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Transforming Last Mile Seed Delivery: Case of High Iron Beans (HIBs) Niche Market Business Model in Lower Eastern Kenya

Second Season Study Report

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Acronyms and Abbreviations

The Alliance	The Alliance for Bioversity International and CIAT
CIAT	International Centre for Tropical Agriculture
CRS	Catholic Relief Services
DSL	Dryland Seed Limited
ECABREN	Eastern and Central Africa Bean Research Network
FAO	Food and Agricultural Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FSC	Farmer Service Centres
IFAD	International Fund for Agricultural Development
KALRO	Kenya Agricultural and Livestock Research Organization
KEPHIS	Kenya Plant Health Inspectorate Services
KNBS	Kenya National Bureau of Statistics
KSC	Kenya Seed Company
KSU	KALRO Seed Unit
Mt	metric tonne
NARS	National Agricultural Research Systems
S34D	Feed the Future Global Supporting Seed Systems for Development activity
SABRN	Southern African Bean Research Network
SDG	Sustainable Development Goals
SSA	Sub-Saharan Africa
TAAT	Technology for African Agricultural Transformation
UNICEF	United Nations Children's Fund
WECABREN	West and Central Africa Bean Research Network
WFP	World Food Program
WHO	World Health Organization

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Executive Summary

It has been reported that more than 90% of farmers access their seeds, including beans, from informal sources. In a world where malnutrition and hidden hunger hinder the achievement of the United Nations' food security goals and poverty eradication efforts, it is now more urgent than ever to use more innovative ways of availing improved and nutrient-rich crop varieties to farmers. In the current period of the COVID-19 pandemic, almost one in 10 people (8.9 percent) of the world population and 23 percent of the Kenyan population is undernourished. In Kenya, 4.2 percent of children under the age of five are severely wasted as of 2019. An additional 26.2 percent of children under the same age stunted. Lower Eastern Kenya (Kitui, Machakos, Makueni counties) is the most affected, with 45.8 percent of children under five wasted in Kitui County. In addition, iron deficiency stands at 73.4 percent and zinc at 51 percent.

Breeding bio-fortified crops is one of the innovative pathways devised to combat both hidden hunger and malnutrition. The Alliance of Biodiversity International and CIAT (Alliance) and National Agricultural Research Systems (NARS) partners have developed high iron and zinc bean varieties through biofortification. These varieties hold the potential to address anemia, improve cognitive abilities and boost the immunity of vulnerable children and adults, thus contributing to a reduction in mortality. PABRA has been coordinating partners to ensure the bean seeds reach the last mile and sustainably enable access to these micronutrient-rich beans.

PABRA conceptualized the niche market business model envisioning efficient and effective last-mile seed delivery of the high iron and zinc beans. A variety is said to be "niche" if, i) it has *unique attributes* linked to breeding (for example, disease resistance, micronutrient richness) that are of urgent need among end-users; ii) the *process of regulatory approval and release* for commercialization is fast-tracked because of the need and; iii) there is *early on-boarding of the private sector* for release and subsequent commercialization of the varieties. The release of the high iron and zinc bean varieties fulfilled these criteria.

The micronutrient-rich attribute of these beans is appealing to seed companies, agro-dealers, and end-user (farmers). However, the delivery of these varieties to the last mile is yet to be achieved. This current study sought to determine if efficient and low-cost non-traditional channels for seed distribution (*viz* use of motorbike riders) can enable reaching the last mile while presenting a viable business case for seed companies and agro-dealers. The objectives of this study included: i) to find out the factors affecting farmers' willingness to test new micronutrient-high iron beans (Nyota); ii) to assess the potential benefits of using motorbike riders (*Boda boda*) for last-mile delivery of high iron bean seed and; iii) to assess the policy implications of the use of motorbike riders (*Boda boda*) for last-mile delivery of bean seeds.

The study results show that among 334 farmers interviewed 54% were male and 46% were female. On average, 57 percent were 45 years and above. The farmers had an average of 1.47 ha of land and women accessed 15 percent more land than males. Despite being a relatively new variety (released in 2017), 19 percent of the farmers were aware of the Nyota variety's existence. The farmers' willingness to "test" the variety, the demand reported as a result of the promotion at the agro-dealer outlets, and the rate of depletion for stock delivered means that it made business sense for agro-dealers to stock the variety. In terms of value chain analysis, Dryland Seed Limited (DSL) gave each of the 13 agro-dealers 240 kg of *Nyota* seeds packed in 2 kg packages (totaling 3.12 metric tonne (mt)), with over 90% being sold out during the two weeks of the survey. However, 78 percent of the farmers reported sourcing their bean seeds from informal channels like fellow farmers, local open-air markets, and neighbors. However, specifically for *Nyota*, 60 percent of seed was sourced from agro-dealers, and seed companies, partly because the seed was available to the farmers for the first time. The willingness-to-adopt results among the 205 farmers who bought *Nyota* seed indicated that *Nyota* variety was preferred for its high yielding, early maturing, and high iron and zinc content attributes. Specifically, females preferred *Nyota* for its drought tolerance/resistance, less flatulence, high yielding, early maturing well-adapted variety, and high nutrition qualities (zinc, iron), not in any given order. Male farmers (62 percent) purchased the *Nyota* variety more than the female farmers, mainly because of its high yielding attributes.

Network analysis indicated that most farmers lived within a 10 km radius of coverage of a given agrodealer, with a few living up to a 37 km radius. Seventy-one percent (71%) of *Boda boda* riders covered a distance of 10 km and below, meaning that most farmers were in areas not too far from the towns where they could source the seeds. From the

analysis, the non-traditional seed distribution method of using *Boda boda* can reach the last mile effectively even with the physical infrastructural challenges. The use of *Boda boda* riders to distribute seed in Kenya may help many farmers while creating business opportunities for themselves, seed companies, agrodealer . An ICT integration (similar to the Point of Sale (PoS) tool) that can enable farmers to place orders for seed (and other farm inputs) and make mobile money payments could potentially increase seed uptake and the number of businesses. Finally, the model can be used to understand the uniqueness of adoption processes for the high iron bean (HIB), given that it is new, and a niche variety compared to other bean varieties.

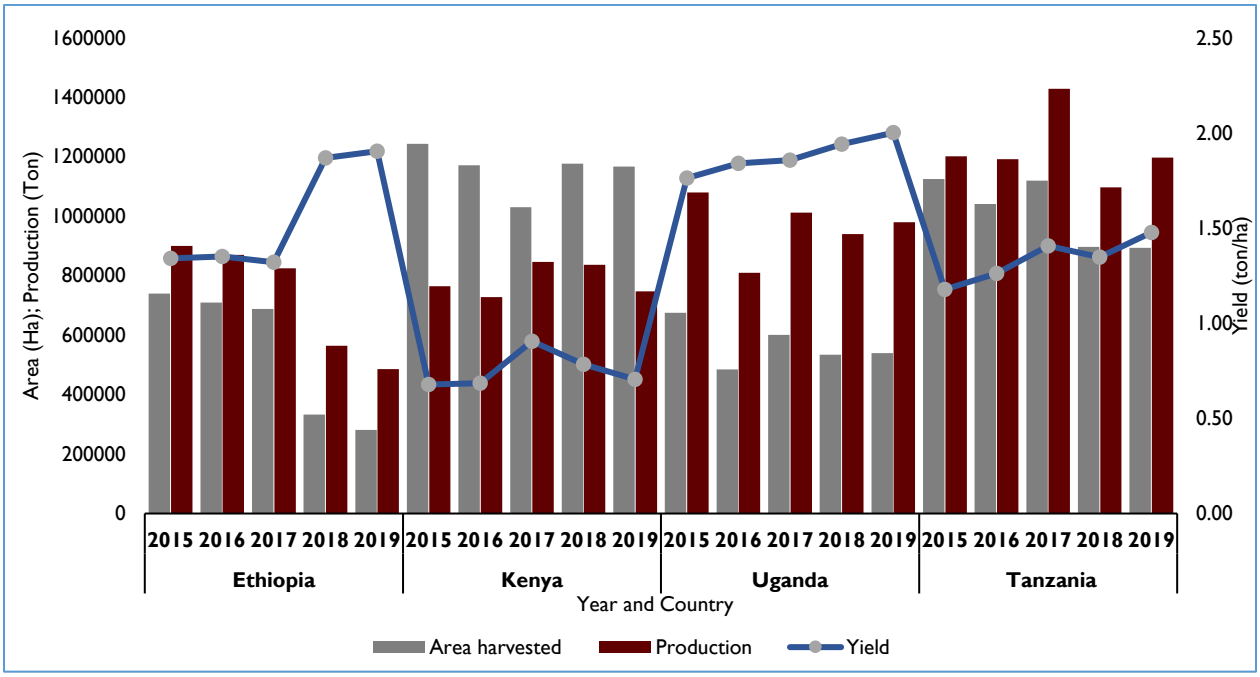
The follow-up feedback survey among 205 farmers showed that farmers were happy with the production of Nyota relative to other bean varieties even though the rains were erratic. However, farmers identified gaps that could hamper *Nyota* seed uptake. These include i) limited awareness of the seed delivery services offered by *Boda boda*; ii) difficulty in finding supplies for *Nyota* seed from local agro-dealers and; iii) the high cost of the 2 kg pack of Nyota seed. Nonetheless 79% (80% of women and 78% of men) said that they would use *Boda boda* services in the future.

1. INTRODUCTION

1.1. Common Bean Outlook – Global and Kenyan Perspective

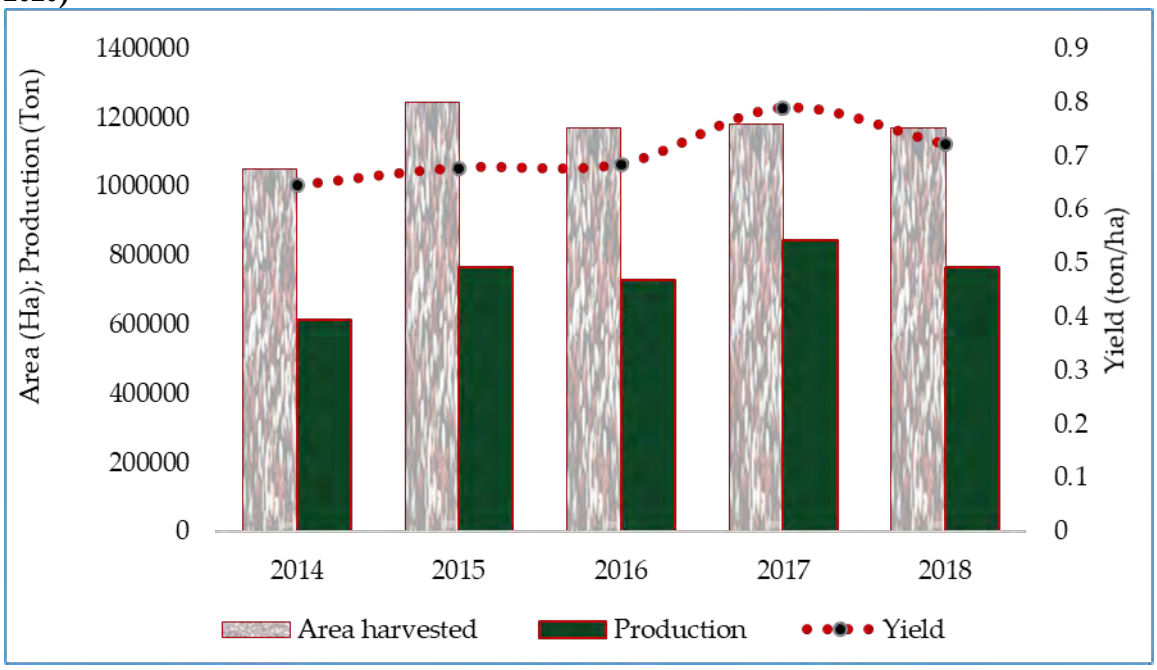
Globally, dry common bean (*Phaseolus vulgaris* L.) outlook indicates that in 2018, approximately 48 million hectares were harvested, with yields approximated at 0.788 metric tonnes per ha (IndexBox, 2020). In East Africa, 82,000 metric tonnes were reported to have been traded in the first quarter of 2020, representing, on average, 21 percent less than what was traded during the same period in 2019 (FSNWG-MAS, 2020). Tanzania is East Africa's bean production powerhouse, with approximately 1,210,359 metric tonnes grown in 2018 (FAOSTAT, 2020). Kenya ranked number 10 in terms of global common bean production in 2018 and the third leading producer in East Africa after Uganda and Tanzania, in the same period as shown in Figure 1 below (FAOSTAT, 2020). In terms of yield, Kenya ranked fourth after Tanzania, Ethiopia and Uganda.

Figure 1: Area harvested, Production, and Yield of Common Beans in Eastern Africa (FAOSTAT, 2020)



Recently, the Kenya National Bureau of Statistics (KNBS) census results showed an estimated 3.6 million households engaged in bean farming (Kenya National Bureau of Statistics, 2019). The top five counties in bean production included Kakamega (6.9 percent), Bungoma (6.2 percent), Machakos (5.4 percent), Meru (5.0 percent), and Muranga (4.9 percent) (Kenya National Bureau of Statistics, 2019). As indicated in Figure 2, production was 765,977 metric tonnes in 2018, which declined by 10.8 percent to 749,000 metric tonnes in 2019 (Kenya National Bureau of Statistics, 2020). The national average production seems to have stagnated, having risen by 149,985 metric tonnes between 2014 and 2018. Despite an increase in area under production from 1,052,408 ha in 2014 to 1,170,173 ha in 2018 (an additional 117,765 ha) productivity still remains low though it increased marginally from 0.64 to 0.72 metric tonnes/ha between 2014 and 2018 (FAOSTAT, 2020).

Figure 2: Area harvested (ha), Production (mt) and Yield of Common Beans in Kenya (mt/ha) (FAOSTAT, 2020)



On the other hand, the national consumption has been assessed to be around 755,000 metric tonnes per annum, with an average estimated per capita consumption of 16 kg per person per year. However, this value rises to 66 kg per person per year in the Western regions of the country (Duku et al., 2020; Kenya National Bureau of Statistics, 2019). To account for deficits in production, Kenya sometimes reportedly imports up to 50 percent of dry beans annually from Uganda, Tanzania, and Ethiopia (IndexBox, 2020). In 2019, Kenya officially imported 16,000 metric tonnes of dry beans to meet its deficit (Kenya National Bureau of Statistics, 2020). Kenya has two main growing seasons for the common beans, with agro-ecological zones dictating the months of long and short rains. For instance, along the Rift Valley and the Western Kenya regions, most farmers grow beans during March – May season; while most farmers from Central and Eastern regions (70 percent) prefer the short rains of October to December (Duku et al., 2020).

1.2. Micronutrient Deficiency and the Potential Role of High Iron and Zinc Beans in Kenya

In the current period of the COVID-19 pandemic, almost one in 10 people (8.9 percent) globally is undernourished, with 250 million being in Africa alone (FAO, IFAD, UNICEF, WFP, and WHO, 2020). This situation adds to the triple-burden of malnutrition (obesity, micronutrient deficiencies, and undernourishment) (Lundqvist & Unver, 2018). It is estimated that 47.5 percent of the population cannot afford nutrient-adequate diets in Kenya, while 23 percent are undernourished (FAO, IFAD, UNICEF, WFP, and WHO, 2020). Additionally, 19.1 percent of the population is severely food insecure. Micronutrient deficiency is severe among women of reproductive age and children under the age of 5 years. About 4.2 percent of children under the age of five are severely wasted as of 2019, with an additional 26.2 percent of children under the same age being stunted *(ibid)*. The highest stunting rates have been observed in Lower Eastern Kenya, especially Kitui County, with 45.8 percent considered stunted (KNBS, 2015).

Kenyan Food and Nutrition Security Policy (MoA, 2011) addresses some of these issues by placing nutrition at the center of human development in Kenya and making it a constitutional right. For example, through a multi-sectoral approach to addressing malnutrition, the biofortification of common beans has been integrated into the policy to address micronutrient deficiency (hidden hunger). While evidence indicates that severely food insecure households consume more than 320 g/capita/day of cereals and their products (FAO, IFAD, UNICEF, WFP, and WHO, 2020), pulses (beans and nuts) have witnessed a 50 g/capita/day consumption among the severely food insecure. According to the Kenya National Bureau of Statistics (2019), common beans formed the bulk of the calories supplied from the

pulses category (52.3%). Among the newly released improved common bean varieties include climate smart high iron and zinc bean varieties which have quickly become the farmers' favorites (Dalberg, 2019).

As the Kenyan Nutrition Security Policy places partnerships among its operational frameworks, Pan Africa Bean Research Alliance (PABRA) and Kenya Agricultural and Livestock Research Organization (KALRO) have taken advantage of the opportunity to breed biofortified common beans with high iron and zinc content (PABRA, 2018). The high iron beans (HIB) and high zinc beans are meant to address the iron deficiency, anemia (26.9%) (Oyungu, et al, 2021) and zinc deficiency (51%) among children under the age of five and 60% iron deficiency among pregnant women in Kenya (MoA, 2011). In 2015, a HIB efficacy trial involving college-age women in Rwanda proved a link between HIB consumption and improved cognitive capacity (Murray-Kolb, 2017). These bean varieties can contribute to alleviating hidden hunger and combating issues of anemia among women of reproductive age.

1.3. Existing Bean Seed Systems Bottlenecks in Kenya

Less than 3 percent of the world's seeds are accessed through formal channels (Sperling et al., 2020); this is as low as 1 percent in Sub-Saharan Africa (Ojiewo et al., 2020), with 0.5 percent coming from community seed production groups. The Kenyan formal seed system began around 1956 through the Kenya Seed Company (KSC). In 1981, the Ministry of Agriculture established a seed multiplication center for open-pollinated varieties (OPV), managed by the then research division, which transitioned to the current KALRO (Mucioki et al., 2016). KALRO Seed Unit (KSU) was established in 1997 to market and disseminate these varieties to farmers. The multiplication rate of the required seeds by farmers was constrained by requirements of extra space, labor, commercial partners (private sector seed companies) and further complicated by an effort to move seeds from breeder seed to certified at commercial scale (Ojiewo et al., 2020). As of 2019, 159 active seed merchants (companies) were registered in Kenya with additional 5,726 seed sellers licensed to sell certified seed (Kenya Plant Health Inspectorate Service, 2019).

A formal seed system ensures varietal identity and purity, with seeds characterized by optimal physical, physiological, and sanitary quality. Building on the PABRA demand led seed systems model (Rubyogo et al, 2010, Rubyogo et al, 2019), KSU, Dryland Seeds Limited (DSL), Bubayi Products Ltd, and East Africa Seed Company have played a critical role in multiplying and distributing the high iron and zinc beans in Kenya. PABRA brought together players from different fields around an off-taker for fast multiplication and generation of tradable volumes of grain to guarantee access to bean seeds and subsequent production and sale of grain through the bean business platforms. Several last mile solutions were tested to reach the last mile smallholder farmers. For example, Bubayi Products Ltd produces over 300 metric tonne of dry bean seed per year to meet the demand. One of the PABRA partners, Cereal Growers Association, formed Farmer Service Centres (FSC), autonomous and self-governing platforms, at the smallholder farmer level where multistakeholder activities occurred. The FSCs support agro-input suppliers-led demonstrations, lead farmers and related farmers, local extension, and agro-dealers (Buruchara et al., 2018). Recently, to reach the last mile, ICT and mobile phone-based tools that trace seed delivery to smallholder farmers using motorbikes (*Boda boda*) have been developed and tested for the HIB seeds (USAID and CRS, 2020). This innovation is being tested further in this study.

