Assessing the adoption and production of iron beans (NUA45) in Zimbabwe – a survey report

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Executive Summary

A nationally representative adoption survey was conducted in Zimbabwe in 2022, to establish the current adoption rate and the drivers and barriers of adoption, for iron beans. The study was carried out in 7 out of the 8 rural provinces of Zimbabwe. The seven selected provinces are the provinces where bean production occurred in 2021/2022 cropping season[1]. The study was carried out in two stages, the listing stage and the main survey that focused on the 2021/2022 cropping season. A 3-stage random cluster sampling method was used to select wards, villages and respondents making the results from the study representative at the national level. A total of 1,512 bean growing households were surveyed across 126 randomly selected villages. Descriptive statistical analysis was performed using STATA and Excel. Overall, 81% of the surveyed households had at least one woman of childbearing age[2], a key target group for biofortification interventions; 30% of the bean growers had planted NUA45 (iron bean variety), in the 2021/22 cropping season and iron bean growers had replaced 84% of their bean area with iron beans; the adoption rate differed significantly between female and male headed bean farming households with more female headed households (34%) adopting iron beans than male headed households (28%). Yield, nutritional value and taste of iron beans were the major drivers of adoption of iron beans, while unavailability of seed was the major barrier to its adoption. The also study found that iron beans had a significantly higher average yield (1,234kg/ha) than non-iron bean varieties (1107kg/ha). This represents a yield advantage of 11.5% for iron bean variety NUA45 over non-iron bean varieties. Overall, iron bean growers sold 65% of their harvested iron beans to the market and allocated 25% and 8% for home consumption and farm saved seed, respectively. The study also revealed that extension staff, radio and fellow farming households were the major sources of information about new bean varieties and that most of the decisions about the production and utilization of beans are made jointly by spouses, for households with married couples, presenting an excellent entry point for designing future projects and targeting which aspects of the value chain should have more involvement of women in decision making.

[1] Crop and livestock assessment survey report https://fscluster.org/zimbabwe/document/2023-first-round-cropfisheries-and

[2] This is the 15-49 years age group, as defined by the World Health Organization

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1. INTRODUCTION

1.1. Background

Micronutrient malnutrition is a serious problem in Zimbabwe affecting more than 70% of women of childbearing age (15 – 49 years) and children under 5 years, exposing them to a high risk of impaired vision and blindness, impaired physical and cognitive development, increased risk of severe disease from common infections and undesirable pregnancy outcomes (Mareya, 2018). According to the Zimbabwe 2012 national micronutrient survey report, at least 19% of children aged 6 – 59 months and 61% of women of childbearing age (15 – 49 years) suffer from Vitamin A deficiency; while 72% of children aged 6 – 59 months and 69% of women of childbearing age suffer from iron deficiency (Ministry of Health and Childcare, 2012). In response to the survey results, the government of Zimbabwe formulated several policies and strategies aimed at addressing malnutrition in all its forms. These include the Food and Nutrition Security Policy (2013), the national nutrition strategy (2014 – 2018), and the national food fortification strategy (2014 – 2018) which has since been replaced with a revised version (2022 – 2026). The latter outlines three strategic interventions for addressing micronutrient malnutrition, namely industrial food fortification, point of consumption fortification and biofortification[3] (Ministry of Health and Childcare, 2022). Biofortification is the breeding of crops, mainly staples, to increase the density of essential micronutrients (vitamin A, zinc, and iron) in their edible parts, without compromising on yield and other farmer desired traits. Studies have shown biofortification to be a cost effective, efficacious, and pro-poor strategy for reducing the prevalence of vitamin A, Iron and Zinc deficiency (Birol, Foley, & Aytekin, 2021); (Meenakshi, et al., 2010).

1.2. Biofortification in Zimbabwe

In Zimbabwe, the breeding of biofortified varieties started in 2006, through a collaboration between HarvestPlus, CGIAR partners and the Department of Research and Specialist Services (DR&SS). The collaboration led to the release of NUA45, the first biofortified variety of beans in the country, in 2010 and by 2022, an additional 5 varieties of Vitamin A Maize (VAM), also known as Orange Maize, had been released.

Maereka et al. (2024), noted that the success of iron beans (NUA45) in Zimbabwe was a multi-pronged varietal adoption story that benefited from targeted investment in promotional work; being the first biofortified bean variety with high levels of the most sought after micronutrients of iron and zinc and; systematic approach to awareness creation, collaboration, and commercialization all which led to the variety becoming a household name, rapidly spreading across all provinces of Zimbabwe. To date, NUA45 grain is available in several urban fresh produce markets.

In 2015, the U.K. Department of Foreign and International Development (DFID - now FCDO) funded a program called the Livelihoods and Food Security Program (LFSP, 2015 - 2021). The Food and

[3] The breeding of crops, mainly staples, to increase the density of essential micronutrients (vitamin A, zinc, and iron) in their edible parts, without compromising on yield and other farmer desired traits.

Agriculture Organization of the United Nations (FAO) was the lead technical implementer and HarvestPlus was a technical partner leading the biofortification component which aimed at promoting the production and consumption of iron beans and VAM. While iron bean had been released in 2010, no seed producer had taken it up for commercial production and marketing. At that point, VAM had only been released in Zambia and was still unavailable in Zimbabwe, and the first consignment of certified VAM seed was shipped from Zambia to Zimbabwe while the bulking of NUA45 seed only started the same year. By December 2022, nine (9) biofortified varieties had been released in Zimbabwe constituting five (5) VAM varieties, two (2) iron bean varieties, and two (2) vitamin A sweetpotato varieties (Kudita S, 2022). These varieties have been licensed to eleven (11) private seed companies for production and marketing across the country.

The LFSP was implemented in four (4) provinces and twelve (12) districts as follows: Mutasa, Mutare and Makoni districts in Manicaland province; Guruve, Mt Darwin, Bindura, and Mazowe districts in Mashonaland Central province; Kwekwe, Gokwe South, Gokwe North and Shurugwi districts in the Midlands province and Zvimba district in Mashonaland West province. While the program focused on the 4 provinces, the promotion strategy resulted in biofortified varieties spreading to other provinces, (Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, 2022).

In 2022, HarvestPlus partnered with researchers from Michigan State University to design and implement a study to assess the adoption of iron beans and VAM, in Zimbabwe. The purpose of the study was to determine the adoption levels of iron beans and to understand the drivers and barriers to their adoption. This report focuses on iron beans only and the VAM results will be presented in a separate report.

1.3. The Study Objectives

The overall objective of the study was to determine the adoption level, production, and utilization, of iron beans in Zimbabwe. The specific objectives were to:

1. Determine the adoption rate, drivers and barriers of adoption, of iron beans in Zimbabwe
2. Assess the production and utilization (consumption, sale, sharing, farm saved seed) levels of Iron Beans
3. To understand the socio-economic characteristics (including sources of information, seed, utilization of harvested beans, types of markets targeted, etc.) of bean farming households that have adopted iron beans (NUA45) and those that have not.

2. RESEARCH METHODS AND MATERIALS

2.1. Selecting Study geographies and determining the sample size

While iron beans were actively promoted in twelve (12) districts under the LFSP, promotion activities by other development partners, organic diffusion of farm saved seed and the realization of a business opportunity by seed companies, resulted in iron beans spreading to more provinces. The sampling methodology was therefore designed to ensure that the study respondents were drawn from all bean producing regions in Zimbabwe. A 3-stage randomized sampling design was used to select study areas and respondents, making the results from the study representative at the national level. Zimbabwe is divided into 4 distinct administrative levels consisting of provinces, districts, wards, and villages – this was key in determining the sampling strategy and ultimately the enumeration areas. First, using nationally representative data from the 2021 crop and livestock assessment survey by the Ministry of Agriculture Lands and Rural Resettlement, the sampling frame was created by selecting those wards that had a total bean area ≥45ha, which account for 80% of national total area planted with beans. From this sampling frame, 85 wards were selected and within the selected wards, a total of 126 villages were randomly selected. The study was carried out in two stages, first, a listing exercise and then the main survey. The listing exercise was conducted in all the 126 villages by enumerating all households in each village, to create a sampling frame for the farmer level survey respondents.

