Assessing the Adoption of High Iron Bean Varieties and Their Impact on Iron Intakes and Other Livelihood Outcomes in Rwanda

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Executive Summary

- An impact assessment (IA) study was conducted in Rwanda in 2015 Season B in order to establish the adoption rates of HIB varieties among rural bean producing and to generate useful information on delivery and breeding efforts by analyzing the facilitating/hindering factors to adoption and diffusion of HIB varieties. A nationally representative listing exercise preceded the main household survey for the impact assessment. The listing exercise was conducted across 120 rural villages in 29 provinces of Rwanda and was administered to a total of **19,575 households**. The aims of the listing exercise were to determine the adoption rate of High Iron Beans (HIBs) and to inform second-stage sampling for the main impact assessment survey that was to follow. This report presents results from the listing exercise.

- Of all households surveyed, **93% had grown beans in the last 5 years**. These households comprise the sampling frame of the impact assessment study.

- Since the release of four HIB varieties in 2010 and an additional six in 2012, **29%** of rural bean-growing households **have grown at least one HIB variety**. Extrapolating the 29% adoption rate to the national-rural bean growing population, it is **estimated that almost half a million rural Rwandan households have grown a HIB variety since 2010**.

- The **Eastern Province had the highest level of HIB adoption** since 2010 with approximately 42% of bean-growing households having grown at least one HIB variety.

- The number of **HIB growers increased** for almost all varieties through the eight seasons studied, with the exception of a few varieties, such as RWV3317, which appear to have some seasonal variation.

- Of all the households interviewed, **84% grew beans in Season B 2015**. **21%** of rural bean producing households were found to have grown at least **one HIB variety in Season B 2015**. Extrapolating the 21% adoption rate for Season B 2015 to the entire rural bean-growing population, it is **estimated that over 350,000 rural Rwandan households grew at least one HIB variety in that season**.

- The Eastern Province had the highest level of HIB adoption in Season B 2015 with approximately 32% of bean-growing households having grown at least one HIB variety.

- **RWR2245**, a bush bean, was the **most popular HIB variety** grown in the past 8 seasons in all provinces except the North, where RWV3316 was the most popular HIB variety. RWR2245 was also the most popular HIB variety grown in Season B 2015 in all provinces except for the West (MAC44) and the North (RWV3316).

- **Early adopters** (households which grew a HIB for the first time prior to 2014) were **located throughout all provinces** with at least one district having between 48%-65% HIB early adopters. The Eastern Province had the highest number of early adopters.

- Of the 21% of the rural bean producing households which grew a HIB variety in Season B 2015, over **50% first grew an HIB variety within the last three seasons** (Season B 2014, Season A 2015, or Season B 2015).

- The main first source of HIB planting material for Season B 2015 growers was said to be the local market, social networks (friends, neighbors and farmer groups), and HarvestPlus direct marketing.

- The **average quantity of HIB planting material** cultivated in Season B 2015 w**as 7.7kgs per household** with a median of 3kgs per household.

- Early adopters, on average, cultivated 13kgs (median of 5kgs) of HIB planting material while late adopters, on average, cultivated 7kgs (median of 3kgs) of HIB planting material.

- Six adopter-type categories were created to represent a household's HIB growing history as of Season B 2015. The **highest proportion of adopters are continuous growers** while the smallest proportion are discontinued growers.

- HIB samples were collected from 31% of the households and were analyzed for iron content. The **average iron content** of all varieties tested was **68.26ppm**, which is below the iron content of HIB seeds. Therefore, it is likely that farmers are using recycled HIB varieties, may not be using good agricultural practices, or have incorrectly identified a local variety as a HIB variety.

1. Impact Assessment Study Background

Following several years of collaborative research between HarvestPlus, the Rwanda Agriculture Board (RAB) and the International Center for Tropical Agriculture (CIAT), four high iron bean (HIB) varieties were officially released for planting in Rwanda in 2010 and another six varieties were released in 2012. Since 2012, HarvestPlus and its partners have been intensively disseminating the seeds of these varieties. Table 1 presents a summary of the release and delivery schedule of the ten HIBs (see Appendix 4 for detailed information about their agronomic properties). In Rwanda, 38% of children under five years of age and 17% of women of childbearing age suffer from anemia (Demographic Health Survey [DHS], 2010), about 50% of which is caused by iron deficiency (de Benoist et al. 2008). At the same time, Rwandans have the highest per capita bean consumption in the world (CIAT, 2004), with rural households consuming beans on average six days in a given week (Asare-Marfo et al., 2011), in significant quantities (Berti et al., 2012). HIB varieties contain higher iron levels than the majority of the popularly grown local varieties; because of that, consumption of HIB varieties is expected to increase iron intake among Rwandans, especially in children under five years of age and women of childbearing age, who are most vulnerable to iron deficiency.

Table 1. Roll-out of ten HIB Varieties in Rwanda

HIB Variety	Bean Type	Year Released	Year Disseminated	Year of Intensive Dissemination	Province(s) where variety was first released and disseminated
RWR2245	Bush	2010	2011	2012	South
RWR2154	Bush	2010	2011	2012	South
MAC44	Climber	2010	2011	2012	South
RWV1129	Climber	2010	2013	2014	South
RWV3006	Climber	2012	2012	2014	North
RWV3316	Climber	2012	2012	2014	North
RWV2887	Climber	2012	2013	2014	North
RWV3317	Climber	2012	2013	2014	North
CAB2	Climber	2012	2013	2014	North
MAC42	Climber	2012	2013	-	North, East

Several delivery channels—partners, platforms and mechanisms—have been employed to ensure wide dissemination of HIBs in Rwanda since Season B 2012. HarvestPlus and its partners, including government agencies, NGOs and agrodealers, made use of local markets, schools, churches, health centers and other platforms to disseminate varying quantities of the seed of HIB varieties to farmers and cooperatives in all 30 districts of the country. The majority of the HIB seed was sold through direct marketing in local markets. Most recently, innovative mechanisms such as the "payback system" (farmers receive free HIB seed on condition that they give back a certain amount of bean grain after the harvest) and "seed swap" (farmers are given an opportunity to trade in their local bean varieties for iron rich HIB varieties) were used for a wider reach. These latter mechanisms not only serve as a conduit for dissemination but also help in the multiplication of HIB planting material, sharing of tacit knowledge about these varieties, and gradually 'flushing out' less nutritious varieties and replacing them with iron rich ones.

Detailed delivery records have been collected by the HarvestPlus Rwanda marketing team since 2012. According to these records, HIB varieties have been delivered in nearly all parts of the country (see figure 1) and over 500,000 farm households had obtained HIB planting material through one of the abovementioned delivery channels. Substantial unrecorded informal diffusion is also believed to have taken place, which, when factored in, raises the estimated total number of HIB recipients to 700,000 households. Even though these estimates provide a sense of program reach, there is a need to have more rigorous evidence to first and foremost support these figures, and secondly, to provide more insight on various dimensions of HIB adoption. In order to better inform future delivery, as well as breeding efforts, further information is needed on the following: (i) what are the various household, agronomic and market-

level/institutional facilitating/hindering factors to adoption and diffusion of HIB varieties, (ii) which one(s) of the delivery channels were most effective in reaching bean farming households, and (iii) which one(s) of the varieties were liked the most by the farmers in terms of their agronomic (e.g., yield) and consumption traits . An impact assessment study (IA) was conducted to generate this information.

Figure 1. HIB dissemination 2012B to 2014B
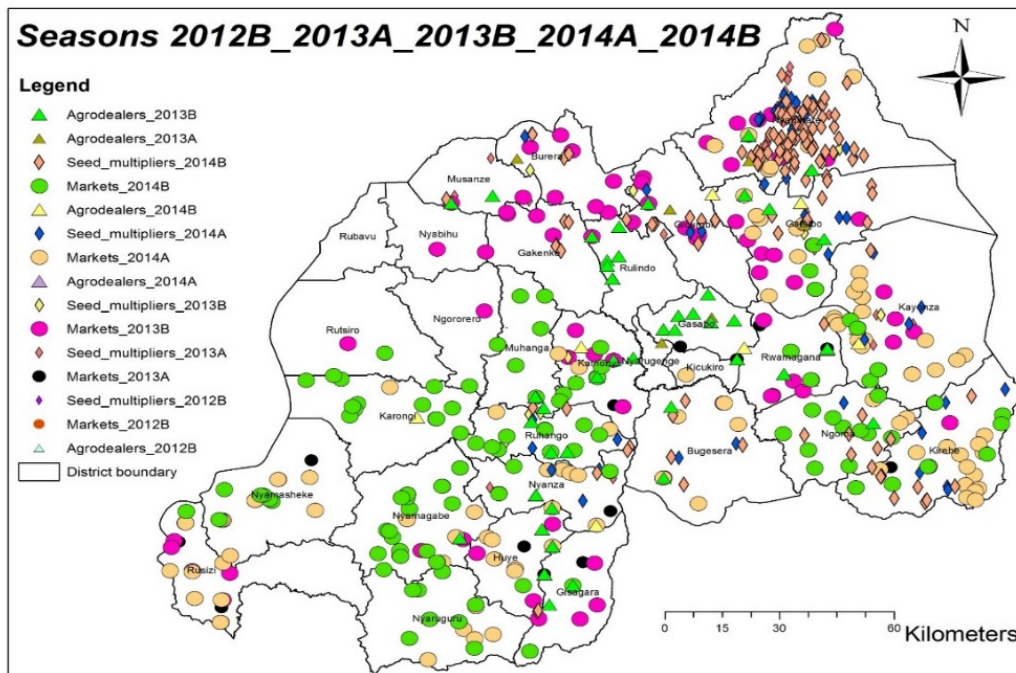
Source: Authors, HarvestPlus Rwanda Marketing Team

The key objectives of the IA are: (1) to determine the adoption and diffusion rates of HIBs after 8 seasons of active dissemination, (i.e. the total percentage of farmers currently planting, the percentage rate of addition, the percentage rate of dropout, the percent of bean area currently under HIB, etc.); (2) to understand temporal and spatial adoption and diffusion patterns across varieties and delivery channels; and (3) to assess socio-economic and nutrition impacts resulting from HIB adoption. Unlike impact evaluations which involve randomized controlled trials that can directly compare the outcomes of adopters to non-adopters as an artifact of the randomized study designs, impact assessments use observational data from areas of the target country where significant delivery has already taken place to identify adopters and non-adopters and to draw inferences based on comparisons of the two groups while controlling for factors affecting adoption.

The IA study has five major research components: adoption, yield, gender, nutrition and marketing. The adoption, yield and gender components were combined and addressed through a nationally representative agricultural household survey (here on referred to as the main survey) which was conducted following Season B of 2015 (February to August 2015)[1]. A listing exercise preceded the main survey and was conducted in May and June, 2015, following the planting period of season B 2015. This document reports the key findings of the listing exercise.

1.1 Defining HIB Adoption for the Rwanda HIB Impact Assessment Study

"Adoption" is a broad category that includes many specific variables that can be defined specifically as they are used and applied. For improved crop varieties such as HIBs, adoption may refer to program **reach** and may have sub-definitions, e.g. number of individuals or households that have *received* the variety through *direct or indirect* means, or both. Adoption may also refer to the **behavior of a farmer upon receiving** an HIB variety, i.e. the number of households that *actually plant*

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[1] Studies related to the nutrition and marketing components are forthcoming and will be carried out separately.

the variety after receiving it. Adoption may also refer to **behavior over time**, e.g. number of years a farmer has continued to grow the variety following initial receipt. Adoption could also refer to the **intensity** with which a farmer decides to grow the new variety, i.e., the percentage of total crop area allocated to that variety. Adoption intensity can be broken down further into **initial adoption intensity** or **adoption intensity over time**. All of these definitions have their uses and limitations and each raises their own range of questions or concerns. For instance, if we consider two farmers who decide to plant HIBs, one dedicates 25% of their bean area and the other dedicates 100% of their bean area (either initially or over time), is the former considered less of an adopter than their latter counterpart? And if this intensity in land allocation was considered to be the true measure of adoption, should the farmer who dedicates 25% of their 10ha bean area (i.e. 2.5ha) be considered less of an adopter than one who dedicates 100% of their 1ha bean area to HIBs?

There are thus many possible definitions of adoption which may be employed for different analyses. For the purposes of this report, and broadly speaking for adoption rates throughout this IA study, unless otherwise stated, **any household that has ever grown at least one HIB variety in at least one season, is considered an HIB adopter**. Subcategories of this broader adoption definition exist and are presented in section 7 of this report.

2. Listing Exercise Overview

2.1 Objectives

The listing exercise had two main objectives: 1) to obtain an accurate, nationally representative HIB adoption rate; and (2) to inform the second stage sampling design of the main survey.

The sample that was to be selected for the main survey needed to fulfill standard requirements for a survey of this nature, including but not limited to random selection and representativeness of the greater target population, which in this case was all bean farming households in Rwanda. A list of all bean farming households within villages from which a subsample could be selected, did not exist and as such, needed to be created to serve as the sampling frame for the selection of households for the main survey. The main survey sample was required to have a sufficient number of HIB and non-HIB adopting households to be able to make ex-post comparisons across the two groups. The enumeration exercise was consequently customized to deviate slightly from traditional listing exercises and to include a brief set of additional questions that would identify bean growers, HIB adopters and the nature and extent of adoption of HIBs (i.e. time and history), all of which would guide and enrich the second stage sampling design. Even though some of the information collected at this stage would again be asked during the main survey (albeit in greater detail), obtaining it at this early stage from almost ten times the number of households that would be interviewed in the main survey is expected to provide more precise estimates of adoption rates.

2.2 Sampling

The sample design for the main survey is a two stage design, with randomization at both stages. Selection of villages was conducted in the first stage and selection of households takes place at the second stage. The listing exercise was conducted as part of the first stage sampling. Based on preliminary power calculations of the study, it was determined that at least 91 villages should be randomly selected in the first stage[2]. However, for greater precision, 120 villages were randomly selected from all villages in Rwanda (approximately 14,000 in total), and were proportionally allocated across all non-metropolitan districts in the country (29 out of 30 districts in total). Selection of study villages was done in collaboration with the country's national statistical agency, the National Institute of Statistics Rwanda (NISR), and excluded peri-urban and urban "villages" that contained more than 500 households. The allocation of villages across districts can be found in Appendix 1, and Figure 2 shows the distribution of the 120 selected villages across the country. A visual examination of Figures 1 and 2 roughly suggests that the selected study sites overlap well with the areas of dissemination; and that the selection of villages resulted in full coverage and adequate representativeness of the target population.

A total of 19,575 households were enumerated across the 120 selected villages. Data collected from the listing exercise is representative of bean producing households in Rwanda.

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[2] Preliminary power calculations also suggest that 12 households get randomly selected during the second stage sampling. Details on second stage sampling and selection of households are provided in the main survey report.

Figure 2. Distribution of Selected Villages
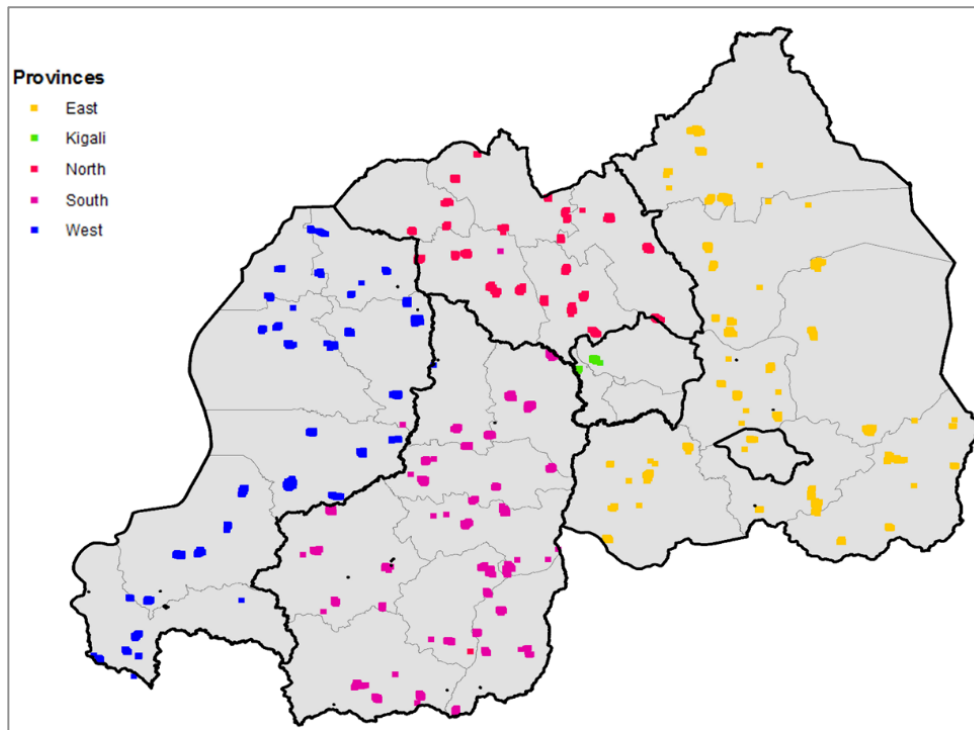
2.3 Data Collection and Identification of HIB Varieties

Data collection for the listing exercise was carried out using computer assisted personal interviewing (CAPI) techniques and therefore required a computer-literate team of enumerators as well as electronic devices to capture the data. Appendix 2 provides the paper version of the survey instrument that was administered to respondents. The electronic version of the questionnaire was available in both English and the local language, Kinyarwanda. The program was developed using CSPro software and was administered to respondents on Samsung Galaxy III tablets, powered by Android.