On the other hand, 90 percent of farmers get their seeds through informal channels (Sperling et al., 2020). These may include community-based seed producers/farmer to farmer and informal grain (seed) markets. Various factors inform access of seed by farmers from informal seed systems. Sometimes, formal seed systems may be characterized by weak oversight, making improved seeds adulterated and labels copied before farmers purchase them from agro-dealers or other formal seed sources (Wineman et al., 2020). Another issue is that seeds are sealed, and farmers may not visually inspect the seed quality or type (*ibid*). For improved varieties, often found at agro-dealer outlets, repeated shortages in regular stocking affect farmers' consistent purchase as they are never sure to find the seed they need. These and other factors may drive farmers to look for seeds from informal channels. However, seed costs and access have been the most challenging aspects for farmers (Mucioki et al., 2016). Some farmers live very far from agro-dealers and may be wary of the high transaction costs these may attract. Subsequently, informal seed systems fill in the gap (GIZ, 2014).

Intermediary systems have also been recognized as those seed systems on their way towards formalized regulations (GIZ, 2014). These include relief seeds and local seed businesses. To harmonize the three seed systems (formal,

informal, and intermediary), some approaches such as Integrated Seed Sector Development (ISSD) may strengthen the informal seed system.

1.4. The Niche Market Business Model and its Assumptions

As mentioned above, KALRO, in partnership with PABRA, has tested and released three biofortified varieties (*Angaza, Faida,* and *Nyota)* rich in iron and zinc. High iron and zinc make these varieties considered "niche products" and candidates for promotion through a niche market business model. The niche market business model provides quality seeds of improved varieties for crops with niche market demand and can be profitable when produced in specific quantities (FAO, 2019). Due to the HIB varieties' nutritional importance, efforts have been put in place for fast-tracked release and promotion to reach many producers and consumers and reduce malnutrition associated with micronutrient deficiency.

A niche market business model is built on the following assumptions:

1. There is an urgent need for micronutrient HIBs to address malnutrition in Kenya.
2. There is awareness and demand for HIB varieties and their seeds.
3. The private seed companies are interested in taking up the seeds for distribution in the country.
4. The inclusion of non-traditional and efficient methods such as motorbikes (*boda boda*) to speed up varieties/seed access and adoption, especially at the last mile. This proposition is because it makes economic sense for the smallholder farmers, *boda boda*, and agro-dealers.

1.5. Research Objectives

1.5.1. Overall objective

The overall objective of this study was to test seed delivery pathways and farmer acceptance patterns and practices of new micronutrient-rich HIB seeds (*Nyota*) among smallholder farmers in Kitui, Machakos, and Makueni counties of lower eastern Kenya. This study delineates evidence for determining the validity and potential of the last mile seed delivery systems for the niche HIB variety.

1.5.2. Specific objectives

i). To find out the factors affecting farmers' willingness to test new micronutrient-HIBs (*Nyota*).
ii). To assess the potential benefits of using motorbike riders (*Boda boda*) for last-mile delivery of HIB seed.
iii). To assess the policy implications of the use of motorbike riders (*boda boda*) for last-mile delivery of bean seeds.

1.6. Significance of the 2020 Short Rains Study

Under the PABRA framework, the Alliance, in partnership with KALRO, has introduced niche HIB products that follow the niche market business model for seed delivery. The HIB varieties are partly delivered through non-traditional methods, using *boda boda* riders for the last-mile delivery of seeds. The use of *boda boda* riders can enhance seed access in rural areas far from town, potentially reduce transaction costs associated with seed purchase and enhance access to improved HIBs and resilient bean varieties by the farmer. PABRA's bean Corridor Approach[1] ensures that access to seed must be physically, temporally, and spatially enhanced, as well as economically affordable. It is believed that with the last mile point of sale (PoS) concept, informal seed systems that dominate farmer practices may be reduced. Besides, the efficiency and effectiveness of the bean seed system can be assessed through the PoS concept.

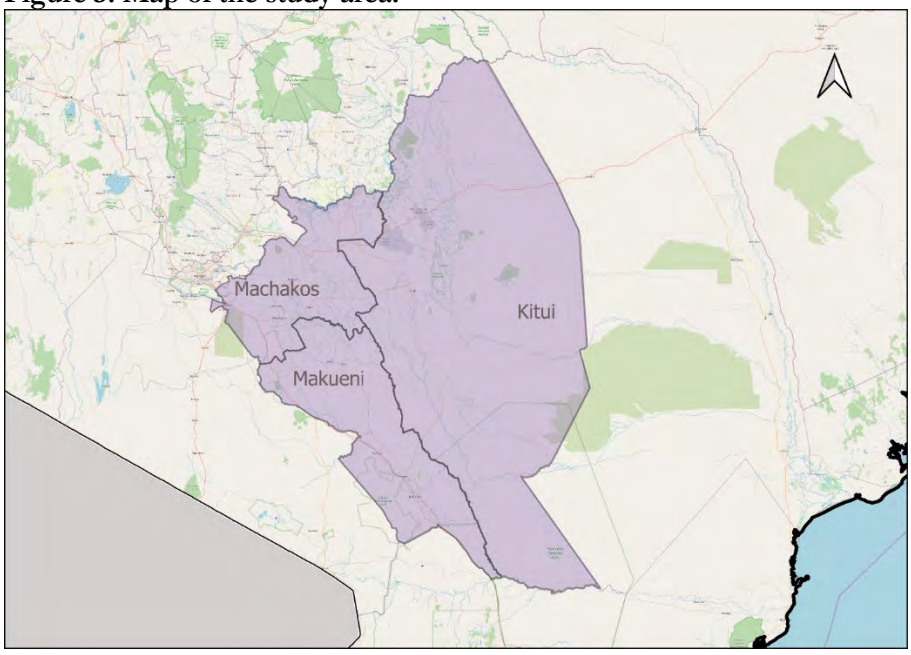
2. METHODOLOGY

[1] The bean corridor approach is framework for market-driven transformation of rural agriculture that focuses on improving the "bean flow" activities including intensifying production, linking farmers and businesses, and mainstreaming nutrition in the value chain. The bean corridor aims at eliminating production bottlenecks, so that improved beans can reach more consumers, and farmers can access better seeds.

2.1 Area of the Study

The study was conducted in Lower Eastern Kenya and targeted seed companies KSU and DSL, agro-dealers, smallholder farmers adopting the *Nyota* bean variety, and *boda boda* riders. Specifically, farmers and agro-dealers in Kitui, Makueni, and Machakos counties (**Figure 3**) were purposively selected for the study. According to the 2019 census, the region covers approximately 65,775 km² with a population of 2,105,493 (Kenya National Bureau of Statistics, 2019). According to Köppen–Geiger climate classification, AW (Tropical Savanna)'s area experiences an arid and semi-arid tropical climate with average annual rainfalls of 1,068 mm and a yearly average temperature of 21.4 °C. The main economic activity is mixed farming with crop farming leading. Specifically, maize and beans are grown on approximately 1.2 ha per farmer on average (County Government of Kitui, 2018). It is, therefore, evident that due to the aridity of the region, it is suitable for improved bean varieties that are drought tolerant.

Figure 3: Map of the study area.



2.2 Data collection

This section describes the various stages of data collection including the baseline survey, main survey and farmer feedback survey.

2.3 Baseline survey

Before the main survey, a baseline survey was conducted among 11 agro-dealers (3 female and 8 male) (customers of Dryland Seed Ltd for seed distribution) between the 21st to the 23rd of September, 2020. The objectives of the study were i) to introduce the Niche Market Business Model, Point of Sale (PoS) pilot, and the second season data collection exercise to the agro-dealers, ii) collect preliminary information on access to bean seed by farmers from agro-dealer outlets and iii) understand the use of motorbike (*boda boda*) riders by agro-dealers for bean seed distribution. The agro-dealer shops were retail outlets, selling a broad spectrum of farm inputs, including fertilizers, pest control products, crop and vegetable seed, and livestock feed, among other inputs, to smallholder farmers within their jurisdictions. Data was collected using a cross-sectional research design. The participants included managers of the 11 agro-dealer shops spread across the three counties of Kitui, Machakos, and Makueni of lower eastern Kenya.

2.4 Main Survey

This section describes two preceding activities – developing the PoS tool (CommCare) and training of enumerators – and the process of actual data collection

2.4.1 Developing the PoS Tool

CRS and Dimagi developed the point of sale (PoS) tool, with input from the Alliance, using the CommCare software. The PoS tool has two distinct components to capture the information accurately: (i) agro-dealer registration and agro-dealer survey and (ii) farmer (customer) registration and farmer survey. The enumerators would first register the farmer or agro-dealers with contextual data, including name, age, location, and contact details in each instance. The design of the tool allowed for registration first and then the survey was conducted. For instance, if an agro-dealer or farmer was too busy at the first encounter, they could be registered first and then complete the survey later.

In addition to including all bean varieties in the tool, all geographies were added for the data collection area. These included the counties of Kitui, Machakos, and Makueni, including their associated sub-counties and wards. Bean varieties and geographies were both uploaded into the CommCare platform using "lookup tables." These tables were first created in Excel then uploaded into the tool, allowing the enumerators to select specific geographies or bean varieties in the registration and survey questions. This process enables ease of use for the enumerator, reduced errors, and contributes to cleaner data sets.

While the PoS tool was designed in English, it was established that a Swahili option for the tool should be included, with the translation into Swahili being verified by PABRA. Consistent testing was carried out on mobile tablets during the tool's design, which would later be used for data collection. After the initial setup of the CommCare tool, the questionnaires were again reviewed and revised with additional changes. These changes were then incorporated into the PoS tool in CommCare. With the PoS tool tested and ready for deployment, an accompanying manual, and PowerPoint presentation were created for the subsequent training.

2.4.2 Training on CommCare and deployment of enumerators

a) Pre-training preparation

Due to the COVID-19 pandemic and to prevent possible contaminations and infections, each enumerator was provided with facemasks and sanitizers sufficient for the data collection exercise. Enumerators were trained on COVID-19 and the necessary restrictions and precautions to be followed during data collection. In addition, they were provided with information on the nearest hospitals within the area of data collection, identification badge for each enumerator complete with contacts of the next of kin.

Before signing a service contract, each enumerator signed a Personal Protection Equipment (PPE) User Agreement (Annex 4), which obligated them to use PPE during the period of the agreement and when on duty in agro-dealer shops. Other COVID-19 measures such as maintaining a social distance of at least 2 meters, holding meetings with three (3) persons, seeking immediate medical assistance, and contacting PABRA representatives through phone, email, and WhatsApp were observed.

b) Enumerator training

The training was divided into two segments. The first segment of the training was conducted virtually on the 30th of September, 2020. The objectives of the training included the following.

i). Train the enumerators on the use of the PoS tool loaded onto CommCare software in tablets. CommCare is a software designed for data collection, and each enumerator was assigned a tablet with a serial number and loaded with the software.
ii). Train the enumerators on administering the questionnaires to the farmers, agro-dealers, and motorbike (*boda boda*) riders (Annex 3).
iii). Train the enumerators on COVID-19 restriction requirements.

The second segment of the training involved a face-to-face interaction between the PABRA trainers and the enumerators. For this segment and because of the COVID-19 preventive measures, the number of persons per session was restricted to 4 in a well-aerated space, complemented by observing social distancing (6ft or 2m) and using face

masks and sanitizers to maximize hygiene. The enumerators were trained on the practical use of the tablets for data collection. The training was held as given in Table 1.

Table 1: Dates and locations of enumerator training

Date	Venue	Number of enumerators
October 1st, 2020	Machakos	4
	Wote	4
October 2nd, 2020	Kitui	3
	Matuu	2

2.4.3 Actual data collection

Actual data collection ran for two weeks from the 5th to the 16th of October, 2020, with each enumerator assigned to a specific agro-dealer shop (Annex 5). The enumerators were introduced to the agro-dealers jointly by DSL and the Alliance team. The second season data collection objectives and how the exercise would be conducted were shared with the agro-dealer shop management.

During the two-week exercise, the enumerators interviewed farmers (as they came to the shops to buy bean seeds), motorbike riders most commonly used by the agro-dealers, and the agro-shop managers. During the interviews, the enumerators indicated that information collected during this exercise was confidential and only used for the Niche Market Business Model Point of Sale (PoS) Pilot second season data collection and treated with the utmost confidentiality. Further, they gave the background of the Niche Market Business Model Point of Sale (PoS) Pilot and the objectives of the exercise.

a) Sampling Methods

Lower Eastern was purposively selected for the study for the following reasons:

i). Nyota variety has been bred for drylands including eastern Kenya.
ii). The seed distributor, DSL, had a suitable distribution network of agro-shops in Kitui, Machakos, and Makueni counties.
iii). To provide expanded scope during the second season data collection over and above western Kenya (Bungoma, Trans-Nzoia, and West Pokot counties).

Agro-dealers (agrodealer shops) were purposively sampled using a list provided by DSL, consisting of agro-dealers the company uses to distribute seeds in the area. All farmers who came to the agro-dealer shops to buy bean seeds were interviewed. Two seed companies (KALRO Seed Unit (KSU) Katumani – the seed producer, and Dryland Seed Ltd (DSL) – the seed distributor) were sampled for interviews.

b) Volumes of Nyota Seed Distributed

The HIB variety (Nyota) was multiplied by KSU and distributed by DSL to the agro-dealers, the source of the Nyota seed and related variety information and agricultural practices. A total of 3,120 kg of seed was distributed to 13 agro-dealers (4 female and 9 male), each receiving 240 kilograms. The survey focused on the quantity of seed bought by the agro-dealer vis-a-vis what the farmers bought. This analysis was essential to determine demand and supply gaps along with the distribution.

c) Study design, participants, and procedures

The study was about tracking the micronutrient rich *Nyota* bean variety from the seed companies to the farmers. Other bean varieties available for the farmers to buy from the agro-dealers were KATB1 (yellow beans) and KATX56. The main participants in the study included farmers, seed companies – KSU (the seed producer) and DSL (the distributor of *Nyota* seeds), and the 13 agro-dealer retail outlets. Other participants were motorbike riders (*boda boda*) regularly used by agro-dealers for last-mile seed delivery to farmers interviewed at the agro-dealer level. The motor bike riders were

interviewed to understand how they could enhance seed delivery to farmers in far-flung areas from agro-dealer outlets. PABRA team coordinated the field activities, facilitated the data collection, analysis, and report writing.

d) Variable measurement (distance between agro-dealers and farmers)

The study uses a mix of socio-economic and agronomic data with selected variables. Socio-economic data include age, sex, location (county/sub-county), and years of experience in farming and agro-dealer business. These control variables are vital in better understanding gender issues related to the bean seed value chain, especially women and youths' role in re-aligning formal seed systems. They can be used to diagnose seed system bias, for example, if women access more seeds than men and how to bridge such gaps (Buruchara et al., 2018). Location data, for example, help to evaluate farmer distance to nearest agro-dealer so that the proposed non-traditional method can be assessed against the transaction cost when the same is tracked. Likert scale variables were also used to measure perception and risk preferences based on farmers' or agro-dealers evaluation of their performance.

Data on land owned in hectares and land tenure type (owned or leased) were collected in assets. The land is critical in determining bean growing, subsequent adoption rates and intensity (percentage share of land dedicated to new variety), as other studies have evaluated (Magambo et al., 2020).

Data on agronomic practices include seed purchased in kilograms, area planted, agronomic practices used, pest and disease control method, and general perception of the varieties' performance on farmer plots. Farmer's preferences of varieties can be used to project a variety's demand and gaps that need to be addressed (Binagwa et al., 2019). Likert-type questions regarding risk preference were also used to assess the willingness to pay or adopt the improved varieties.

2.5 Farmer Feedback Survey

In February and March 2021, a survey was conducted among farmers who had bought *Nyota* seed for the short rains of October/November 2020, planted it, and harvested grain. The survey assessed access to information on Nyota seed, last-mile delivery by *boda boda*, varietal performance (maturity period, grain quality, utilization of harvested grain, market performance), and the likelihood of repeat purchases (Annex 6).

2.5.1 Data Analysis

The report utilized a descriptive statistical analysis framework aided with visualizations of crucial variables. Microsoft Power Bi was used to store the datasets in a database securely and for visualization. The variables were visualized in charts and network analysis to show networks of partnerships along the bean value chain that aid movement from seed multipliers to farmers. With network analysis, an array of the essential stakeholders around the HIB value chain can be visualized, including their perceived degree of influence. As a result, farmers' proximity to the nearest agro-dealers can be mapped to determine seed access and a general sense of how the agro-dealers are distributed. Network analysis techniques are similar to Net-Map (Schiffer & Waale, 2008) with participatory interviews to determine social networks that aid farmers and agro-dealers in business. Network analysis is also crucial in understanding, visualizing, discussing, and improving situations in which many actors influence outcomes.

3. RESULTS AND DISCUSSIONS

This section discusses key findings from the baseline survey among the agro-dealers, results from the subsequent main survey – the PoS study – conducted among smallholder farmers, motorbike riders, agro-dealers, KALRO Seed Unit, and Dryland Seed Ltd, and the farmer (customer) feedback after harvest. The study generates pointers to policy dialogue for enhanced efficiency of seed systems and last-mile delivery of seeds to the smallholder farmers in Lower Eastern Kenya.

3.1 Key findings from the baseline survey

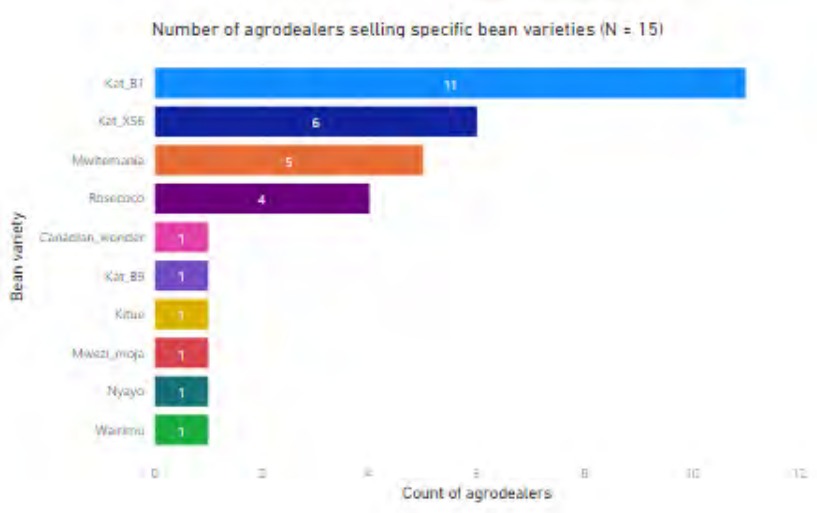
This section discusses the findings from the baseline survey conducted between the 21st to the 23rd of September, 2020.

3.1.1 Factors affecting farmers' willingness to test new micronutrient-high iron beans

a) Availability of seed at the agro-dealer level.

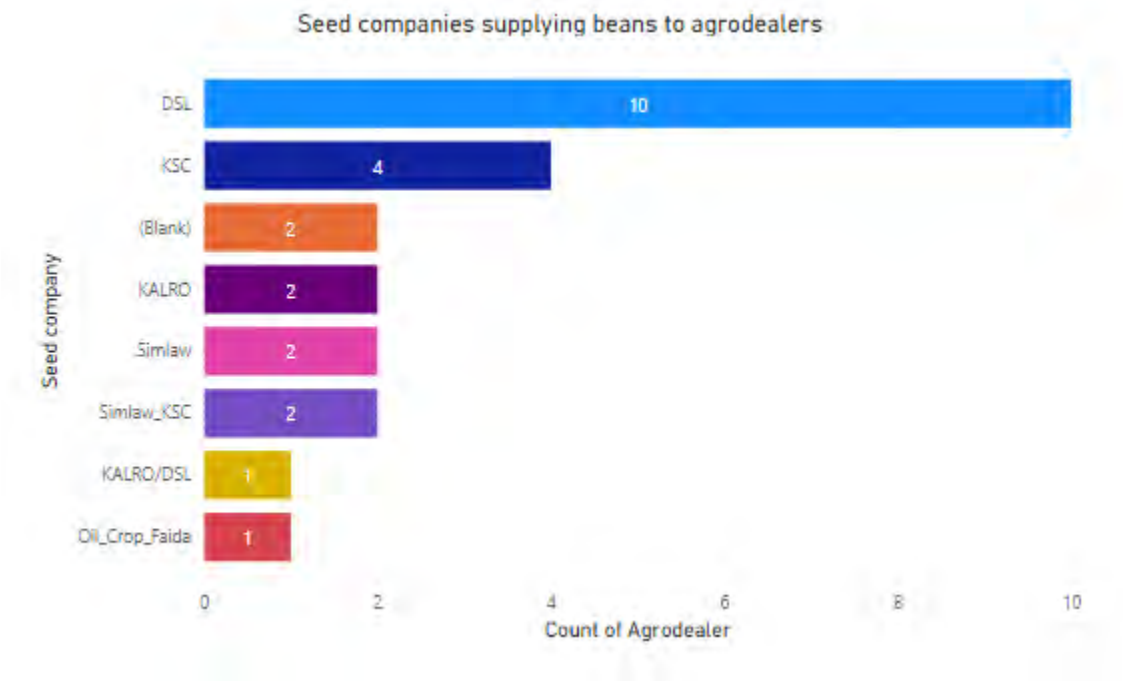
Agro-dealers sold eleven bean varieties to farmers from high and low altitude agro-ecologies across the three counties (Figure 4). The four leading varieties based on number of agro-dealers engaged in the sale were KATB1, KATX 56, Mwitemania, and Rosecoco. KSU produces KATB1 and KATX 56 while Mwitemania (GLP 92) Rosecoco (GLP 2) are produced by Kenya Seed Company Ltd. The other five varieties were stocked by a single agro-dealer each. Agro-dealers confirmed that seed of Nyota had never been sold from any of the outlets, and therefore they did not have sufficient information about the micronutrient bean variety.