Using this approach of selecting wards using the 2021 crop and livestock assessment, the list of study districts and ultimately provinces, was determined (in reverse) hence the study was carried out in 7 out of the 10 provinces and 31 districts out of the 61 districts. A decision was made to sample 12 farming households per village, giving a total of 1,512 "unique respondents". This sample size had enough power to detect a 12% adoption rate, as the number of observations needed under simple random sampling (with 95% confidence level and 3% precision) is around 450. Given that the sample was created in three stages, the decision to triple the sample size was made to include extra households and to oversample adopters. Table 1 below shows the distribution of wards and villages per province.

Table 1: The resultant sample size and distribution

Province	Number of wards per province	Number of villages per province	Number of bean-growing households
Manicaland	20	29	348
Mashonaland Central	21	32	384
Mashonaland East	12	19	228
Mashonaland West	21	30	360
Masvingo	6	11	132
Matabeleland South	1	1	12
Midlands	4	4	48
Grand Total	85	126	1512

From the listing stage, where we listed all households in a village using a listing questionnaire, we were able to identify bean growers, and bean growers that had planted iron beans at least once, since 2015, thus creating a sampling frame from which respondents would be selected. Using the sampling frame created from the listing stage and the proportion to size allocation of villages per ward, randomly sampled bean growers were interviewed using the farmer level bean questionnaire. The aim of the main survey was to interview the households' main/primary decision maker with regards to the production of beans. Only primary decision makers who were 18 years and above were interviewed. The survey was carried from November to December 2022, five months after the harvesting period of beans in Zimbabwe. Computer Assisted Personal Interviewing (CAPI) was used to collect face-to-face interviews. Training of data collectors/supervisors was carried out in 2 stages. First, Master Trainers/Quality Controllers were trained in a 3-day training session while data collectors were trained in a 4-day training session. Data collectors were given seed samples and seed pictures of the common bean varieties to help respondents identify the varieties they had planted and consumed. Data analysis was carried out using STATA version 18 and Excel.

2.2. Classification of study wards by farming system

In Zimbabwe, there are 6 farming systems, largely defined by either land size holding, tenure type, production objective or the history of land acquisition by the farmer – a bit complicated! This study covered 5 of the 6 farming system types and excluded the large-scale commercial farms, Table 2. The land holding sizes vary across farming systems while production systems and agricultural enterprises also vary within provinces depending on the Agro-Ecological Zones (AEZ), Annex 10, proximity to urban area, Matondi P. B., (2020), shown in Annex 1 and 2. Generally, Communal Area farms are the smallest (0.1-3ha/farm) followed by A1 farms (5-50ha/farm), then by small-scale commercial farms (50-240ha/farm), and finally A2 farms (250-2000ha/farm).

The production of beans is largely rainfed, but irrigated bean production does exist but mostly in the drier AEZ. While farming households interviewed in this study were not selected based on AEZ or farming system type, the sample had a good representation of farming households from all the 5 farming systems and AEZ. Table 2 below, shows the classification of respondents by farming systems. Most of the respondents were drawn from the A1 farming area followed by communal farming areas.

Table 2: Classification of respondents by farming system

Province	Communal Area	Old Resettlement	A1	A2	Small Scale Commercial	Total
Manicaland	265	25	57	0	1	348
Mashonaland Central	216	0	118	25	25	384
Mashonaland East	48	24	120	0	36	228
Mashonaland West	36	73	189	13	49	360
Masvingo	13	0	119	0	0	132
Matabeleland South	0	0	12	0	0	12
Midlands	12	0	36	0	0	48
Grand Total	590	122	651	38	111	1,512

Figs 1 and 2 below are maps of Zimbabwe showing the provinces and districts in which the study was carried out and the AEZ in which the selected districts lie.

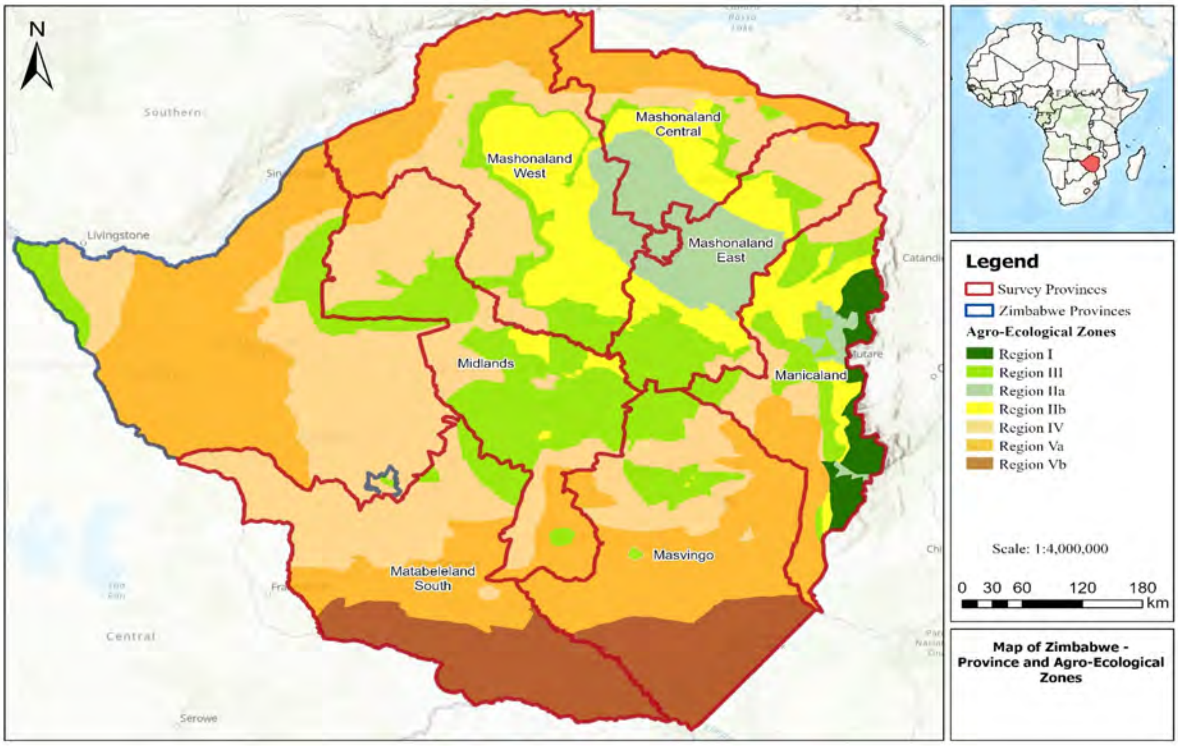

Figure 1: Zimbabwe Province and Agro – Ecological Zones where the survey was conducted -see annex 10 for detailed breakdown of the characteristics of each zone.

