seed'-that is broken, immature, or discolored?	18	78
Sell seed and grain separately, at different prices?	17	74

Table 28: Potential seed retailers (N=41) management practices — relating to potential seed.

a. Number of practices

Minimum # practices used (out of 12)	0
Maximum # practices used (out of 12)	10
Range	10
Average practices used (out of 12)	5.5

b. Type of practice

Type of Practice	# yes	% yes
Get grain from specific regions- with similar adaptation	9	22
Seek out specific varieties to buy (which can be planted)?	31	76
Buy from specific growers who are known for high quality seed?	11	27
Ask growers (ahead of time) to multiply select varieties	0	0
Keep each variety pure—as single variety?	30	73
Keep freshly harvested stocks apart?	30	73
Grade stocks (which grain/which seed)?	19	46
Do germination tests?	5	12
Have special storage conditions (to help with seed viability)?	16	39
Sort out 'waste' (pebbles, dirt, dust)?	27	66
Sort out 'bad grains/seed'-that is broken, immature, or discolored?	27	66
Sell seed and grain separately, at different prices?	19	46

The issue of grading

Some nuances of trader grading of bean stocks proved especially important (as related to future supportive actions). The general premise was that higher graded stocks either: a) fetch higher prices, and/or b) sell faster. The discussions of grading were important for the details shared but also because 'lower quality' – and the active need to improve this – was one of the major concerns raised by traders when reflecting on improvements for the future (see number VII, below).

Note that the quality discussions embraced issues of both variety type (that is, 'variety quality') and seed quality per se. Traders noted that the 'un-preferred' varieties might be sold to institutions such as schools, or routinely mixed and sold with more preferred varieties to boost the price. In terms of seed quality, issues of mixing different types featured most prominently as a negative feature, along with the complaint that waste (dirt, sticks, pebbles) was not sorted out sufficiently.

Concrete examples of grading examples are listed below:

- One large trader (in Kilimanjaro) instructed his collectors to look for seed that was 'good' and even asked for an accompanying photo (to be sent by phone) prior to purchase.
- One retailer (in Karagwe/Kyerwa) explained that she has two strategies when farmers come to her with beans of low quality to sell.
    - She negotiates a low price and then pays someone else to sort;
    - She asks the farmer to sort (at home), and then return and the retailer will pay the normal price.

Therefore, grading is actively done, and maintenance of both level of variety and seed quality seems important to a range of traders.

VII. When buying, farmers give clear signals that they are looking for seed.

Signals that farmers are seeking seed from traders are constantly noted. Table 29 reports those signals most mentioned by traders. Sometimes farmer-buyers overtly say they are looking for seed. Other times, the signals are more nuanced: buyers seek specific varieties or search for especially clean stocks, or other practices. The point is that farmers come to traders specifically seeking something to plant. Conversely, traders are very familiar with this type of seed-seeking transaction.

Table 29: Yellow bean seed purchase patterns by farmers at retailer outlets (N=41)

	Search for pure varieties, not mixed	Search for stocks which are clean (no debris)	Search for a specific variety by name	Ask about the origin (place) where stocks are from	Ask how the stocks were stored/ conserved	Ask for a particular quantity	Say they are buying seed	Give other signals*
# yes	30	35	35	12	20	18	35	9
% yes	77%	85%	85%	29%	49%	44%	85%	22%
Minimum # patterns observed (out of 7)								0
Maximum # patterns observed (out of 7)								7
Range								7
Average patterns observed (out of 8)								4.73

**Note: This was an optional category. Other signals included mainly requests to get a local variety.*

VIII. Potential seed traders have clear concerns, which could also be seen as opportunities.

Finally, there is the issue of traders' own concerns: those that they expressly asked to be addressed. The concerns mentioned were wide ranging, primarily relating to general business constraints (e.g. lack of capital, high transport costs, high taxation especially trade levies, etc.).