Figure 4: Bean varieties sold by agro-dealers



On the source of the seeds, agro-dealers got supplies of seeds mainly from Dryland Seed Limited (10), Kenya Seed Company/Simlaw Seed (8), Oil Crop Faida Seed (1), and KALRO Seed Unit (3) (**Figure 5**). It is noteworthy that some of the seeds sold by Dryland Seed, including KATB1 and KATX56, were sourced from KALRO Seed Unit.

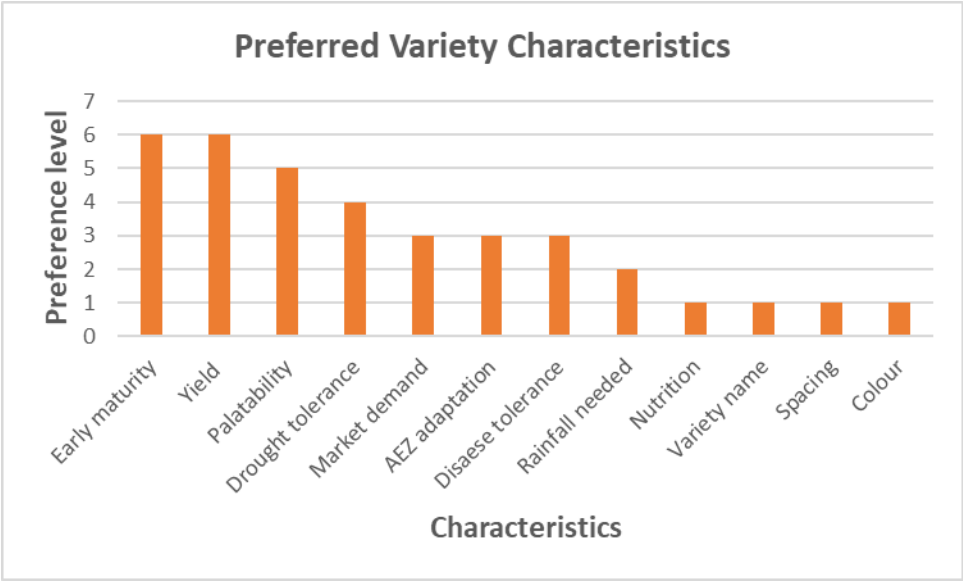
Figure 5: Sources of seed sold by agro-dealers



b) Preferred variety characteristics

Farmers do ask for information on the characteristics of the varieties sold at the agro-dealer shops. Early maturity, yield, palatability (including taste, low flatulence), and drought tolerance were the leading characteristics, which informed the choice of bean variety for planting (**Figure 6**). Conversely, nutrition aspects linked to micronutrients ranked low in the preferred aspects, implying that farmers' most significant reason for adoption could be related to income as inferred from the characteristics of interest (early maturity, yield, palatability, and drought tolerance). Further, it suggests a need for awareness creation on the HIBs' nutritional benefits to inform the choice of seed.

Figure 6: Farmer preferred bean characteristics



c) Challenges of bean distribution in Kenya

The agro-dealers interviewed identified several challenges in bean distribution in Kenya, including i) limited supply of certified seeds against a high demand; ii) use of packaging which does not allow farmers to see the physical characteristics of the seed, e.g., color and size; iii) high cost of seed which acts as a disincentive for repeat purchases and; iv) limited access to information on new bean varieties. On availability of certified seed, agro-dealers pointed out that the market demanded varieties like KATB1 often ran out of stocks before starting the planting season. Therefore, farmers would prefer to see the seed's color, size, and shape (as is the case for some maize packages) on seed packages before buying. Though the seed cost continues to be a factor in decision-making to buy or not to, farmers continue to buy new seeds when they see value in them regarding yields, market access, and nutritional benefits.

d) Information gaps in seed access

Agro-dealers were asked if there is a missing link in the information delivery chain from research to the farmers concerning access and adoption of improved seed. Table 2 identifies the information gaps, which need to be addressed.

Table 2: Information gaps in the research to farmer chain

Player	Information gaps	Details
Seed companies	Limited focus on beans	• There is more focus on maize as opposed to beans
	Late seed delivery for the season	• There is a delay in seed delivery relative to the rain seasons • It may be necessary to deliver seed more than twice a year to meet the demand
	Limited awareness creation at the local level	• There is a need for complementary information in the form of leaflets on the seed packages • There is a need for more demos, located closer to the farmer as much as possible • There is a need for additional officers at the local level to support the County extension services • There is unutilized potential in the media (local, print) for awareness creation
	The limited linkage between seed companies and agro-dealer	• There is a need for after-sales service, complete with explicit varietal attributes and performance • There should be a sustained link between agro-dealers, and seed companies, especially on stock levels
Researcher	The limited interface between research and agro-dealers	• Researchers communicating only to seed companies in most instances • There is a need to interface well with the agro-dealers, who are the direct link to farmers • There is a need to invite farmers, agro-dealers, and seed companies to participate in research trials
Seed companies and research	Limited information on the variety and agro-ecological adaptation	• There is a need to equip farmers with information relevant to their agro-ecological zones, including varieties that can do well in short or long rains
	No interface between research and agro-dealers	• Information on varietal attributes should flow from research to seed companies to agro-dealers before the farmers can take the seed.
	Limited training on multiple areas	• Training needs to be done on multiple areas, including attributes, cost, and availability of seeds

3.1.2 Potential benefits of using motorbike riders (*Boda boda*) for last-mile delivery

Four of the agro-dealers interviewed, representing 33%, reported that they frequently used motorbike riders either at the request of the farmers or on their volition to ferry varied amounts of seed and complementary inputs to smallholder farmers. The frequency of use of the riders was estimated to range from 18 to 60 times a week, and they delivered seed and other farm inputs to farmers located between 1km to as far as 100km away. The number of different riders per shop ranged between 10 and 15. While these findings may be anecdotal, they present a picture of the great potential and scope of the usage of the riders in reaching many smallholder farmers in far-flung areas and thus improving adoption, yield and livelihoods. This potential could be achieved with some organization and formalization of the last mile delivery as contemplated in the ICT enabled last-mile delivery of seeds using motorbike riders, reported in the first season PoS study (Mabeya et al., 2020).

3.1.3 Policy implications of the use of motorbike riders (*boda boda*) for last-mile delivery

The majority of the agro-dealers interviewed (over 90%) observed that the motorbike riders would add value to their businesses by linking the businesses to farmers located far from the shops and creating loyalty for those paying via mobile money (MPESA). However, the agro-dealers expressed the need for training of the riders. These aspects were: i) seed handling to ensure farmers receive quality seed and ii) business skills to enable the riders (predominantly youth) to run cost-effective businesses and ensure that their untapped potential is fully utilized. In addition to training, the riders would also need to be branded with reflector jackets to enhance seed traceability. These aspects of capacity building related to the expressed interest by KEPHIS to closely monitor the pilot deployment of ICT enabled last-mile delivery of HIBs by motorbike riders to ensure traceability and quality assurance of the seeds.

3.2 Key findings from the main survey

This section discusses the key findings from the main survey conducted from the 5th to the 16th of October, 2020.

3.2.1 Factors affecting farmers' willingness to test new micronutrient-high iron beans

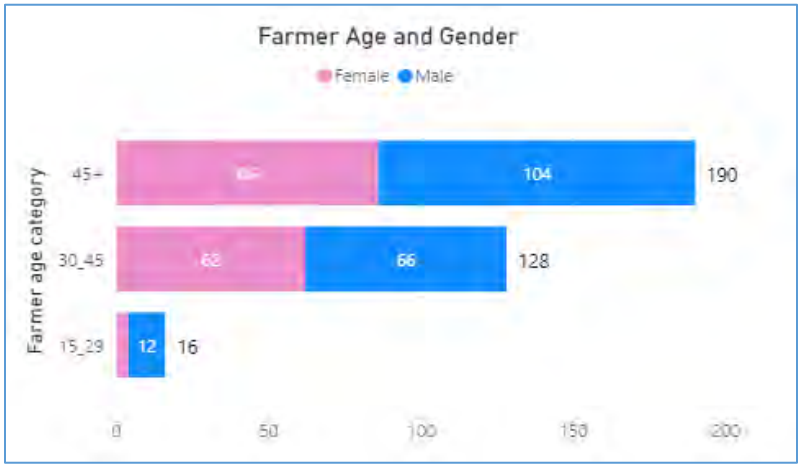
a) *Farmer demographic characteristics*

This section highlights the study population disaggregated by gender and activity along the HIB value chain, e.g., farmers and agro-dealers.

A total of 205 farmers purchased *Nyota* seed. Most of the farmers (57 percent) who bought *Nyota* were 45 years and older (**Figure 7**). Similarly, those between 30 and 45 years old made-up 38 percent of the sample, with the rest between 15 and 29 years old (youths). This observation implies that most farmers are in a category where most Sub-Saharan Africa farmers lie, with youth seemingly less engaged in bean farming. According to the Food and Agriculture

Organization (FAO), the average age of a farmer globally is 49 years, and many studies have confirmed this with ages ranging between 39 and 70 years (Gichangi et al., 2012; Wossen et al., 2019).

Figure 7: Farmer Age and Gender (N = 334)



This observation has implications for technology transfer as older farmers tend to stick to old farming practices and be risk averse. However, with information on the value of seed (e.g., yield and income), they may decide to try the new variety, as was the case with *Nyota*. Most farmers are males, making up 54 percent of the total sample. Females aged between 30 and 45 seem not to significantly differ in their numbers from male farmers of the same category. This observation points out to the need for further work which would include disaggregation of the analysis to learn of any gender barriers or opportunities.

The study was also disaggregated by the location (County) from which the farmer came. As indicated in **Figure 8**, the majority of the farmers were from Makueni County (48 percent), followed by Machakos (38 percent) and Kitui (13 percent).

Most males (21%) were from Machakos County, while most females (26%) were from Makueni. These locations may not be an indicator of the rate of adoption of *Nyota* variety. However, they may be based on the sampling methodology employed, ease of reaching farmers, and general information available at the disposal of the agro-dealers who used the PoS tool to reach the target farmers. Nonetheless, it should be noted that KSU is in Machakos County. Its proximity to Machakos town and centrality for the three counties would be used as a distribution hub to reach most farmers in the three counties. In addition, it would be used as a distribution hub to reach most farmers in Makueni and Kitui with information on the *Nyota* bean variety. On the other hand, the analysis of farmers at the sub-county level (Table 3) indicated that most farmers (34 percent) were sampled from Mbooni Sub-County in Makueni County, followed by

Machakos town and Kaiti sub-counties, respectively. Kilome and Mwingi North Sub-counties had the least number of respondents.

Figure 8: Gender of farmers disaggregated by county

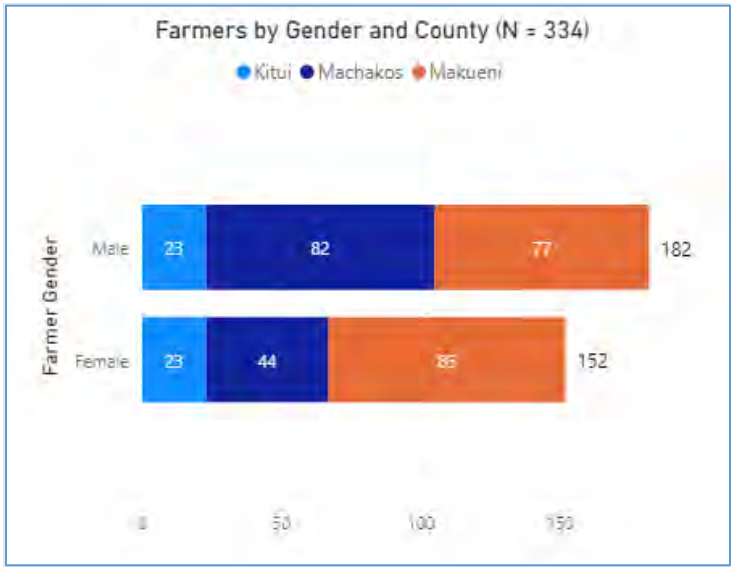


Table 3: Farmer Distribution by sub-county (N=334)

Sub County	Farmer #
Mbooni	105
Machakos Town	46
Kaiti	29
Makueni	28
Kitui Central	24
Kangundo	16
Yatta	15
Matungulu	12
Kitui West	11
Masinga	10
Kathiani	9
Kitui Rural	6
Mwingi West	5
Mwala	4
Mwingi Central	4
Kibwezi West	3
Kitui South	3
Kilome	2
Mwingi North	1

b) *Land ownership*

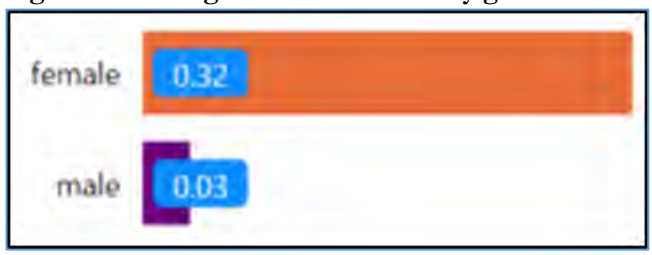
i). Land size and tenure system

The land is an essential asset in variety adoption practices as it determines the adoption intensity (share of land allocated to new variety) and good agricultural practices to adopt. For example, the average land cultivated by male farmers was 1.4 ha compared to 1.31 ha for female farmers (**Figure 9**).

Figure 9: Average land cultivated by gender

Of those who purchased *Nyota* seeds this season, only 11 farmers said that they leased land. The average plot of land leased was 0.32 Ha for female farmers and 0.03 Ha for male farmers (**Figure 10**).

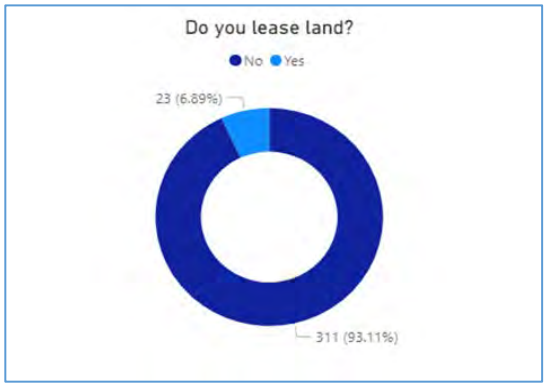
Figure 10: Average land area leased by gender



The size of the land is a significant determinant of the volume of seed that farmers purchase in a given season, as large farms tend to buy more seed. However, most literature is concentrated on the use of rights and access, especially by women. In Lower Eastern Kenya, the average land owned without disaggregating by sex is 3.64 acres (approximately 1.47 Ha). Recently, Syagga and Kimuyu (2016) found that 98 percent of Kenyans have land holdings averaging 1.2 hectares with an average occupation of 46 percent of the farmed land area. Machakos, Makueni, and Kitui, under the Agro-ecological Zones (AEZ IV-VII), had an average land size owned by a household as 1.85 ha, 3.29 ha, and 13.3 ha, respectively. The finding is also corroborated by the recent Kenya National Bureau of Statistics (2019) that the average landholding in Kenya is 3.9 ha. When disaggregated by sex, women seem to access more land as a total and under crops (15 percent higher than males). This observation may not be the true reflection of land ownership by Kenyan women; who own only 1 percent of land titles (Chigbu et al., 2019). It may be associated with women in these counties, perhaps, have access through their husbands, and when asked if they owned the land, they could not differentiate between access and right of use or total ownership. Further study would help better understand these findings.

Related to access to the land under Nyota bean production was land tenure, where it emerged that most farmers own the land either from inheritance or from purchase or both, which land or part of which they used to grow Nyota beans. Again, as indicated in **Figure 11**, most farmers did not lease land (7 percent).

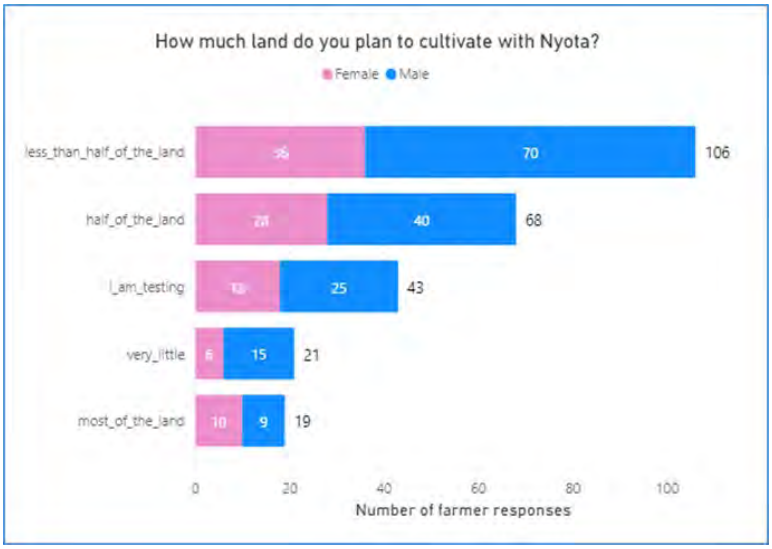
Figure 11: Land leases (N = 334)



ii). Future land allocation for improved variety

When asked whether they would plant a new, improved variety (*Nyota*), 70 males (66%) and 36 females (34%) were less willing to buy the new varieties. Those that were willing to buy the new variety allocated only less than half of their land to the *Nyota* variety. Partly because of limited awareness of this new variety among the farmers. As indicated in **Figure 12**, this category was the highest, meaning that, in general, 32 percent of all the respondents were only willing to give tiny pieces of land for testing. This observation also indicates that awareness creation and convincing the farmers to adopt the varieties are needed within the project.