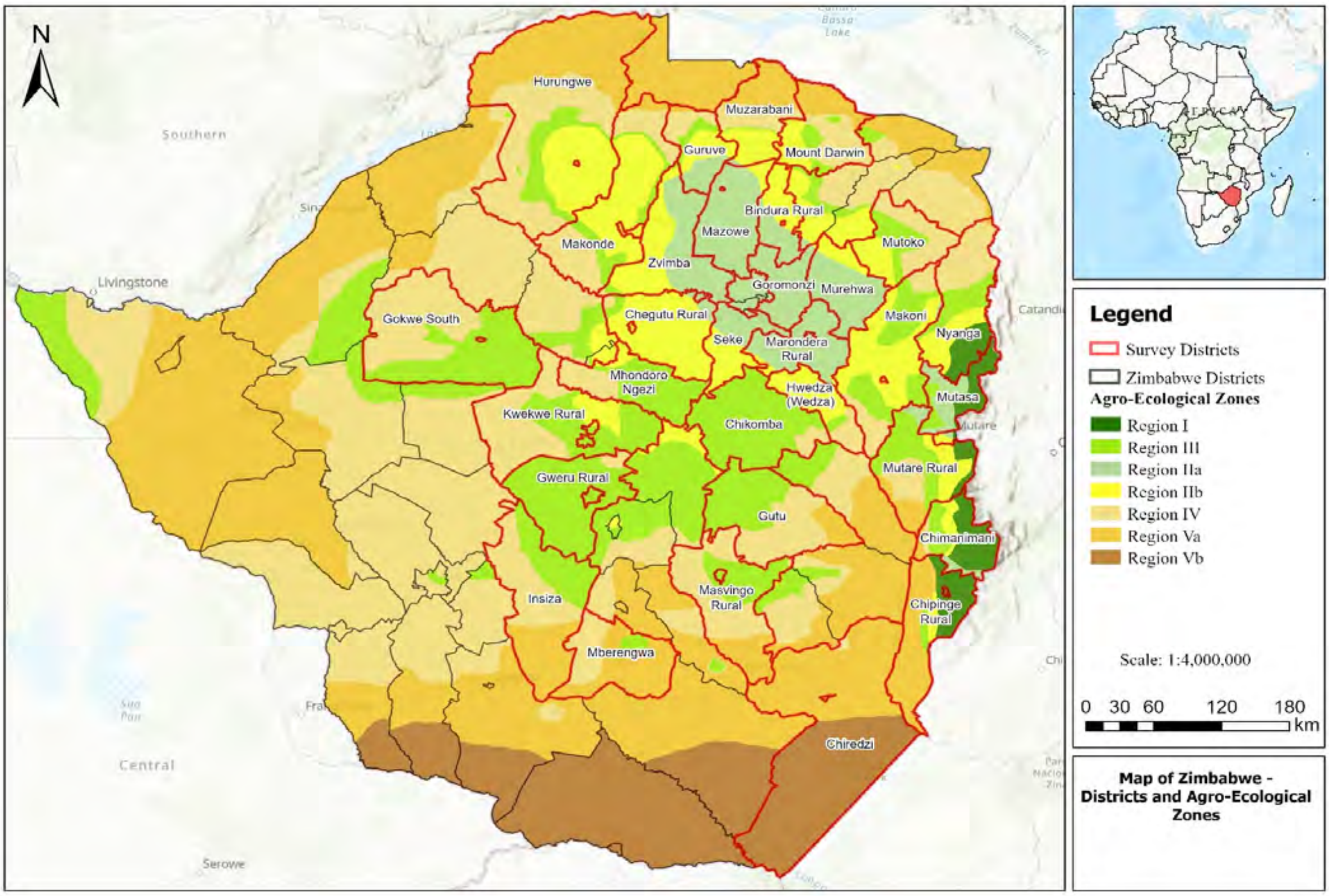

Figure 2: Zimbabwe districts (named) where the survey was conducted

3. DESCRIPTIVE STATISTICAL ANALYSIS RESULTS

3.1. LISTING EXERCISE RESULTS

3.1.1. Profile of households interviewed

A total of 6,251 farm households were enumerated in the listing stage. Figure 3 shows the percent of households surveyed during the listing exercise, across the seven provinces. Mashonaland Central had the highest number of villages sampled hence it contributed 43% of the total listed households.

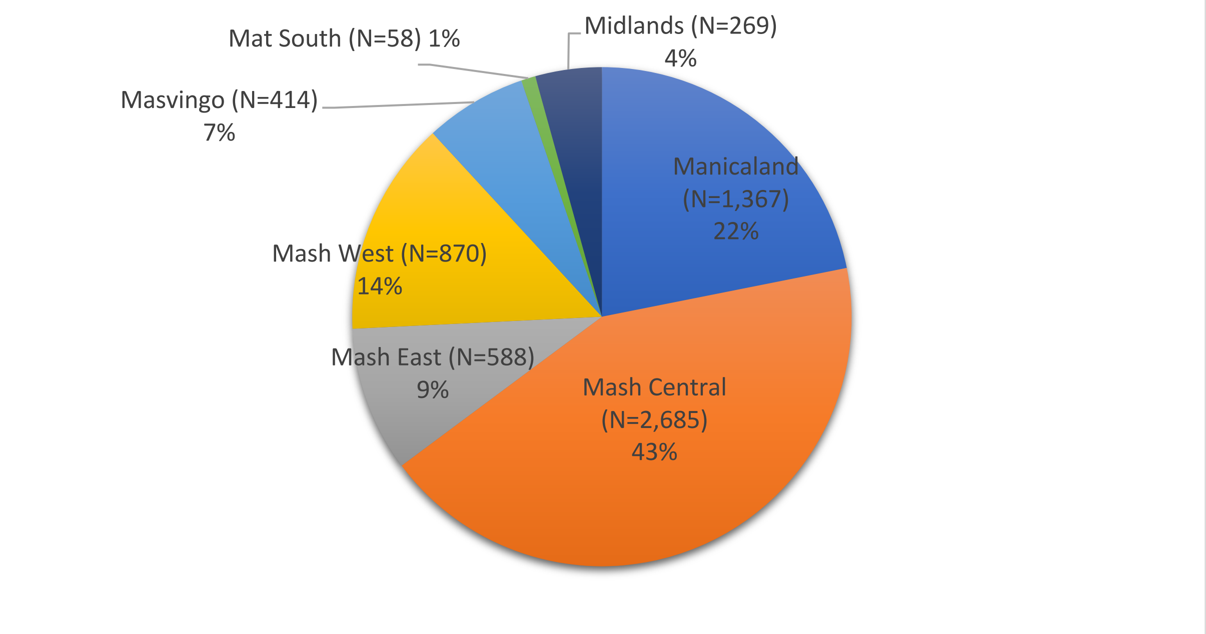

Figure 3: Distribution of listed households, by Province

Table 3 shows the proportion of listed households who grew crops, including all beans and iron beans, in the 2021/22 agricultural season. About 69% of the farming households grew common beans (also called sugar beans in Zimbabwe). Nearly 77% of respondents indicated that they were aware of iron beans (NUA45). This awareness level demonstrates that the promotional strategy employed was effective. Maereka et al. (2024) and Zozo (2020), stated that (1) systematic awareness campaigns and (2) a strong value proposition (brand creation) for iron beans, were pivotal to the success of iron beans in Zimbabwe. Among those who were aware of iron beans, 36% had grown the variety at least once, since 2015.

Table 3: Crop and bean production and awareness of iron beans for the surveyed farming households in 2021/22 season.

Variable	N	Yes (%)
Households that grew any crop in 2021/22 season	6,251	99.18
Farming households that were aware of iron beans	6,200	76.89
Farming households aware of iron beans that have ever grown it	4,767	35.77
Farming households that grew common beans in 2021/22 season	6,200	69.47
Bean growing households that grew iron beans in 2021/22 season	4,307	29.72

We assessed the incidence of adoption (proportion of bean farming households that grow iron beans in a selected cropping season) and how this differed across provinces. The study found out that 30% of the common bean growers had grown iron bean varieties in 2021/22 season, table 4. Asare Marfo et al. (2016) reported a similar adoption rate and reasons, for iron beans in Rwanda, nearly the same 6-year period after the start of dissemination. Focusing only on the bean production corridor of Zimbabwe (annex 3), Maereka et al. (2024), reported a NUA45 adoption level of 47% and an increase of 45 percentage points from a 2% adoption rate in 2015. Adoption rates were significantly different across provinces with Manicaland reporting the highest (nearly 48%)

Table 4: Percentage of farming households that grew iron beans in 2021/22 season, by province.