There were five central issues raised by traders about potential seed:

a. Information on new varieties and range of varieties available

While some traders knew of new modern varieties, a large number did not (and were not even clear about which varieties were local and which were modern). There is a number of diverse aspects here. Can the traders be exposed to new varieties? Can the new varieties address specific problems, like flatulence or low fertility soils or climate variability? Are there new varieties that can stimulate business further, which buyers really want? Are there new varieties that can augment profit?

b. Market information —— for both grain and seed

The variability in markets, as well as the general lack of knowledge about differentiation among markets, was raised repeatedly for both internal and international markets. Which varieties should be invested in—and where?

c. Mixed varieties

Overall, traders complained about farmers' mixing of varieties. This was linked to the unresolved issue of "who should pay for improving the quality —— the trader or farmer?" Some traders viewed the solution as simply training farmers better in grain and seed management. However, perhaps the issue is not one of lack of knowledge, but rather of lack of financial incentive. Given a premium by traders, farmers might be encouraged to sort and select out varieties more consistently.

d. Managing quality more generally

Similar to (c). Traders raised the issue of seed not well sorted or damaged on multiple occasions.

e. Storage pests

Storage loss was raised as a significant problem, as well as seed maintenance more generally, from the time of harvest to sowing.

4.3. Possible areas for Immediate Research and Development Actions

Action points need to be tailored to address these specific concerns raised by traders linked to their interest in potential seed. A vibrant, informal potential seed trade exists for yellow bean. There is a need to actively foster it. Among the easier actions are the following:

1. Variety Information on range of yellow bean types. Traders should be actively linked to information on both local and modern yellow bean types, and their full characteristics. *(Note that the research team completed a preliminary classification prior to fieldwork)*. Radio, SMS texts-typologies, simple flyers might all prove useful. Even photo-classifications of the samples collected during the yellow bean research work might prove useful. It is important for traders to get better information on variety options.
2. Post-harvest storage techniques. Reduction of storage losses can bring important economic gains. For potential seed retailers, hermetic bags (whether PICS or Grain Pro, or other brands) might be quickly popularized.
3. Stimulating on-going Potential Seed Trader to researcher interactions could further give insight into immediate and impactful collaborative action points. It is essential that researchers recognize these potential seed traders as legitimate and very important actors in the yellow bean corridor business.
4. Yellow bean corridor success is not just about grain movement. It is also about potential seed movement—and supporting **informal seed availability, access and quality enhancement** across regions within Tanzania and beyond.

5. DNA ANALYSIS OF TRADERS' YELLOW BEAN SAMPLES

5.1. Introduction

Variety market share based on trader surveys relies on traders' perspectives and knowledge to varietal identification. This often results in biased estimates if the traders are unable to provide the correct name or give names that match with the improved variety list. To tackle these potential problems requires time for intensive data collection including follow-up questions in the survey instrument, visiting the field to observe plant characteristics, or collecting sample materials (i.e., photos, seeds/plant tissues) from the farmers for later verification by experts. This still does not provide accurate information as many varieties bred to have similar physical seed characteristics are commercialized at the same time. DNA fingerprinting on the other hand offers a reliable method that accurately identifies grain/ seed traded and increases the accuracy and credibility in the interpretation of results. DNA fingerprints, resembling barcodes, are unique to the individual variety and hence used in much the same way as conventional fingerprints —— to identify individuals with absolute certainty (Bhat, 2006). Fingerprinting has been used to support variety identity studies in rice and wheat in Ethiopia (Yirga et al., 2015) and beans in Zambia (Mywish et al., 2015) and is increasingly being used for quality control purposes in many breeding programs.

In this project, a set of Quality Control (QC) Single Nucleotide Polymorphism (SNP) markers (the DNA fingerprint) was utilized to identify yellow bean varieties traded in Tanzania. *A DNA fingerprint is a suite of molecular markers that can be tested against any variety in contention to obtain its true genetic identity.*

5.2. Materials and Methods

A total of 501 yellow bean trader samples and 10 reference materials (samples of known released yellow bean varieties and three samples from Bubayi and Mbuzi markets and two (unlabeled) maintained by TARI with contested identity) were collected by a team of the Alliance and TARI researchers and sent to the Alliance station based at the National Agricultural Research laboratories (NARL)-Kawanda, in Uganda. The samples were assessed for seed characteristics, and the results showed that some samples were damaged/spoilt, color mixed or had incomplete codes. In the end, 472 samples, including 461 trader samples and 14 reference samples (10 10 TARI collected and four maintained at Alliance Kawanda regional gene bank), were genotyped (see Table 30).

Three seeds per sample were planted, and at two weeks old two leaf discs were collected from each sample and transferred into 96-place deep well plates and sent to Intertek laboratories (Intertek Laboratories, Alnarp, Sweden) for analysis using 48 previously identified Quality Control (QC), single nucleotide polymorphism (SNPs) molecular markers. SNPs are differences in DNA sequence of just one nucleotide and usually bi-allelic and are the most common type of polymorphism. SNP markers are useful for genetic studies because they are available in large numbers, distributed throughout the genome, co-dominant and transferable between different genotypes (Thomson, 2014).