Figure 12: Planned land allocation for the Nyota variety (N=106)



It is evident from Figure 12 that males in most categories regarding the decision to allocate land from *"allocating less than half" to* "*allocating half land*" to "*allocating just for testing*" to "*allocating minimal land*" were leading in the unwillingness to allocate more land to *Nyota* variety. This observation could imply that they are likely to be more risk-averse compared to women. Studies such as Gebre et al. (2019) have identified the intensity of adoption to be lower for female-headed households relative to households with the male as the decision-maker. However, legumes are regarded as "women's crops" due to their input, and women tend to adopt more and allocate more land for such crops.

c) Factors Associated with Value Chain

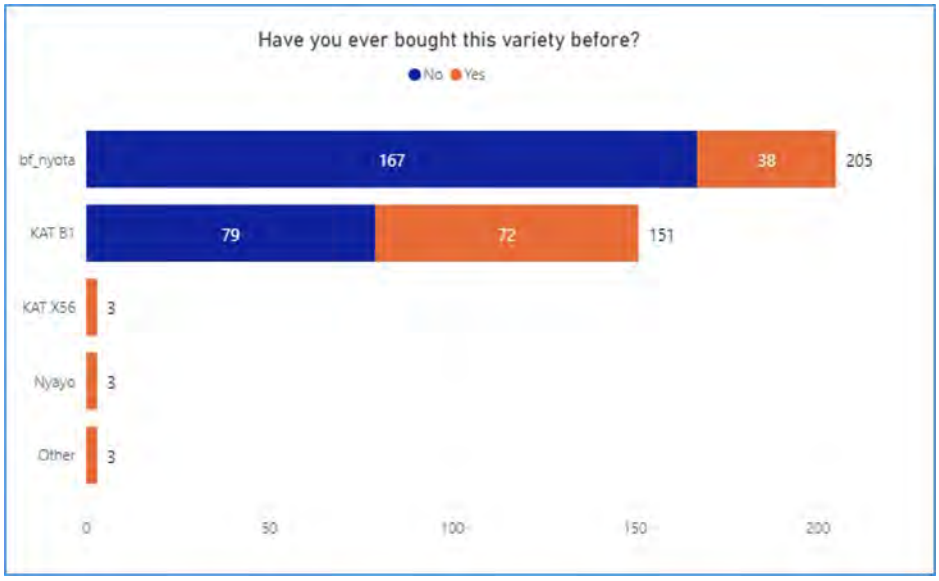
This section discusses the factors affecting farmers' willingness to test micronutrient varieties in relation to leading players in the HIB value chain with regards to distribution and access of *Nyota* bean seed. These players include farmers, research organizations, seed companies and agro-dealers.

Farmers

i). Variety Awareness

The awareness level of varieties among farmers was assessed against four main varieties. As shown in **Figure 13**, only 19 percent of the farmers were aware of the existence of the *Nyota* variety. It seems that KATB1 was the most popular among farmers (48 percent) mainly because of its market demand and longer-time production by farmers. On the other hand, KATX56 and Nyayo were some of the least popular varieties, even though they are some of the oldest. Despite the seemingly small percentage of awareness of the *Nyota* variety, willingness to buy it is remarkable given that they are only a few years old in the market (less than three years since it was released for commercialization), and farmers are just starting to be aware of it. Nonetheless, awareness creation by agro-dealers, seed companies, and research institutions among farmers should be enhanced.

Figure 13: Variety awareness

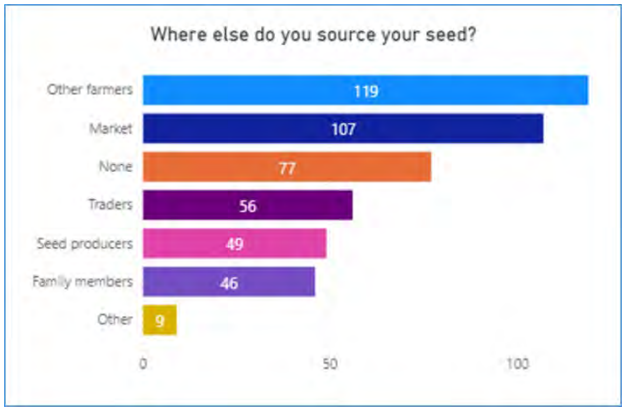


***Note**: Total farmers queried are 334. There are instances where a farmer made a purchase of more than one variety.*

ii). The primary source of bean seed planted by farmers

From the above discussions, it is evident that most farmers are not aware of the varieties. Perhaps looking at the source of the seeds may explain the reason. As shown in Figure 14, 36 % of the farmers got their seeds from other farmers, 23 % from local open-air markets, 10 % from family members, 17 % from their own saved seeds (None), and 2 % from other non-identified sources. Together, these made up 78 % of the seed sources. These are commonly referred to as informal seed channels. It conforms to the previous findings that most farmers access their seeds from informal channels. However, this case is better than the more than 90 percent elsewhere, where informal seed channels are the primary seed source (Sperling et al., 2020). This case may be deemed the cause of low awareness because farmer-to-farmer seed exchange may mean they conform to what other farmers are doing, including planting similar varieties. Markets also dictate what farmers grow as consumers demand particular varieties that may force farmers to grow just similar crops and varieties. Hence, the high demand for KATB1, which is highly sought after in the market.

Figure 14: Other sources of seed (N = 334)



The role of agro-dealers in awareness creation and shift in variety demand may not be overlooked. From figure 15, it is also evident that 11 percent of the farmers obtain their bean seeds from formal channels (seed companies and agro-dealers). This number is slightly better than the Sub-Saharan Africa (SSA) average of less than 10 percent (Sperling et al., 2020). This observation may be associated with enhanced awareness in these regions. Nyota is a niche variety promoted by multi-stakeholders that combines research organizations (PABRA, KALRO), a seed company (DSL), and several agro-dealers.

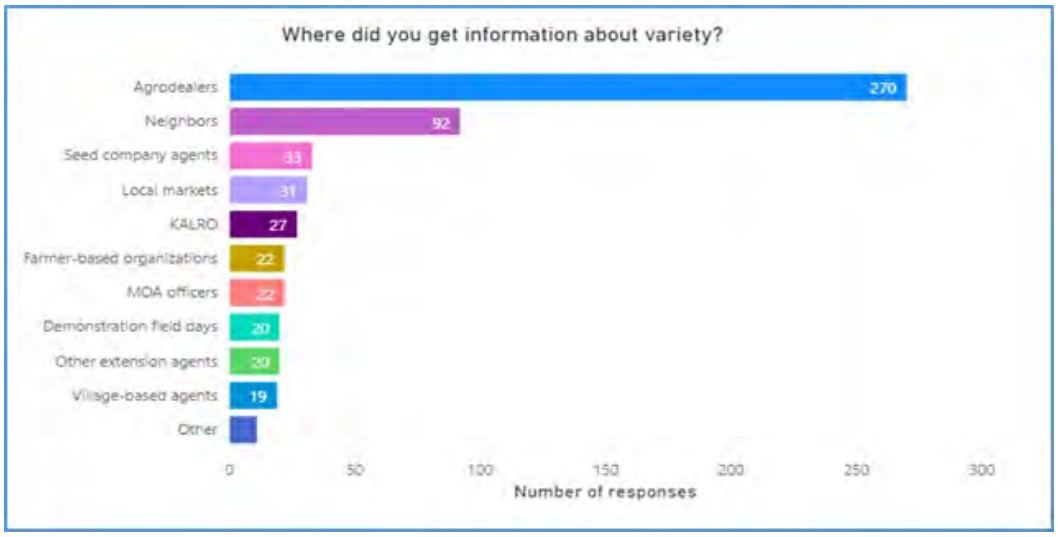
***Note**: Total farmers queried are 334. There are instances where seed sources are more than 1.*

iii). Source of information about varieties (all varieties)

The source of information is vital in determining the adoption rates of new varieties. For existing and established varieties e.g. KATB1, the agro-dealers were the primary sources of information, as shown in Figures 15 and 16 below. The next most important sources of information were neighbors and seed companies. The first and third sources of information are formal, yet evidence shows that most farmers get seeds from informal channels. This observation is unique for the demand for *Nyota* seed, which was new to many farmers and promoted by agro-dealers and seed companies. Nevertheless, this contrasts with Mittal & Mehar (2013) who found that 41 percent of farmers ranked other farmers as the most important source of information, with agro-dealers at 21 percent and mobile phones at 10 percent. This result may need further investigation.

Figure 15 about the source of information on KATB1 is not significantly different from **Figure 16** about the source of information on all bean varieties.

Figure 15: Sources of KATB1 variety information (N =334)



Note: Total farmers queried are 334. There are instances where information source is more than 1.

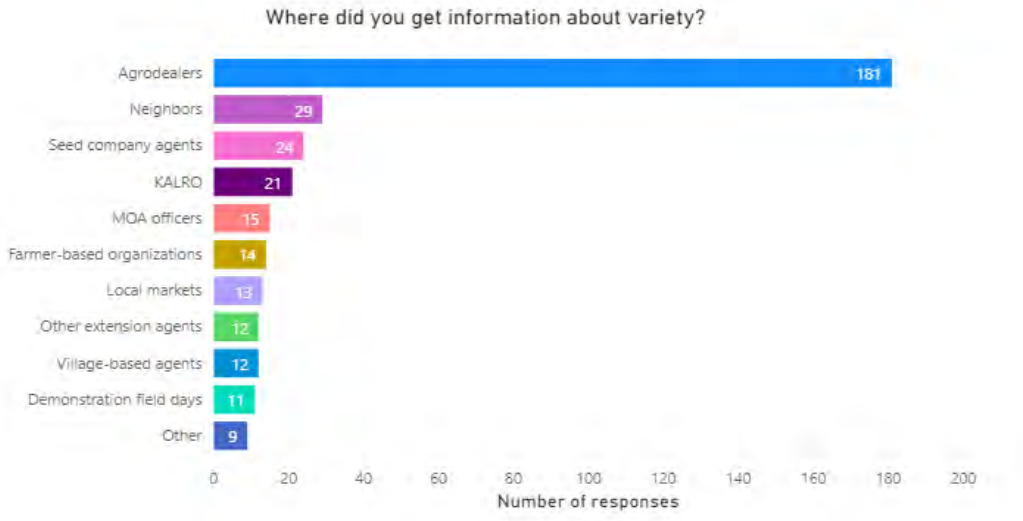
Figure 16: Source of variety information - all beans (N = 334)

Note: Total farmers queried are 334. There are instances where variety information sources are more than 1.

iv). Source of information for Nyota variety

Fifty-three (53 percent) farmers who bought *Nyota* got their information from the agro-dealers, as indicated in Figure 17 below. Again, other farmers (9 percent) got information on *Nyota* seeds from neighbors. The implication of this is a farmer-to-farmer information exchange during seed exchange. However, it is remarkable that 60 percent of information about the Nyota variety is sourced from agro-dealers and seed companies in combination. This observation represents a shift from traditional methods of seed information such as farmer-to-farmer or other informal channels. The situation may be unique for Nyota and during the pilot/data collection exercise.

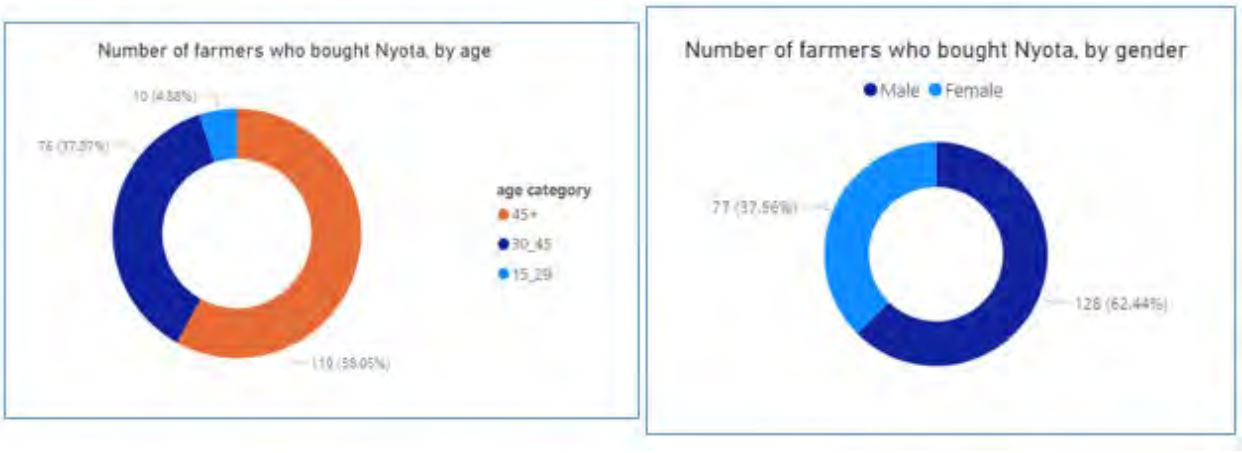
Figure 17: Source of variety information - Nyota



v). Gender and age-disaggregated seed access

The 205 farmers who bought *Nyota* differed by gender and age (**Figure 18**). Male farmes/buyers were 62% while female buyers/farmers were 38%. Apart from sex, age played a critical role in *Nyota* seed purchase.

Figure 18: Nyota purchases by age and gender (N = 205)

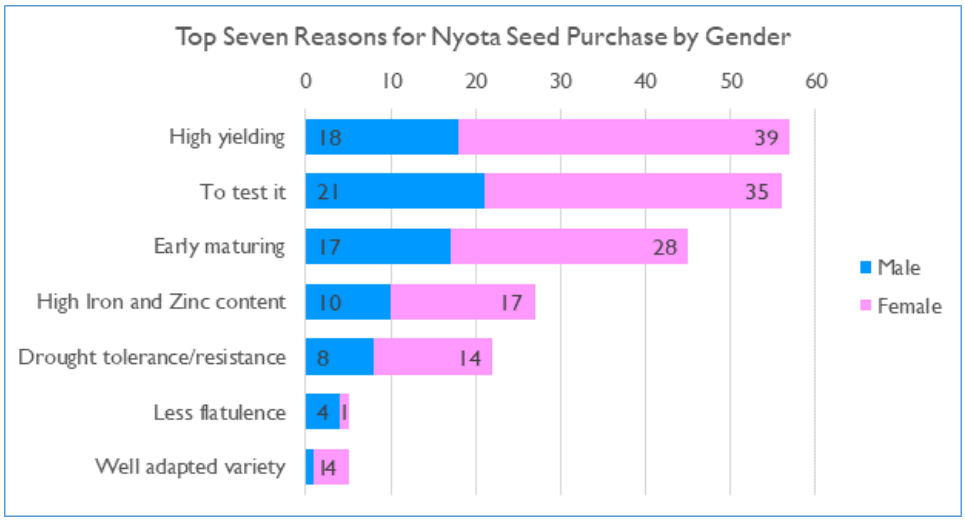


As shown in Figure 18 above, 58 percent of the buyers were aged 45 and above. This category was followed by those between 30 and 45 years (37 percent) and those between 15-29 years (5 percent). As discussed in the demographics section, age is a significant determinant of variety adoption. However, youths (35 years and below) need to be integrated into the system to enhance wider variety adoption.

vi). Reasons for Nyota seed purchase

Nyota variety is mainly preferred due to its high yielding, early maturity, and high iron and zinc content (**Figure 19**). Other farmers purchased the variety "to test it." A gender disaggregation indicates that 68 percent of males and 32 percent of females would grow *Nyota* due to its high yielding properties. Further, males lead in preference for early maturity compared to females. Females prefer drought tolerance/resistance, less flatulence, high yielding, early maturing well-adapted variety, and high nutrition qualities (zinc, iron), not in any given order. From these, it is evident that peculiar attributes related to either marketability or nutrition only appeal to women. The observation is a strong indicator that the focus on Participatory Varietal Selection (PVS) and Participatory Plant Breeding (PPB) is essential and should consider the attributes desired by (women) caregivers.

Figure 19: Reasons for purchasing the Nyota variety



The above findings corroborate those of Katungi et al. (2015), who found that resistance to intermittent drought and root rot, early maturing, taste, and reduced cooking time was more appealing to women than men.

Seed companies involved in the second season data collection

i). KALRO Seed Unit (KSU) seed production and distribution capacity

KALRO Seed Unit (KSU) was established as a Foundation Seed Unit (FSU) in 1997 and was renamed KSU in 1999 to conform to the terms used in The Seed and Plant Varieties Act "Cap 326". KSU plays the role of technology transfer and research commercialization for the premier research organization, Kenya Agricultural and Livestock Research Organization (KALRO).

KSU produces both early generation seed (essential and breeder seeds) and certified seeds. Seed companies use breeder or basic seed purchased from KSU to produce certified seeds. KSU also multiplies certified seeds and plant materials suitable for semi-arid areas for distribution and sale to farmers. However, KSU distributes certified seed through selected seed producers/companies assisted by Non-Governmental Organizations (NGOs) and community-based organizations (CBOs) through various seed projects because of limited distribution capacity. With regards to this study, KSU produced and sold certified *Nyota* bean seed to Dryland Seed Ltd for distribution using DSL's agro-dealer network. KALRO is recognized as the government agency with the leading role of crop and animal research, producing early generation seed for onward sale to private seed companies to produce and distribute certified seed.

ii). Dryland Seed Limited (DSL)

Dryland Seed Limited (DSL) is a limited liability company established in 2004 to produce and sell crop seeds adapted to dryland conditions. The company based in Machakos in Eastern Kenya is listed on the KEPHIS website as a registered seed company. DSL specializes in the production, processing, and dissemination of drought-tolerant seed varieties. DSL distributes the seeds through agro-dealers located in the low and medium-altitude ASAL areas of Kenya. In addition, it works closely with research institutions to develop more improved varieties, among which KALRO belongs. It also supplies quality seed and provides technical and growth advice to farmers and agro-dealers. In collaboration with other partners, the company also provides extension services, farmer training on certified seeds, and guidance on good agricultural practices that may help them realize optimum yields.

Agro-dealers

a) Agro-dealer profiles

Thirteen (13) agro-dealers (four which are women owned) across Kitui, Machakos, and Makueni counties were selected as retail outlets for Nyota, by DSL for the main survey (**Table 4**). The agro-dealers also doubled as awareness creation agents by availing information to farmers on the source of the seed and the best practices for optimal production of *Nyota* grain, among other types of information. Further, agro-dealers were the contact points for *boda boda* riders as they collected seeds and delivered them to farmers at the last mile.

Table 4: Agro-dealers selected for the study

No	Name	Owner (Gender)	Location (Town)	County
1.	Clear Agrodealer	M	Kikima	Makueni
2.	Kithimani Agrodealer	M	Kitui	Kitui
3.	Kitui Horticulture	F	Kitui	Kitui
4.	Snow Agrodealer	M	Kitui	Kitui
5.	Kenya Farmers' Association (KFA)	M	Machakos	Machakos
6.	Makamithi enterprises	M	Machakos	Machakos
7.	Riziki Agrodealer	F	Machakos	Machakos
8.	BS Agrodealer	M	Matuu	Machakos

9.	Plum Agrodealer	M	Matuu	Machakos
10.	Hammu Ventures	F	Mukuyuni	Makueni
11.	Sabana Agrodealer	M	Tala	Machakos
12.	Grace Agrodealer	F	Wote	Makueni
13.	Makamithi Entreprises	M	Wote	Makueni

b) Seed sold to farmers by agro-dealers disaggregated by a variety, age, and gender

DSL supplied 13 agro-dealer shops with two hundred and forty (240) kilograms of Nyota seed each. The seeds were packed in 2kg packs. Other certified seeds like KATB1 and KATX56 sold from agro-dealers were also packed in 2kg packs. Figures 20 and 21 below show the average bean purchased disaggregated by variety, sex of the buyer, and age category of the buyer. The figure on the left shows that, on average, the *Nyota* variety was purchased most (56 percent) compared to KAT B1 (42 percent), with the rest of the varieties such as KATX56, Nyayo, and other varieties taking 2 percent. Purchase of Nyota was boosted by both its availability and awareness creation by the agro-dealers.

Further, 62 percent of males purchased *Nyota* varieties compared to only 38 percent of females. This result shows good potential for high adoption of *Nyota* because of its attributes supported by strong awareness creation. However, females (55 percent) seemed to prefer KATB1 more than males. On the other hand, farmers aged 45 years and above preferred Nyota to different varieties, which was valid for KATB1. They were followed by those between 30 and 45 years, as indicated in Figure 18b. Purchases of seed by farmers was not based on the gender of the outlet owner.