Descriptive statistics	**Manicaland (N=970)**	**Mashonaland Central (N=1743)**	**Mashonaland East (N=529)**	**Mashonaland West (N=591)**	**Masvingo (N=309)**	**Matabeleland South (N=14)**	**Midlands (N=151)**	**Overall (N=4307)**	**P value**
Farming households that grew iron bean varieties in 2021/22 season (%)									
Yes	47.63	33.51	15.88	8.63	31.07	0.00	1.99	29.72	0.0000
No	52.37	66.49	84.12	91.37	68.93	100.00	98.01	70.28	

3.1.2. Gender and Adoption of Iron beans

We compared the common bean and iron bean production between male and female headed farming households in the study area. The results show that the proportion of common bean growers among male farming households was not significantly different from that of female-headed farming households, Table 5. However, significantly more female farming households (34%) grew iron beans than their male counterparts (28%). It will be useful to explore whether this difference has anything to do with more women heeding to the value proposition contained in the promotional messages[4] from different development partners.

Table 5: Proportion of farming households who grew iron beans in 2021/22 season, disaggregated by gender.

Variable	Sex of the household head		Overall	**P value**
	Male (N=4,194)	Female (N=2,006)	(N=6,200)	
Proportion (%) of farming households that grew common beans in 2021/22 season	69.46 (4,194)	69.49 (2,006)	69.47 (6,200)	0.978
Proportion (%) of bean growing farming households that grew iron beans in 2021/22 season	27.50 (2,913)	34.36 (1,394)	29.72 (4,307)	0.000

Values in brackets () are the n values.

[4] Promotional messages included the agronomic, nutritional and health benefits, and the short cooking time, of iron beans.

3.1.3. Area allocated to common beans and iron beans among iron bean adopters, by gender

We assessed area allocated to beans and iron beans and this differed between male and female adopters of iron beans. The results show that despite more women adopting iron beans than men, Table 5 above, the average area planted with common beans was significantly higher (p<0.01) for male growers than female growers, as was the area planted with iron beans (significant at only the 10% significance level), Table 6.

Table 6: Allocation of land to bean varieties by male and female adopters of iron beans.

Variable	Sex of household head		Overall	**P value**
	Male (N=2,913)	Female (N=1,394)	(N=4,307)	
Average area (ha) planted with common beans	0.41	0.35	0.39	0.0007
Average area (ha) planted with iron beans	0.32	0.26	0.30	0.0855

3.1.4. Production history for biofortified varieties – disadoption

Overall, the study established that only 8% of the 4,767 farming households that had ever grown iron beans between 2015 and 2022, had disadopted. Asare-Marfo et al. (2016) reported a similar dis-adoption rate for iron beans in Rwanda, nearly the same 6-year period after the start of dissemination. Farming households that had stopped growing iron beans prior to 2022, were asked for the reason(s) why they had discontinued. The results are presented in Table 7. At least 52% of the respondents cited unavailability of iron bean seed in the input market, while 21% mentioned that they had used all their previous season's harvest for other purposes as the reasons for disadopting iron bean. Overall, the shortage of seed was the reason for disadopting iron beans.

Table 7: Main reasons for disadoption of iron beans production by farming households

Reason for iron bean disadoption	**Percentage of respondents, (%) (N=402)**
Unavailability of planting material in nearby markets	51.99
Previous season's harvest was all used	20.90
Seed(s) need replacement	11.94
Seed was too expensive	4.73
Yield was not good	3.73
Poor drought resistance	2.24
Land constraints	1.24
Did not fetch a good price in the market	1.24
Too many inputs required	1.24
Crop management (rotation) practice	0.75

3.2. SAMPLE SURVEY RESULTS

This section presents results of the descriptive statistics performed on data collected from the main survey[5]. For some variables in this section, we link the results from the listing exercise to the main survey results, for better understanding of some of the results found.

3.2.1. General characteristics of the sampled households

Table 8 presents the demographic and socio-economic characteristics of household heads, by province. Mashonaland West, Manicaland and Mashonaland Central had the highest number of sampled respondents for the main survey with each constituting 29%, 26% and 19%, respectively. Sex of household head significantly differed (P<0.01) across provinces. Most of the households (76%) were headed by men. Midlands, Mashonaland West and Masvingo provinces had the highest percentage of households headed by men, with each reporting 90%, 82% and 81%, respectively.

The mean household size was 5 persons per household, but this was not significantly different across provinces (p<0.10). The mean land holding area was 3.27 hectares and this differed significantly (p<0.01), across provinces, with Mashonaland East having the highest mean land holding area of 5.69 hectares per household, while Manicaland had the lowest mean land holding area of 1.52 hectares, Table 8.

Table 8: Demographic and socio-economic characteristics of the households

Descriptive statistics	Manicaland (N=312)	Mashonaland Central (N=296)	Mashonaland East (N=181)	Mashonaland West (N=314)	Masvingo (N=127)	Matabeleland South (N=8)	Midlands (N=24)	Overall (N=1,262)	P value
Sample distribution across province (%)	25.76	19.21	13.11	28.52	8.92	1.57	2.90		
Sex of household head (%)									0.0005
Male	73.75	72.29	68.03	82.05	81.87	25.00	90.36	75.52	
Female	26.25	27.71	31.97	17.95	18.13	75.00	9.64	24.48	
Household size (persons)	5.01	5.18	5.32	5.99	4.86	5.38	4.73	5.35	0.0667
Mean land holding area (ha)	1.52	2.77	5.69	4.25	2.32	3.63	4.19	3.27	0.0000

Age composition of target population groups

The promotional messages under the LFSP and other projects were designed to increase the consumption of biofortified foods by children under the age of 5 and women of childbearing age (15-49 years) old, the demographic groups most affected by mineral and vitamin A deficiency. The survey results show that just over 35% of the surveyed households had male children under the age of five years while just over 33% had female children under the age of five years. Overall, over 80% of the surveyed households had at least one woman of childbearing age. There were no significant

[5] Note that weights were used/included in the below analyses given the oversampling of adopters.

differences in the demographic composition of adopter and non-adopter households, with regards to the demographic groups of interest (under-fives and women of reproductive age), Table 9.

Table 9: Age composition of target population groups

Demographic Groups	**Iron bean non - adopter (% Households) N=859**	**Iron bean adopter (% Households) N=403**	**Overall (% Households) N=1,262**	P - Value
Male below 5 years	35.74	34.87	35.47	0.3575
Female below 5 years	35.55	28.98	33.48	0.3624
Male 5 – 14 years	53.57	54.15	53.75	0.3774
Female 5 – 14 years	51.58	54.63	52.54	0.5688
Males 15 – 49 years	76.95	72.56	75.57	0.0000
Females 15 – 49 years	80.48	80.46	80.47	0.7999
Males 50 years or older	34.03	38.97	35.59	0.2331
Females 50 years or older	30.81	32.82	31.44	0.8254

Household wealth index/Income/Asset

The proportion of adopters that had access to electricity and piped water was significantly higher (p<0.01) than that of non-adopters, while there were no significant differences in access to free inputs between non-adopters and adopters, Table 10. Only 7.43% of the interviewed households had obtained loans.