Table 30: Yellow bean reference lines used in study.

Sample Name and no.	Source	**Variety category	Release date for official varieties	Lab code	Brill	100 S/W	SIZE	Seed Shape	Notes
R1: Selian 13	TARI	Official	2018	TZYR4	3	37.4	medium	Round oval	Brown hilum
R2: Njano Uyole	TARI	Official	2008	TZYR2	2	30.5	medium	Round flat	Dark hilum
R3: Uyole 16	TARI	Official	2016	TZYR8	3	41.2	Large	Elongated round	Brown hilum
R4: Vwawa from Mbuzi Market	TARI	Identity contention	-	TZYR14	2	40.1	Large	Elongated round	Dark hilum
R5: Rusharura from Bubϯ Market	TARI	Identity contention	-	TZYR16	1	46.1	Large	Elongated flat	Dark hilum
R6: Uyole Njano Ndefu	TARI	Identity contention	-	TZYR9	2	42.3	Large	Kidney shaped	Dark hilum
R7: Njano Gololil from Bubϯ market	TARI	Identity contention	-	TZYR15	3	38.1	medium	Round oval	Dark hilum
R8R8: Uyole 98	TARI	Official	1998	TZYR5	3	39.4	Large	Elongated round	
R9: TZUnlabeled1	TARI	Identity contention	-	TZYR12	2	35.2	medium	Round oval	Dark hilum
R10: TZUnlabeled2	TARI	Identity contention	-	TZYR13	2	45.2	Large	Elongated round	Dark hilum
R11: Masindi yellow long	CIAT*	Landrace (Uganda)	-	TZYR10	3	44.2	Large	Elongated round	Dark hilum
R12: Masindi yellow short	CIAT*	Landrace (Uganda)	-	TZYR11	3	29	medium	Round oval	Brown hilum
R13: Njano Gololi	CIAT*	Identity contention	-	TZYR2	2	35.4	medium	Round oval	Brown hilum
R14: Moore 88002	CIAT*	Released in neighboring countries	-	TZYR6	3	29	medium	Round oval	Brown hilum

**CIAT-Kawanda*

***Official varieties are the ones officially released and registered in Tanzania. Identity contention refers to varieties that TARI breeders frequently encountered with varying names and hence contested their identity*

Bubϯ=Bubayi market

5.3. Data Analysis

The Intertek lab generated a dataset consisting of 1,312 biallelic SNP data from the 48 single nucleotide polymorphic (SNP) markers. The data was cleaned by converting any 'unused' or 'uncallable' entries to missing data ("NA"). The cleaned data set was imported into the Adegenet R package (Jombart and Ahmed, 2011). Preliminary analysis was carried out to identify and remove any non-informative SNP markers using the same program. This resulted in eight SNP markers being removed from the final analysis. Data was analyzed using Discriminatory Analysis of Principal Components (DAPC). DAPC was chosen because usual approaches such as Principal Component Analysis (PCA) or Principal Coordinates Analysis (PCoA / MDS) focus on the global variation/diversity overlooking differences between groups. On the contrary, DAPC optimizes the diversity between groups while minimizing the diversity within groups by seeking synthetic variables, the discriminant functions, which show differences between groups as best as possible while reducing variation within groups. DAPC transforms data using PCA and then performs a discriminant analysis on the retained principal components. For this analysis, 15 principal components accounting for 85% of the observed variance were retained for analysis using DAPC.

Individual coordinates from the DAPC output were finally extracted and a scatter plot made using the ggplot2 R package (Wickham, 2016). This analysis resulted in the trader samples clustering around only 10 of the 14 varieties. To investigate the inability of DAPC to cluster market samples around all the 14 yellow bean reference lines, a physical map file of the SNP markers was developed and a similarity matrix for the 14 reference lines was calculated using the program TASSEL (Bradbury et al., 2007). TASSEL calculates distance as one - IBS (identity by state) similarity, with IBS defined as the probability that alleles drawn at random from two individuals at the same locus are the same. The distance of+ an individual from itself is set to zero. The similarity matrix was imported into R (R core team, 2018) and a heat map was drawn using the R package Complex Heatmap (Gu et al., 2016) to cluster the reference varieties. Finally, a set of trader samples were grouped to the identified clusters of the reference varieties.