Figure 20: Seed purchases by gender

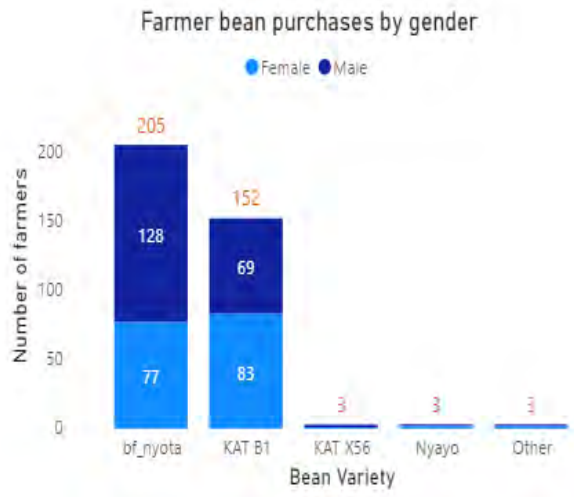
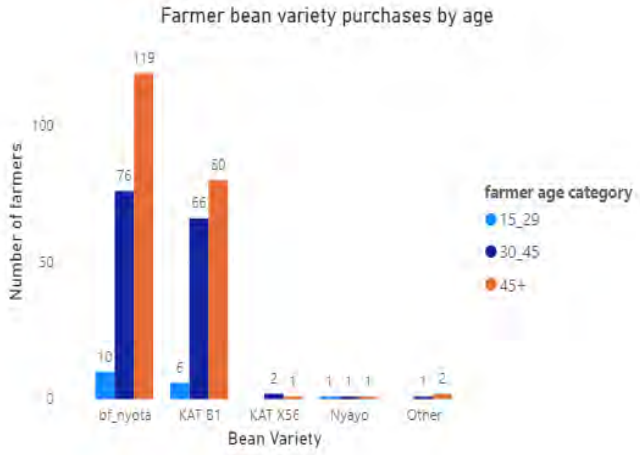


Figure 21: Seed purchases by age



Perhaps more males (see Figure 21), willing to test the new varieties and allocate half of their land for such purposes, pushed the need for this *Nyota* variety. The variety was also indicated as males' favorite in high yield, and early maturity attributes that perhaps drove men to purchase it. It is also evident that women need access to affordable seeds and characteristics that appeal to them, such as cooking time and tolerance to weather elements.

***c)* Business status of agro-dealers**

Figures 22 and 23 show the aggregate business status and years of existence for the agro-dealers involved in *Nyota* seed distribution. For example, figure 23 shows that most businesses had been in existence for more than five years.

Figure 22: Status of agrodealer business compared to last season

Figure 23: Agrodealer business experience

Therefore, it may be a good indicator of the experience in farm inputs sales, including understanding the dynamics in customer satisfaction and after-sales support services to the farmers, e.g., agricultural extension knowledge. Again, this may be supported by the fact that most businesses expressed an increase in sales by introducing *Nyota* seed relative to the previous season's stock (Figure 23).

3.2.2 Potential benefits of using motorbike riders (*Bodaboda*) for last-mile delivery

a) Network analysis: Seed availability and purchases

For farmers that purchased *Nyota* seeds, geo-locations were created based on the approximate location of the farmer's village or town to the nearest agro-dealer (**Figure 24**). In some cases, the village could not be located, and the farmer's administrative ward was used as the nearest approximate location. The blue dots show the approximate location of the farmer's farm from the nearest agro-dealer (red dot).

Figure 24: Location of farmers vis a vis closest agro-dealers

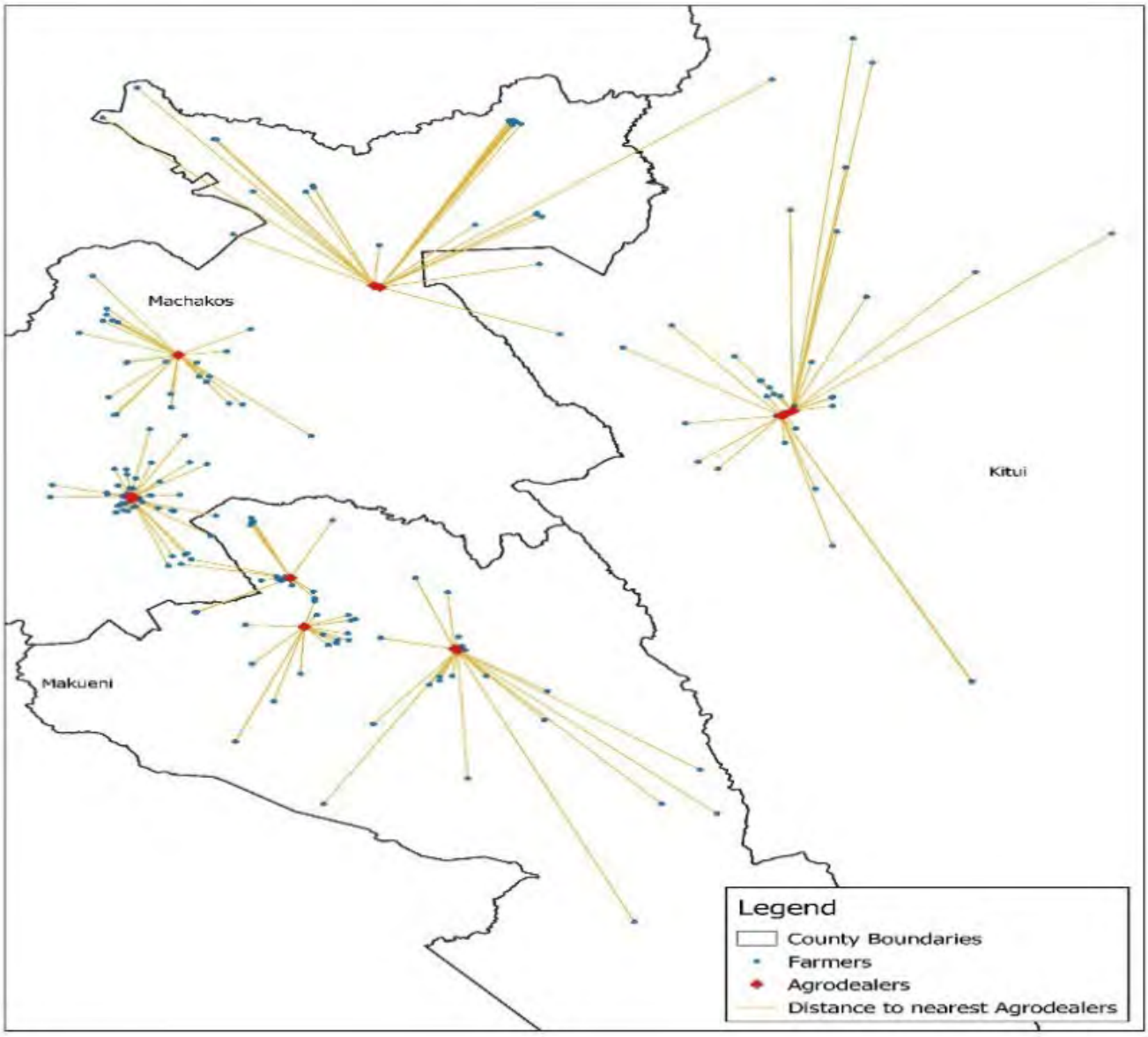
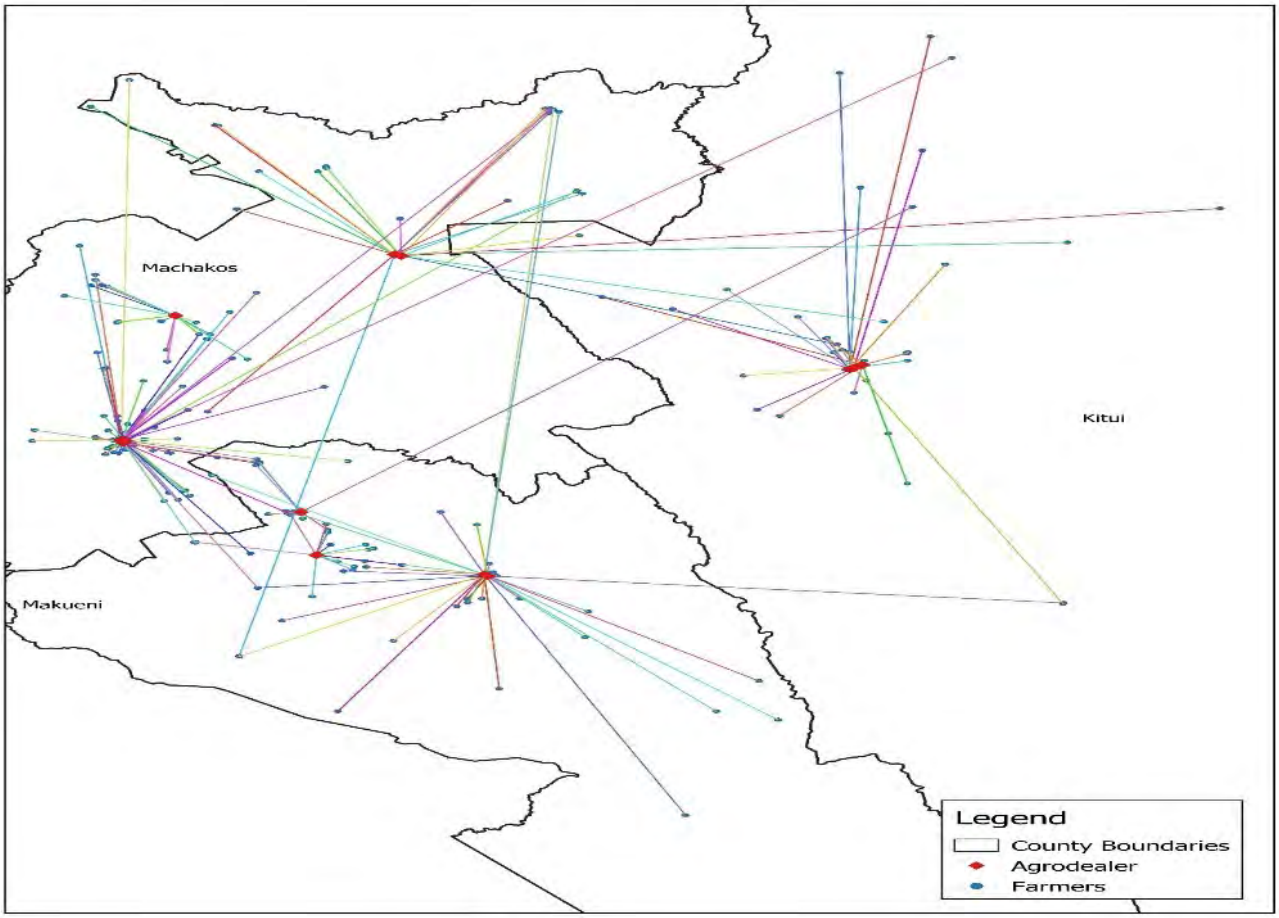


Figure 25 shows farmers who purchased *Nyota* relative to the agro-dealer shop where farmers made their *Nyota* purchases. The map indicates that agro-dealers shops preferred by the farmers were not necessarily the closest to the farmer. The distance between farmers and agro-dealers and attributes associated with boda boda including convenience and efficiency of last mile delivery and profit motives demonstrate a potential for the use of them for last-mile delivery of seed and complementary inputs to the farmers.

Figure 25: Nyota purchases by farmers and agro-dealers



b) Frequency, distance covered, and time used by motorbike riders in delivering beans and their experiences

Motorbike riders were interviewed around agro-dealer shops they mostly worked with to deliver seeds to the customers. On average, most *boda boda* riders covered a distance of 9.1 km. The maximum distance covered was 37 km, and the minimum was 0.2 km. Besides, 71 percent of the *boda boda* riders covered a distance of 10 km and below, meaning that most farmers were in areas not too far from the towns. **Figure 26** suggests the buffer zone/radius most of the agro-dealers covered using the *boda boda* riders. In Kitui, for example, most of the farmers fall within a radius of 10 km. Machakos seems to have most farmers fall within the radius of 10-20 km. The average distances covered are as indicated in **Figure 27**.

Overall, agro-dealers serve a wide area, with some locations far from towns. Geo-referencing agro-dealers can help determine the farmer population they serve and reveal the degree to which they are concentrated in particular regions (Jérôme, 2019). The recent census in Kenya confirms that the motorbike riders' radius of operation tends to serve areas of high population densities. For example, Mbooni Sub-County in Makueni County and Machakos town and Kaiti sub-counties where most farmers (34 percent) were sampled from are areas with highest population density in the area. Machakos Town has 609 and Kathiani 544, the first and second highest population densities in Machakos County (Kenya National Bureau of Statistics, 2019). Mbooni West has the second-highest population density of 379 in Makueni County. The use of motorbike riders is likely to impact farmers in these high population pockets positively as convenient and efficient means of transport and as reported later in this report, motorbike riders can improve adoption of the new

bean varieties. Reports on local access to inputs as reported by agro-dealers can also help breeders concentrate on key attributes of the different varieties along the value chain.

Figure 26: Distance covered by boda boda

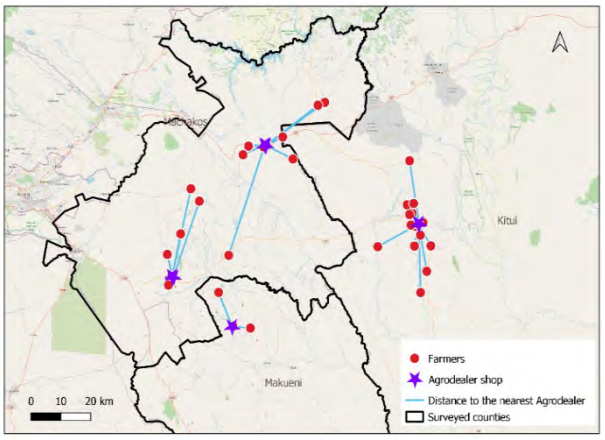


Figure 27: Radius covered by boda boda

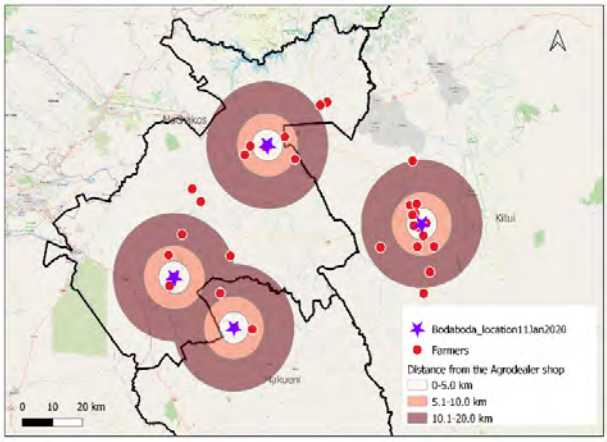
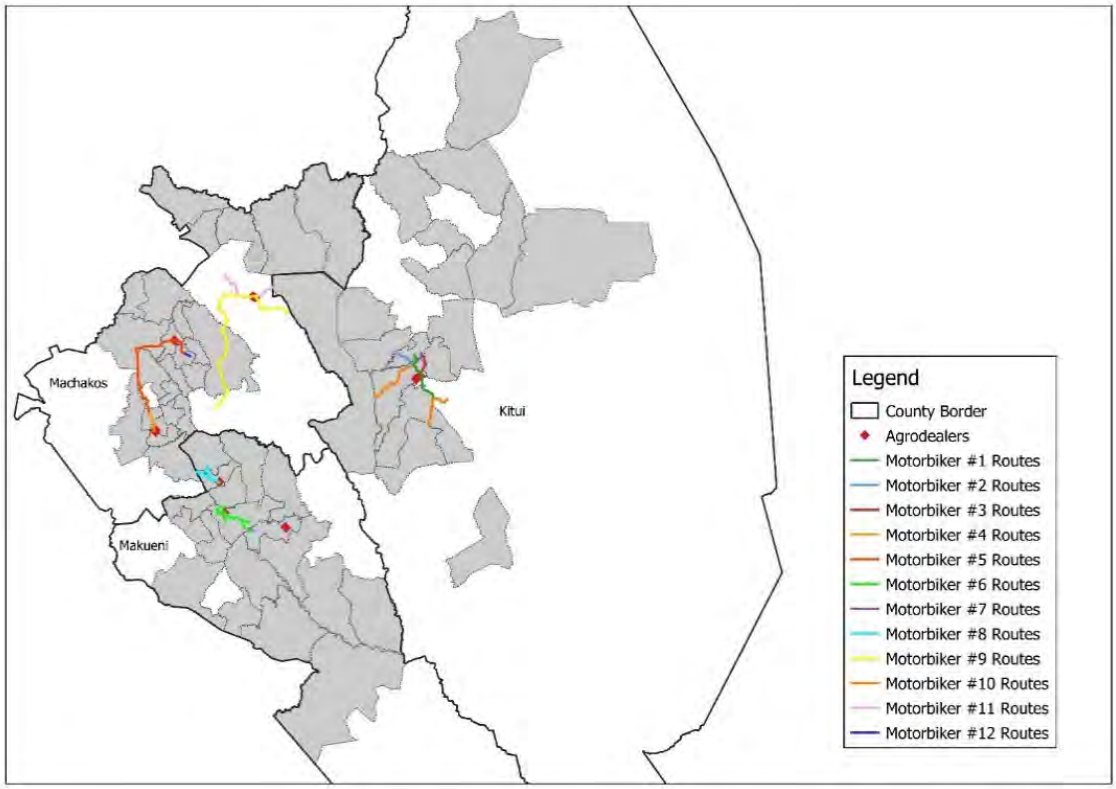


Figure 28 shows the routes used by the selected *boda boda* riders. *Boda boda* riders were interviewed and asked to trace their approximate delivery routes. The areas in grey represent the administrative wards of farmers that purchased *Nyota* seed. This observation highlights the excellent potential for exploiting the use of motorbike riders towards enhanced adoption of Nyota and other improved technologies and thus contribute to farmers' resilience.

Figure 2728: Routes taken by the *boda boda* riders



3.2.3 Policy implications of the use of motorbike riders (*boda boda*) for last-mile delivery

Twenty-one *boda boda* riders were interviewed on their perception of the seed delivery business model and use of the PoS tool. Their ages were between 19 and 49 years, and they did 1-3 deliveries per week. The riders reported that their main challenges were poor road infrastructure and harassment by police due to unlicensed seed transportation. The riders would like to see interventions to facilitate formalizing with agro-dealers for the last mile seed delivery of seed and complementary inputs to reduce the transaction costs.

3.2.4 Value chain actors' perceptions on the last mile seed delivery business and *Nyota* variety

a) Seed Companies (KSU and DSL)

KSU has been multiplying the HIB since 2018. In 2020 KSU produced 46 mt, which was sold at a wholesale price of KSh. 220 and retail price of KSh. 250. For the distribution of *Nyota* through DSL, KSU sold *Nyota* at a wholesale price of KSh. 200 per kg. KSU's promotional channels are on-farm demonstrations, shows, and field days. The company reported increased sales from the demand for seeds but required the PoS study to expand the market for the product through advertisement and awareness creation on a broader scale. Also, due to unpredictable weather, limited finances (resources), production under irrigation would be a viable option.

DSL is currently distributing *Nyota* from KSU among other bean varieties like KATB1 and KATX56. During the survey period, DSL distributed over 5 mt of Nyota (some of which were sold to other agro-dealers that were not sampled for this study), retailing between Ksh.225 and Ksh. 250 per kg. The primary awareness creation channels include demos, brochures, posters, and small packs to attract smallholder farmers. Despite the challenges of drought, floods, pests, and diseases, the company indicated that a niche model could positively impact the company business, as seen from increased bean seed demand. The company, however, requires the PoS model to generate information about bean growers such as their locations and gender and timely information on seed demand to help fast-track delivery.

b) Agro dealers

Most agro-dealers reported high demand for *Nyota* from farmers partly because of the micronutrient richness (high in iron and zinc), high yielding, fast-maturing, and drought tolerance attributes. However, some agro-dealers reported that the demand would possibly have been even higher without the COVID-19 pandemic. Further, they said those motorbike riders could improve the adoption of the new bean varieties. The cost of the 2 kg pack ranged between KSh. 450 and 500, which they would like to see reduced, to make it more affordable for smallholder farmers.

c) Farmers

High yielding and fast maturity were factors that made farmers want to adopt the varieties. However, most farmers were concerned about the seed, and other associated transaction costs, such as the distance traveled to urban areas to get seeds. Last-mile delivery by motorbike riders would reduce the transaction costs and time associated with farmers traveling long distances to urban centers to access bean seeds.