Proper identification of HIB varieties was a primary concern in this study. Qualitative information obtained from the HarvestPlus Rwanda country team and experts on the ground suggested that some traditional bean varieties in Rwanda closely resemble some of the HIB varieties. Major steps and checks therefore had to be taken to ensure that the varieties identified by farmers as HIB varieties were truly HIB varieties. As a first step, each farmer was presented with actual seed samples of all ten HIB varieties to identify them both visually and through touch. Secondly, upon indication of having grown one or more of the ten HIB varieties that they were presented with, respondents were asked additional questions about the local name(s) known for the variety identified, the agronomic properties of the variety, and the time of first adoption and source of first adoption (see questions B5 to B11). For instance, if a farmer indicated that a variety had been grown for decades or had been passed on from generation to generation, that variety was unlikely to be a HIB variety, given the recent years of HIB releases. The final check for verification consisted of collecting bean samples from farm households that indicated growing HIBs during that season. If farmers had samples available and were willing to spare a handful, enumerators collected and labeled them. At the end of the survey, all samples were checked and verified by a subset of supervisors from the overall enumeration team and sent to a lab for analysis by a professional technician to determine their iron content using XRF technology.

2.4 Training and Fieldwork

Recruitment and training of enumerators took place in February and again in April 2015. Ninety enumerators and supervisors were trained and underwent a series of evaluations and interviews to demonstrate satisfactory understanding of the study objectives, processes and survey, as well as proficiency in tablet use. The 12 day long training covered a range

of theoretical, technical and practical topics including the purpose of the overall study and the aim of the listing exercise; all questions being asked in the questionnaires; practical training on interviewing techniques and best practices in eliciting as accurate information as possible from respondents; identification of HIB varieties, collecting and labeling of seed samples; technical training on the use and maintenance of the electronic devices while in the field; uploading and sending data on a daily basis and communicating with the field management and technical team throughout the period of the survey. Supervisors were also given an additional management and leadership training session. Training also included one day of pretesting where all trainees were sent to four adjacent non-study villages in Rwamagana district of the Eastern Province to administer the survey to the residents of those villages. Feedback obtained from that exercise helped to further fine-tune the survey instrument and plans for field operations. A pilot exercise, which entailed actual data collection in one of the study villages, was conducted the day before field work officially began.

In the end, 61 enumerators and 12 supervisors qualified to undertake field work. Twelve teams consisting each of 1 supervisor and 5 enumerators (one team had 6 enumerators) were deployed for data collection which officially began on May 12 and ended on June 14, 2015. On average, interviews took between 10 to 15 minutes to conduct and each village was enumerated over two or three days depending on how sparsely distributed the households in the village were, and how hilly the village was. A field management team was also in place throughout data collection and consisted of a field manager and two assistant field managers. Assistant managers mainly served as the forward team responsible for village level sensitization activities prior to the arrival of field teams in each village. The field management team played a critical monitoring role, developing and ensuring effective implementation of the field calendar while also handling various coordination and organizational duties including but not limited to making supplies available to teams at various points throughout data collection and collecting seed samples from teams and sending them back to a central storage location at the HarvestPlus Rwanda country office in Kigali.

The data collection process was closely monitored by the technical team on a daily basis. Even though several consistency checks were built into the electronic questionnaire, other checks had to be done through preliminary analysis of the data. Any anomalies or inconsistencies detected, e.g. excessively longer- or shorter than average interviewing times, contradictions in age and relationship to household head (e.g. a 19 year old grandmother) or excessively high figures for quantity of planting material used, were immediately relayed to the team on the ground for immediate correction or explanation. All in all, field teams were highly motivated and worked diligently, and there was effective communication flow between the field team and the technical team, all of which helped to produce the high quality data presented herein.

3. Profile of Households Interviewed

The majority (57%) of the 19,575 households interviewed in the listing exercise were located in the Eastern and Southern provinces of Rwanda. Figure 3 shows the percentage allocation of households across the five provinces and similar information is presented at the district level in Appendix 3.

As a screening question, respondents were asked "Has anyone in your household grown beans in the last five years?" (See question A1 in Appendix 2). This question was asked to identify our sample frame and target population of bean farmers. If the response was affirmative, the interview would proceed; if not, enumerators were instructed to end the interview and move to the next household. Upon establishing eligibility to be interviewed, enumerators were to request to speak to the household member most knowledgeable about bean cultivation, provided that that person also met the age criterion for eligibility of 21 years. 57% of the respondents identified themselves as the recognized household head and even though only 25% of the households were female headed, 65% of the respondents were female. The average respondent was 43 years old. A majority (96%) of respondents indicated farming as their primary occupation and on average, respondents indicated that their households had between 4 and 5 resident members that lived within the same dwelling and shared meals from a common pot.

Figure 3. Distribution of Interviewed Households by Province
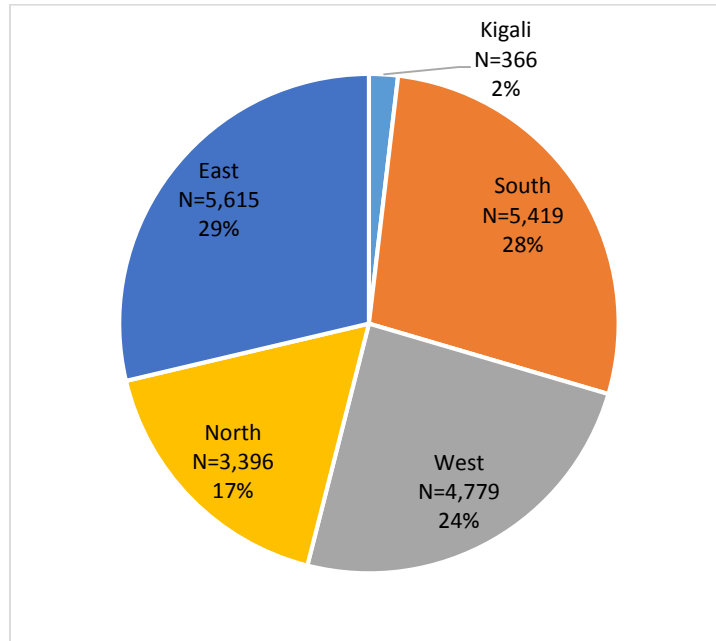
3.1 Bean Cultivation

3.1.1 Last Five Years: Since 2010

Of the total 19,575 households visited, **18,206** (i.e. 93%) indicated having grown beans within the last five years. **These households will serve as the reference population throughout this report, whenever we speak of aggregate HIB adoption** (or adoption over the last five years preceding the study, i.e. since 2010). When disaggregated at the province level as in figure 4, bean cultivation over the last five years appears to be slightly more prevalent in the Southern, Northern and Eastern Provinces than in the Western province, and expectedly, in Kigali province.

Figure 4. Households cultivating beans in Rwanda, Last five years, By Province

Rwanda has two major bean cropping seasons: Season A, which runs from September to January, and Season B, which runs from February to August. Given that the study was implemented in Season B, respondents were asked to indicate whether they typically cultivate beans in Season A. The main reason for this was to see the extent to which the results obtained from the study conducted in Season B could be extrapolated to bean cultivation in Season A and thus to overall bean production in Rwanda. Figure 5 suggests that, overall, the majority of farmers grow beans in both seasons A and B.

Seasonality in cultivation appears to differ when examined at a provincial level. This finding is key and quite noteworthy for the Western and Eastern provinces where there is a ten percentage point differential in the cultivation of beans across the two seasons. Bean production is slightly more widespread in the West during season A than it is for the East and the same is true for bean production in Season B for the East when compared to the West. While the purpose is not to unearth the reasons for the seasonality differences across regions, it is important to bear these in mind throughout the report as they may account for possible differences observed in HIB adoption patterns across regions.

Figure 5. Seasonality in Bean Cultivation Among Bean-producing Households, By Province
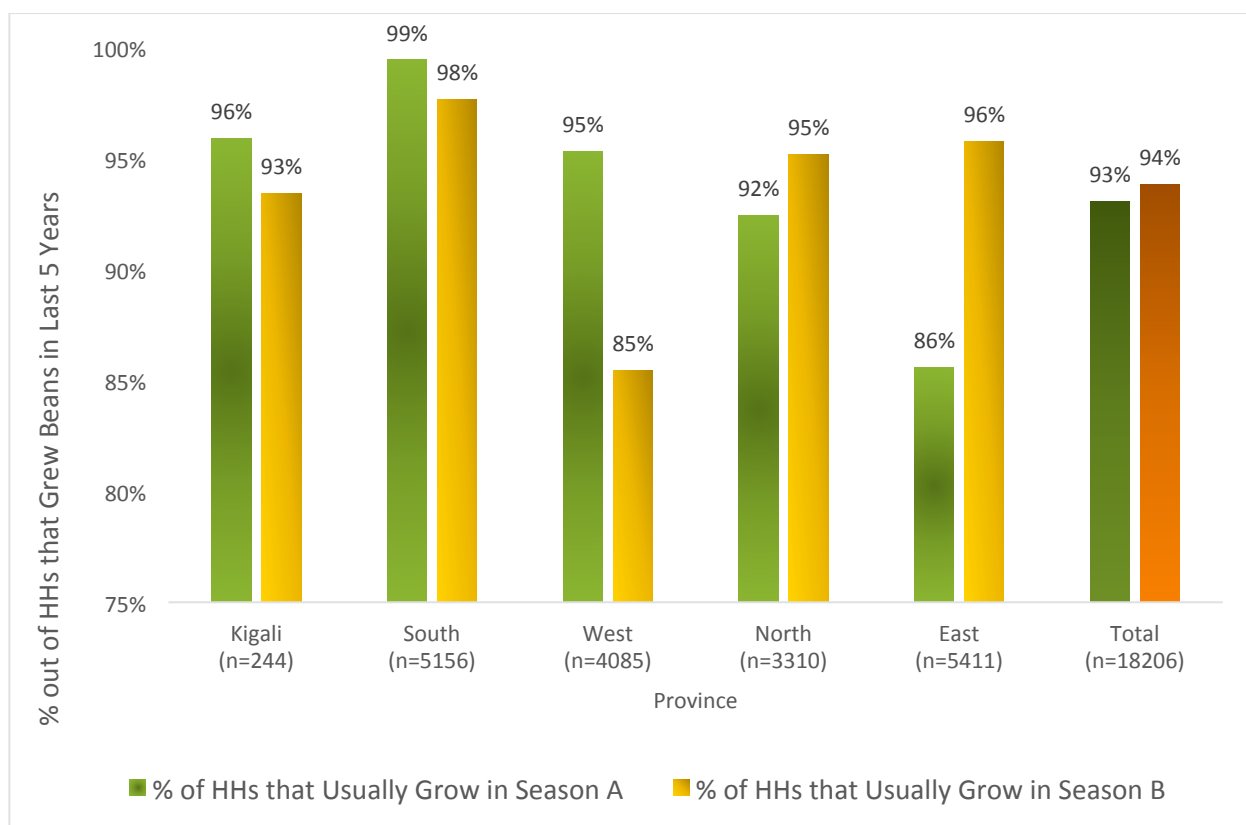
3.1.3 Bean Cultivation in Season B 2015

All bean producing households were asked a second screening question (see question A20 in Appendix 2) to determine whether they were bean growers in the most recent season (Season B 2015). Respondents who answered the question affirmatively proceeded to the subsequent module of the questionnaire where a set of questions were asked about the varieties being cultivated that season, and more specifically, HIB varieties. These questions provided the necessary information to achieve the two main objectives of the listing exercise, i.e. determining the HIB adoption rate and informing the second stage sampling.

Of the 19,575 households visited, **16,467** (i.e. 84%) indicated growing beans in Season B 2015. **These households will serve as the reference population throughout this report, whenever we speak of Season B 2015 HIB adoption** (or adoption

in Season B 2015). Bean cultivation in the season of interest also appears to have some differences when disaggregated at the province level. Figure 6 suggests that a greater proportion of bean growers cultivated beans in Season B 2015 in the Southern, Northern and Eastern Provinces than in the Western province (and Kigali), supporting the seasonality pattern for the Western region which was observed in figure 5.

**Figure 6. Bean Farmers in Season B 2015 by Province**
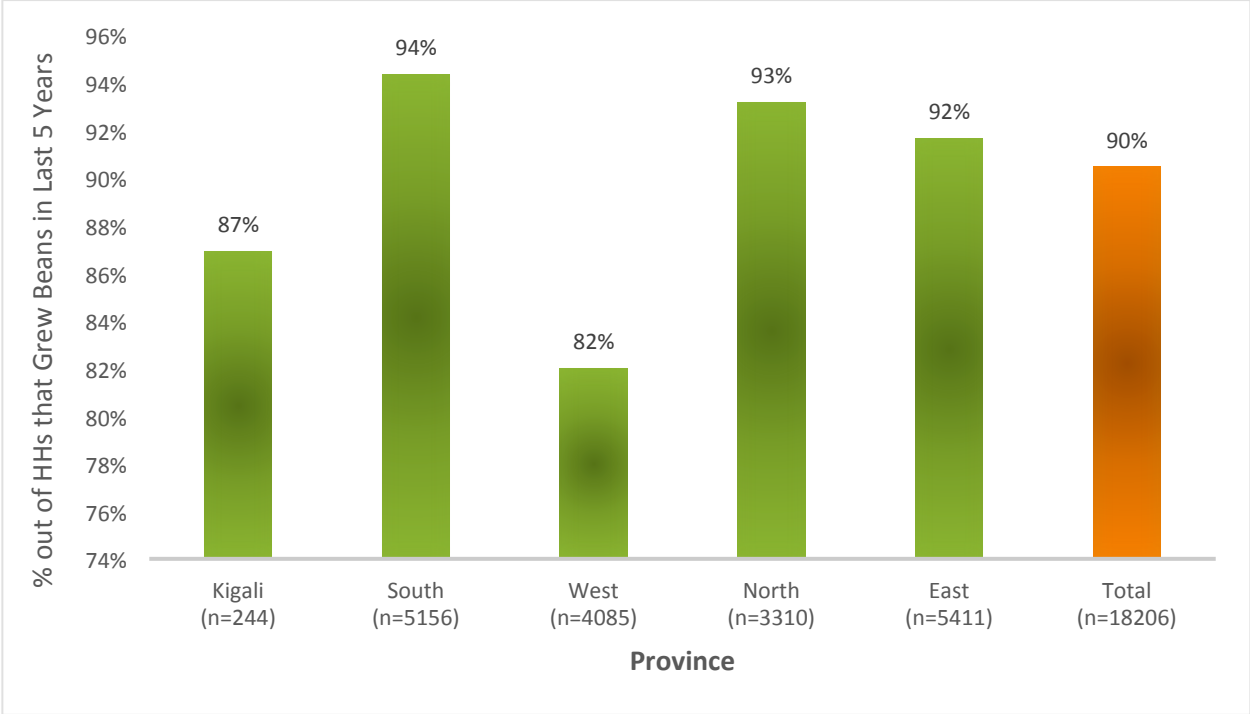
4. Aggregate HIB Adoption 2015

The overall adoption of HIBs in Rwanda since 2010 is 28.6% (approximately 29%) – with a 0.65% margin of error at a 95% level of confidence. Of the 18,206 households that grew beans in the last five years, 5,205 indicated having grown an HIB variety in at least one season during that period. Given that four HIBs were released in 2010, six in 2012, and that intensive dissemination efforts did not begin until Season B 2012, this adoption rate is encouraging. Extrapolation of this 29% statistic to the total Rwandan population reveals that approximately half a million (489,681) households, out of an estimated 1.8 million rural households in the country, have been "reached" with HIBs. Considering each rural household has an average of 4.6 members, this amounts to 2.3 million rural Rwandans.