Table 10: Housing characteristics

Variable	**Iron bean non - adopter (% Households) N=859**	**Iron bean adopter (% Households) N=403**	**Overall (% Households) N=1,262**	**P value**
Access to electricity (national grid and or solar)	55.89	70.01	60.34	0.0005
Access to piped water	9.37	18.15	12.13	0.0006
Access to loans	8.21	5.74	7.43	0.3287
Access to free inputs	55.01	55.11	55.04	0.9817

Ownership of livestock, and other agricultural assets

Over 98% of the households interviewed owned a mobile phone, a significant tool that can be used to share and receive information. Table 11 presents household ownership of agricultural assets disaggregated by adoption type. Although no distinct overall pattern was observed, there were significant differences (p<0.05) in asset ownership for bicycles and television sets between adopters and non–adopters.

Table 11: Ownership of household assets

Variable	Iron bean non - adopter (% Households) N=859	Iron bean adopter (% Households) N=403	Overall (% Households) N=1,262	P value
Motorcycle/scooter	6.59	5.88	6.36	0.7068
Bicycle	41.93	31.49	38.65	0.0082
Car	10.31	12.26	10.92	0.4556
Mobile phones	98.41	98.10	98.31	0.8056
Television	35.10	43.06	37.61	0.0479
Grinding mill	5.78	2.51	4.75	0.0806

Table 12, present results for agricultural asset ownership. Most households (72%) reported owning a plough, while 63% owned wheelbarrows and 74% owned a knapsack sprayer. Only a few households (5%) had water tanks installed at their homes for harvesting/storing water. However, significantly ($p<0.01$) more non-adopters owned ploughs than adopters, while significantly more adopters owned wheelbarrows ($p<0.01$), water tanks and water pumps (both $p<0.05$), than non-adopters.

Table 12: Ownership of agricultural assets

Agricultural Asset	Iron bean non - adopter (% Households) N=859	Iron bean adopter (% Households) N=403	Overall (% Households) N=1,262	P value
Plough	75.33	65.94	72.37	0.0095
Carts	51.22	44.87	49.22	0.1286
Wheelbarrows	59.70	70.12	62.98	0.0089
Cultivators	35.15	35.19	35.17	0.9924
Harrows	30.73	35.99	32.39	0.1778
Knapsack sprayer	72.93	75.84	73.85	0.4185
Water pumps	12.36	18.58	14.32	0.0368
Water tanks	4.04	7.35	5.08	0.0476
Boreholes	7.11	10.91	8.31	0.1022

Slightly more than 63% of the interviewed households owned cattle, while 64% and 90% of the households, owned goats and chickens, respectively, Table 13. Generally, non–adopters had significantly larger cattle herds ($p<0.10$) compared to adopters, while adopters had more rabbits ($p<0.01$). This is likely so because most of the adopters were from communal areas that generally own smaller land areas compared to farming households in A2 (most of the non-adopters were from A2 and small-scale commercial areas who own fairly, large land areas), see Table 15 below.

Table 13: Household ownership of livestock assets, by adopter type

Livestock Asset	Iron bean non - adopter (% Households) N=859	Iron bean adopter (% Households) N=403	Overall (% Households) N=1,262	P value
Cattle	65.71	58.17	63.33	0.0560
Goats	63.19	66.39	64.20	0.4264
Sheep	2.39	3.81	2.84	0.2887
Donkey	4.86	4.64	4.79	0.9072
Guinea fowls	11.10	11.92	11.35	0.7716
Pigs	3.58	3.49	3.55	0.9535
Chickens	90.53	90.17	90.42	0.8812
Rabbits	4.62	10.87	6.59	0.0048
Turkey	17.86	19.75	18.45	0.5959
Ducks	5.29	8.29	6.23	0.1449

3.2.2. Land use and plot ownership

Slightly over 52% of the households managed one plot while nearly 48% managed between 2 and 5 plots, Table 14. The number of plots managed by a farming household differed significantly (p<0.05) between adopters and non-adopters, Table 14.

Table 14: Plot management by adopters and non-adopters

Number of plots managed	Iron bean non - adopter (% Households) N=859	Iron bean adopter (% Households) N=403	Overall (% Households) N=1,262	P value
One	56.06	44.60	52.45	
Two	25.31	35.20	28.42	
Three	13.33	11.74	12.83	0.0266
Four	2.90	4.57	3.43	
Five	2.40	3.88	2.87	

Distribution of adopters across farming system

Over 40% of the iron bean growers were in communal areas, Table 15, followed by the Old resettlement area (35%). This is because the LFSP program targeted farming households in communal areas and intentionally excluded those in A2 and small-scale commercial farming areas. Although A1 farming system areas were not targeted under the LFSP program, the study found a high proportion of iron bean growers in this farming system, suggesting a significant organic diffusion (spillover) of iron bean varieties. This result may also suggest that the mass media campaigns that were carried out through national media contributed to the spill over into areas that were not targeted by the LFSP project. Such campaigns were useful in creating the brand effect as cited by Maereka et al, 2024.

Table 15: Distribution of adopters across farming system.

Farming system type	Iron bean non - adopter (% Households) N=859	Iron bean adopter (% Households) N=403	P value
Communal Area	59.60	40.40	0.0001
Old Resettlement	65.10	34.90	0.6295
A1	75.30	24.70	0.0012
A2	85.96	14.04	0.0460
Small Scale commercial area	74.52	25.48	0.3295

Table 16 below shows that there were no significant differences (p<0.1) between the average area allocated to all bean varieties by adopters and non-adopters across farming systems, except for Old Resettlement farming system. Communal area farming households had significantly smaller (1.51ha) land holdings compared to the other farming systems and small-scale farming households had the largest (7.41ha). A2 farming households allocated the highest proportion (21%) of their cultivated land to beans, whereas communal area farming households allocated the second highest proportion (18%) of their land area to beans, Table 16.

Table 16: Mean land holding (ha), area allocated to beans (ha), by farming system and adopter type.

Farming system	Iron bean non - adopter	Iron bean adopter	Overall	P value
Communal Area	(N=291)	(N=224)	(N=515)	
• Mean land holding area	1.66	1.29	1.51	0.0356
• Mean area planted with beans	0.27	0.27	0.27	0.9336
Old Resettlement area	(N=99)	(N=16)	(N=115)	
• Mean land holding area	3.35	3.87	3.53	0.6660
• Mean area planted with beans	0.36	0.80	0.51	0.0759
A1	(N=387)	(N=143)	(N=530)	
• Mean land holding area	4.19	4.50	4.27	0.6390
• Mean area planted with beans	0.47	0.66	0.51	0.2489
A2	(N=27)	(N=4)	(N=31)	
• Mean land holding area	5.04	3.00	4.75	0.0179
• Mean area planted with beans	1.05	0.85	1.02	0.5183
Small Scale Commercial farming households	(N=55)	(N=16)	(N=71)	
• Mean land holding area	5.70	12.43	7.41	0.3169
• Mean area planted with beans	0.40	0.34	0.39	0.4932

We assessed the intensity of adoption (the extent to which adopters replace other varieties of beans with iron beans), by the adopters in different farming systems. Overall, the study showed that farming households who adopted iron beans allocated 84% of their bean area to iron beans, Fig 5, demonstrating confidence in the performance of iron bean variety. Farming households in communal and small-scale commercial farming areas allocated the highest proportion, 89% and 93%, respectively, of their bean area. The high varietal replacement was likely driven by the high yield (1234kg/ha) of iron beans vs 1107kg/ha for non-iron bean varieties, equating to a 21% higher yield, Table 23.