3.2.5 Comparative analysis with first season survey findings

Table 5 compares the findings from season 1 in Western Kenya and from season 2 in Eastern Kenya.

Table 5: Comparative analysis of season 1 and 2 findings

	Season 1: Western Kenya	Season 2: Lower Eastern Kenya
Demographics	• Three counties targeted included Bungoma, Trans-Nzoia, and West Pokot • 298 farmers (213 males and 85 females), 14 agro-dealers, one seed company	• Three counties targeted included Kitui, Machakos, and Makueni • 334 farmers (182 males and 152 females), 13 agro-dealers, 21 motorbike

	(Bubayi), and two motorbike riders involved in the study	rides, and two seed companies (DSL and KSU) were involved in the study
	• The average land size was 1.5 Ha	• The average land size was 3.64 acres (approximately 1.47 Ha).
Value chain analysis	• The total purchase for the season was 1366 Kgs	• The total seed distributed by DSL was 3120 Kg (240 Kg of *Nyota* seed to each of the 13 agro-dealers)
	• The main challenge was the timely availability of seeds, seed price, and unpredictable weather	• The main challenge was the late supply of seed relative to the start of the rain season, low demand due to the COVID-19 pandemic, and unreliable rains.
Motorbike use	• The riders faced challenges related to approval for them to deliver seed to farmers and high transaction costs due to poor infrastructure	• The riders supplied seeds between 1-3 times a week but faced infrastructural and licensing challenges
Viability of niche model	• Unmet demand was reported with farmers willing to plant the new varieties, and business performance increased among agro-dealers and seed companies. Awareness creation is needed.	• Demand reduced due to pandemic but fast-rising. Farmers were willing to test the new varieties. The use of motorbikes enhanced business, and returns were better compared to before.

3.2.6 Efficiency analysis of the last mile seed delivery business model against its assumptions

The first hypothesis for last mile seed delivery Business Model was that there is an urgent need for micronutrient HIBs to address malnutrition in Kenya. The process of regulatory approval was fast-tracked to enable access to micronutrient HIB seeds to address malnutrition in Kenya. From this study there is an indication that *boda boda* linked to agro-dealers were instrumental to enhanced access to seed by farmers in remote areas and contributes to enhanced use of improved varieties including HIBs.

The second assumption was that there would be vibrant awareness creation that lead to increased demand for HIB seeds. Awareness creation and campaigns carried out by KALRO and other partners have triggered demand for HIB seeds in Lower Eastern Kenya. During this study, previous awareness creation efforts augmented by information shared by agro-dealers, farmers bought the new variety upon being convinced of their value regarding yields, market access, and nutritional benefits despite the perceived high cost of the seed.

The Nyota variety was purchased during the second season data collection more than older varieties (56 % against 42% for KATB1 and 2% for others like KATX56). This indicator signals the likely success of awareness creation and the use of non-traditional channels in seed distribution. Demand for HIB exists, and it seems that male farmers above 45 years are more interested than other age groups. Ultimately, this means that youths and young women may need to be brought into the process as they are the majority of bean farmers in the study aera. Awareness creation by PABRA and KALRO needs to be strengthened through institutional collaboration and working with local leadership and *boda boda* riders to reach last-mile farmers. Most agro-dealers are already stocking the seeds and aligning the distribution to accommodate the increasing demand, but the long distances may still hinder access. This issue needs to be addressed alongside the cost of seeds associated with the 2 kg and 5 kg packets that may not be affordable to smallholder farmers.

While DSL is already distributing the seeds in Lower Eastern Kenya, it is evident from the maps that most areas remain uncovered by the current agro-dealers network. The implication is that there is a need to grow the agro-dealer network to smaller towns and centers to help reach farmers in very distant areas, alongside the development of last-mile delivery

by *boda boda* riders. Further study may be needed to determine how use of *boda boda* could contribute to reaching farmers in far distant areas including women and youth.

The third assumption was that private seed companies would be interested in taking up the seeds for distribution in the country. Over time and due to active awareness creation and the ensuing demand for the high iron and zinc varieties, and the potentially profitable seed distribution venture, more seed companies beyond Bubayi and KSU have applied for and been granted a license by KALRO to multiply and distribute the micronutrient rich *Nyota* bean variety. The newly licensed seed companies include Seed Co, DSL, and Lano Agro.

The fourth assumption is that non-traditional and efficient methods, e.g., motorbike (*boda boda*) riders enhance adoption, especially at the last mile. Agro-dealers continue to use *boda boda* riders for last-mile delivery to smallholder farmers based on demand. While the Seed and Plant Varieties Act (Cap 326 of the Laws of Kenya) does not provide for seed distribution by *boda boda* riders, it doesn't disallow their use either. Their use for seed delivery (as a courier) from an agro-dealer where the seed has been purchased to the farmer (buyer) is an innovative way to reach the last mile. While *boda boda* riders would potentially add value in the last-mile delivery of HIB seeds, it is of great interest for KEPHIS to determine that their use does not compromise seed quality and therefore disadvantage the farmers.

However, the extent to which last-mile delivery by *boda boda* positively makes business and economic sense to the smallholder farmers, *boda boda,* and agro-dealers needs further investigation. This cost-benefit and profitability analysis is an area that can be investigated alongside the piloting of the ICT-enabled last-mile delivery of HIB seeds to the farmers. In addition, it requires a formal relationship between agro-dealers and *boda boda* riders, showing traceability of the movement of HIBs from the agro-dealers to the farmers. Currently, this relationship does not exist.

Further, it was observed from the second season data collection that KALRO, in collaboration with Makueni County staff, and Cereal Growers Association have been conducting awareness creation for demand about the HIB seeds alongside its seed production activities. But these activities had a limited scope, and there has been no deliberate awareness creation across Lower Eastern Kenya to support the adoption of HIBs. This opportunity can be filled through collaboration with other partners, especially those involved in extension from government and non-government actors. This second season data collection exercise found that agro-dealers would be a good partner in creating awareness of the micronutrient beans from the point of sale.

3.3 Farmer Feedback after Harvest Season

Overall, the feedback from 205 farmers (customers) who bought Nyota, with regards to information access, last-mile delivery of seed using *boda boda*, varietal performance, and use of Nyota was positive. There were minor differences in farmer satisfaction between the short rains seasons of October/November 2019 and 2020 and the two regions of western Kenya counties (West Pokot, Trans-Nzoia, and Bungoma) and eastern Kenya counties (Kitui, Machakos, and Makueni).

3.3.1 Information Sources and Agro-dealers

Farmers cited agro-dealers as the leading source of information on *Nyota*. All 106 respondents (70 male; 36 female) who intended to purchase *Nyota* again planned to purchase directly from agro-dealers rather than community members, traders, aggregators, or retailers. This observation emphasizes the critical role agro-dealers could play in the variety demand creation and hence the need for capacity strengthening for agro-dealers to enhance information dissemination. Of those who did not intend to purchase *Nyota* in Lower Eastern in the following season, most (88%) planned to use their saved seed. At the same time, a small number of the farmers said they were disappointed by the yield (3), did not harvest any beans (2), or will plant a different variety (2).

3.3.2 Last-Mile Delivery Services

The majority (97%) of farmers who responded were unaware that motorbike riders *boda boda* make seed deliveries of seed and complementary inputs (**Figure 29**). However, 79% (80% of women and 78% of men) said that they would use *boda boda* services in the future (**Figure 30**). *Boda boda* services may help expand seed access of improved bean varieties like *Nyota*, recognizing that repeat farmer intended to purchase from agro-dealers in the following season. Enhanced formalization of *boda boda* services will be crucial to expanding their use for the last-mile delivery of seed and complementary inputs.

Figure 30: Awareness of boda boda deliveries (N=154)

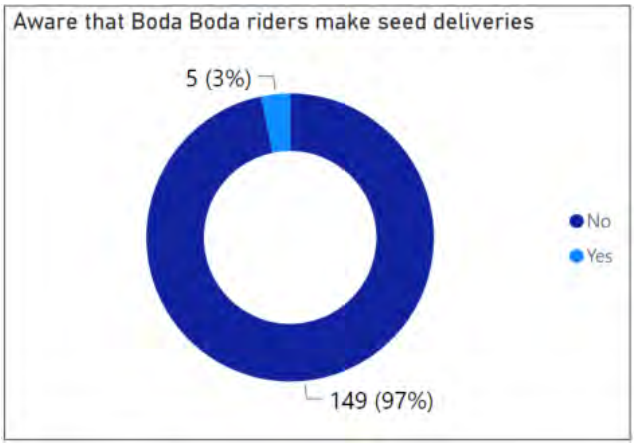
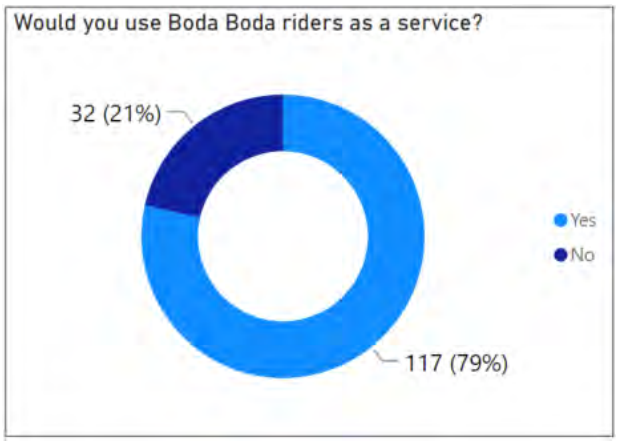


Figure 29: Interest in boda boda deliveries *(N=149)*



3.3.3 Varietal performance

On maturity time, the majority (78%) of respondents said that the variety matured in about two months or less (**Figure 31**), similar to the 2020 season, where 79% of respondents agreed with this statement. On grain quality, 84% of the respondents said that the grain was either excellent or good quality (**Figure 32**), which was consistent with a high proportion (62%) of farmers who said they would purchase *Nyota* again in the following season (**Figure 33**). Both responses are slightly lower than in the 2020 season, where 92% of respondents found the varieties excellent, and 79% said they would purchase Nyota again the following season. This observation suggests that greater awareness creation is needed to make information more accessible.

Figure 32: Maturity time for Nyota (N=167)

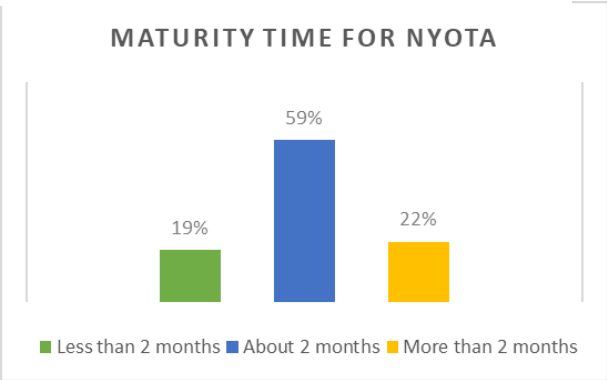


Figure 31: Quality of Nyota (N=170)

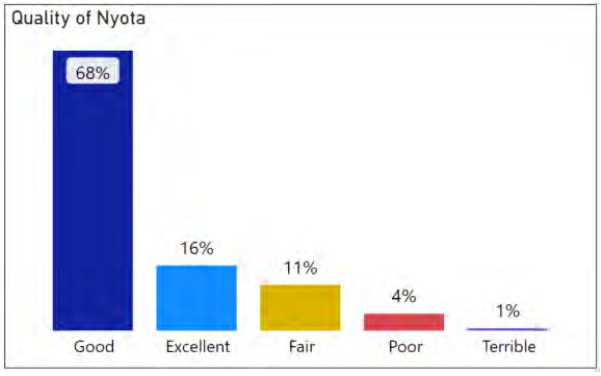
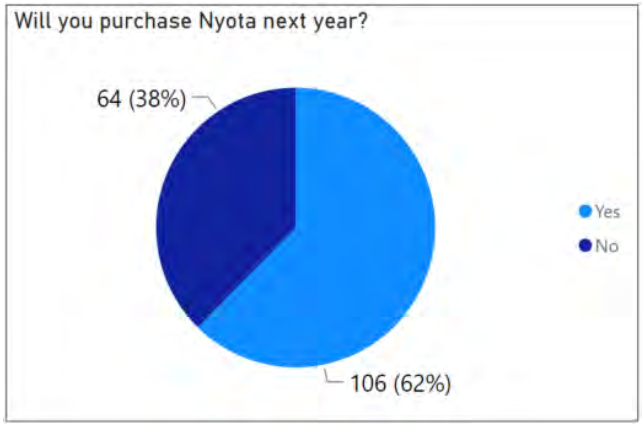


Figure 33: Repeat purchase of Nyota (N=170)



3.3.4 Uses of Nyota

Nyota was used by farmers for food, seed and sold as grain (**Table 6**). The most common use for Nyota was to consume as food (92%), followed by 68% who planned to save seeds for the next season, and only 5% planned to sell Nyota as grain. These uses did not vary substantially by gender, as 87% of women used Nyota for food, 68% saved seeds for next season, and 9% sold Nyota as grain. This case was similar to the responses in 2020, where 90% said they would consume it as food, 59% said they would save it for seed, and 13% said they would sell it.

Table 6: Number of respondents use of Nyota harvested

Consume as food	*Save seeds*	*Sold as grain*	*All*	*Women*	*Men*
No	No	No	3	2	4
No	Yes	No	5	3	9
Yes	No	No	27	29	25
Yes	Yes	No	60	63	54
Yes	No	Yes	2	1	4
Yes	Yes	Yes	3	2	5
Total sample size			*154*	*56*	*98*

3.3.5 Farmer Comments on Consumption of Grain and Seed Access and Cost

When asked for feedback on the Nyota variety, many farmers commended the quality of the harvest, despite low rainfall. Some mentioned that the harvests were not as high as expected due to low rainfall, but many were impressed with the performance despite the unfavorable conditions.

On consumption of *Nyota,* all participants who mentioned the taste expressed satisfaction with the "sweet taste" and low flatulence, which were seen as positive aspects of Nyota.

Many farmers reported difficulties in locating places to purchase new Nyota seeds. The challenge of access to seed, added to their frustrations by the lack of consistent supply. *"Farmers are getting tired at the several numbers of varieties that are being introduced and leaving the market."* This observation suggests that more needs to be done to promote and expand the distribution of *Nyota.* Sharing the positive feedback (taste and low flatulence over and above health, nutrition) of *Nyota* with agro-dealers and raising awareness of sources of *Nyota* seed for restocking could help support consistent supplies of *Nyota* and convince agro-dealers of the demand for this variety.

On the seed cost, farmers expressed concern that KES 250 per kg (~USD 2.25) was expensive and thus contributing to the high cost of grain in the market. "One is not able to plant it in bulk for sale as people shy from buying it. Since early February, I am not able to sell the 100kgs remaining." This observation suggests that more demand generation

and awareness-raising for *Nyota* could help improve both supply and demand for the variety and make it more available and accessible.

3.3.6 Gaps Identified by Farmers in Production of Nyota

Overall, the feedback from farmers who grew Nyota beans was very positive. There are a few critical takeaways regarding room for improvement, including:

1. Most respondents (97%) were not aware of the seed delivery services offered by *boda boda*. Greater awareness and their formal integration into seed distribution systems are needed to link them to farmers in remote areas.
2. Many farmers experienced difficulty finding suppliers for *Nyota* seeds, which were mostly (97%) purchased from local agro-dealers. This observation suggests that new outlets (agro-dealers and *boda boda*) should be included in Nyota's distribution channels.
3. Some farmers stated that Nyota took longer than two months to mature (22%), and a few mentioned that Nyota might not be adapted to their location or had lower production due to low rainfall. This case may suggest that Nyota sales should be targeted to appropriate agroecologies that complement various traits.
4. Price seems to be an issue for some smallholders, and pack sizes smaller than 2 kg could potentially be an essential marketing strategy to capture this farmer segment.

4. RECOMMENDATIONS

4.1. Seed distribution should continue to respond to farmers' needs about access and cost of seed

a) Seed distribution by seed companies and access by farmers could be enhanced with ICT support and use of boda boda

Dryland Seed Limited (DSL), its agro-dealership and other seed companies may integrate the ICT platform tool or its equivalent in its seed distributorship to monitor demand, transport, traceability, digital payment and claims, etc. This integration is likely to enhance efficient delivery even at peak demand times. Further, the use of non-traditional distribution channels, especially the *boda boda* riders, may need to be integrated into the company's distribution network for targeted distribution based on demand and thus enhance delivery of seeds to farmers and therefore adoption. Both strategies are likely to reduce transaction costs associated with distribution through agro-dealers.

b) There is a need for more miniature seed packs to encourage adoption

The need to package seed into more miniature affordable packs (less than 2kg packs) came out strong in the previous report and has emerged in the survey under review. This issue needs to be investigated, including exploring the use of 1 kg packages and less. The bottom line is that price is a factor that seed companies need to consider since it directly translates to the adoption or dis-adoption of the varieties. Seed multiplication through numerous registered bean business platforms around a lead farmer or an off-taker is a possible area to consider. This move enhances the utilization of economies of scale and potentially brings down the cost of seeds.

4.2. Coordinated, continuous, and sustained awareness and demand creation are necessary for enhanced adoption of HIBs

The study found out that there are awareness creation efforts by various players, including agro-dealers, county governments, seed companies, among others. However, it was also reported that the majority of the farmers (including youth and women) were not aware of Nyota and its nutritional and production attributes to enable them to decide to buy.

Subsequently, there is a need for targeted awareness creation to trigger demand for *Nyota*. This being the first such study in lower eastern Kenya and the fact that the survey was also an opportunity for many getting to know about the high iron beans, awareness efforts towards women farmers should focus on the health and nutritional benefits of Nyota, a factor that seems to inform the decision to purchase *Nyota*. For youth, awareness should aim to excite their interest in bean farming, which could be achieved by focusing on potential incomes the development of vibrant and profitable bean value chain/processing and complementary services e.g. mechanization services. Overall, farmers need information on production and income, source of *Nyota* seed, and the possibility of last-mile delivery by *boda boda*. There is a need for coordinated effort among the various actors and expanded scope to achieve this. In this respect, the agro-dealers, recognized by this report as one of the most important sources of information, will need capacity building for effective awareness creation that reaches both men and women.

Overall, awareness creation should be continuous. To enhance awareness creation among the farmers, the seed company needs after-sales service, complete with explicit varietal attributes and performance tied to the critical attributes of health, nutrition, low flatulence, and good taste. A sustained link between agro-dealers and seed companies is necessary, complete with information on the seed stock levels and the possibility of last-mile delivery of seed and complementary inputs by *boda boda*.

4.3. There is a need for the KALRO to focus on the production of early generation seed

With increasing demand for HIB seeds and the increase in the number of seed companies licensed by KALRO to produce and distribute certified seed KALRO could capitalize on this demand to meet growing demand of early generation seed (basic and breeder seed). KALRO, in partnership with the Alliance – PABRA, would do well to continue breeding/releasing better farmer and consumer demanded varieties to increase genetic gains, including climate resilience.

4.4. There is a need to facilitating enhanced use of motorbike riders for last-mile delivery of seed

Motorbike riders are often used for the last-mile delivery of bean seeds and other complementary farm inputs. However, their use has been informal, without certainty of being cost-effective for agro-dealers, *boda boda* riders, and farmers. This study recommends formalizing the use of *boda boda* riders in the seed distribution system Since this is both a business decision and policy aspect, it would require agro-dealers to independently make that decision based on whether it makes business sense, hence the need for cost-benefit analysis.

From a policy perspective, the formalization would potentially assure the regulator, KEPHIS, of traceability and maintenance of seed quality as the *boda boda* make deliveries, aspects which will require capacity building. Formalization will thus contribute to improved access to quality seeds leading to better adoption and resilience of the smallholder farmers.