4.1 Aggregate HIB Adoption – By Location

When HIB adoption is examined by province, a great variation is seen. The Eastern Province has the highest rate of adoption among the five provinces at 42%, whereas the Southern and Kigali Provinces have similar rates of HIB adoption among bean growing households with 30% and 29% of adoption, respectively (figure 7). Twenty percent of the Northern Province's bean growing households have grown a HIB variety in the last five years while 17% of bean growing households in the Western Province have grown a HIB variety in the last five years. The results seen in the data roughly follow the expected pattern of delivery efforts to date, as presented in Figure 1 above.

Figure 7. HIB Adoption Rate 2010-2015, By Province
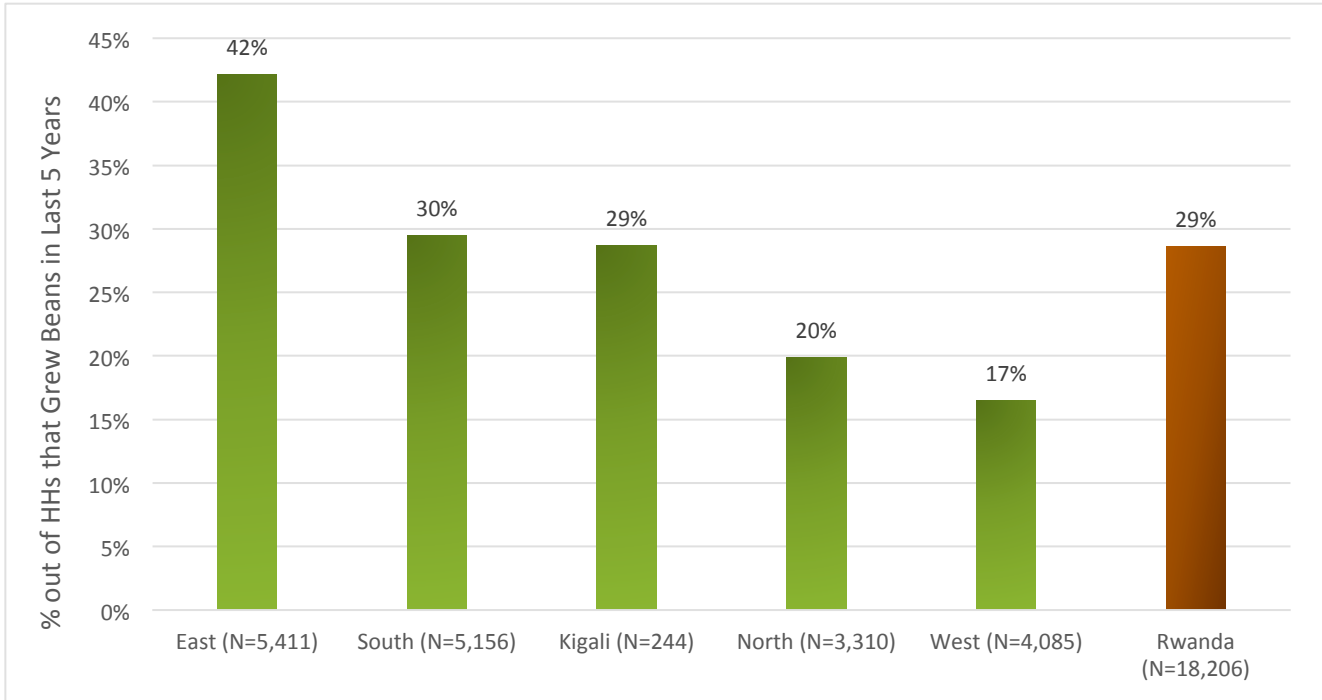
Adoption rates by district were disaggregated into quintiles with the fifth quintile representing the highest rate of adoption. Four out of the six highest adopting districts are located in the Eastern Province. As seen in Figure 8, these districts include Rwamagana (56%), Bugesera (54.6%), Gatsibo (52.5%), and Nyagatare (46%). The Western Province districts appear to have relatively lower adoption rates and the weakest penetration of HarvestPlus HIB delivery efforts.

Figure 8. HIB Adoption 2010-2015, By District
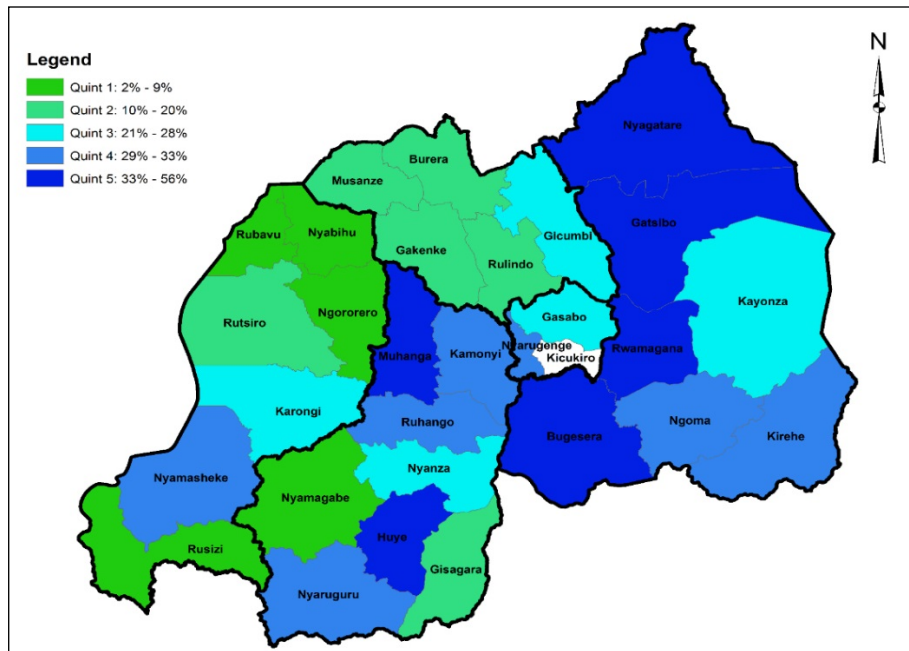
4.2 Aggregate HIB Adoption – By Variety

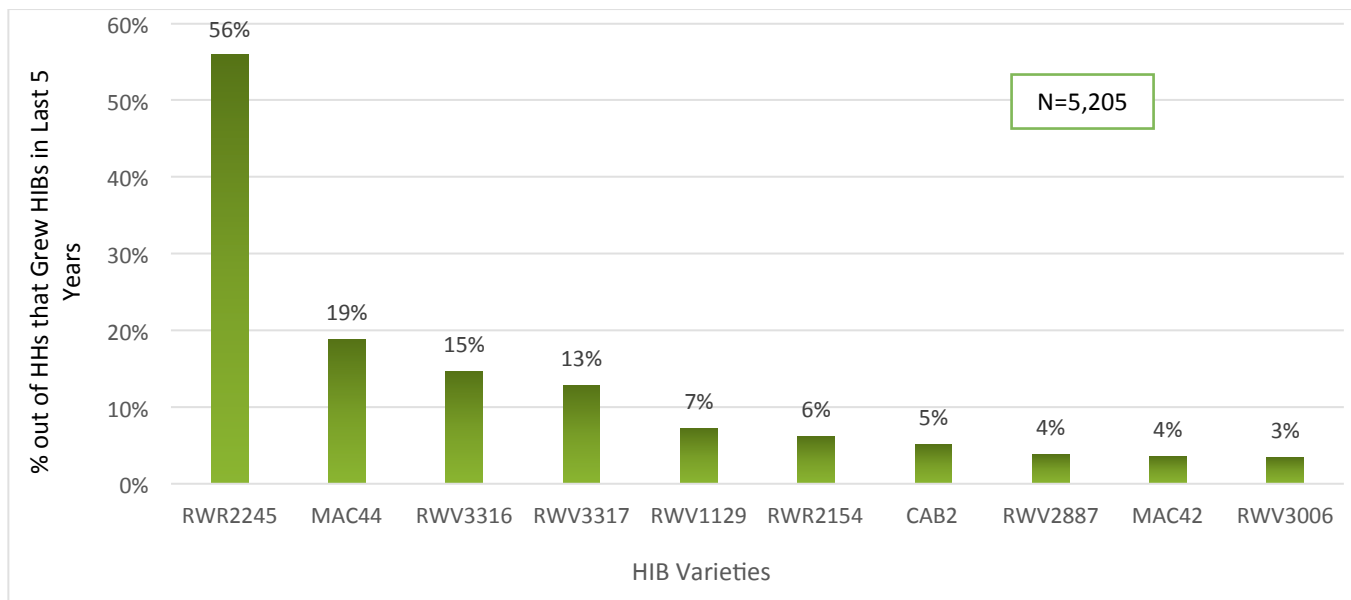Approximately 25% of the HIB adopting households have grown more than one of the HIB varieties. When HIB adoption is analyzed by variety, one HIB variety in particular stands out among the remaining nine varieties. RWR2245, one of the two HIB bush bean varieties, was overwhelmingly the most popular HIB variety grown by HIB adopting households in the last five years. According to table 1, it was also one of the pioneer HIB varieties to be released. Of the 5,205 households that have ever grown HIBs, 56% (approximately 2,900 households) have grown RWR2245 in at least one season (Figure 9). Across provinces, RWR2245 was the most popular HIB variety grown in all provinces except the Northern Province, where climbing beans are more popular. The HarvestPlus Rwanda country team was not surprised by this finding; RWR2245 is grown in all locations because it is a bush variety. It is believed that farmers like the variety because it is high yielding and does not require staking. Additionally, there are many seed multipliers for RWR2245 and there is an international market for this HIB variety in Uganda and Sudan. While bush varieties are preferred in the East, anecdotal evidence suggests that Rwandans do not particularly like the other HIB bush variety, RWR2154, because of its 'sugar' (cream/white) color and lower yield compared to RWR2245. More information on farmer evaluation of the production and consumption traits of various HIBs is investigated and will be reported in the main survey report.

The second most popular HIB variety grown in the last five years was MAC44, a climbing bean also introduced in the first wave of HIB releases, and having been grown by 19% of HIB growing households in the sample. The third most popular HIB variety, RWV3316, was the most popular HIB grown in the Northern Province and was grown at the national level by 15% of HIB adopting households. The least popular HIB variety, RWV3006, was grown by only 3% of HIB adopting households in the last 5 years. The main survey report, as well as the forthcoming research papers will further investigate the effect of seed dissemination efforts/delivery channels, as well as on the performance of the varieties themselves, on the adoption and diffusion rates across varieties, time and space.

Figure 9. HIB Adoption Rate 2010-2015, By Variety

Note: The sum of percentages do not add up to 100% because some households grew more than one HIB variety

5. HIB Adoption Rate in Season B 2015

The overall adoption of HIBs in Rwanda in Season B 2015 was 20.6% (approximately 21%) – with a 0.62% margin of error at a 95% level of confidence. That is, one in five rural bean producing households planted an HIB variety in that season. Of the 16,467 households in the sample that indicated growing beans in Season B 2015, 3,397 households grew a HIB variety. When extrapolating this number to the greater Rwandan population, approximately 354,596 households out of an estimated 1.8 million rural households in the country, grew HIB varieties in Season B 2015.

5.1 HIB Adoption in Season B 2015 – By Location

As before, Season B 2015 HIB adoption rates vary substantially across provinces. The Eastern Province had the highest rate of HIB adoption at 32% of their 4,958 bean growing households in Season B 2015 as shown below in Figure 10. Twenty percent of Season B 2015 bean growers in the Southern and Kigali provinces grew a HIB variety while 14% and 11% of bean growers in the Northern and Western provinces, respectively, grew HIB varieties in Season B 2015.

Figure 10. HIB Adoption Rate in Season B 2015, By Province
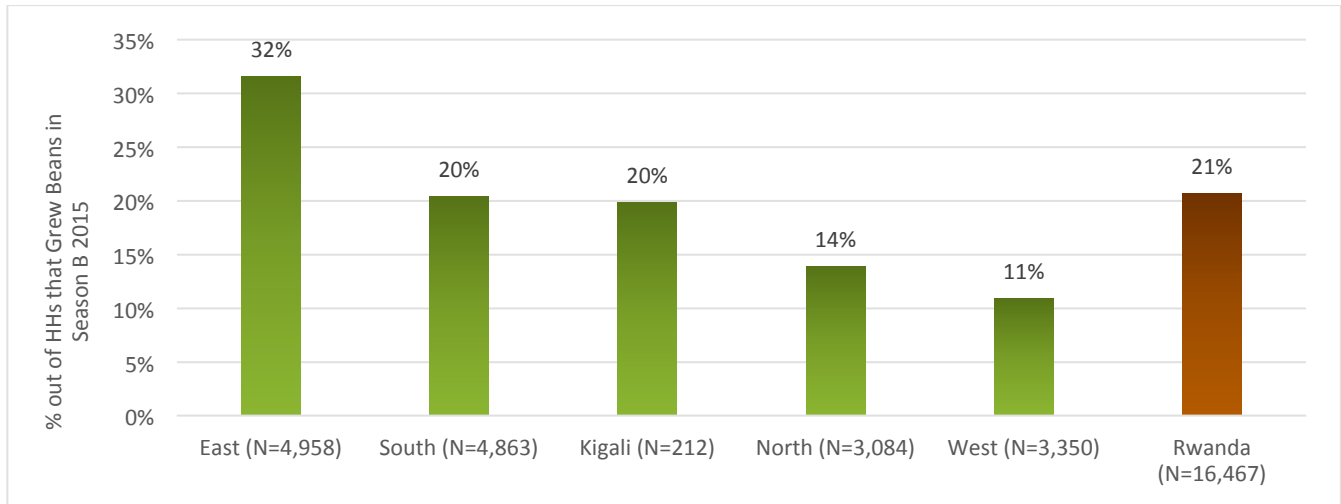
Given that the highest rates of HIB adoption among bean growers in Season B 2015 occurred in the Eastern Province, it is not surprising that the districts that have the highest level of HIB adoption among bean growers are predominantly located in the East. Five of the seven districts in the Eastern Province have HIB adoption in the highest adoption quintile, ranging from 26 to 48% adoption. Specifically, the top five HIB adopting districts in season B 2015 are Rwamagana (48%, East), Bugesera (47%, East), Huye (40%, South), Gatsibo (35%, East), and Ngoma (29%, East).

Figure 11. HIB Adoption Rate in Season B 2015, By District
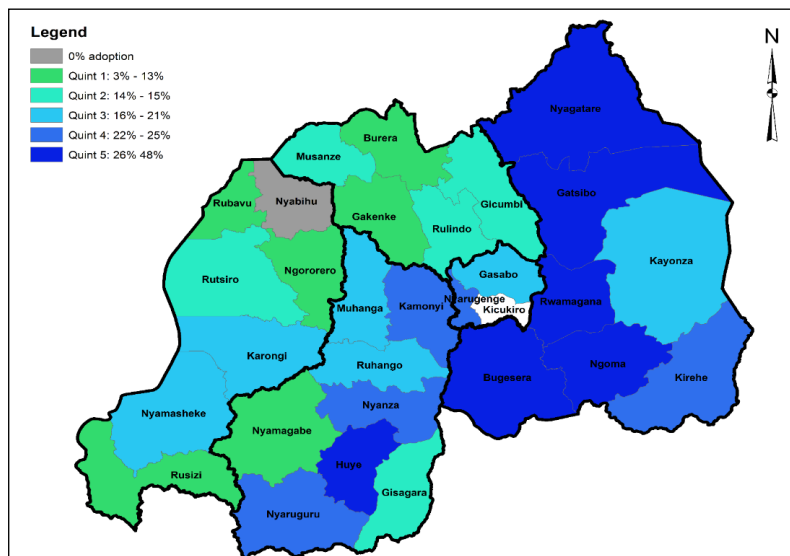
5.2 HIB Adoption in Season B 2015 – By Variety

Approximately 16% of HIB growers in Season B grew more than one HIB variety. By far, the most popular HIB variety cultivated in Season B 2015 was RWR2245, with 53% of the 3,397 HIB-growing households in Season B 2015 growing this variety (see Figure 12). The second and third most popular HIB varieties were RWV3316 and MAC44 with 18% and 17%, respectively. Compared to the overall, last 5 year ranking, RWV3316 and MAC44 switched order in the top ranks while RWV3006 and MAC42 switched order in the bottom ranks. RWR2245 was the most popular HIB variety grown in the Eastern, Southern, and Kigali Provinces. MAC44 was most popular in the Western Province while RWV3316 was the most popular HIB variety grown in the Northern Province.