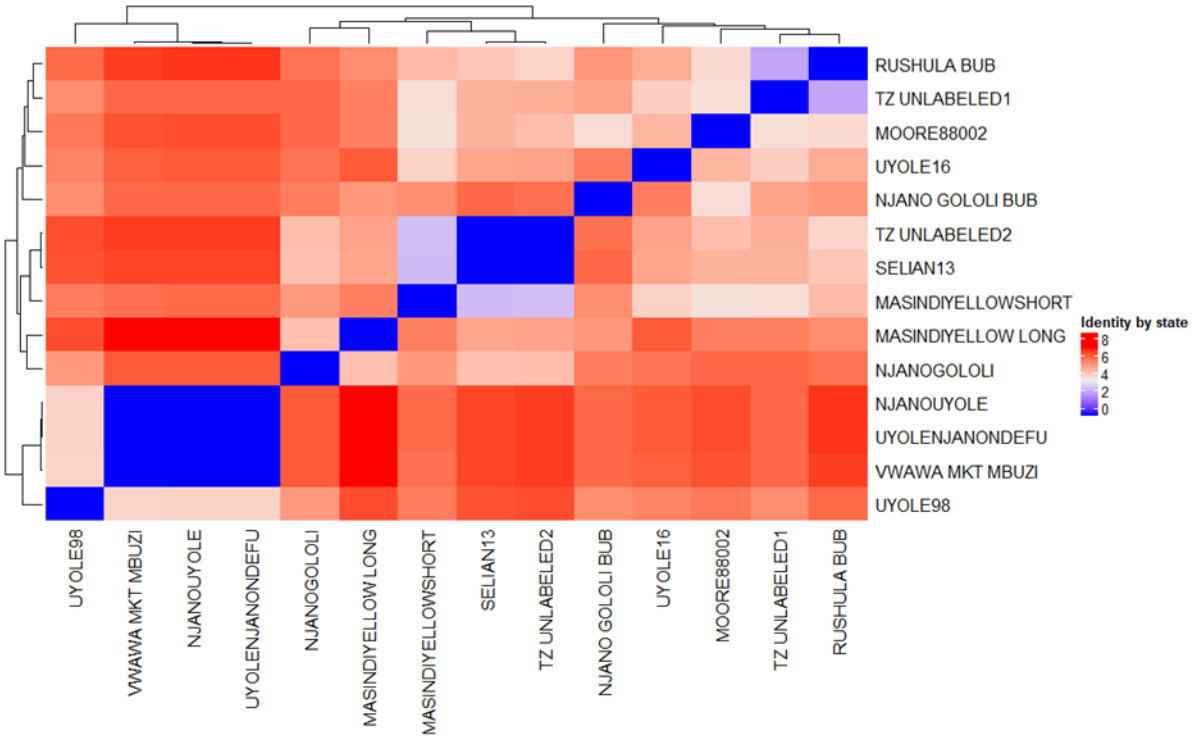
5.4. Results and Discussions

DNA fingerprinting is a powerful tool that can be used to accurately identify individuals and its power has been demonstrated in this study. DNA fingerprinting is the process through which genetic material is extracted from a sample taken from an individual plant, or population of plants, in a field and then compared to a known set of genetic profiles – referred to as a library of reference samples. The individual sample is then matched to its closest reference sample providing a definitive answer whether the sample is or is not that variety or cultivar. In this study, 48 QC SNP markers and 14 reference varieties were used to differentiate among the yellow trader samples. Eight of the markers were uninformative and had a minimum allele frequency (MAF< 0.1) and hence were removed remaining with 40 informative markers. DAPC Clustered the market samples around 1010 of the 1414 yellow bean reference lines and three groupings were obtained:

i) Most of the market varieties clustered with yellow bean reference varieties *Njano Gololi*, Selian 13, TZ Unlabeled specimen2, Rusharura, and Masindi yellow long in one cluster.
ii) Other market samples formed a smaller cluster with reference varieties *Uyole 16, Masindi yellow short*, *Moore 88002*, and *Njano Gololi* Bub† in cluster.
iii) The smallest number of market samples clustered with reference variety Njano Uyole in cluster.