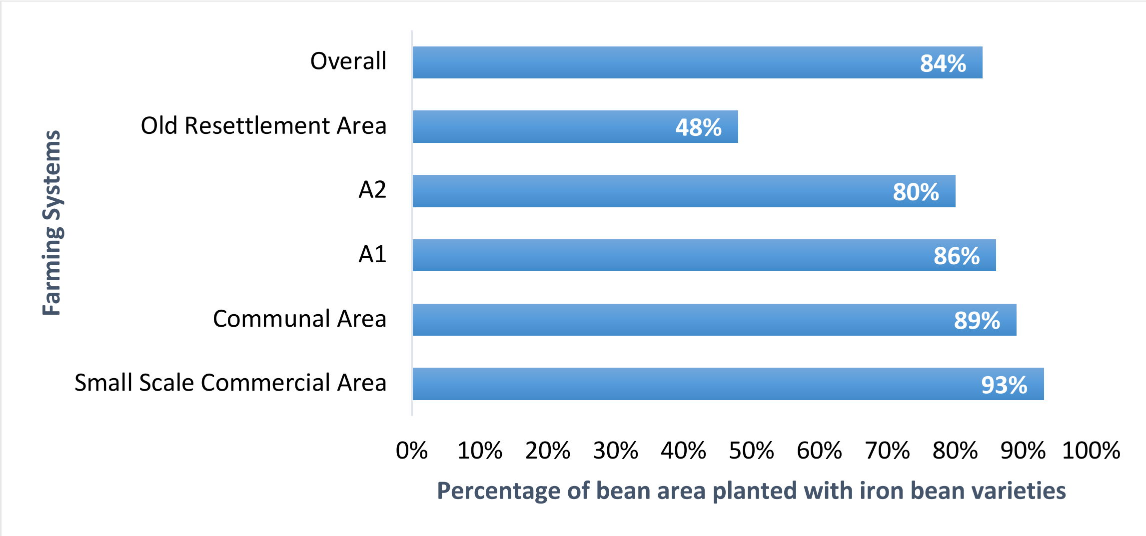

Figure 4: Proportion of bean (all varieties) area allocated to iron bean varieties by adopters.

3.2.3. Source of information and when farming households first heard about iron beans

Naturally, promotional messages reach different people at different times in the same geography. This is why it is important to repeatedly share such messages, over time. The study showed a gradual increase in the number of people who received iron bean promotional messages, in each year between 2015 and 2021, Fig 6.

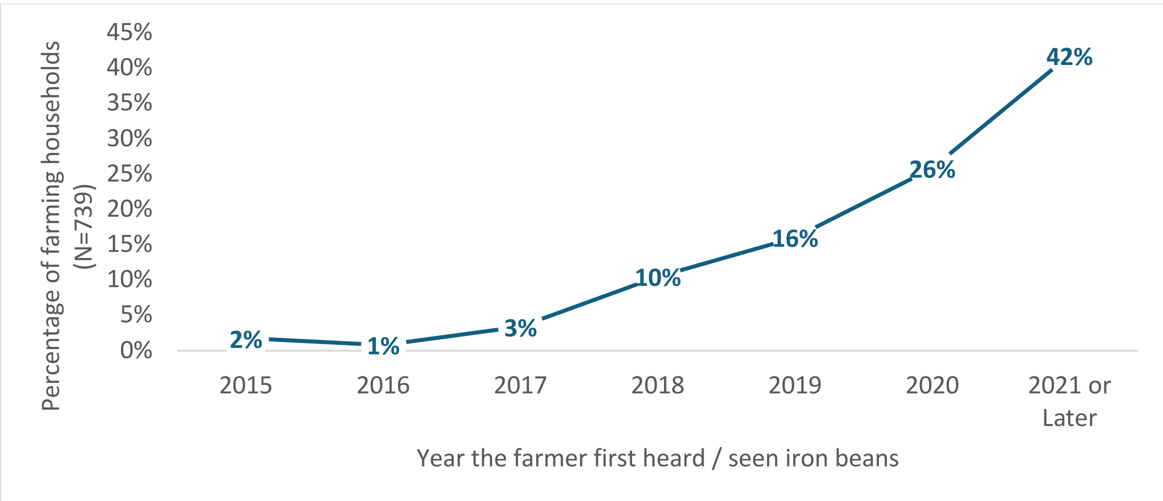

Figure 5: Proportion (percent) of farming households who indicated to have first heard/known of iron beans in a particular year.

Respondents were also asked what their first source of information about iron beans was. Fellow farmers or relatives, followed by the extension staff and NGO staff, were the top 3 sources of information about iron beans, Table 17.

Table 17: Proportion (percent) of households who got information about iron beans from a particular information source.

Source	**Percent (N=739)**
Another farmer or relative	62.13
Ministry of Agriculture	11.57
NGO	11.49
Radio	3.71
Cannot remember	2.99
Input supplier	2.48
Market	2.24
Health clinic	2.06
HarvestPlus staff	0.93
Television	0.37
Social media	0.03

Factors that motivate adopters to continue growing iron beans

Farming households who reported to have continued growing iron beans, were asked what motivated this decision, Table 18. The results show that the most important drivers of sustained adoption were high yield (57%), nutritional quality (12%), and taste of the cooked iron beans (11%). These are the most important traits that should form the basis of the value proposition messages for promoting iron beans. While there were no significant differences (p<0.10) between female and male respondents, on how they valued yield, nutrition and taste, slightly more female than male respondents, cited these factors as key determinants for continuing to grow iron beans.

Table 18: Factors that motivate adopters to continue growing iron beans

Attribute/factor		**% Households**		
	Male **(N=170)**	Female **(N=72)**	Overall **(N=242)**	P value
High yield	55.96	58.84	56.79	
Nutritional quality	11.49	12.40	11.75	
Taste	9.26	16.78	11.44	0.5451
Marketability	10.82	3.11	8.59	
Cooking quality	7.10	6.03	6.79	

3.2.4. Bean production in 2021/2022 season by province and variety

We unpacked the adoption beyond iron bean vs non-iron bean varieties, to understand the extent to which farming households were growing specific varieties – this can be called varietal penetration into farming systems. Fig 7 shows that there are 3 most popular varieties grown by bean growers. Gloria, a non-biofortified variety, was the most widely grown variety by 45% of the farming households, followed by the iron bean variety NUA45, grown by over 29% of the farming households, and Ngoda, grown by 24% of households.

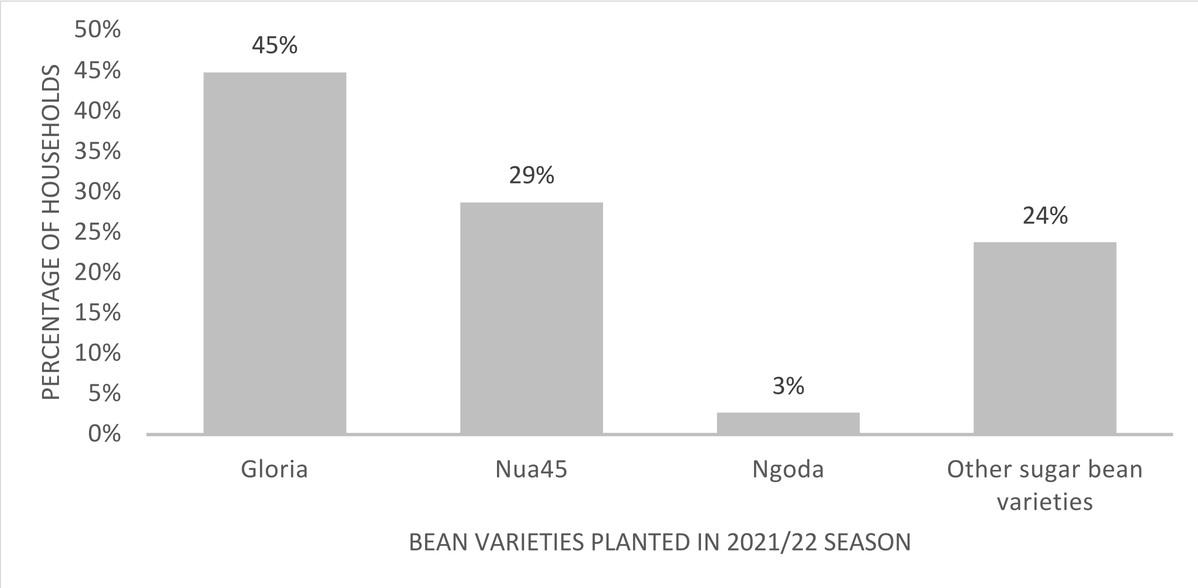

Figure 6: Bean varietal penetration

The study revealed that the proportion of farming households that planted different bean varieties differed significantly across provinces, Table 19. While Gloria was the most widely grown bean variety nationally, iron bean NUA45 was the preferred variety in Manicaland province. Although Masvingo province was not an LFSP target province, the observed high proportion of iron bean growers was likely due to the location of Zimbabwe Super Seed (ZSS), the main producer/supplier of certified iron bean seed in the country, with outgrowers located in irrigation scheme in Masvingo province. This result may suggest the importance of increasing availability of good quality seed as one of the key drivers for varietal adoption.