Figure 12. HIB Adoption Rate in Season B 2015, By Variety
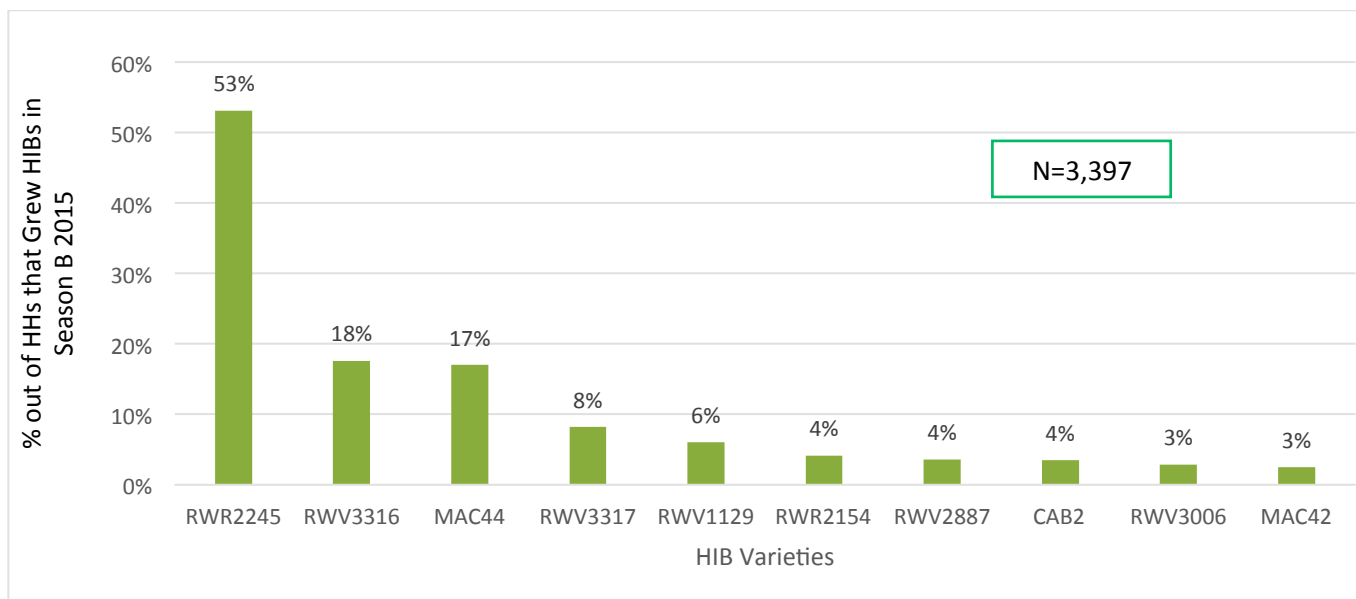
Note: The sum of percentages do not add up to 100% because some households grew more than one HIB variety

6. HIB Adoption History

Following intensive dissemination efforts by HarvestPlus and partners since 2012, as well as the apparent diffusion among farmers, there has been a net increase in the number of HIB growers with each progressive season. Some HIB varieties have experienced a faster growth rate across seasons than other varieties, e.g. MAC44 versus MAC42. RWR2245 seems to have the most number of growers irrespective of season, and also, the rate of growth seems faster than all other HIB varieties. Also, the number of growers for each HIB variety has increased each year with the exception of a few varieties, such as RWV3317, which appear to have some seasonal variation. Of course, the number of growers may be a direct function of seed supply for the specific varieties in each season. Fluctuation in growers may therefore be due to fluctuations in supply rather than in demand for the varieties. These issues will be investigated into greater detail in the main survey report and/or as part of the research papers.

Figure 13. Net Number of HIB Growers across Seasons

*Total = # of HIB variety cases, not households. Some households grew more than one HIB variety.
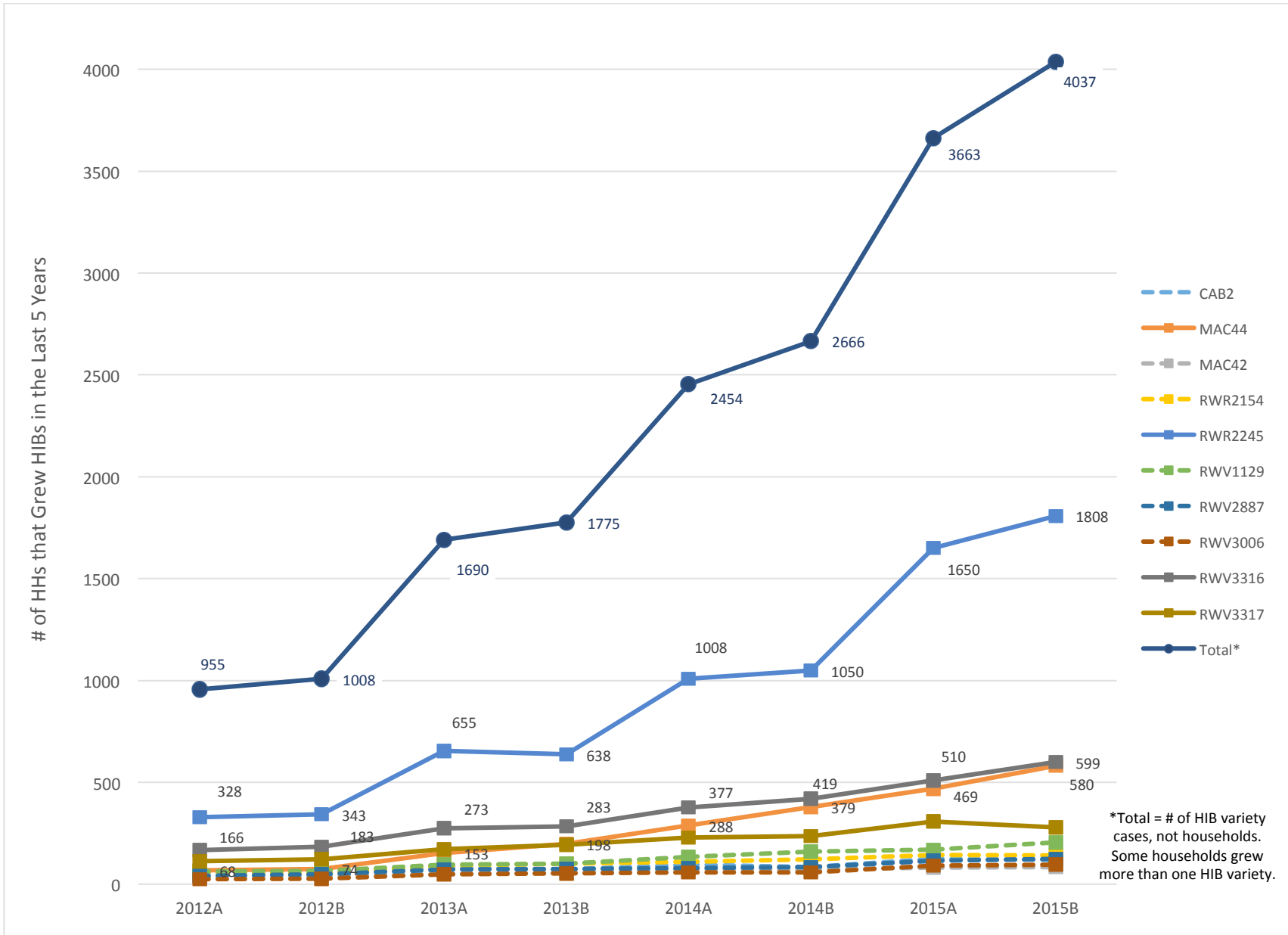
6.1 Time of First Adoption

Season B 2015 HIB-cultivators were also asked the season and year in which they began growing each HIB variety (see module B of Appendix 2). The responses to that question are illustrated in Figure 14 and show that the majority (over 65%) of HIB growers interviewed grew a HIB variety for the first time in the last three major bean cropping seasons, i.e. Season B 2014, Season A 2015 or Season B 2015, and that Season B 2015 was the first HIB growing season for 30% of HIB-growers. A few respondents indicated that they began growing HIB varieties prior to 2012, before intensive dissemination efforts began. Such farmers are likely to be those who received seeds for testing and multiplication on test plots during and/or immediately following release of the first five HIB varieties in the country in 2010. There were also a few farmers who indicated adopting a HIB for the first time in a season prior to 2010. This is not possible as HIB varieties were not released then. It is highly likely that a few farmers in the sample may have wrongly identified their local varieties as HIB varieties. This issue will be discussed and addressed in greater detail in section 8.

Figure 14. First Year of Growing HIBs
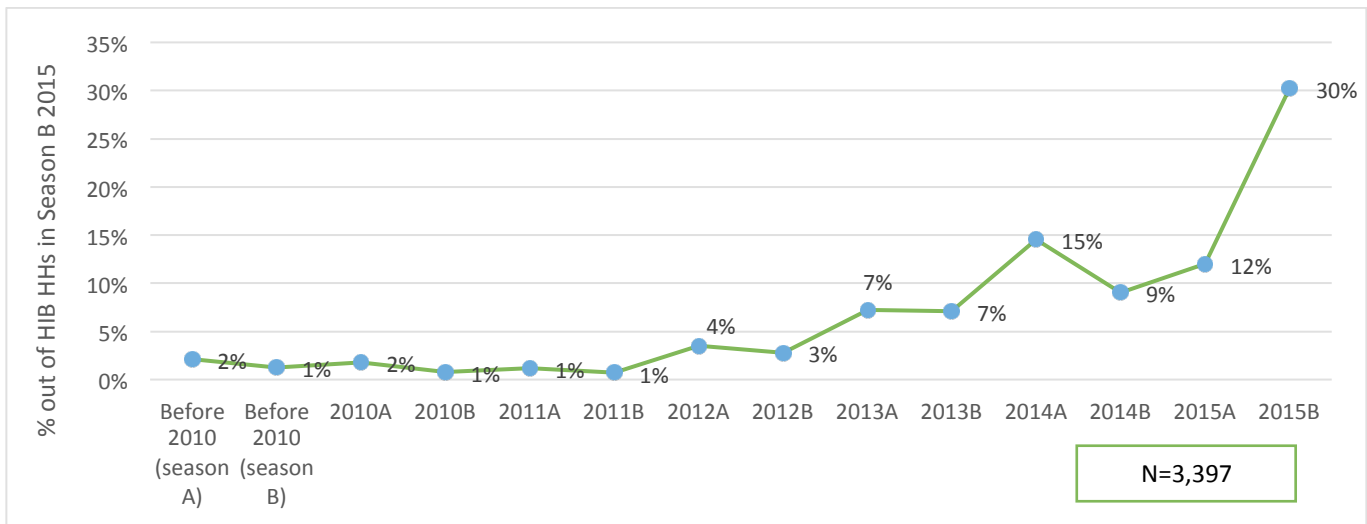
HIB adopting households were also divided into two categories of adopters: early adopters—households which grew a HIB variety for the first time prior to 2014 Season A, and late adopters— households that grew HIB varieties for the first time from 2014 Season A onwards. Of the 5,205 households which have ever grown a HIB variety, 1,957 were early adopters. Early adopters were located throughout all 29 districts and within each province, there was at least one district belonging to the highest quintile of HIB early adoption (Figure 15). In line with figure 8, the Eastern Province, had the highest number of early adopters when compared to other provinces. The top five districts with the highest rates of early adopters were Nyarugenge in Kigali (65%), Gicumbi in the North (60%), and Gatsibo and Bugesera both located in the East (57% and 56% respectively).

**Figure 15. Early Adopters – Percentage Distribution across Districts**
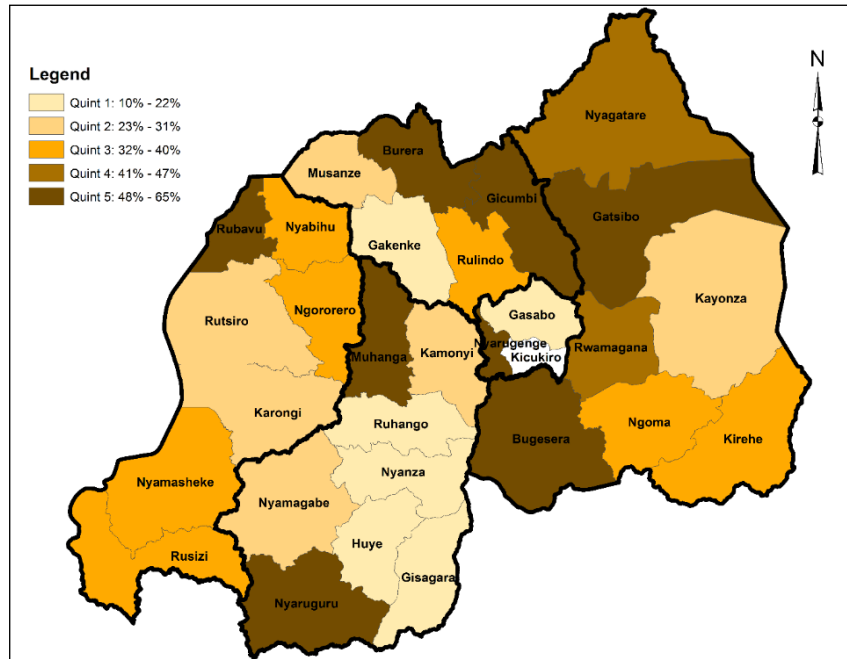
6.2 Source First HIB Planting Material

HIB farmers in Season B 2015 were also asked to indicate how they obtained HIB seed for the first time in the year they indicated initial adoption. According to 41% of those farmers, their first HIB planting material was obtained from the local market. Even though a separate category was available for HarvestPlus direct marketing as the source of first planting material, and the enumerators were thoroughly trained on all of these categories, it is possible that some proportion of farmers who indicated having received their first HIB planting material through local markets includes those who received it through direct marketing that took place in local markets. This possibility will be investigated in greater detail with further analysis of the listing and main survey data, and through triangulation with the delivery records. Social networks appear to be very important in the dissemination and diffusion of HIBs in Rwanda, accounting for 33% (friends/neighbors and farmers' groups) of the first source. The fourth most popular first source of HIB planting material was from the Ministry of Agriculture, RAB, or an extension agent (7%). The remaining "all others" category shown in Figure 16 encompasses 8 other categories,[3] which collectively account for the original HIB planting material for the sampled farmers. Informal diffusion seems to be more prevalent than the direct delivery efforts. At the provincial level, local markets remain the top cited source of first planting material while the second and third vary by province between social networks and "all other" sources.

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[3] "All others" category includes Agro-input dealer, NGO/Development Project, Church, HarvestPlus direct marketing, Seed swap, Health worker/hospital and "others" and "don't know/remember" category.