The heatmap (*Figure*) generated from TASSEL showed similarity among the reference materials making six unique clusters from the 14 reference varieties. Two of the reference varieties that did not group into any cluster by DAPC (Vwawa Mbuzi market and Njano Uyole ndefu) were shown to be highly similar to the Njano *Uyole* variety as shown by the heatmap (IBS=0). The third variety un-clustered by DAPC (TZ Unlabeled 1) was shown to be similar to *MOORE88002* and *Rusharura*. All the *Uyole* lines with the exception of *Uyole 16* were shown to be genetically similar. *Selian13, Masindi yellow short* and *TZunlabled2* were shown to be very similar while Masindi yellow long was shown to be similar to *Njano Gololi* from CIAT (Figure 13).

Figure 11: Similarity matrix derived heatmap of fifteen yellow bean reference lines



Trader samples were clustered to the six clusters generated from the heat map (Figure 13).

- The largest cluster, Group 1, comprised of the references Selian 13, Masindi Yellow *short, Njano Gololi from Bubabyi Market* and Tzunlabled2 that made up 44.9% of the samples,
- Group 2 comprised of the samples that did not cluster with any of the reference varieties and contributed 18.9% of the trader samples,
- Group 3: The next largest group comprised of Masindi yellow *long* and *Njano gololi (CIAT)* and contributed 13.2% of the trader samples,
- Group 4: *Uyole 16* (11.5%),
- Group 5: *MOORE88002, Rusharura* and *TZ Unlabled1Unlabled1* (6.5%),
- Group 6: *Vwa Mbuzi, Njano Uyole, Nyole Ndefu* and *Uyole98* (5.0%) (

- *Table 31*).

The findings indicate that traders deal in mixed populations of yellow beans (landraces and improved varieties) as shown by the groupings observed with a good proportion (approximately 19%) of the traded beans not identifiable. It can be assumed that the unidentified samples are probably landraces or other regionally released varieties that have existed with farmers for some time or even introduced bean lines that remain with farmers through participatory variety selection exercises conducted by TARI and have gained notable market share in the Tanzanian grain markets. The reference set included known yellow bean varieties in Tanzania but missed some varieties released in the region or neighboring countries.

Three of the TARI released yellow bean varieties; *Selian13, Uyole16* and *Njano Uyole* (Group 1, 4 and 6) have been identified as major components of the yellow beans being traded as they accounted for 61.3% of all the traded yellow bean varieties (

Table 31).

Table 31: Proportion of yellow bean trader samples according to the reference varieties

Key	Reference varieties	% of trader samples	Group name
Group 1	SelianSelian 13 Njano Goroli Bub† Market Market (TARI) Masindi Yellow short TZ Unlabeled 2	44.9	Selian 13
Group 2	Un-clustered	18.9	Unknown
Group 3	Masindi Yellow long Njano Goroli (CIAT*)	13.2	Masindi Yellow
Group 4	Uyole 16	11.55	Uyole 16
Group 5	Moore 88002 TZ Unlabeled 1 Rusharura	6.5	MOORE 88002
Group 6	Njano Uyole Uyole 98 Uyole Njano Ndefu Vwawa Market Mbuzi	5.0	Njano Uyole

BUB†= Sample from Bubabyi market in Tanzania.
CIAT=Sample maintained at CIAT gene bank in Kawanda.*

Selian13 (Group 1) was released in Tanzania in 2018. The study showed that the variety has successfully penetrated the market as it contributed to 44.7% of the yellow beans being traded. This points to a pluralistic seed system and multi-channels that has managed to push this variety that is only two years old in the market since its official release. 122.18122.18 MT of *Selian 13* have been disseminated through the formal channels (TARI research farm, seed companies, QDS producers, etc.) and on thousands of farm demonstrations bundled by small packs distribution. Considering the variety's highly desirable attributes, that make it attractive to the consumers/market (high palatability, short cooking time, low flatulence among others), there is also a great possibility of cross-border grain/seed flow from Kenya where the variety was earlier released in 1987 as Kat B1 and from Burundi where it was released in 2010. It was released in Tanzania to respond to high market/farmers' demand.

However, *Selian13* was shown to be very genetically similar to a local landrace in Uganda known as *Masindi yellow short*. This could be a case of very low genetic diversity among these two bean varieties but possibly an issue of seed mixture as the two are similar phenotypically. It is also probable that the parentage of *Selian13* included *Masindi yellow short*. Pedigree information of *Selian13* is not known.