Table 19: Comparison of bean varietal penetration across provinces

Bean variety	Manicaland (N=312)	Mashonaland central (N=296)	Mashonaland East (N=181)	Mashonaland West (N=314)	Masvingo (N=127)	Matebeland South (N=8)	Midlands (N=24)	Overall (N=1262)	P value
Gloria	10.14	39.03	59.05	67.41	56.06	100.00	77.10	44.81	
NUA45	48.36	25.50	30.38	10.99	35.07	0.00	14.98	28.73	
Other sugar bean varieties	40.81	32.71	7.66	15.80	8.82	0.00	7.92	23.78	0.0000
Ngoda	0.69	2.75	2.91	5.80	0.06	0.00	0.00	2.68	

Drivers of adoption

Most farming households (83%) indicated yield as the main factor to consider when adopting a new bean variety. However, 36% of the respondents indicated tolerance to drought and resistance to diseases were important factors too, while 32% indicated that shorter days to maturity was equally important, Table 20. This is an important drought mitigation factor/trait. It is important to note that significantly more adopters of iron beans (25%) considered good taste while only 15% of non-adopters considered taste as an important factor in deciding whether to adopt a new variety ($p<0.01$).

Table 20: Factors that farming households consider when deciding on whether to adopt or not to adopt a new bean variety.

Variety attribute	**Percentage (%) of farming households**			
	Non - iron bean adopters (N= 859)	Iron bean adopters (N=403)	Overall (N=1262)	P value
Yield	80.95	87.11	82.89	0.0489
Drought tolerance	35.70	36.88	36.07	0.7665
Disease resistance	33.96	39.49	35.70	0.1676
Days to maturity	30.56	36.49	32.42	0.1302
Grain size	19.23	22.30	20.2	0.3578
Good taste	15.46	25.36	18.57	0.0029
Good market value	14.44	18.51	15.72	0.1778
Withstands excess rainfall	9.09	16.21	11.33	0.0104
Must be more nutritious	7.08	10.08	8.02	0.1900
I don't like testing new varieties	0.77	0.84	0.79	0.9194

Trait comparison for iron bean and non-iron bean varieties by adopters of iron-beans

Iron beans growers were asked to compare iron beans to their most preferred non-iron bean variety, on seven traits. Fig 9 shows that iron bean growers ranked all traits as higher for iron bean than their most preferred non-iron bean varieties. This could partly explain why adopters allocated 84% of their bean area to iron bean varieties, as shown in Fig 5 above.

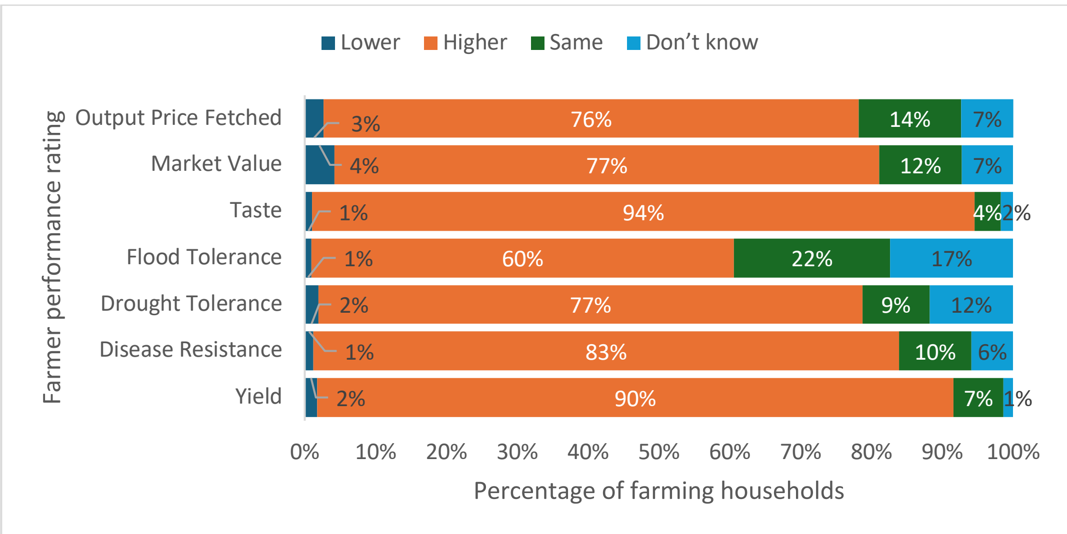

Figure 7: Trait comparison for iron bean and non-iron bean varieties, among adopters.

3.2.5. Sources of bean seed in Zimbabwe

Respondents were asked to name their main source of seed for the bean varieties they grew in the 2021/22 season, Table 21. The results indicate that own farm saved seed (bean grain that is planted as seed) was the most common source of iron bean seed used by nearly 39% of the farming households, in the 2021/2022 season. A combined 46% of the farming households paid for iron bean seed either from fellow farmers (using farm saved seed) or input shops, while just over 25% of the adopters got their seed from fellow farmers either as gifts or purchases. This shows that fellow farmers are a major external source of seed and a significant factor in farmer-to-farmer diffusion of new varieties because lack of seed may slowdown varietal replacement.

Table 21: Sources of bean seed for adopters and non-adopters

Seed Source	Iron bean non – adopters (%) N = 859	Iron bean adopters (%) N=403	Overall (%) N=1,262
Retained (from previous harvest)	42.31	29.72	38.69
Purchased from another farmer	27.41	24.75	26.65
Purchased (input supplier or seed company)	17.49	22.32	18.88
Seed aid (Government or NGO)	6.30	7.11	6.53
A gift from another farmer	4.42	10.53	6.17
Other	1.87	1.99	1.90
Contract farming with private company	0.00	2.73	0.79
Contract farming with NGO	0.10	0.53	0.22
Don’t know	0.11	0.08	0.10
LSFP test packs (NUA45 seeds only)	0.00	0.25	0.07

3.2.6. Bean production and utilization

While the average quantity of seed planted, area planted, and quantity of harvested bean grain (all varieties) was higher for non-adopters than adopters, these differences were not significant even at ($p<0.1$). This could have been because most of the non-adopters were from the A2 farming system where farming households inherently have larger land holdings compared to communal areas (where most adopters came from), who have smaller average land holdings. However, despite the low average quantity harvested, iron bean growers attained a slightly higher seed-to-grain ratio (quantity of grain harvested for every kg of seed planted) than non-adopters, suggesting a higher yield advantage for iron beans over non-iron bean varieties, Table 22.

Table 22: Comparison of production parameters between iron beans and other varieties.