Figure 16. Source of First HIB Planting Material
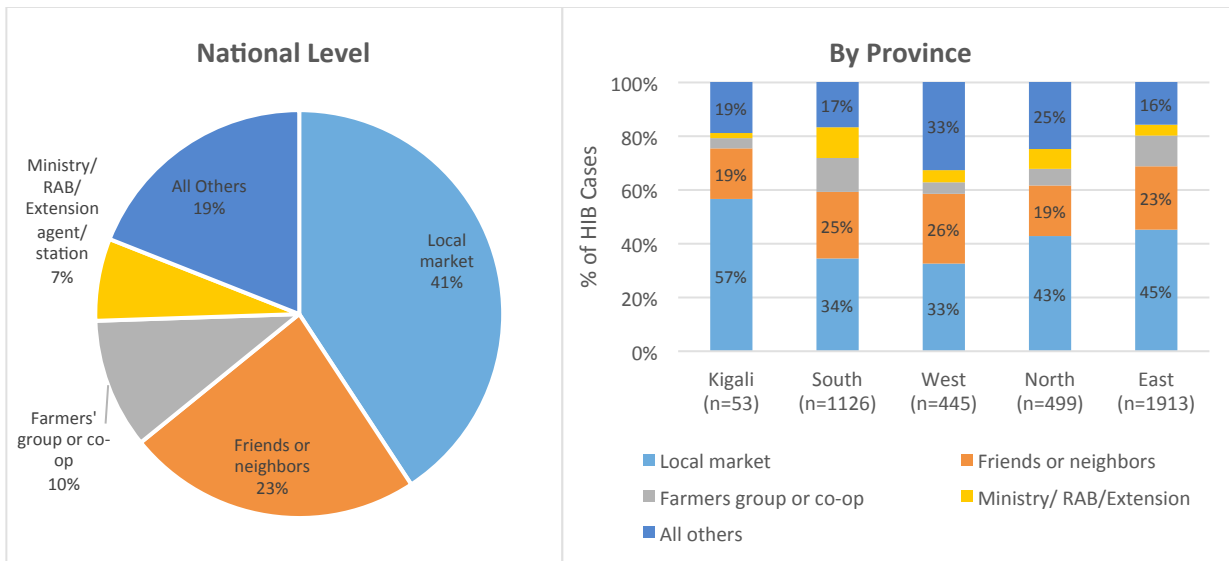
6.3 Quantities of HIB Planted

Among the 3,397 households that planted HIB varieties in Season B 2015, an average of 7.7 kilograms of HIB planting material was cultivated per household and the median quantity planted per household was 3 kilograms. The aggregate amount of HIB planting material that was cultivated by HIB adopters in the sample for Season B 2015 was equivalent to 31 metric tons (31,081 kilograms). When examining the contribution of planting material by province, the Eastern province had the highest contribution with households from that province planting a total of 22,163 kilograms (71% of the total) HIB planting material. The remaining province contributions are as follows: South (14%), North (10%), West (4%), and Kigali (1%).

Recalling the earlier definition of early and late adopters (see section 6.1), there is variation in the quantity of HIB planted within each group. Early adopters on average cultivated 13 kilograms of HIB planting material (median of 5 kilograms) in Season B 2015, while late adopters cultivated an average of 7 kilograms of HIB planting material (median of 3 kilograms). This finding is encouraging for HarvestPlus as it may suggest that early adopters seem to plant significantly higher quantities of HIB, indicating that they are happy with the varieties and are expanding their area share in them, and also that the late adopters are likely to follow a similar trend in coming years. This will be investigated further in the main household survey and various research papers.

7. HIB Adoption Patterns

7.1 Types of Adopters

The seasonal growing history of the 5,205 households that grew HIBs in the last five years was analyzed based on patterns exhibited from Season A 2012 until Season B 2015. Six mutually exclusive categories were created to describe the nature of the different adoption patterns that were observed among HIB adopting households. If a household has grown more than one variety, that household can fall into a different category for each of those varieties. The adopter categories are explained below.

1. **Continuous.** A household that has grown HIB(s) for every season since first adopting the HIB(s). The household has to have grown an HIB variety for at least two seasons to be considered a continuous grower.

2. **Intermittent**. A household that has grown HIB(s) off-and-on in each season since the season of first adoption. This category includes households that have a classic pattern/tradition of cultivating bean varieties (or beans in general) in one season only, e.g. every season B.

3. **Discontinued.** A household that has grown HIB(s) continuously for at least 2 seasons and then stopped in a season prior to Season B 2015.

4. **One-Time.** A household that has grown HIB(s) in one season only, prior to 2015 season B.

5. **Discontinued-Season B 2015**. A household that has grown HIB(s) continuously for at least two seasons but did not grow in 2015 season B. This group of households are in limbo as they may become *intermittent growers* or *discontinued growers* depending on the actions they exhibit in coming seasons.

6. **First-Time.** A household that grew HIB(s) for the first time in 2015 season B.

The first four categories are considered the classic and more permanent categories, which can be used over time and at any point in time. *Discontinued-Season B 2015* and *First-Time* grower categories are more fluid and were created specifically for this study given that Season B 2015 is the study season. Since one cannot predict what a household will do after the study season of interest, we did not want to hastily classify these two groups of adopters. *First-time* growers are not yet considered *One-time* growers as they may, for instance, become continuous or intermittent growers in seasons to come. Similarly, we cannot classify what we are currently calling *Discontinued-Season B 2015* growers as *Discontinued* growers—or possibly disadopters—as they may become *Intermittent* growers down the line[4]. If the time frame for adoption status were restricted to the period 2010 to 2015 and we were not so concerned about what may happen down the line, *Discontinued-Season B 2015* growers would be combined with *Discontinued* growers, and *First-time* growers would be combined with *One-time* growers. The six disaggregated categories are recommended at this stage not only because aggregating at a later stage would be easier than disaggregating, but more importantly, to avoid potentially either overestimating and/or underestimating the adoption of HIBs.

As shown in Figure 17, the highest percentage of HIB adopters (36%) are classified as *Continuous*. The next highest category are the *One-time* growers (23%) followed by *First-time* growers (21%). Eighteen percent of households were classified as *Intermittent growers* while 7% were classified as *Discontinued* growers. Of the 5,205 households, 4% were classified as *Discontinued-season B 2015* growers. While further analysis will be carried out to make more concrete conclusions either for or against adoption over time, figures 17 and 13 suggest a net growth in the number of adopters over time. In other words, this preliminary analysis reveals that the percentage of new adopters has been outpacing the percentage of disadopters.

Figure 17. HIB Adopter Types
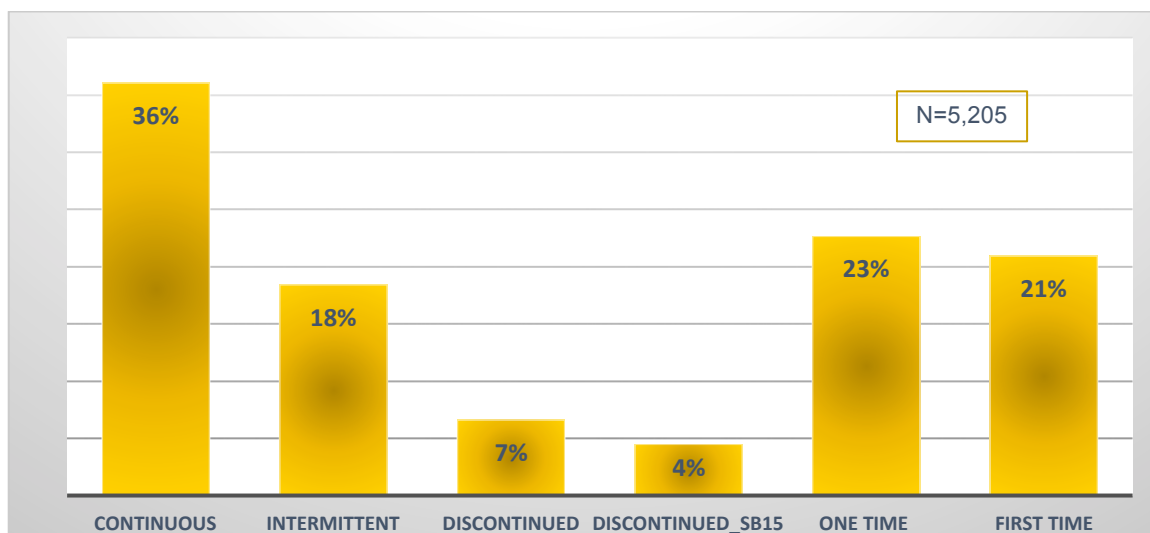
Note: The sum of percentages do not add up to 100% because some households grew more than one HIB variety. If a household has grown more than one variety, that household can fall into a different categories.

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[4] Technically speaking, *Discontinued* and *One-time* growers are also temporary categories in nature; such growers may become *Intermittent* growers if they adopt HIBs again in a future season. This is why the term *Discontinued* is being used as opposed to *Disadopter*.

7.2 Adopters Types – By Location

When evaluating adopter type at the provincial level, interesting results arise. Recalling that households can be classified as more than one adopter type if they have grown more than one HIB variety and have exhibited different growing histories among the varieties, the top three adopter types are ranked below in Table 2 by province. The relatively high percentage of continuous adopters in all provinces may suggest high preference of the HIB for Rwandan farmers in general.

Table 2. Main Adopter Types by Province

Rank of Types	Kigali (n=1639)	South (n=74)	West (n=744)	North (n=698)	East (n=2529)
1st	Continuous (41%)	Continuous (38%)	Continuous (31%)	Continuous (31%)	Continuous (31%)
2nd	One Time (22%)	One Time (21%)	One Time (31%)	First Time (23%)	Intermittent (22%)
3rd	First Time (18%)	First Time (20%)	Intermittent (15%)	One Time (22%)	First Time (19%)

7.3 Variety Specific Adopting Behavior

Interesting results arise also when adopter types are examined by variety. Even though *Continuous* adopters are the largest group of adopters for 7 out of the 10 HIB varieties, their contribution varies quite significantly from variety to variety. RWV3316, the second most popular variety for aggregate adoption and third for Season B 2015 adoption, has the highest percentage of *Continuous* growers, with more than half (54%) of adopters belonging to the *Continuous* category. It also has the lowest percentage of *Discontinued* adopters among all varieties. For the most popular variety, RWR2245, approximately a third of the adopters are *Continuous* adopters and half are either *Continuous* or *Intermittent* adopters. The largest contribution to the *Discontinued* adopters comes from MAC42, the least popular variety for Season B 2015, and RWR2154, the less popular bush variety. Aside from having a large percentage of *Discontinued* adopters, the less popular varieties which include RWV3006 and MAC42 have relatively higher percentages of *First-Time* adopters. There appears to be some linkage between the popularity of the varieties and the loyalty from farmers and the ensuing sustainability of the variety. This will be explored further in the main survey report when trait valuations are examined for the HIB varieties.

Figure 18. Adopter Type, By Variety
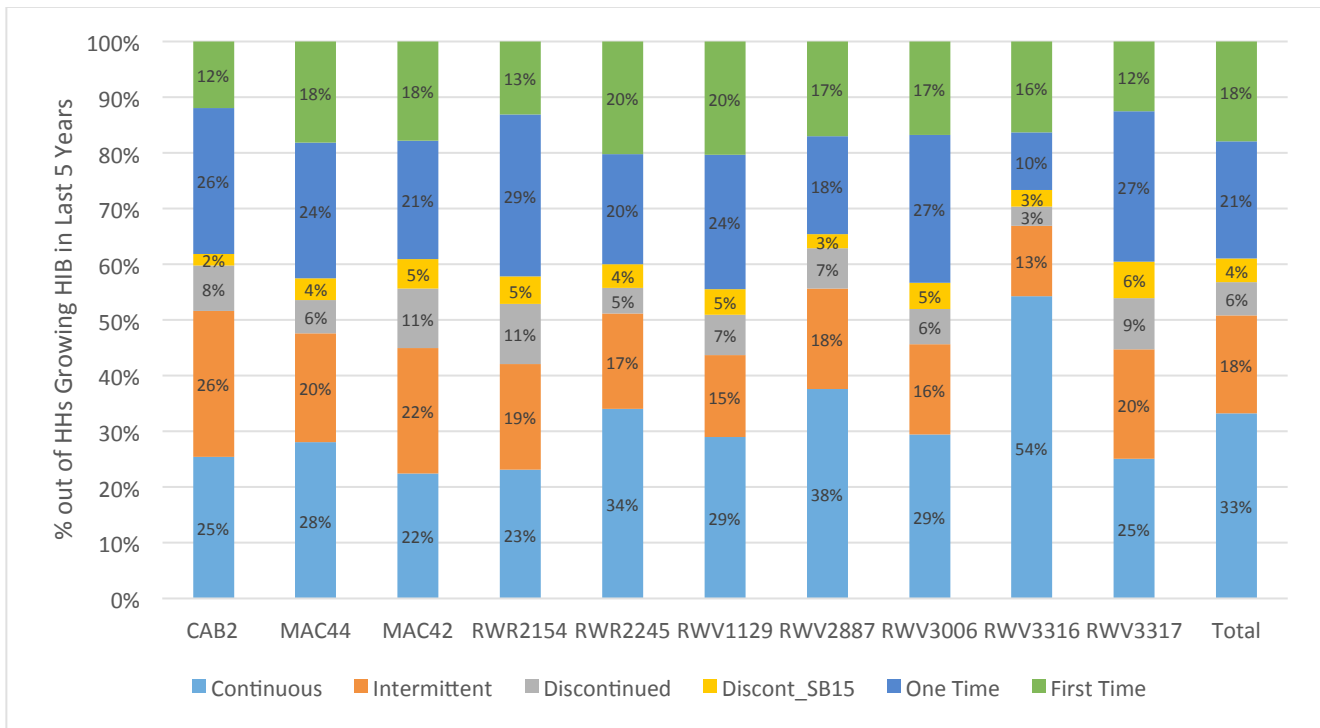
7.4 Reasons for Discontinuing Growth of HIB

While it is encouraging to see that the greatest percentage of adopters are in the continuous category and the smallest percentages are in the two "discontinued" categories, it is necessary to examine why farmers who fall in the "discontinued" categories decided to stop growing HIB varieties after being exposed to them. It is also unclear why some households were only *One-time* growers. Some of the top reasons cited by HIB Season B 2015 growers were planting material not being available at the nearby market, poor drought resistance, poor flood resistance, poor yield, and the seed being too expensive. Other reasons cited include crop rotation practices being used, land constraints, and previous season's harvest being completely used thereby resulting in no grain left over to be used as planting material. These reasons are variety and region specific and will be investigated in greater detail in the main survey report.

8. Variety Identification

As mentioned earlier, certain steps were taken in the listing survey to ensure that the HIB varieties identified by farmers were truly HIB varieties. It is important to shed some light on this because it may have implications on the adoption rates that were reported, and the margin of error that may need to be factored into them. Results obtained from two of the verification methods are presented in this section, namely, verification by means of additional questions and verification by collecting and testing bean samples using XRF technology.

8.1 Verification by Means of Additional Questions

8.1.1 Other Names

After visually identifying a HIB variety and confirming having grown it before, farmers were asked to report the local name(s) they know of for the variety. On average, 48 different names were recorded for each of the ten varieties and as many as 136 were recorded for RWR2245. As one would expect, these names varied by location. Some local names such as "Agronome" were used across several varieties. Other names, such as "RAB" were possibly coined from an aspect of the variety, such as the source of first receipt or being an improved variety. The different names provided for the varieties are listed in Appendix 5, by district. Knowing the several possible names of a variety greatly helps with its identification.

8.1.2 Bean Type

Two out of the ten HIB varieties—RWR2245 and RWR2154—are bush beans, while the rest are climbing bean varieties. Overall, 19% of farmers who indicated growing HIB varieties, incorrectly identified the two bush varieties as climbing varieties and the eight climbing varieties as bush varieties. Figure 19 illustrates the incorrect identification at the varietal level. By far, the most alarming of the incorrectly identified varieties by type is RWV3317, which was reported to be a bush variety by 65% of farmers when in fact it is a climbing variety. MAC42, CAB2, RWV1129 and RWV2887 are also among the top incorrectly identified varieties by bean type with at least a third of the farmers who grew them identifying them as bush varieties instead of climbing. It is possible that farmers are growing local varieties which closely resemble some of the HIB varieties, or that farmers could be growing climbing varieties as bush varieties because they lack the technology and inputs needed for climbing varieties, such as staking. The silver lining in figure 19 is that the most popular HIB variety, RWR2245, had the lowest (5%) incorrect identification based on the bean type criteria.