Another local landrace from Uganda, *Masindi yellow long*, appeared to be dominant in the markets contributing 12.9% of the yellow beans traded. The variety is also very popular in Uganda, and it is probably also popular to Tanzania farmers and consumers because of its culinary traits (fast cooking, swelling when cooked, thick light-colored brown soup when cooked). Although it is highly susceptible to many bean diseases, it performs well under a well-managed system. Due to its similarity to *Selian 13* it has been referred to as *Njano Gololi* based on one sample "*Njano Gololi"* collected by TARI from the market as a reference to be confirmed. Naming of varieties has been recognized as one of the sources of variety identity loss (Bodo et al., 2019).

The *Njano Uyole* cluster (Group 6) included *Njano Uyole* and *Uyole 98*. This was probably as a result of their genetic similarity with both of them having a parent (*Yellow line*) in common in their pedigree, i.e., *Uyole 98* pedigree: *T23/Chipukupuku)/Yellow line* and *Njano Uyole* pedigree: *L112 x Yello*w line though they are

phenotypically different varieties (see Table 30). *Uyole98* (orangish in color) was released in 1998 while *Njano Uyole* (bright yellow towards green in color) was released in 2008. This point to the need to strengthen the QC marker set to be able to differentiate very closely related individuals. On the other hand, *Uyole 16,* light yellow in color (pedigree: *Uyole 04/Kirundo)/L110*) still remains popular, commanding a market share 11.4% on its own. The QC marker set was able to differentiate it from *Njano Uyole* though they both have the line "*L110*" in their pedigree.

The clustering of very few traders' samples (5.0%)0 with the improved yellow bean varieties *Njano Uyole* and *Uyole 98* compared to 44.9% around Selian13 implies that *Selian13 (*phenotypically similar to *Njano Uyole*; Table 30*)* is slowly replacing *Njano Uyole*. TARI has been proactive in promoting Selian 13 using various dissemination channels, conducting seed fairs where seed is sold in affordable seed packets, and has decentralized the production of early generation seed while at the same time promoting quality declared seed production and distribution.

5.5. Conclusion

Our findings show that:

a) The majority (61.3%) of the yellow beans currently traded in Tanzania are released varieties,
b) There is a proportion (18.9%) of the yellow bean varieties that are not known and could be landraces; or probably yellow bean varieties that were introduced to Tanzania through other informal cross border grain/seed channels and have gained popularity in the market as farmers own varieties because of the consumer demand
c) There is need to strengthen the QC marker set to be able to differentiate between very closely related varieties, e.g., Uyole 98 and Njano Uyole.
d) Good understanding of grain market lay founding for more private investors in seed systems
e) The consumer's variety demand pulls the specific farmers' variety demand and ultimately accelerates the variety wider dissemination and adoption (see also Rubyogo et. al 2019a).
f) Women traded in relatively smaller quantities compared to men. Furthermore, women were more dominant in the retail trade than export or wholesale trade.
g) Traders play a major role in variety dissemination especially when it responds to consumer's demands.
h) A majority of the varieties, though informally traded, originated from research stations thus indicating the need to strengthen the link between research and informal bean traders to participate in the dissemination of improved varieties.

6. RECOMMENDATIONS

The survey targeted major traders in the yellow bean corridor in Tanzania and included retailers, wholesalers, aggregators and exporters. The survey shows that the trade in yellow bean was active and dynamic across the corridor in Tanzania and beyond. It can be developed further to improve livelihoods of millions of men and women small holders and traders whose majority are women and youth. However, its potential is yet to be attained due to some challenges that need to be addressed. These are addressed via the recommendations discussed below.

I) Informal grain traders should be supported with more knowledge and skills to maintain a higher quality of potential seed by closely working with breeders and dissemination agents.

The seed supply system to the yellow bean corridor is largely informal, managed by the grain traders, and is quite vibrant. Oftentimes, yellow bean traders also double as seed suppliers and could be an avenue for improving the seed system supply of the yellow bean corridor. Sustaining supply of high-quality planting material is critical to the success of the yellow bean corridor. The seeds are mainly sourced locally in the same districts or region; grain is sourced beyond the trader localities. In addition, data suggests that most seeds are sold around sowing times, a period that mainly ranges between September and December. This is the period when traders are most active in sale of planting material, and the price change reflects the heightened demand for planting materials, well above the regular consumption demand. Traders expressed interest to be supported on how to improve supplying seeds to producers that they buy grain from. This provides interesting opportunities for improving the informal-led yellow bean supply system in the production hubs in Tanzania. Most traders were not aware that they were trading new improved yellow bean varieties or never worked with the varieties. Most traders mentioned the *Gololi* type that they would prefer to work with due to established consumer preferences and demand in the major captive markets such as Dar es Salaam. Suitable production hubs should be supported to improve seed quality and production for the demanded varieties. Only a few (less than 4) yellow bean varieties have been released though the number of varieties in the market exceed 10.