4.5. There is a need to consolidate policy support for last-mile delivery of HIBs

a) National policy dialogue on the last mile delivery of HIBs

With emerging demand-led breeding, KALRO as the bean program lead organization in Kenya could oversee coordination between research institutions, the private sector, and government institutions. Developing a feedback loop (that is cognizant of the barriers which affect youth, women and other marginalized groups in technology adoption) between the seed companies, agro-dealers, researchers, and farmers will enhance efficiency in communication and understanding of market demands and farmer needs.

With the support of PABRA, KALRO can initiate a national dialogue among seed research institutes, policymakers, farmers, seed companies, and donor communities on the last mile seed systems delivery business model. The dialogue should be deliberate and inclusive of the gender, youth and marginalized groups' perspectives. Enhancing multi-sectoral partnerships and synergies around last-mile delivery will expand seed access and ultimately increase common bean production and utilization. Key among these is facilitating private sector-driven development and deployment of ICT-enabled last-mile delivery of HIB seeds. This action will help formalize the use of *boda boda* riders in seed distribution and increase seed access to farmers. In addition, embracing the non-traditional seed distribution methods may be the future.

b) Optimizing the last mile seed delivery business

Informally, farmers and agro-dealers use motorbike riders for last-mile delivery of bean seeds and other farm inputs. Though not disallowed in law, motorbike riders would want their business of seed and farm inputs delivery formally recognized. The Alliance–PABRA in collaboration with KALRO, private sector players (ICT companies, agro-dealers, and seed companies) and KEPHIS can work at validating an ICT-based platform for the last-mile delivery of seed using motorbike riders. This pilot would help demonstrate the model's capacity to ensure traceability and accountability in this innovative seed delivery process. The result will most likely boost the enhanced use of improved quality seed and other agricultural technologies and smallholder farmers' resilience.

5. NEXT STEPS

Complementary efforts towards a viable and sustainable Niche Market Business Model for micronutrient-rich beans hinge on the following two critical actions that and should be sequentially implemented.

a) Conducting the cost-benefit analysis (CBA) of the last mile delivery of HIBs

This action is necessary to help ascertain the cost-effectiveness of the last mile delivery of HIBs by *boda boda*. The CBA will establish the model's profitability to the players on the seed delivery chain (seed companies, agro-dealers, motorbike riders and farmers), including identifying its social benefits and risks to farmer as especially women farmers in remote areas.

b) Feasibility study and development of an ICT enabled last-mile delivery of HIBs

This report and the preceding one encourage the development of an ICT-enabled last-mile delivery of HIBs by *boda boda*. The platform will enable the farmers to make and pay for orders of seed and complementary inputs and access necessary extension information, including market information. Contingent to and before the development of the platform, there will be the need to ascertain the platform's feasibility among the various actors, including farmers (both men and women plus youth), agro-dealers, motorbike riders, seed companies, ICT companies, seed regulators and researchers.

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7. ANNEXES

Annex 1: A training manual for data collectors

Two documents detail the training manual that was used to train the enumerators: POS application instruction guide and User Training Deck. Both documents can be found in separate .pdf files.

Annex 2: Interview Guide for Baseline Survey with Agro-dealers in Kitui, Machakos, and Makueni

Name of Agro-dealer Agro-dealer shop & location:
Name of owner:

a) Self-introduction of the interviewer

The interviewer introduces himself, stating the full name, the organization he works for (the Alliance), and the fact that the Alliance collaborates with KALRO and DSL. The interviewer also gives the agro-dealer agro-dealer his business card.

b) Objectives of the visit

The interviewer also states that the objectives of the visit are:

i). To introduce the Niche Market Business Model Point of Sale (PoS) Pilot second season data collection exercise, which is scheduled for 5th to 16th October 2020;

ii). Collect preliminary information via an interview on bean seeds distribution and motorbike riders (boda-boda) for bean seeds distribution.

c) Confidentiality

The interviewer further indicates that information collected during this exercise is for the Niche Market Business Model Point of Sale (PoS) Pilot second season data collection and shall be treated with uttermost confidentiality.

d) Background of the Niche Market Business Model Point of Sale (PoS) Pilot and the reconnaissance exercise

The Niche Market Business Model Point of Sale (PoS) Pilot is a component of the Feed the Future Global Supporting Seed Systems for Development (S34D) activity being implemented by the Catholic Relief Services (CRS) and Alliance of Bioversity International and CIAT (Alliance) through Pan-African Bean Research Alliance (PABRA), with their partners. Some partners include Kenya Agriculture and Livestock Research Organization (KALRO) and Dryland Seed Ltd (DSL).

The specific objectives of the pilot include:

1. To establish evidence and data using the geospatial location of sellers (agro-dealers) and consumers (farmers) to show the distance between the agro-dealers and farmers;
2. To understand the factors affecting the adoption of the niche micronutrient-rich (with iron and zinc) varieties along the supply chain, and;
3. To understand the overall regulatory framework affecting the use of motorbike riders (*boda boda*) in seed distribution.

The first season data collection was conducted in September and October 2019, followed by a feedback survey in January 2020. This second season data collection is undertaken between September and October 2020 in lower eastern Kenya counties of Kitui, Machakos, and Makueni. Enumerators are posted to the 13 agro-dealer agro-dealer shops spread across the three counties, which DSL uses to distribute its seeds

.

This meeting aims to understand the experience of the agro-dealers about bean seeds distribution and sales.

Annex 3: Survey tools

a) Farmer (customer) questionnaire

Part 1. Customer Information

1.5 Select agro-dealer agro-dealer where this farmer is being registered
1.6 What is your first name
1.7 What is your last name
1.8 What is your phone number
1.9 Select gender of the customer
1.10 Select the age category the customer falls in
1.11 Are you the head of the household?
1.12 How much land do you own in Acres?
1.13 Do you lease land?
1.14 How much land do you lease?
1.15 How much land do you cultivate?

Part 2. Location Information of the farmer (customer) where the seeds are carried to

1. Do you live in one of the following counties: Machakos, Makueni, Kitui
2. If no, write the name of the County, Sub-county, Ward, and Village where the farmer lives
3. In which county do you live?
4. In which sub-county do you live?
5. In which ward do you live?
6. In which village do you live?

Part 3. Stock and Sell Information for Bean varieties

- Have you purchased these beans for yourself or someone else? (Purchased for myself; purchased for someone else; purchased for myself and someone else)
- Please select the bean varieties customer has purchased (Nyota, KATEX 56, KATB1, Nyayo, Amin, Mwitemania
- The following questions will repeat for each variety selected
- How many 2 kg packs ____ variety packs did you buy?
- How many 5 kg packs ____ variety did you buy?
- Have you bought ____ variety before? (Yes/No)
- Where did you get information about ____ variety? (Agro-dealers, Seed company agents, Village-based agents, Farmer-based organizations, Other extension agents, Neighbor, Local markets, Demonstration/field days, Other).
- Would you mind specifying where?
- How much of your land do you cultivate with ____ variety? (Most of the land, Half of the land, Less than half of the land, Very little, I am testing).
- Did the agrodealer have enough seed of ____ for what you needed? (Yes/No).
- Please specify why.
- In addition to buying, do you also use your own saved seeds for ____ variety? (Yes/No).
- How many kg ____ did you save?
- Why do you want to buy ____ variety?

End of repeating question sets per variety

- In addition to agro-dealers, where else do you source your seed from? (Other farmers, Family members, Local seed producers, Local Traders, Local markets, Other, None/not applicable).
- Are there other bean varieties, not mentioned, that you grow with your own save seed?
- Please specify the name of the variety. (Skip if the customer doesn't know the name).
- What other crops do you grow that are important for you? (Banana, Maize, Potato, Other, None).
- Please specify other

- Do you have any other feedback for us?

b) Agro-dealer questionnaire

Part 1. Agro-dealer Information

1. What is your first name?
2. What is your last name?
3. Gender
4. What is your phone number?
5. Age category
6. Are you the owner of this shop?
7. If "No," what is the name of the owner?
8. What is the gender of the owner?

Part 2. Location Information of the Agro-dealer Agro-dealer where the data is collected

1 In which county is your shop located?
2 In which sub-county is your shop located?
3 In which ward is your shop located?
4 In which village do you reside?
5 Is the agro-dealer agro-dealer in a shopping complex?
6 What is the name of the shopping complex?

Part 3. Stock and Sales Information for Bean varieties

1. Do you sell bio-fortified beans such as Nyota?
2. Which bean varieties do you sell?
3. What is the cost per 2kg pack of ____ in KSH?
4. What is the cost per 5kg pack of ____ in KSH?
5. When did you last receive stock of ____?
6. How many kg stocks did you receive of ____ variety?
7. How many kg stocks do you have of ____ variety right now?
8. How often do you restock for ____ variety?
9. Do you have enough supply to meet the demand of ____ variety?
10. If no, how many customers, on average, do you turn away
11. How frequently do you turn customers away?

Part 4. Business questions

1. What is the most popular variety for female farmers?
2. Why is that variety popular with female farmers?
3. What is the most popular variety for male farmers?
4. Why is that variety popular with male farmers?
5. How long have you been in business?
6. Compared to last season, how is the business doing now?
7. Do you know why sales have ____?

Part 5. Motor Bike Riders (Boda Boda) Questions

1. Do you use your motorbike riders to deliver seeds?
2. How long have you been using motorbike riders for delivering seeds?
3. How many motorbike riders do you use to deliver seeds?
4. How many motorbike riders are male?
5. How many motorbike riders are female?
6. What are their average ages?
7. How often do you give motorbike riders seeds to deliver

8. Which varieties do you deliver
9. Please tell me the routes of the motorbike riders. What are their delivery locations? County, sub-county, ward, villages.
10. What volume of seed (kgs) do you give a motorbike rider each time?
11. Which other products do motorbike riders deliver to farmers alongside bean seeds?
12. Do you have any other comments about using motorbikes to deliver seeds?

Part 6. Final Questions

2. Are you experiencing any constraints to the growth of your business?
3. Which ones are these and why?
4. Do you have any other comments

c) Motorbike riders questionnaire

Name of Data Collector: _____

Location of Data Collection:

County	Sub-County	Ward	Village

Date (mm/dd/year):

Part 1: Motorbike Rider Information

1 1) First Name			
2) 2) Last Name			
3) Contact Info – Phone #			
4) Gender	☐ Male	☐ Female	
5) Age	☐ 15 – 29	☐ 30 – 45	☐ 45 +

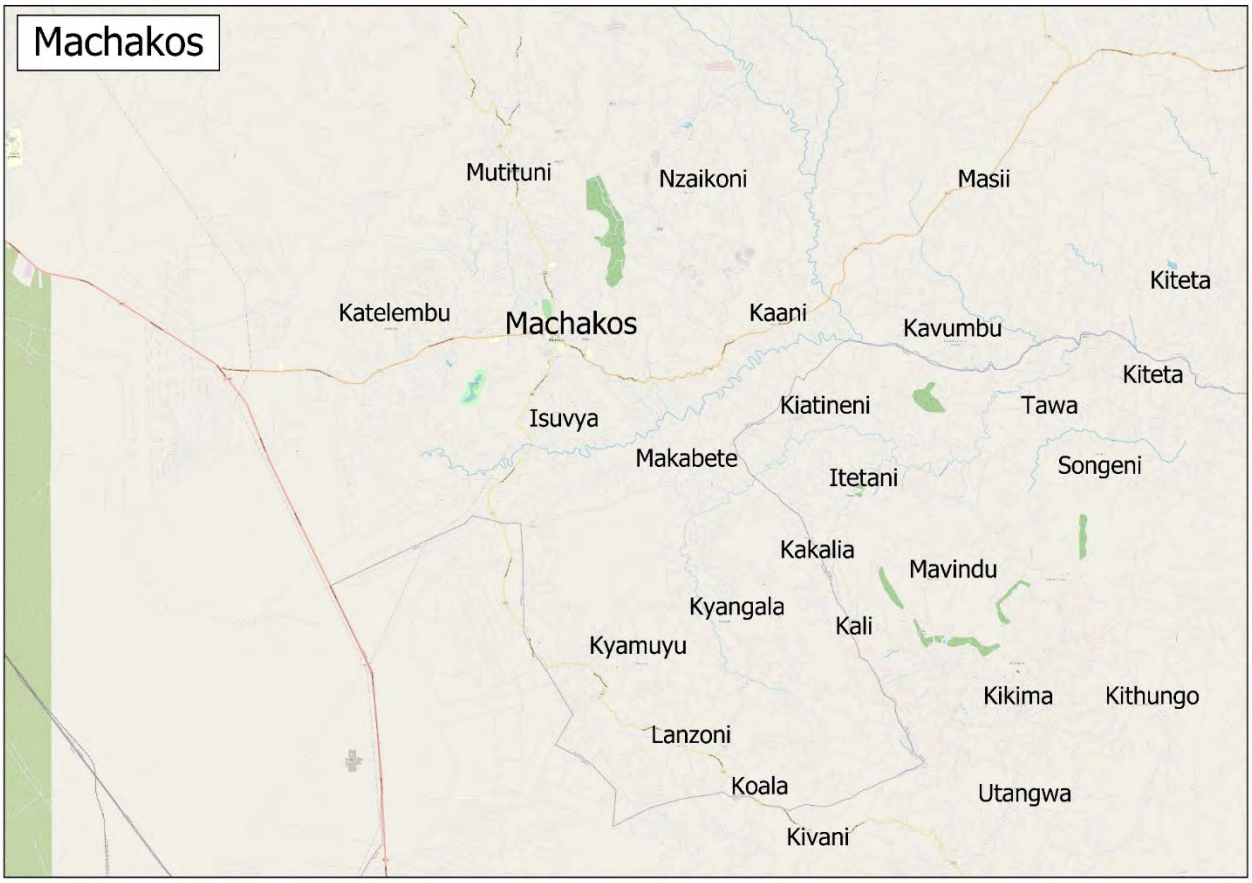
6) Agrodealer Name (*motorbiker rider delivers for this agrodealer*)					
7) Agrodealer address and contact info					
8) How long have you been riding a motorbike to deliver agricultural inputs?	☐ Less than 1 year	☐ 1 – 3 years	☐ 3 – 5 years	☐ More than 5 years	
8) 9a) What Inputs? (Check all that apply)	☐ Seeds	☐ Fertilizers	☐ Pesticides	☐ Livestock products	☐ Other
9b) If Other – What inputs?					
10) How often do you deliver inputs to the farmers per week?	☐ 1 – 3 Deliveries per week	☐ Bi-monthly	☐ Monthly		
11a) Where do you get your orders from? (Check all that apply)	☐ Farmers	☐ Agrodealer	☐ Other		
11b) If other – *please specify*					
12) Who are your customers?	☐ Mostly Women	☐ Mostly Men	☐ Men and Women		

Part 2: Delivery Route Information

1) Route Start	County	Sub-county	Ward	Village
2) Route Finish	County	Sub-county	Ward	Village

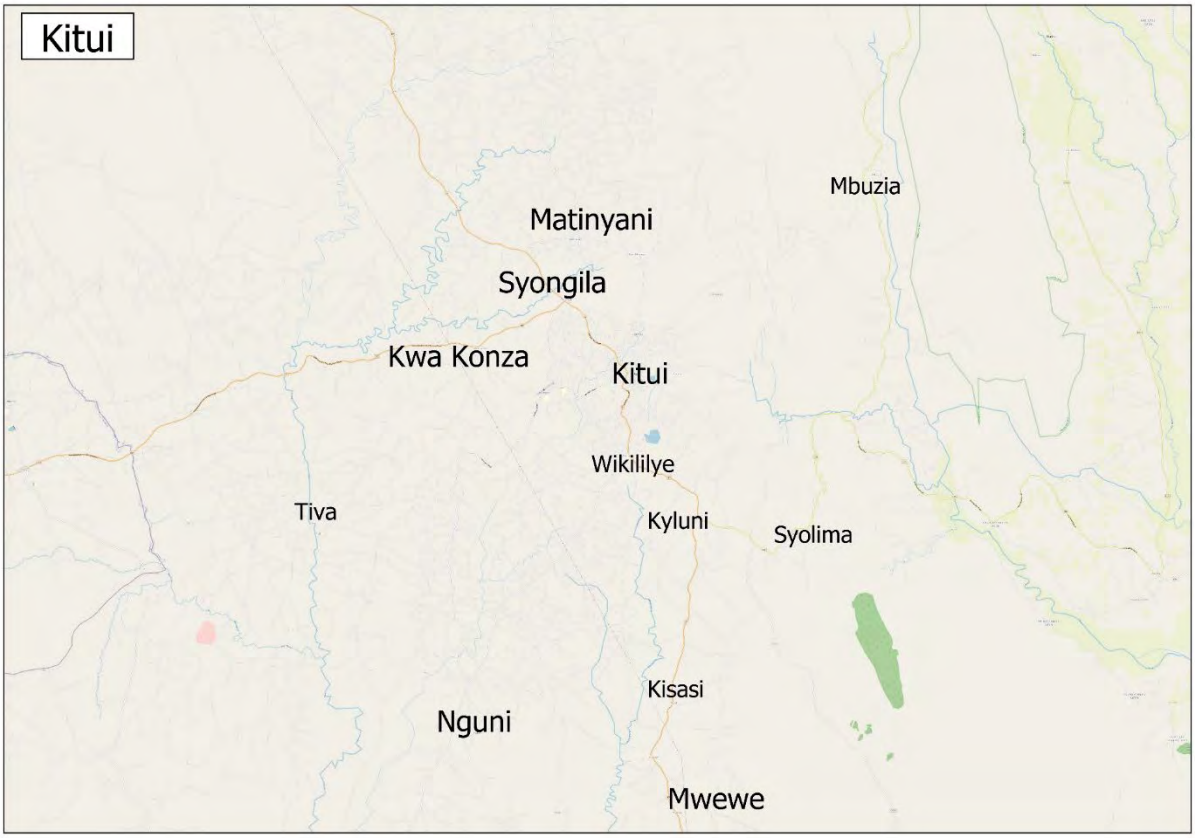
3) Stops in Between (how many and where)	Stop 1 *(ward, sub-county)* *Example- Ukia, Kaiti*	Stop 2 *(ward, sub-county)*	Stop 3 *(ward, sub-county)*	Stop 4 *(ward, sub-county)*	Stop 5 *(ward, sub-county)*
4) Please describe the stops (market, community center, school, etc.)	Stop 1	Stop 2	Stop 3	Stop 4	Stop 5

5) Which crop-varieties do you deliver? What quantity of seed per crop variety?	Crop Variety *Example Bean – Nyota Variety*	Quantity of seed per crop variety