Figure 19. Incorrectly Identified Bean Type
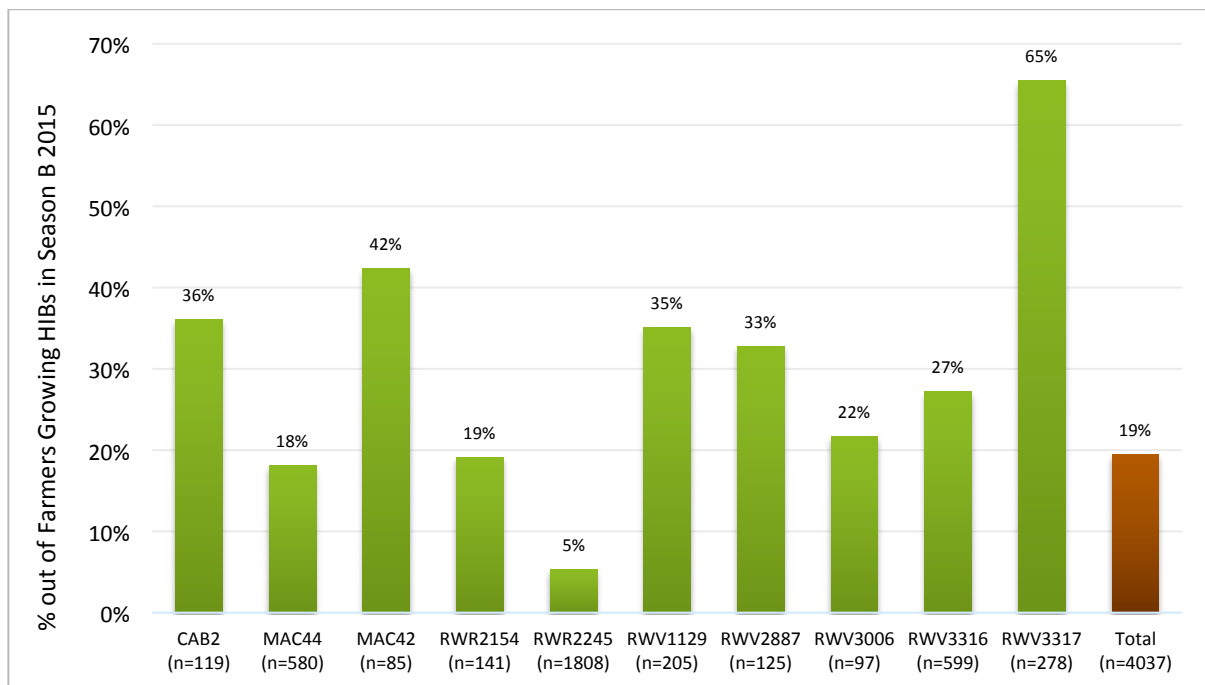
8.1.3 Bean Color

Figure 20 presents the results of color identification by farmers. Results for this are a little less reliable because color identification can be subjective, especially when there are similar colors such as "maroon" and "dark red" listed. Also, bean colors can change depending on climate and soil conditions. Nevertheless, during the survey, enumerators presented farmers with color sheets (see Appendix 6) and farmers were asked to point out the color of the variety they had visually identified to be growing, on the color sheet they were provided. Farmers' responses were compared to the official color names given to the varieties in the HIB information sheet provided in Appendix 4. Close examination of the color names in both sheets independently, and comparatively, should already give an indication of how possible problems may arise with regards to color identification. For example, even though the official color for RWR3317 (based on Appendix 4) is 'red', it is easy to envision one perceiving it to be something else considering its mottled appearance. This may explain the unusually high percentages seen in figure 20. Overall, 24% of farmers incorrectly identified the HIBs by their color. For four of the varieties, RWR2154, RWV1129, RWV2887 and RWV3317, more than half of the farmers got it wrong. Color identification is more straightforward for varieties like CAB2 and RWV3006 which are white in color. All in all, color identification proves to be a weak measure and should not be given much weight in the variety identification checks.

Figure 20. Incorrectly Identified Bean Color
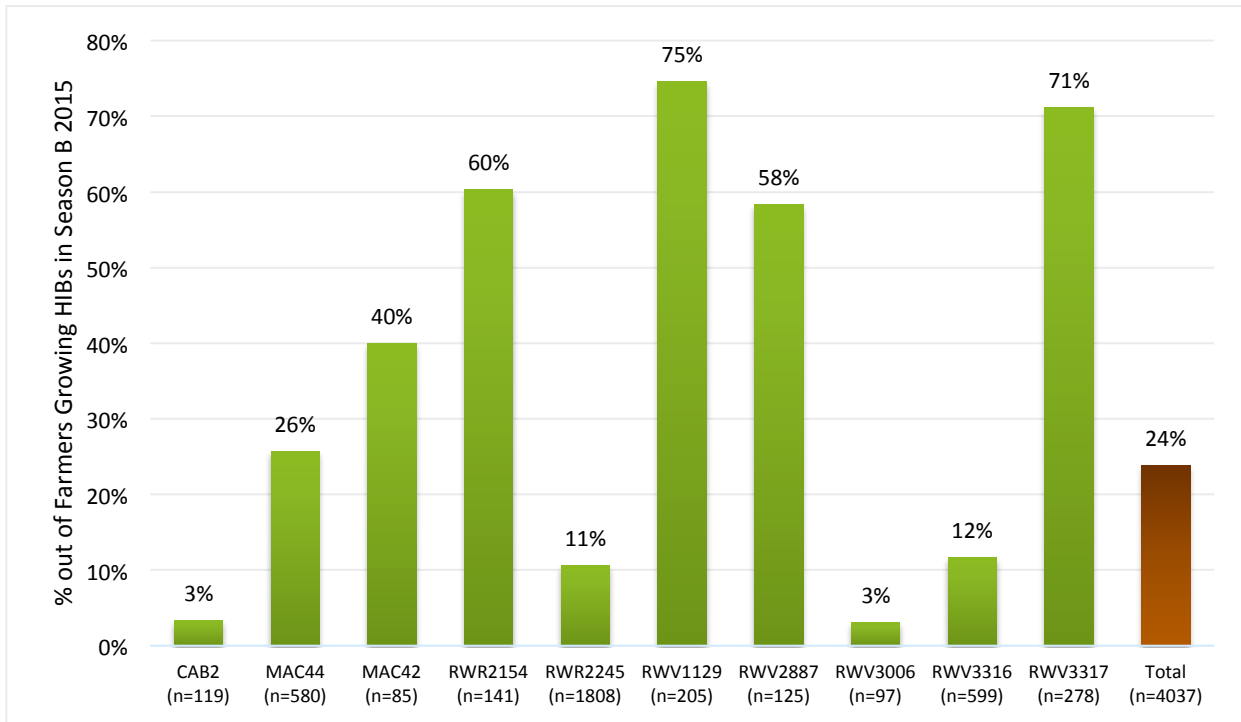
8.1.4 Time of First Adoption

In light of the fact that the first wave of HIBs were initially released for testing in 2010, it is impossible for a farmer to have had access to an HIB seed prior to 2010. Additionally, if a farmer does not know the time of first adoption, it is likely they have been growing it for several years (more than five) and/or that it was passed down from previous generations. As such, more than likely a "Don't know" response or indication of growing a variety pre-2010 signals that the variety is less likely to be an HIB variety. Eight percent of farmers interviewed fell into this category (see figure 21 below). At the variety level, it seems CAB2 was the most incorrectly identified (by 17% of farmers) and MAC44 was the least incorrectly identified (by 2%), based on this criterion. Again, this may suggest that there are some local/traditional varieties in the system that are being mistaken for HIB varieties by farmers.

Figure 21. Incorrect Identification Based on Time of First Adoption
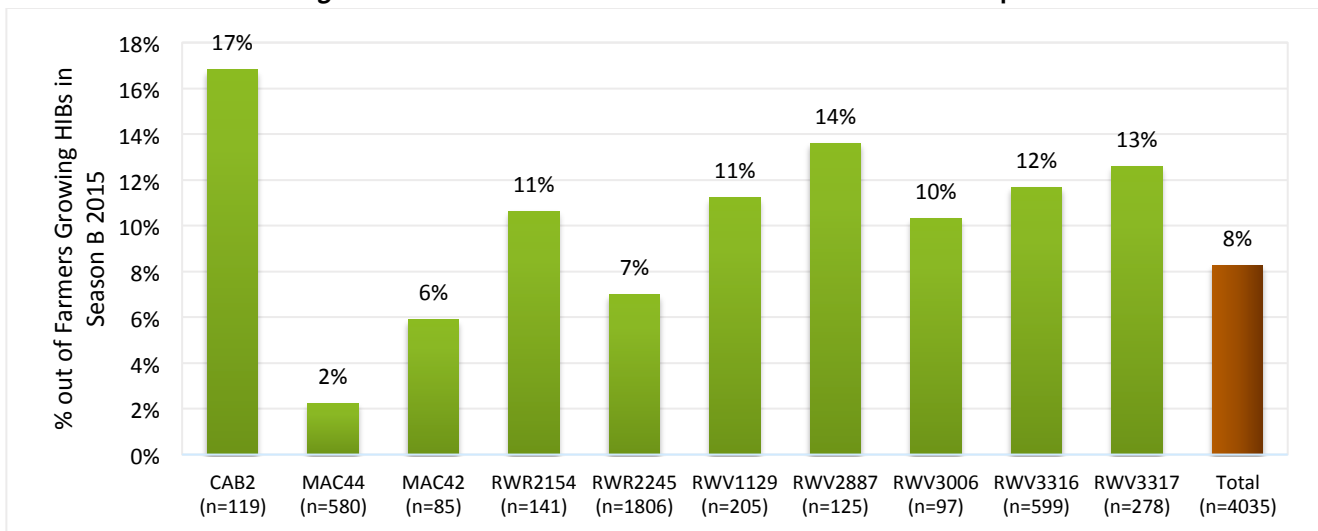
8.2 Verification by Means of Collecting and Testing Bean Samples using XRF Technology

Bean samples were collected from approximately one-third of all HIB growing households in Season B 2015, approximately 1,068 households in total. Of the 1,178 bean samples that were sent to the lab, approximately 15% were discarded for various reasons including incorrect labelling, seed/sample damage, inclusion of local varieties or HIB variety identity was not well established. In the end, 1,004 bean samples were tested for iron content with the XRF machine.

The overall average iron content of all varieties tested was 68.26ppm. This figure is 3ppm below the minimum amount of ppm which the HIB varieties are expected to have, i.e. 71ppm according to Appendix 4. The average iron content is presented by variety in figure 22. Only two of the HIB varieties analyzed, CAB2 and RWV1129, seem to have samples that meet the minimum iron content level of 71ppm, on average. Some samples recorded extremely low iron content levels that were under 50ppm. Again, this may support the fact that some local bean varieties may have been incorrectly identified by farmers as HIB varieties. In addition, it is likely that farmers are using recycled HIB varieties, i.e. second or third generation seeds, or that they are not growing their beans under the best farming conditions and practices. It may also be possible that farmers provided a sample that contained a mixture of HIB and local varieties.

Figure 22. Iron Content of HIB Samples Collected in Season B 2015
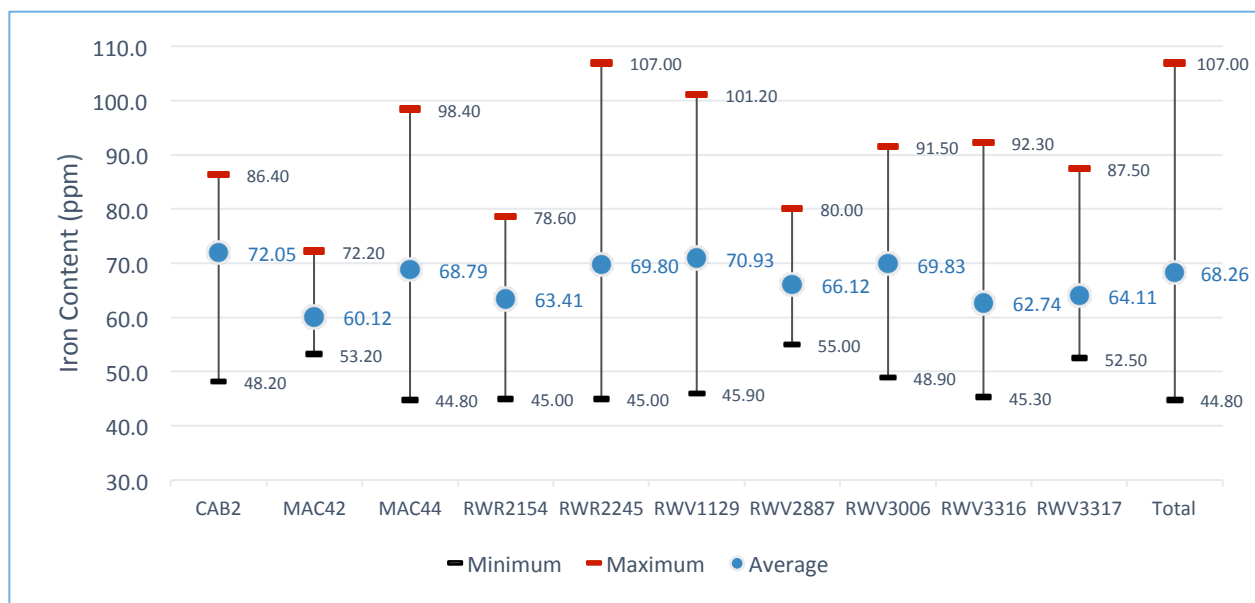
Appendix 7 provides descriptives for the iron content analysis by district and Table 3 presents the variation across districts by variety. Overall, it appears that higher iron content readings were recorded for farmers from the Western province and for CAB2, while farmers in the North had recorded lower readings as did iron content readings for MAC42.

Table 3. Iron content of Collected HIB Samples: Two-way comparison by Location (District) and Variety

Province	District	No. of Samples	All HIB Varieties	CAB2	MAC42	MAC44	RWR2154	RWR2245	RWV1129	RWV2887	RWV3006	RWV3316	RWV3317
Kigali	Nyarugenge	15	64.26	--	--	--	--	67.18	--	--	63.80	56.30	58.47
	Gasabo	16	63.98	--	--	59.30	--	64.83	--	--	--	65.70	55.90
	Nyanza	70	68.45	63.60	--	70.38	--	67.68	--	--	78.82	60.33	--
	Gisagara	41	65.96	--	--	66.20	63.40	67.22	--	--	63.08	63.83	61.27
	Nyaruguru	46	64.97	--	--	69.51	--	72.75	--	55.00	--	61.64	--
	Huye	135	69.66	64.10	--	71.68	69.50	71.08	75.00	--	70.52	64.09	64.82
South	Nyamagabe	5	66.56	--	--	70.50	--	--	--	--	69.30	61.85	--
	Ruhango	71	66.98	--	--	61.52	65.40	68.23	--	--	69.60	65.58	--
	Muhanga	11	67.05	--	--	69.90	--	68.70	69.60	73.70	--	55.50	--
	Kamonyi	83	68.77	61.40	--	67.96	--	69.38	49.30	--	72.20	61.60	66.50
	Karongi	50	67.90	--	--	67.76	55.10	66.79	80.82	62.40	70.60	61.71	--
	Rutsiro	9	70.73	78.30	--	68.14	--	--	--	--	--	61.00	--
West	Ngororero	13	65.80	--	--	65.37	--	76.77	--	66.70	66.80	49.70	--
	Rusizi	17	76.46	--	--	--	69.40	81.15	69.40	--	73.05	--	61.20
	Nyamasheke	22	65.84	--	63.10	66.74	--	67.56	--	--	--	58.27	68.60
	Rulindo	12	64.63	75.73	57.57	--	--	--	62.80	--	--	62.56	--
	Gakenke	6	61.02	--	--	--	--	66.80	--	--	--	59.86	--
North	Musanze	8	62.19	--	--	60.60	--	--	--	61.00	65.40	62.10	--
	Burera	7	75.00	83.80	--	--	--	--	--	73.90	--	62.10	73.60
	Gicumbi	20	64.15	80.90	56.70	75.00	--	--	81.00	--	--	59.29	--
	Rwamagana	62	71.33	61.60	--	69.55	62.90	73.39	93.50	63.70	--	68.52	68.32
	Nyagatare	61	71.76	77.40	--	72.65	56.95	72.09	86.20	--	--	63.55	--
	Gatsibo	54	67.33	--	--	74.95	--	66.62	76.90	67.40	--	64.00	62.10
East	Kayonza	24	68.05	--	62.60	70.20	61.13	73.43	74.70	61.10	74.40	--	71.30
	Kirehe	24	69.82	73.80	--	70.29	--	74.15	66.00	62.40	--	--	63.85
	Ngoma	58	67.22	62.60	58.60	74.65	65.00	68.74	63.58	--	--	--	59.48
	Bugesera	64	68.63	66.70	72.20	71.93	--	70.85	--	66.50	62.15	68.14	63.20
	Total	**1004**	**68.26**	**72.05**	**60.12**	**68.79**	**63.41**	**69.80**	**70.93**	**66.12**	**69.83**	**62.74**	**64.11**

9. Concluding Remarks

An impact assessment study was conducted in Rwanda in 2015 Season B. The main aim of this study was to establish the temporal and spatial adoption rate (i.e. reach) of these varieties. The study also aimed to generate useful information for delivery and breeding efforts by shedding light onto issues such as the facilitating/hindering factors to adoption/diffusion of HIB varieties; adopters' evaluation of various production and consumption traits of HIB varieties and effectiveness/reach of various delivery channels used.