Results from the DNA analyses showed that more than half of the traded varieties were released in Tanzania while the rest were either local landrace or have been released in neighboring countries. The released varieties provide a chance to improve the informal based seed supplies to respond to market demand. The released varieties such as *Uyole 16* and *Selian 13* show high market preference.

Areas for improvement in informal seed supply include variety awareness creation and information materials, quality and post-harvest management and advisory on improved agronomic practices. The other area of improvement would be to support to local seed production of market demanded varieties by large traders or improve linkages between seed producers and grain traders. Since already more than 50% of the major bean traders also supplied planting materials, and among these traders, some also grew yellow bean—observations also indicated that most traders that also grew yellow bean usually reserved their grain to be sold as planting materials. They usually planted good quality grain and practiced some post-harvest management so that the grain can be recommended for seed to potential buyers and producers during sowing times.

II) There is need to strengthen the yellow bean corridor to better translate grain market demands to seed demands to leading to more structured yellow bean trade: The existence of the yellow bean corridor is established across Tanzania and the region at large (Burundi, DRC, Kenya, Rwanda, Uganda, Zambia). it demonstrates a huge market pull in the Eastern and Southern Africa region. . Within Tanzania, the corridor is active across five (5) zones in the country: Southern Highlands, Western, Lake, Northern and Coastal zones. These zones contain the main production hubs and consumption hubs that require attention to promote the yellow bean corridor. This study demonstrated that surveyed traders handled more than 40,000 MT of yellow bean. The actual and potential grain and seed market is much higher for trade and incomes for Tanzania.

The yellow bean corridor is active, agile and dynamically growing from the original corridor mainly in Lake and Western zones to new zones such as Southern Highlands, Northern zones, and Coastal zones. The major production zones include the regions of Kigoma, Kagera, much of southern highlands, Arusha, Manyara,

Kilimanjaro and the Tanga region. The major distribution hubs are found in Arusha, Dar es Salaam, Kagera, and Kilimanjaro markets. The major consumption hubs for the yellow bean include Dar es Salaam and Pemba; Kenya via Arusha and Kilimanjaro. Very small quantities of yellow beans come from neighboring countries into Tanzania; however, the quantities exported out of the country are much larger. The yellow bean corridor provides an interesting avenue to strengthen the informal yellow bean seed especially when the platforms that implement the corridor work are further strengthened through interlinking of the key actors and stakeholders.

Traceability in the yellow bean corridor, especially for potential seed supply but also for closer linkages between aggregators and grain producers. This is one area in which traders expressed interest to be supported as part of yellow bean corridor strengthening in Tanzania. Digital payment solutions via the system of aggregators is one such possibility to support the development of the value chains. The digital payment system links each individual supplier with the produce he/she supplies for quality purposes when contracting seed multipliers. Delivery of grain or seed is directly associated with the supplier via digital traceability integrated in the payment service. Discussions have been initiated with some of the aggregators in Kagera region to support the closer linkages through a platform that fosters more collaboration with other actors in the value chain via social media communications (WhatsApp platform).

III) There is need to estimate the sizes of market segments for the different yellow bean varieties due to current diversity in preferences across the country's hubs. The yellow bean diversity is highest in the West of the country (Kigoma). The prices of these varieties also differ to reflect demand in the market. Despite the diversity in the yellow beans, there are clear preferences among the varieties by traders and consumers. There are also quality perceptions of the varieties which are linked to the source of the varieties; yellow beans from the Northern zone and Tanga region are considered of superior quality, while yellow beans from Kagera are considered low quality beans by markets in Dar es Salaam. The preferred yellow bean in Dar es Salaam and other markets is a relatively large-sized, round yellow bean variety, generally referred to as '*Gololi*.' This variety was also the most traded in Dar es Salaam and northern zone markets. It is one of the released varieties though the seed is mainly informal in nature.