Part 3: Please look at map and trace route

Name of Data Collector: **Name of Motorbike Rider:** **Date (mm/dd/year):**

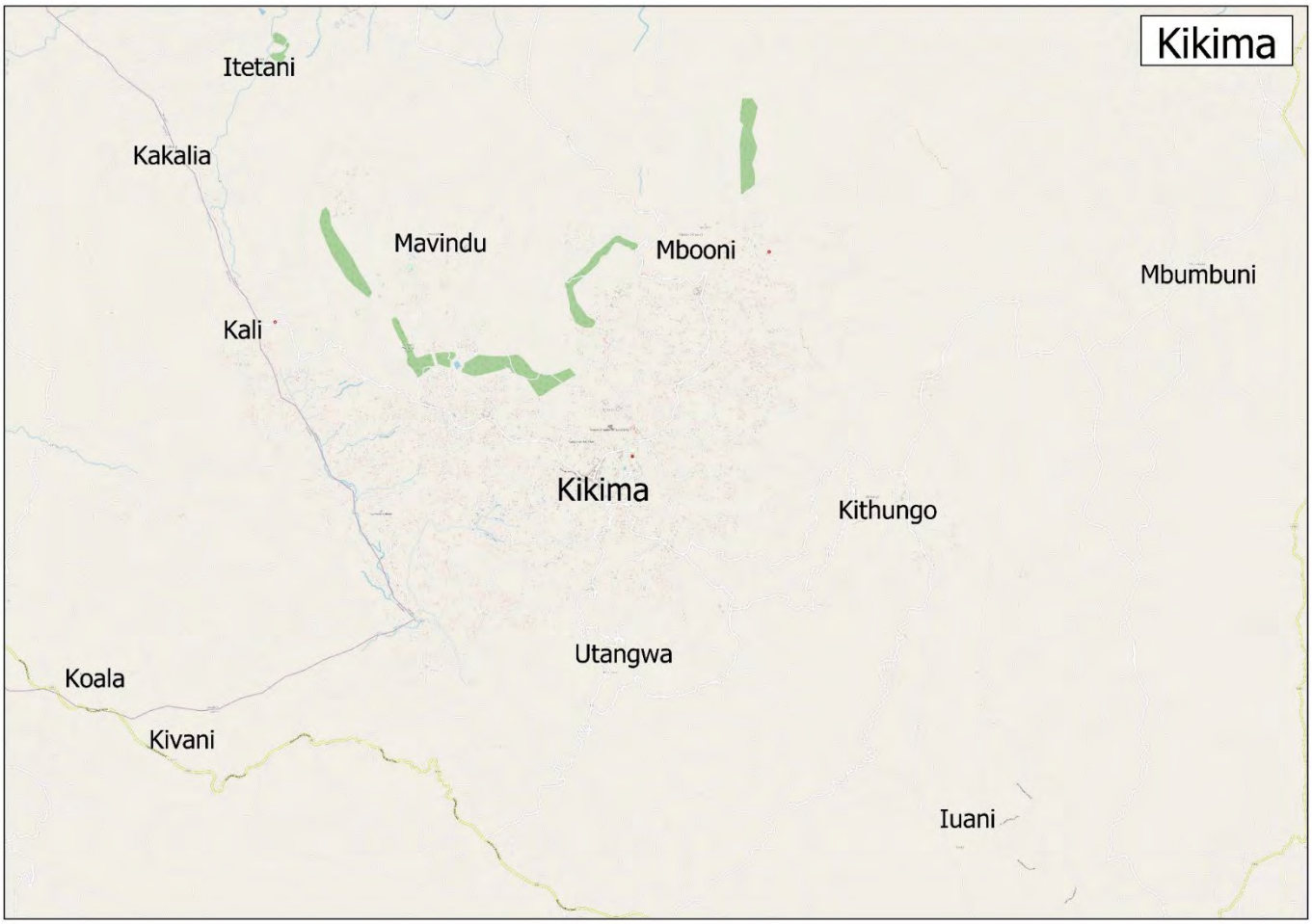


Name of Data

Collector:

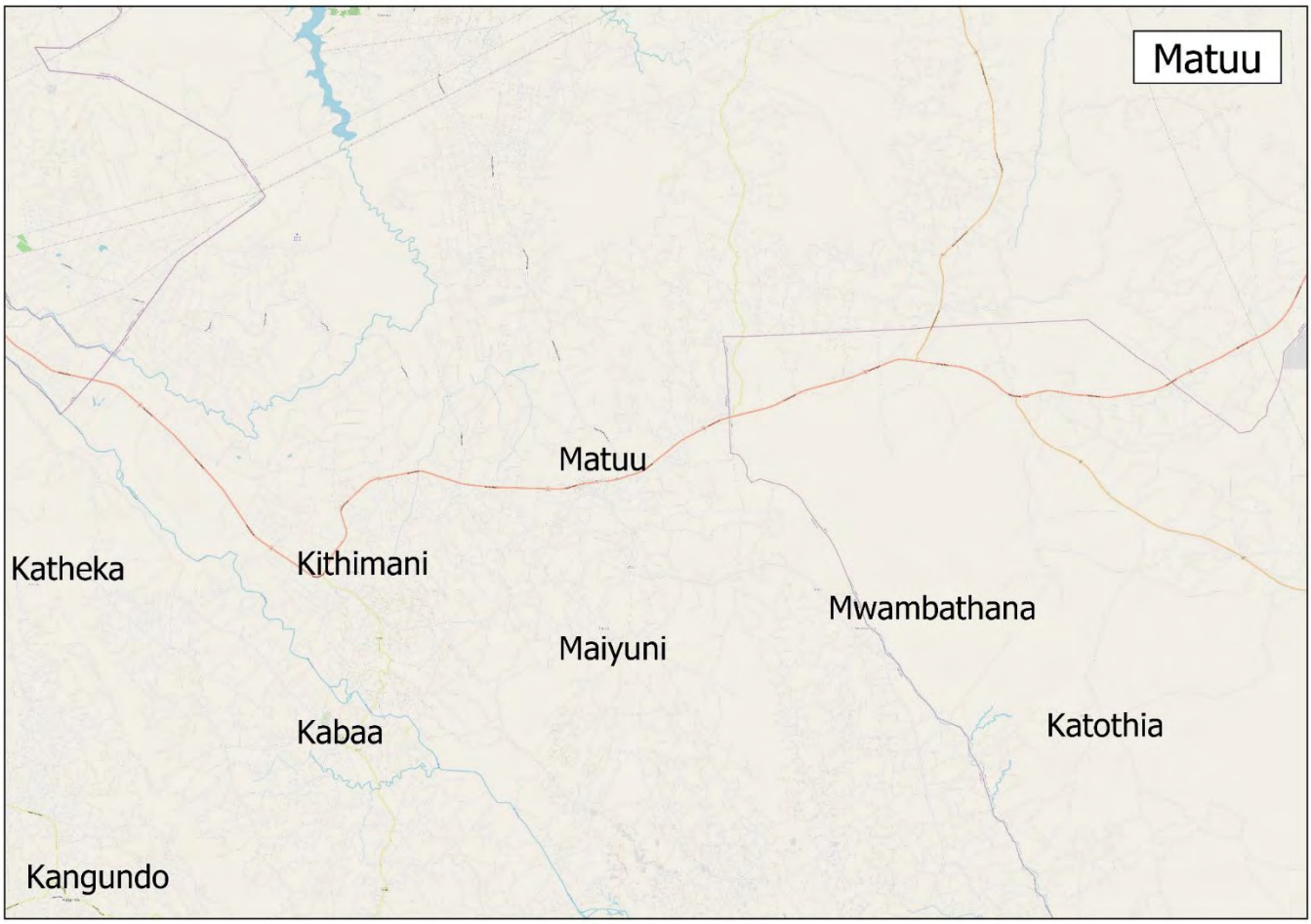
Date (mm/dd/year):

Name of Motorbike Rider:



Name of Data Collector:
Date (mm/dd/year):

Name of Motorbike Rider:



Name of Data Collector:
Date (mm/dd/year):

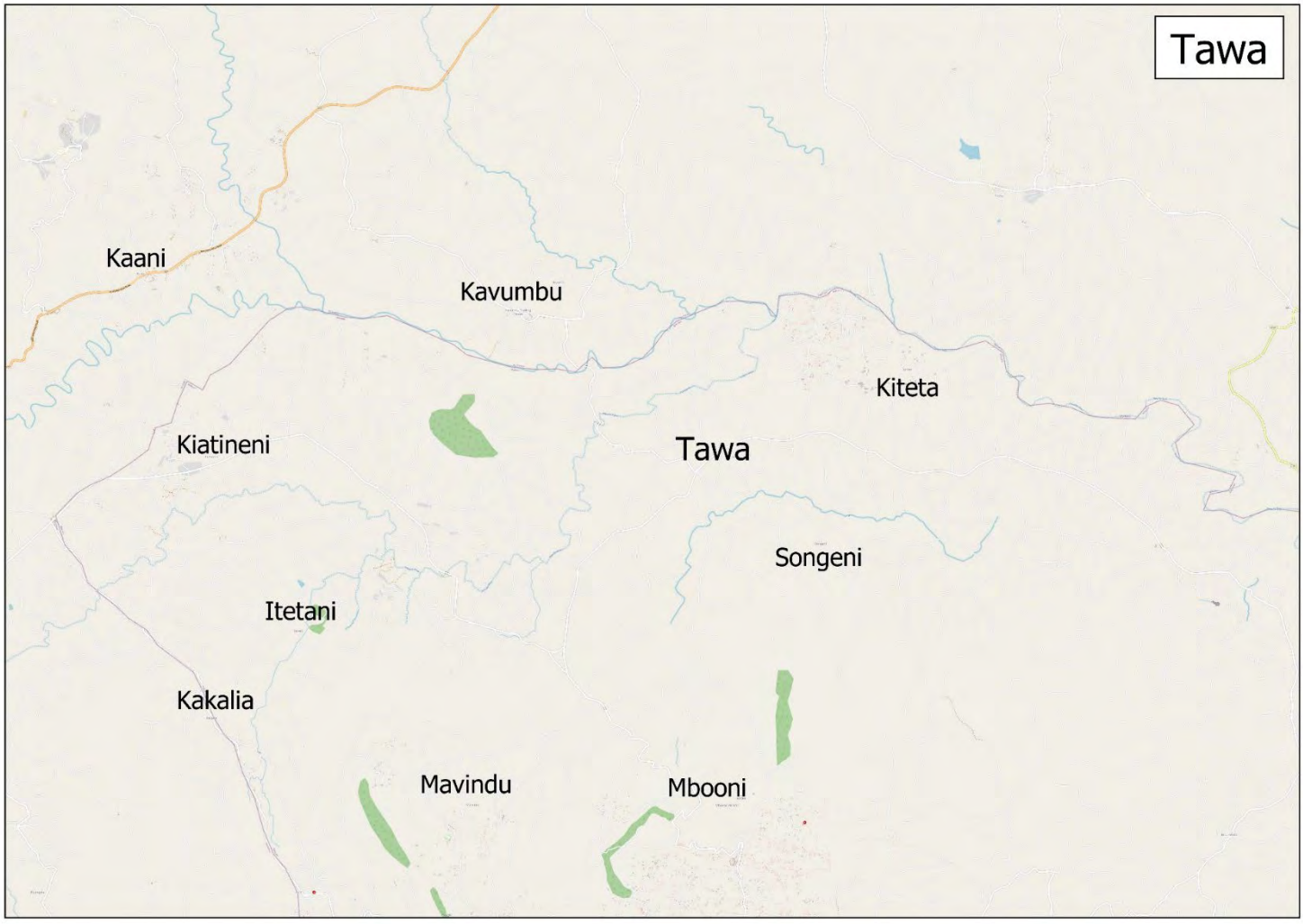
Name of Motorbike Rider:

Name of Data Collector:
Date (mm/dd/year):

Name of Motorbike Rider:

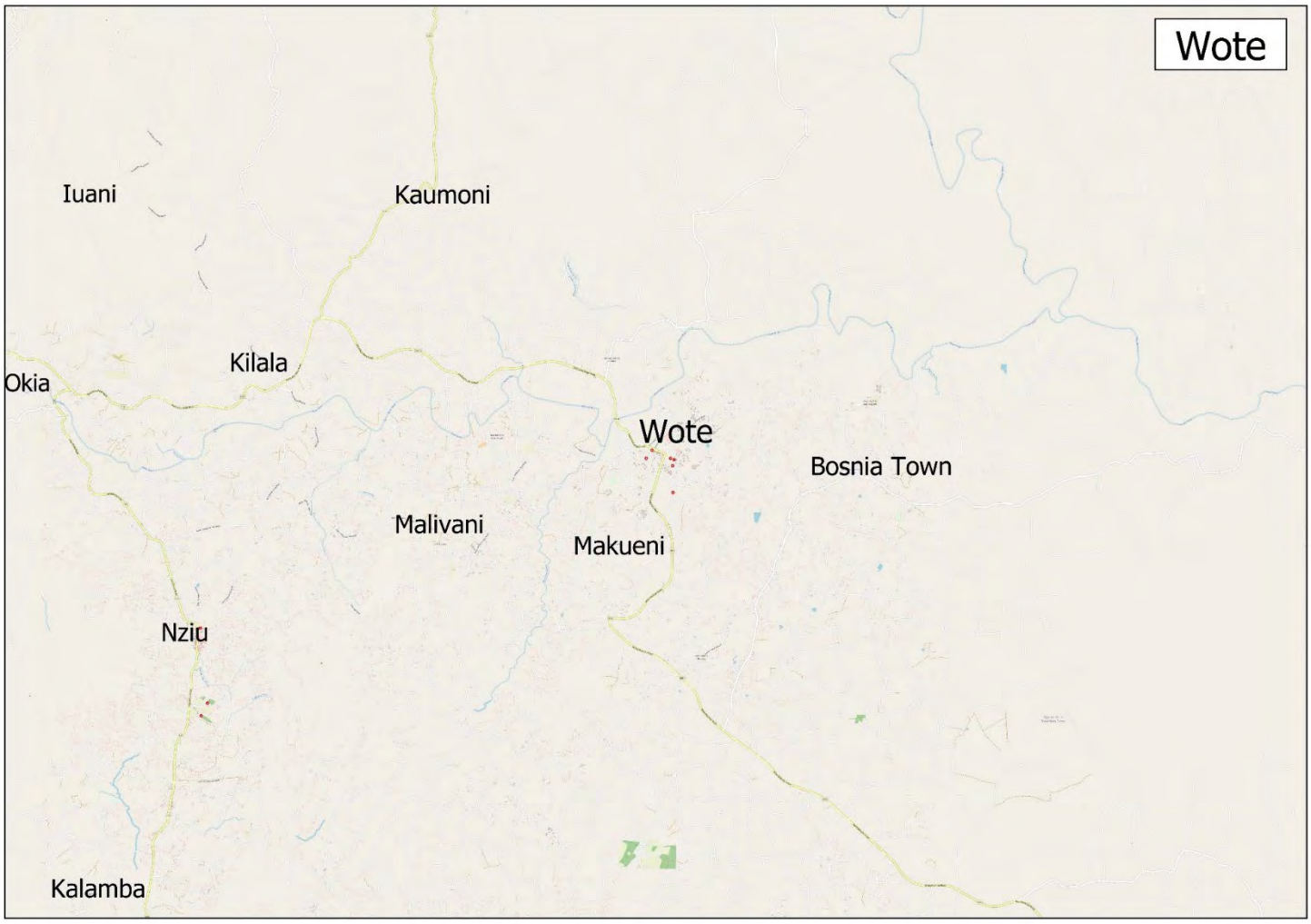
Name of Data Collector: **Name of Motorbike Rider:**

Date (mm/dd/year):



Name of Data Collector: **Name of Motorbike Rider:**

Date (mm/dd/year):



Part 4: Contextual Information

1) What constraints do you face, if any?	
2) Do you collect farmer seed orders along the route and bring it back to the agrodealer?	
3) Do you also disseminate information about the varieties themselves? If Yes, please describe the process. Where did you get information about the varieties?	
4) What can you tell us about your customers? Are they more men or women? Young or old? Who prefers what?	
5) What opportunities do you see in your inputs delivery business? How can we scale it up?	
6) Do you have unmet demand in any agricultural inputs? Please describe	
7) Other comments or suggestions?	

Annex 4: Personal Protection Equipment (PPE) User Agreement

Introduction

Niche Market Business Model Point of Sale (PoS) Pilot is a component of the Feed the Future Global Supporting Seed Systems for Development (S34D) activity being implemented by the Catholic Relief Services (CRS) and Alliance of Bioversity International and CIAT (Alliance) through Pan-African Bean Research Alliance (PABRA), with their partners.

The specific objectives of the pilot include the following:

a) To establish evidence and data using the geospatial location of sellers (agro-dealers) and consumers (farmers) to show the distance between the agro-dealers and farmers;
b) To understand the factors affecting the adoption of the niche micronutrient-rich (with iron and zinc) varieties along the supply chain, and;
c) To understand the overall regulatory framework affecting the use of motorbike riders (*boda boda*) in seed distribution.

The first season data collection was conducted in September and October 2019, followed by a feedback survey in January 2020. This second season data collection will be undertaken between September and October 2020 in the lower eastern Kenya counties of Kitui, Machakos, and Makueni. Enumerators will be stationed in or preferably outside 15 agro-dealer agro-dealer shops spread across the three counties.

Given the prevailing COVID – 19 pandemic, it is imperative for the enumerators and the organizers of the data collection to stringently observe specific necessary restrictions and precautions to avoid the possibility of infection by the virus. Further, in case of infection, the person will take action for treatment and avoid spreading the disease.

Parties to the Agreement

The agreement is made this …… day of September 2020, between (name of enumerator) …… of P.O. Box ……, ID No……., Tel:..... and Pan-Africa Bean Research Alliance (PABRA)[2].

Terms of the Agreement

1. **Effective period of the contract**: The contract shall take effect from the day the enumerators effectively take training on the COVID-19 response mitigation measures, for the time being, scheduled for 11th September 2020, and shall run throughout data collection for the time being scheduled from 16th September 2020 to 2nd October 2020. These dates may be changed through a mutually signed consent between an official representative of PABRA and the enumerators.

2. **Obligations of PABRA**. The following shall constitute the obligations of PABRA.
   i). Provide the necessary personal protective equipment (PPE) suitable for the data collection exercise. These shall include facemasks and sanitizers. PABRA may arrange with the host agro-dealer agro-dealer shop to get some or all of these materials provided by the agro-dealers.
   ii). Train the enumerators on COVID-19 and the necessary restrictions and precautions which must be adhered to during the data collection.
   iii). Provide information on the nearest medical facilities in the areas/geographies where the studies will occur.
   iv). Provide identification batch for each enumerator.
   v). Sign a short-term contract with the enumerators, details next of kin contacts and a clause on dealing with COVID-19 (before and after infection).

3. **The obligation of the enumerators.** The following shall constitute the obligations of the enumerators.
   i). Use the PPE during the agreement and when on duty at the respective agro-dealer agro-dealer shops.
   ii). Use facemasks, gloves, and overalls, and regularly wash hands using water and soap and sanitize from time to time.
   iii). Maintain a social distance of at least 2 meters during the cause of duty.
   iv). Hold meetings of at most three (3) persons, including the interviewer and preferably outside buildings.
   v). Seek immediate medical assistance and contact the PABRA representative through phone, email, WhatsApp, or any other suitable means to exhibit COVID-19 like symptoms or any feeling of bad health.

[2] Signatures are at the last page of this service agreement.

vi). Wear an official identification batch provided by PABRA during the period of the agreement.

4. **Indemnity**. By signing this PPE user agreement, the enumerator is aware of the covid-19 virus infection risks, indemnifies both CRS and Alliance/PABRA from all reasonable costs associated with misuse or failure to use the PPE and consequently being infected with the covid-19 virus.

SIGNED

ENUMERATOR	
Name:	Telephone No:
Next of Kin:	Telephone No of Next of Kin:
Signature:	
Date:	
PAN-AFRICA BEAN RESEARCH ALLIANCE (PABRA)	
Name: **JEAN CLAUDE RUBYOGO**	
Position: **BEAN PROGRAMME LEADER & DIRECTOR, PAN AFRICA BEAN RESEARCH ALLIANCE (PABRA**	
Signature:	
Date:	

Annex 6: Customer (Farmer) Feedback Questionnaire
Part 1: Customer (Farmer) information

First Name	
Last Name	
Phone Number	
Gender	
Age Category	

Part 2: Farmer feedback

1. How was the quality of Nyota seed you purchased? How many kgs of seed did you purchase?
2. How much area did you plant the Nyota seed? (Acres)
3. What was your total harvest from the acreage you planted? (Kgs)
4. How long did it take to mature?
5. What did you do with your harvest? (Save as seeds for the next season - how many kgs; Consume as food; Sold as grain)
6. If sold as grain, to whom did you sell? (Community Members & Farmers; Traders and Aggregators; Retailers)
7. If sold as grain, at what price did you sell? KES/Kg
8. Will you purchase Nyota seeds next season? Yes/No?
9. If Yes, why?
10. If Yes, where do you intend to source Nyota next season? (Agro-dealers; Community Members & Farmers; Traders and Aggregators; Retailers)
11. If No, why? Do you have any suggestions on how to improve Nyota?
12. If No, what variety will you buy?
13. Do you purchase seeds from your nearest agrodealer?
14. If No, what is the reason for making purchases at farther locations?
15. Were you aware of boda boda riders making seed deliveries in your area?
16. If No, would you use a boda boda rider as a service if they delivered to your area?
17. How did you find information on the Nyota variety?
18. Do you think that you had enough information on Nyota before making a purchase?
19. Do you have any other comments?