In order to conduct this impact assessment study, a sampling frame of all rural bean producing households in Rwanda was needed. A listing exercise was conducted which involved implementing a very short survey on all households in 120 randomly selected rural villages, representative of all rural villages in Rwanda. A total of 19,575 household were listed. Ninety-three percent of these households were bean growers, and comprise the sampling frame of the impact assessment study. The short listing survey collected information on whether or not the household grew beans in general, HIB varieties in particular and additional information on their HIB variety adoption/disadoption patterns since 2010.

This report presented the key findings of this listing exercise. Following the listing exercise a main survey was implemented on a representative sample of rural bean farming households to shed further light onto the abovementioned adoption/diffusion/disadoption issues. The findings of the main survey will be presented in another report.

According to the listing exercise, almost one third (29%) of rural bean farmers in Rwanda have grown HIBs in at least one season since their first release in 2010, and about one fifth (21%) of rural bean farmers reported to have grown at least one HIB variety in Season B 2015. Over half (approximately 54%) of farmers who adopted HIBs since 2010 have continued to cultivate these varieties either on a continuous basis or intermittently. There are variations in adoption patterns across provinces and varieties. Adoption rates are highest in the Eastern province (roughly 42% of bean farmers) and lowest in the Western province (roughly 17% of bean farmers).

Across all seasons and in all provinces except for the North, RWR2245 (one of the two climbing varieties), is by far the most popular variety. Spatial and temporal spread of each one of the HIB varieties will be investigated in greater detail and triangulated with the delivery records as part of the main survey report and research papers.

In terms of numbers of households reached with HIB planting material, extrapolation of the 29% to the population amounts to about half a million rural bean producing households in Rwanda. Though similar to the figure from the delivery records, it should be noted that one third of the HIB adopters identified through the listing survey have stated to have acquired the planting material from social networks, and several others from local markets (likely from market stalls), alluding to the significant diffusion of HIB grain used as planting material. Therefore the delivery records stating that HIB seeds are delivered to about half a million households cannot be translated to half a million adopters, probably due to the repeat purchases of several households.

According to the preliminary information from financial records, since 2010 a total of $1.5 million was spent on HIB development, multiplication, delivery and promotion activities in Rwanda. A preliminary, back of the envelope calculation reveals that the cost of reaching a HIB growing household is $3. Further analysis will be conducted to establish further cost per beneficiary figures, both through time, and by variety and delivery channel.

Finally, it should be noted that while the adoption rates reported here are based on a very thoughtful, meticulous and quality data collection process and several quality control checks, results obtained through the various verification checks that were put in place for this study may indicate that some of the varieties which farmers identified as HIBs may in fact be local varieties. As such, it is likely that the adoption rates presented are slightly overestimated. This and several other issues will be investigated further from the data collected in the main survey which should shed more light and give an even more precise estimation of the level and extent of adoption of HIBs that has occurred in Rwanda to date.

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Appendix 1. Allocation of Villages across Districts

Province	District	Number of villages
Kigali	Nyarugenge	1
Kigali	Gasabo	1
South	Nyanza	4
South	Gisagara	5
South	Nyaruguru	3
South	Huye	4
South	Nyamagabe	5
South	Ruhango	5
South	Muhanga	3
South	Kamonyi	3
West	Karongi	5
West	Rutsiro	4
West	Rubavu	3
West	Nyabihu	4
West	Ngororero	4
West	Rusizi	5
West	Nyamasheke	5
North	Rulindo	5
North	Gakenke	6
North	Musanze	3
North	Burera	5
North	Gicumbi	5
East	Rwamagana	4
East	Nyagatare	5
East	Gatsibo	5
East	Kayonza	3
East	Kirehe	6
East	Ngoma	4
East	Bugesera	5

Appendix 2. Listing Survey Instrument (paper based questionnaire)

Assessing the Adoption of High Iron Bean Varieties and Their Impact on Iron Intakes and Other Livelihood Outcomes in Rwanda

Village Census (Listing) Instrument

May 2015

HarvestPlus is a global program that seeks to reduce micronutrient deficiencies by developing staple food crops that have high micronutrient content. In Rwanda, HarvestPlus is working with the Rwanda Agriculture Board (RAB) to develop and deliver improved bean varieties that contain high levels of iron. Dissemination of these high iron bean (HIB) varieties began in 2012. In order to assess the adoption and nutrition impacts of the HIB delivery efforts, we will be conducting a study towards the end of Season B 2015 to elicit information from farm households in Rwanda on their adoption and consumption of HIB varieties. Results of this study will inform design and effectiveness for further development and delivery of high iron beans in Rwanda.

We are currently conducting this census in your selected village to help inform the sampling strategies that will be used for the main survey. We   would sincerely appreciate it if you could kindly spare approximately 15 minutes of your time to answer a few questions in this regard. The information you   provide will be treated with strict confidentiality. Thank you in advance for your cooperation.

Participant's Consent: I am over 21 years of age and agree to participate in this survey in writing. I have been fully informed of this study and I am aware that should I not wish to continue participating in this study I can do so at any time and without giving a reason. This authorization is only valid for this study. I hereby consent to participate.

………………………………….…………………   …………………………….…………………….   …………………….……………..

Signature or thumbprint of participant   Name (in print)   Date

………………………………….……………………..   …………………………….........................   …………………….……………..

Signature of enumerator   Name (in print)   Date

If you have any questions you may contact the following:

Mr. Augustine Musoni   *Head of the Bean Research Program at RAB*   *Tel:* 0788747932

Dr. Jean-Baptist Mazaraki   *Chairperson, RNEC*   *Tel: 0788309807*

Dr. Laetitia Nyirazinyoye   *Secretary, RNEC*   *Tel: 0738683209*

NOTES:

Respondent should be the main decision maker in the household's bean production. If the main bean decision maker is not available, then ask for the second in command (most likely the spouse), otherwise, respondent should be other household member who is 21 years of age or older.

Definition of a household: A household is a group of people who sleep in the same dwelling and share meals. These people may or may not be related by blood, but make common provision for food or other essentials for living and they have only one person whom they all regard as the head of the household. A household may consist of one member, a couple or several couples with or without children. **All persons that have been away from the household for underline more than six months are not considered to be household members EXCEPT**:

1) the person who is identified as head of the household even if he/she has not been with the household for nine months or more; 2) a newly born child; 3) students and seasonal workers who have not been living in or as part of another household.

Module A: Identification

Interview and Location

A1	Has anyone in your household grown beans in the last 5 years?	[1] Yes >> A2 [2] No >> **End after A17. Move to the next household.**
A2	Household ID	
A3	GPS coordinate - elevation (meters)	
A4	GPS coordinate - latitude (decimal degrees)	*(Programmer: please use decimal degrees)*
A5	GPS coordinate - longitude (decimal degrees)	*(Programmer: please use decimal degrees)*
A6	Interviewer's name	
A7	Interviewer's ID	
A8	Supervisor's name	
A9	Date of interview	
A10	Time started	*(Enumerator: Please use military time)*
A11	Time ended	*(Enumerator: Please use military time)*
A12	Language in which the interview was conducted	[1] Kinyarwanda [2] English [3] French
A13	Province	
A14	District	
A15	Sector	
A16	Cell name	
A17	Village name	

Bean Production Screening

A18	Do you or anyone in your household usually grow beans in Season A?	[1] Yes [2] No
A19	Do you or anyone in your household usually grow beans in Season B?	[1] Yes [2] No
A20	Did you or anyone in your household plant beans in 2015 Season B?	[1] Yes [2] No >> **Skip A21, After Module A go to Module C. Skip Module B.**
A21	Who is the most knowledgeable person on bean seed varieties planted in this household?	[1] Me [2] Someone else *(Enumerator: If A21 = 2, ask to interview that person, otherwise see notes for alternate respondents.)*

Respondent Identification

A22	Name of the respondent (first, middle, and last names)	*(Programmer: use 3 boxes for each respondent.)*
A23	Relation to the household head	Code A23
A24	Sex of respondent	[1] Male [2] Female
A25	Age of respondent	
A26	Main occupation of respondent	Code A26
A27	Cellular phone number	
A28	How many people live in this household?	

Code A23: [1] Self [2] Husband/wife [3] Son/daughter/adopted child [4] Father/mother [5] Sister/brother [6] Grandchild [7] Grandparent [8] Mother/father-in-law
[9] Daughter/son-in-law [10] Sister/brother-in-law [11] Other relative [12] Not related [96] Other (specify)

Code A26: [1] Farmer [2] Farm help (unpaid) [3] Non-farm help (unpaid) [4] Agricultural wage labor [5] Non-agricultural wage labor
[6] Non-agricultural salaried labor [7] Self-employment, non-agricultural (includes petty traders) [8] Student [9] Civil servant (government) [10] Unemployed/idle
[11] Retired [12] Sick/disabled [96] Other (specify)

*ENUMERATOR: If A1 = 1, A20 = 2 >> Proceed to Module C, skip Module B.

Appendix 3. Distribution of Interviewed Households by District

Province	District	No. of HHs	% of Total HHs Interviewed (%)
Kigali	Nyarugenge	132	0.7
	Gasabo	234	1.2
South	Nyanza	681	3.5
	Gisagara	737	3.8
	Nyaruguru	554	2.8
	Huye	633	3.2
	Nyamagabe	752	3.8
	Ruhango	602	3.1
	Muhanga	666	3.4
	Kamonyi	794	4.1
West	Karongi	717	3.7
	Rutsiro	658	3.4
	Rubavu	345	1.8
	Nyabihu	469	2.4
	Ngororero	992	5.1
	Rusizi	866	4.4
	Nyamasheke	732	3.7
North	Rulindo	666	3.4
	Gakenke	805	4.1
	Musanze	614	3.1
	Burera	601	3.1
	Gicumbi	710	3.6
East	Rwamagana	674	3.4
	Nyagatare	1,052	5.4
	Gatsibo	753	3.9
	Kayonza	664	3.4
	Kirehe	810	4.1
	Ngoma	958	4.9
	Bugesera	704	3.6
	Total	**19,575**	**100**

Appendix 4. HIB Varieties

AGRONOMIC PROPERTIES OF IRON BEAN

Varieties	Color	Type	Yield potential	Adaptation	Iron content	Maturity
RWV 3316	Red	Climber	4 t/ha	High altitude	92ppm	110 days
RWV 3006	White	Climber	4 t/ha	High altitude	78ppm	110 days
MAC 44	Red mottled	Climber	4 t/ha	Mid to low altitude	78ppm	84 days
RWR 2245	Red mottled	Bush	3 t/ha	Mid to low altitude	76ppm	115 days
RWR 2154	Sugar	Bush	3 t/ha	Mid to low altitude	71ppm	110 days
RWV 1129	Salmon	Climber	4 t/ha	Mid to high altitude	77ppm	110 days
Cab2	White	Climber	3 t/ha	High altitude	76ppm	115 days
RWV 3317	Red	Climber	4 t/ha	High altitude	74ppm	110 days
RWV 2887	Dark red	Climber	4 t/ha	Mid to high altitude	85ppm	110 days
MAC 42	Sugar	Climber	4 t/ha	Mid to high altitude	91ppm	85 days

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Appendix 5. Other Names Mentioned by Farmers for HIB Varieties

CAB2		
Province	**District**	**Other Names**
South	Nyanza	Ubunyange
	Kamonyi	Nyiragateja, Ubunyange
West	Rutsiro	Nyiramweru, Nyamweru
	Rubavu	Nyiramabenga
North	Rulindo	Nyiragashaza
	Gakenke	Agronome
	Musanze	Umushingiriro
	Burera	Colta, Giramata, Ibyumweru, Nyamweru, Giramata, Nyiramata
	Gicumbi	Mata, Kigondo, Nyiramata, Nyiramweru, Ingemane zumweru, Injyamane Y'umweru, Injyamane z'umweru
East	Nyagatare	Karorina, Shyushya
	Gatsibo	Mushigiriro
	Kayonza	Kenyera, Nyiragatare
	Kirehe	Nyiragatare, Rwari, Sindayizamu, Singayisambu
	Ngoma	Nyiragatare, Ubunyange
	Bugesera	Carolina, Nyirakeru, Nyiramweru, Ubweru, Urunyange, Uruyange, Utunyange, Ubunyange, Utunyanjye

MAC42		
Province	**District**	**Other Names**
South	Nyanza	Tubura
	Gisagara	Imbuto Nini
	Nyamagabe	Karabundunge
West	Karongi	Ibiyungu, Kiryabageni, Mukwararaye, Umwizarahenda, Gisiku, Igihogere
	Rusizi	Ndimubujumbura
North	Rulindo	Gatabazi, Imberege, Kigondo, Kanda Biscuit, Worldvision
	Gakenke	Agronome, Mwirasi, Nyiragisenyi, Runyamanza, Urunyumba
	Burera	Cyenyera
	Gicumbi	Cab 2 (Mata), Kigondo, Uruyumba, Injyamane
East	Nyagatare	Agronome
	Gatsibo	Umugeri
	Ngoma	Ibigufi, Tubura
	Bugesera	Ibigondo, Mbagara, Mutiki, Rwaka, Murangazi

MAC44		
Province	**District**	**Other Names**
South	Nyanza	Amakunjapantalo, Mushigiriro, Mutiki, Tubura, Umushingiriro
	Gisagara	Mutiki, Mutiki ntoya, Tubura, Umushingiriro
	Nyaruguru	Mushigiriro, Conseline, Conserne, Kijyambere
	Huye	Mushigiriro
	Nyamagabe	Mushigiriro
	Ruhango	Ibinyarwanda, Mushigiriro, Mutiki, Umushingiriro, Ibyokumodoka
	Muhanga	Mushigiriro, Manyobwa, Manyobwa Ishingirirwa

Province	District	Other Names
	Kamonyi	Agronome, Umugeri
West	Karongi	Ibiyungu, Mushigiriro, Ruvuzo, Rwandarushya, Umushingiriro, Igihogere, Igihogere Cy'umushingiriro, Mwatayiki
	Rutsiro	Ibyimodoka
	Ngororero	Mutiki ndende, Umusengo
	Rusizi	Mukwararaye
	Nyamasheke	Ibiyungu, Tubura, Akamodoka, Ibishagasha, Ibyakamodoka, Ibyegerwa, Ibyo Kumodoka, Kamodoka, Kamodoka Yegerwa, Ndwanekubuzima, Runihira
North	Rulindo	Umugeri, Biscuit
	Gakenke	Ibishimbo Bigufi Byokumodoka, Inyumba
	Musanze	Kivuzo, Nyiragikoti
	Burera	Colta, Koruta, Ijamani, Ingemane
	Gicumbi	Colta, Kigondo, Ingemane
East	Rwamagana	Kiryugaramye, Kwezikumwe, Mushigiriro, Mutiki, Mutiki ndende, Nyiramabuye, Umushingiriro, Amaterasi/Mishingiriro, Imishingiriro, Kiryabagaramye, Matarasi, Ntabwo Azi, Ruhwahu, Ruhwahwa
	Nyagatare	Colta, Leta y'ubumwe, Mushigiriro, Mutiki, Nambare, Rwaka, Uruyumba, Ibituburano, Shendabakazi
	Gatsibo	Kigondo, Kiryugaramye, Umugeri, Zaire, Ibyumushinga, Mugeriwikigondo, Mushingiriro
	Kayonza	Umushingiriro, Uruyumba, Rozikoko
	Kirehe	Kigondo, Mac, Inyumba, Make
	Ngoma	Akararakagenda, Colta, Ibigufi, Mushigiriro, Tubura, Umushingiriro, Kamodoka, Mutuburo, Rada
	Bugesera	Mushigiriro, Mutiki, Mutiki Ndende, Mutiki Ntoya, Rubona, Shyushya, Butama, Kijyambere