Results show that there are distinct consumer preferences for the yellow bean genotypes and that the beans are not homogenous with respect to the preferences. Two traits that drive the preference for yellow bean over other bean market classes—its superior taste and palatability (with more than 70% of responses). There is a market for high quality/premium-high price yellow bean in Dar es Salaam and much of Northern Tanzania that requires single, non-mixed *Gololi* type beans. Prices of yellow bean varieties vary by variety, type of hub and by type of trader or stage in the value chain. The *Gololi* variety fetches the highest prices in all markets. Consumers naturally paid more for the beans compared to traders and selling closer to the consumer hubs fetched higher prices. There is also a market for second rate quality yellow beans—could be mixed with other yellow beans, generally lower price (price sensitive consumers) and this is largely found in some of the export markets such as Kenya. However, though the traders in Kenya purchased this kind of bean, they ultimately sorted out the beans and still sold them out to consumers as top-quality beans and at higher prices (almost Dar es Salaam market). Overall, production hubs had lower prices as expected. According to traders, the peak selling periods coincides with planting periods. September to December reflect the peak selling periods, and in these periods, prices are highest for the beans. The increased demand stems from use of the grains for planting materials. More than 50% of the traders reported being actively involved in selling grain used by farmers for planting. Based on the yellow bean market segmentation, there is a need to develop and deploy investment plans based on specific varieties. This will incentivize farmers and traders to invest in their business.

IV) ***There is need to support women and youth to upgrade their yellow bean enterprises by addressing key constraints that affect them***. Traders close to production hubs handled relatively larger quantities of bean—traders aggregated grain from producers using networks of aggregators and collectors in the production areas. Being closer worked better for women traders. Women dominate retail trade in the yellow bean, while men dominate export and aggregation businesses. Women sold closer to their locations within the district; similarly, they mainly sourced grain nearer their localities while men tended to source and sell in distant regions or regional markets. Disaggregated data by age and gender reflects key business opportunities for women and

youth. More than 60% of traders and retailers are below the age of 45 in our sample and 55% of the traders were women, and most of the retailers were women. Establishing new or strengthening existing linkages and platforms between key stakeholders will generate business for burgeoning youth in Tanzania and women retailers in markets through services such as credit, mechanization, threshing, transport and aggregation of produce.

V) Policies to eliminate non-tariff barriers will reduce the cost of moving beans from one administrative unit to another or across borders: Some levies are still in place especially when moving beans from one district to another; cross border trade is also affected by higher costs of processing export papers — as such, few traders directly venture beyond the borders and would rather stop at the border points while their trading partners cross over to pick grain at the border points The nature of trade is mainly informal trade –non firms processing yellow beans were observed except in Kagera where one company had started processing the grain for export markets. These could be supported from policy angle. The support for local yellow bean seed systems of market preferred beans varieties needs to go beyond formal seed systems. Such support should be cognizant of existing seed supply in the informal seed systems comprising of grain traders. There is a need to establish sustainable linkages between the grain/seed traders and the formal seed producers and bean breeding programs

VI) Breeding programs should be cognizant of market demands for the varieties.

There are constraints that effect the supply of good grain and seeds which can be improved by the breeding of more consumer and farmer demand varieties. These include the challenges regarding quality such as discoloration of some of the yellow beans when stored for longer periods; traders preferred that the beans should retain the original colors. Other challenges include lower productivity of the existing yellow beans varieties. This will be strengthened through the ongoing demand led breeding approach which is being implemented by PABRA. Already product profile for purposes of supporting yellow bean breeding have been developed targeting the replacement of some of the indigenous varieties (that are susceptible to diseases and have low yields though sometimes resilience to droughts), while ensuring that consumer preferences remain intact and that both consumers and producers are able to make necessary choices.

VII) Institutional support for the development of yellow bean integrated seed systems

The YB study provides insights on seed and grain business opportunities. The study showed that informal seed systems are highly resilient and disseminate new varieties in case they are market demanded. However, they can be improved if they were sustainably linked to formal seed and the bean breeding program. Furthermore, the study showed that a good understanding of the grain market will lay the foundation for more private and public investments in both informal and formal seed systems. Generally, there is limited policy support and public investments in the informal seed system. There is a need to develop investment plans to support an integrated seed system and bridge formal and informal systems. This will require engagement with relevant institutions and organizations (Ministry of Agriculture, TARI and TOSCI), to support integrated seed systems particularly for the market-preferred yellow bean varieties.

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