RWR2154		
Province	District	Other Names
South	Nyanza	Gitsimbayogi
	Huye	Amaterasi
	Ruhango	Tubura
	Muhanga	Rwakadisi
	Kamonyi	Inyongeramusaruro, Kinyamanza
West	Karongi	Gitsimbayogi
	Ngororero	Mukotoro
	Rusizi	Ibiganzu, Ibishyimbo Bini, Ibishyimbo Binini
	Nyamasheke	Tubura, Byongera Amaraso, Kamodoka Ngufi
North	Gakenke	Runyamanza
East	Rwamagana	Nyiramacumu, Rwandarushya, Umugeri, Amatarasi, Amaterasi, Ntabwo Arizi, Ruhwahu, Ruhwahwa, Rurwahwa Yumweru, Ruwahu, RWH
	Nyagatare	Agronome, Kenyera, Gikoba
	Gatsibo	Nyirakabonobono, Umugeri
	Kayonza	Kaki, Kanyebwa, Rugandura, Urunyumba, Amatarasi, Amaterasi, Ibishimbo By'amaterasi, Matarasi, Muringa, Urugandura
	Kirehe	Kigondo
	Ngoma	Ibigufi, ISAR, Tubura, Zaire, Kamodoka
	Bugesera	Akanyamanza, Kirundi, Runyamanza, Rwaka, Kimirire

RWR2245		
Province	District	Other Names

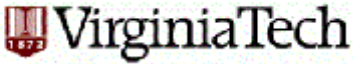| Province	District	Other Names
Kigali	Nyarugenge	Umugeri, Zaire
	Gasabo	Umugeri
South	Nyanza	Amakunjapantalo, Cooperative, Ibigondo, Kujipantalo/Kujipantaro, Kunjikoti/Kunjipantalo/Kunjipantaro/Kunjipataro/Kunkipantaro, Matarasi, Makunjapantaro, Mushigiriro, Mutiki, Rubona, Tubura, Umushingiriro
	Gisagara	Gatera , Mutiki, Mutiki Ntoya, Tubura
	Nyaruguru	Gafuni, Kijyambere, Mushigiriro, Mutiki
	Huye	Amaterasi/Materasi, Bitukura, Gafumba, ISAR, Ibigondo, Ibyagitifu, Ibyamatarasi/Ibyamaterasi, Kunjipantalo, Kanyebwa, Koruta, Mutiki, Mutiki Ntoya, Rubona, Tubura
	Ruhango	Bagarumbise, Ibinyarwanda, Ibyokumodoka, Mushigiriro, Mutiki, Mutiki Ntoya, Rwandarushya
	Muhanga	Mbagarumbise, Mutiki, Mutiki Ntoya, Manyobwa, Manyobwa Ngufi
	Kamonyi	Colta, Girubuzima, Ibigufi, Inyongeramusaruro, Kiryugaramye, Mutiki, Tubura, Umugeri, Mutuburano, Umutuburano, Mugufi
West	Karongi	Ibigufi, Ibiyungu, Igihogere, Mukwararaye, Mutiki, Rwandarushya, Umwizarahenda, Urwurungu
	Ngororero	Ibigufi, Ibizagiriza, Mutiki, Umugeri
	Rusizi	Byongera Amaraso, Ibigufi, Mukwararaye, Tubura
	Nyamasheke	Akamodoka, Amazagiriza, Ibigufi, Ibishagasha, Mukwararaye, Rwagapita Tubura, Udushagasha
North	Rulindo	Umugeri
	Gakenke	Ibigufi, Ntabwo Bazi Ukobyitwa
	Musanze	Mutiki
	Burera	Ingemane, Koruta
	Gicumbi	Colta, Ingemane/Injyamane, Kigondo, Umugeri/Umuryeri
East	Rwamagana	Amatarasi/Amaterasi, Amaterasi Yumutuku, Byomumaterasi, Ibigondo, Ibyamaterasi, Kigondo, Kingarukomere/Kiryabagaramye/ Kiryugaramye/Kiryumukwe/Kwezikumwe, Kwezi Kumwe, Luwahu, Matarasi/Materasi, Misengo, Mugeri, Mukwararaye, Murangaza, Mushigiriro, Mutiki, Mutiki Ntoya, Nambare, Ndungirabakwe, Nyiramabuye, Nyiramatarasi, Poroje, Rozikoko, RWH, Ruhahwa/Ruhawa/Ruhwahu/Ruhwahwa/Ruwahu, Rwamaterasi, Rwandarushya, Tubura, Umugeri/Umuryeri, Utubundi
	Nyagatare	Colta, Cooperative, Gacwekan/Gakwekane/Gacwekano/ Gashwekane, HarvestPlus, Ibigondo, Ibigondo Binini, Ibigufi, Imbuto ya Agronome, Kagondo, Kijyambere, Koruta, Midiyana, Mutiki, Mwenda, Mwenda Gatoya, Mwenda Ngufi, Mwenda Ntoya, Ntambala/Ntambane/Ntambare/Nambare, Nyiragisenyi, Nyiramabuye, Rozikoko, Rubona, Rushali Y'umutuke Rwaka, Rwandarushya, Twenty, Zaire
	Gatsibo	Cyiryugaramye, Cyivuzo, Ibyumushinga, Inyongeramusaruro, Kenya, Kigari, Kigondo, Kiryugaramye, Kivuzo, Mbagarumbise, Mutiki, Ruzikoko, Rwakenya, Rwindinganire, Tubura, Umugeri/Ubugeri, Mugeri Wakigondo/Umugeri Wa Gondo/Umugeri Wikigondo, Umugerimuto, Zaire
	Kayonza	Kanyebwa/Kenyera, Kiryumukwe/Kiryabagaramye, Nambare, Ntabwo Arizi/Ntazina Azi, Nyiramabuye, Rozikoko/Ruzikoko, Rwamodoka, Shyushya
	Kirehe	Colta, Ibigufi, Imbuto Ya Rada, ISAR, Mac Ngufi, Mutiki, Nyiragitenge
	Ngoma	Colta, Byakijambere , ISAR, IZARI, Kacwekano, Kamadoka/Kamodoka, Kamodoka niho Babiguze, Kanyobwa, Kijyambere, Kiryugaramye/Kiryumukwe, Korota Yumutuku, Koruta, Marirahinda, Mushigiriro/ Mushingirizi, Mutiki, Ngeriyabeza, Ntazi Ukobyitwa, Nyiragitwe, Poroje, RAB, Rwaka, Rwandarushya, Tubura, Umushimandengo/Umushingiriro, Uruyumba, Shimama
	Bugesera	Agronome, Ibigondo, Ibishyimbobinini, Imbuto Y'indobanure, ISAR, Kiburamutwe, Mutiki, Mutiki Ndende , Mutiki Ngufi, Mutiki Ntoya, Pasabu, Rubona, Ruhwaho, Rwaka, Rwandarushya, Sayitoti, Shimama, Ubugondo
RWV1129		
Province	District	Other Names
South	Nyaruguru	Baya

	Kamonyi	Poroje
West	Karongi	Kiryumukwe, Nyiramabuno, Tubura
	Rutsiro	Kajamalika
	Ngororero	Mushigiriro
	Nyamasheke	Ibiyungu, Kiringiti, Kivuzo, Kiringiti, Utunyobwa
North	Rulindo	Kirojana, Urunyumba, Uruyumba, Kilojana, World Vision
	Gakenke	Kivuzo, Ruvuzo, Ikivuzo, Nyirakivuzo
	Musanze	Nyiragisenyi, Imbuto y'ibishyimbo Yadutse
	Burera	Muhinzimworozi
	Gicumbi	Colta
East	Rwamagana	Rwirungu, Kijuju, Mishingiriro
	Nyagatare	Ibivuzo, Kivuzo
	Gatsibo	Kivuzo, Ruvuzo, Rwirungu, Umugeri, Nyiramabuye
	Kayonza	Muvuzo
	Kirehe	Ruvuzo, Mukungugu, Rwave
	Ngoma	Kivuzo, Kwezikumwe, Ruvuzo, Urunyumba/Uruyumba, Uruvuzo, Inyumba, Ndarubogoye
	Bugesera	Kivuvu, Kivuzo, Kwezikumwe, Ruvuvu

RWV2887		
Province	**District**	
South	Nyanza	Shyushya
	Muhanga	Shyushya, Umushingiriro, Rwandarugari
West	Karongi	Umubano, Gihoro
	Rubavu	Mwirasi
North	Rulindo	Garukurare, Poroje
	Gakenke	Suserayi
	Musanze	Kansirida, Nyiragaserayi
	Burera	Garukurare, Kenyera, Kenyeruhure, Kenyerumpure, Nyiragatuku
	Gicumbi	Kanyeshuri, Kenyera, Uruyumba
East	Rwamagana	Murangaza/Murangazi, Rwandarushya, Shyushya, Nyiramutuku
	Nyagatare	Akararakagenda, Mushigiriro, Famingi
	Gatsibo	Akajagari, Kajagari, Mweko, Nyiramaganura
	Kayonza	Nyiragatuku, Nyiramabuye
	Kirehe	Shyushya
	Ngoma	Mutiki
	Bugesera	Rwandarushya, Shyushya/Shusha, Singayisambu

RWV3006		
Province	**District**	**Other Names**
Kigali	Nyarugenge	Nyiramweru
South	Nyanza	Mushigiriro, Ibinyange, Imiteja
	Gisagara	Mushigiriro, Umubano
	Huye	Nyiragateja, Ibinyamiteja, Mushingiriro Yimiteja
	Nyamagabe	Imiteja
	Ruhango	Imishingiriro Yimiteja

Province	District	Other Names
West	Karongi	Imiteja
	Nyamasheke	Ibyimiteja
North	Rulindo	Nyamweru
	Musanze	Nyiramweru
	Burera	Umweru
	Gicumbi	Gateja
East	Gatsibo	Mushigiriro
	Kayonza	Nyiragatare
	Kirehe	Urunyumba, Nyamweru
	Ngoma	Ubunyange, Urunyange
	Bugesera	Mushigiriro, Nyiragateja, Nyirakeru, Nyiramweru, Shyushya, Uruyumba, Nyamweru, Ubunyange

RWV3316		
Province	**District**	**Other Names**
Kigali	Nyarugenge	Inyumba
	Gasabo	Umushingiriro
South	Nyanza	Mushigiriro
	Nyaruguru	Amakunjapantalo, Mushigiriro, Mutuku, Rwandarushya, Umubano, Umushingiriro, Kanyobwa, Kayobe, Ngwinurare
	Huye	Mushigiriro, Umubano, Umushingiriro, Vuninkingi, Utubundi
	Nyamagabe	Umubano, Vuninkingi
	Ruhango	Colta, Mushigiriro, Umushingiriro
	Muhanga	Umushingiriro, Icyibundi, Mabuno
	Kamonyi	Umushingiriro, Inyumba
West	Karongi	Nyiragateja, Nyiramabuno, Umubano, Agatangaza, Florance/Florence
	Rutsiro	Tubura, Umundereri
	Ngororero	Kenyerumpure, Nyiragateja, Serayi, Urunyumba
	Rusizi	Mpemberwa
	Nyamasheke	Ibiyungu, Tubura, Umubano, Kansirida
North	Rulindo	Imberege, Mushigiriro, Poroje, Umubano, Umushingiriro, Urunyumba/Uruyumba, Forora
	Gakenke	Hagararundebe, Kenyerumpure, Nyiragisenyi, Rushali y'umutuke, Sidiri, Ferediyana, Forora
	Musanze	Hagararundebe, Kajamalika, Nyiragikote, Nyiragisenyi, Nyirakagorori, Ruvuninkingi, Urunyumba, Sibiri
	Burera	Nyiragatuku, Nyiramagorori, Sidiri
	Gicumbi	Kanyeshuri, Mushigiriro/Mishingiriro, Mwirasi, Ngwinurare, Nyiragatuku, Ruvuninkingi
East	Rwamagana	Kiryumukwe, Murangazi, Mushigiriro, Nyiramacumu, Rwandarushya, Shyushya, Umugeri, Umushingiriro, Ntazina Bigira, Shusha
	Nyagatare	Akararakagenda, Rwandarushya
	Gatsibo	Akararakagenda, Mushigiriro, Ruvuninkingi, Umugeri, Kinyobwa
	Kayonza	Akararakagenda, Karorina, Kiryumukwe, Nyiragatuku
	Kirehe	Mushigiriro, Umushingiriro
	Ngoma	Marirahinda, Mushigiriro, Ruvuninkingi, Shyushya
	Bugesera	Karorina, Mushigiriro, Mutiki, Nyiragatuku, Nyiramabuno, Rwandarushya, Urunyumba, Gashusha, Shusha/Shyushya

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Province	**District**	**Other Names**

South	Gisagara	Rwandarushya
	Kamonyi	Inyongeramusaruro, Rwaka, Rwandarushya
West	Karongi	Ibiyungu, Ruvuzo, Umwizarahenda, Foloranse, Igihogere Cy' Umweru
	Rutsiro	Kajamalika
	Rubavu	Urushari
	Rusizi	Amanihira, Ibinini, Ibishyimbo Binini, Kijyambere
	Nyamasheke	Kanyamanza, Mpemberwa, Tubura
North	Rulindo	Umugeri
	Gakenke	Kivuzo, Urunyumba, Gikote
	Musanze	Nyiramushari, Uzajyinyanza
	Burera	Ingengabukungu, Kigome, Nyamanza, Urunyumba, Ingemane, Nyumba
East	Rwamagana	Kwezikumwe, Umugeri, Kwezikumwe, Matarasi Yumweru, Materasi, Ruhwahu/Ruwahu(LWH), Umuryeri
	Nyagatare	Agronome
	Gatsibo	Kigondo, Mbagarumbise, Umugeri
	Kayonza	Ibinyarwanda, Uruyumba, Amatarasi, Ntazina Bigira, Nyiramatarasi, Rwabasaza, Urugandura
	Kirehe	ISAR, Kigondo, Rwari
	Ngoma	Ibigufi, ISAR, Umushingiriro, Uruyumba, ISAR, Magana, Nyiragitwe
	Bugesera	Gitsimbayogi, Ibinyarwanda, Kinyamanza, Kiryugaramye, Kiryumukwe, Mutiki, Mutiki ndende, Rwaka, Shyushya, Cyimiriro, Gitenge, Kimirire

Appendix 6. Sample Color Sheet

Appendix 7. Iron Content of Collected Samples, presented by District

Province	District	No. of Samples	Average	Std. Dev.	Minimum	Maximum
Kigali	Nyarugenge	15	64.26	6.54	53.9	73.7
	Gasabo	16	63.98	6.42	52.4	77.2
South	Nyanza	70	68.45	8.52	49.6	91.5
	Gisagara	41	65.96	8.97	48.9	101.3
	Nyaruguru	46	64.97	7.90	52.4	91.8
	Huye	135	69.66	6.60	53	88.2
	Nyamagabe	5	66.56	5.93	58.3	73.8
	Ruhango	71	66.98	7.64	52.4	87.3
	Muhanga	11	67.05	9.64	53.6	83.1
	Kamonyi	83	68.77	6.34	49.3	83
West	Karongi	50	67.90	9.16	51.1	101.2
	Rutsiro	9	70.73	15.50	44.8	98.4
	Ngororero	13	65.80	11.03	45.3	91
	Rusizi	17	76.46	10.83	56.3	101.2
	Nyamasheke	22	65.84	8.38	47	86.7
North	Rulindo	12	64.63	8.79	53.2	83.3
	Gakenke	6	61.02	3.89	57.1	66.8
	Musanze	8	62.19	5.50	51.3	68.7
	Burera	7	75.00	8.07	62.1	84.2
	Gicumbi	20	64.15	9.85	54	86.4
East	Rwamagana	62	71.33	9.35	45	94.2
	Nyagatare	61	71.76	7.54	56.2	86.2
	Gatsibo	54	67.33	7.33	53.6	88
	Kayonza	24	68.05	9.69	51.3	87.5
	Kirehe	24	69.82	7.30	56.4	85.4
	Ngoma	58	67.22	9.80	45.9	107
	Bugesera	64	68.63	8.59	48.2	92.3
	Total	**1004**	**68.26**	**8.47**	**44.8**	**107**