Variable	Iron bean non - adopter N=859	Iron bean adopter N=403	Overall N=1,262	P value
Mean land holding area (ha)	3.44	3.10	3.33	0.4206
Mean area planted with beans (ha)	0.41	0.36	0.39	0.4476
Mean quantity of seed planted (kg)	26.75	25.87	26.49	0.8812
Mean quantity of beans harvested (kg)	283.40	258.43	276.07	0.5335
Seed to grain ratio	11.07	12.34	11.45	0.0963

We assessed bean production and utilization by bean farming households across provinces by asking respondents to indicate the area planted, quantity of beans that they had harvested and how they allocated the harvested beans to various uses, in the 2021/2022 season. The results show that there were no significant differences (P<0.15) in the area planted, yield, quantity of beans harvested, quantity of bean grain saved for household consumption and quantity sold, between iron bean and non-iron bean varieties, Table 23. Mashonaland Central had the highest yield of nearly 1053kg/ha for iron beans. Overall (nationally), the mean yield of iron beans was significantly higher (p<0.05) at 1234kg/ha, than that of non-iron bean varieties (1107kg/ha). Farming households that adopted iron beans sold most (65%) of their harvested iron beans and allocated only about 25% of their harvest to household consumption. The iron bean portion allocated for household consumption in these farming households translates to a per capita consumption of nearly 13kg/person/year, in line with the 12kg/person/year reported by Mutari et al (2014). Overall, farmers allocated just above 20kg of their iron beans to seed, enough to this amount is enough to plant 20% of a hectare and 20% and 74%of the bean area reported in A2 and Communal Area, respectively[6] and demonstrating the key role that farm saved seed can play in increasing the share of bean area that is planted with iron beans.

[6] In Zimbabwe, the average seed rate for sugar beans is 100kg per hectare

Table 23: Comparison of bean production and utilization across provinces, by adopter type

Seed Source	Manicaland (N=312)	Mashonaland Central (N=296)	Mashonaland East (N=181)	Mashonaland West (N=314)	Masvingo (N=127)	Matabeleland South (N=8)	Midlands (N=24)	Overall (N=1262)
Mean area planted with beans (ha)								
Non – iron bean varieties	0.17	0.41	0.21	0.31	0.15	0.08	0.20	0.27
Iron bean varieties	0.15	0.17	0.24	0.97	0.25	-	0.26	0.26
Overall	0.16	0.35	0.22	0.38	0.18	0.08	0.21	0.26
P value	0.3279	0.0001	0.6543	0.2207	0.2683	-	0.6961	0.8812
Mean quantity of beans harvested (kg)								
Non – iron bean varieties	123.61	511.11	188.52	319.54	186.75	54.50	264.48	283.40
Iron bean varieties	173.73	241.46	299.57	717.29	153.75	-	277.65	258.43
Overall	148.59	440.55	223.27	363.78	176.23	54.50	266.77	276.07
P value	0.0919	0.0040	0.2494	0.0791	0.5732	-	0.9384	0.5335
Mean yield (kg/ha)								
Non – iron bean varieties	937.34	1201.96	1149.95	1155.62	948.39	765.83	1554.41	1107.48
Iron bean varieties	1196.08	1420.26	1266.93	1411.79	877.74	-	865.29	1233.61
Overall	1066.27	1259.08	1186.56	1184.11	925.88	765.83	1434.38	1144.53
P value	0.0569	0.1771	0.5228	0.2579	0.6904	-	0.0045	0.0963
Mean quantity of harvest saved for seed (kg)								
Non – iron bean varieties	10.07	23.29	33.71	32.30	14.92	3.57	5.07	23.61
Iron bean varieties	9.93	33.33	30.57	31.85	19.24	-	6.48	20.08
Overall	9.99	25.94	32.70	32.24	16.35	3.57	5.32	22.55
P value	0.9462	0.5375	0.8675	0.9714	0.6293	-	0.8182	0.4589
Mean quantity of harvest saved for consumption (kg)								
Non – iron bean varieties	45.79	103.62	38.39	101.67	37.72	37.29	105.91	76.26
Iron bean varieties	49.93	50.91	61.86	152.53	54.13	-	124.78	63.61
Overall	47.89	89.73	45.90	107.43	43.16	37.29	109.30	72.47
P value	0.6615	0.0002	0.2346	0.3139	0.2798	-	0.8296	0.1819
Mean quantity of harvest sold (kg)								
Non – iron bean varieties	71.17	369.73	105.74	166.99	129.57	16.29	156.21	175.36
Iron bean varieties	110.81	146.32	193.34	528.71	74.09	-	146.40	168.36
Overall	91.31	310.84	133.78	207.93	111.17	16.29	154.44	173.26
P value	0.1292	0.0082	0.2461	0.0983	0.2960	-	0.9161	0.8422

3.2.7. Consumption of iron beans

We used a seven-day recall period to assess the frequency of consumption of beans and to estimate the extent to which consumers of beans were consuming it. Overall, 57%[7] of the respondents indicated that they had consumed iron beans 2-3 days in the last 7 days preceding the survey while 33% had consumed it once in the same period, and 10% had consumed it more than 3 days in the 7 days preceding the survey, Fig 10. It is useful to understand that this consumption pattern was established, approximately 6 months after the bean harvesting period indicating the availability of beans long after harvesting. The results show that the frequency of consumption for all bean varieties was higher than that of iron beans alone most likely because of the lower harvested quantities of iron beans and higher proportion (65%) of iron beans that was sold, Table 23.

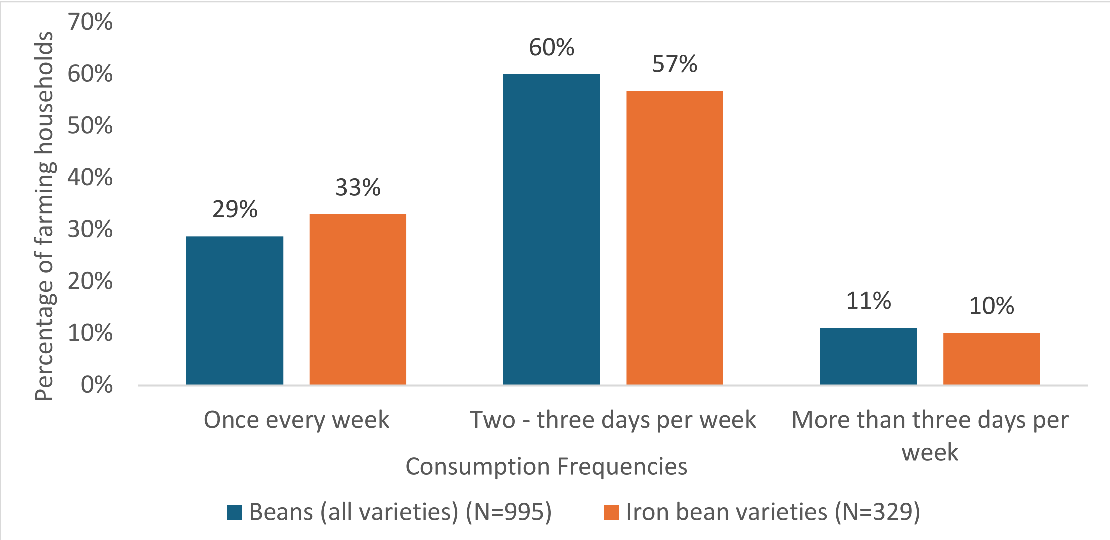

Figure 8: Proportion of people who consumed beans (all varieties) and iron beans varieties.

Intra-household allocation of bean food

Assessing intra-household allocation of food is important to understand if the intervention is adequately reaching target groups like the under-fives and women of child-bearing age (WOCBA). We asked the respondents to indicate which household members had eaten food prepared from iron beans in the seven days preceding the survey, Fig 11.

The results show that WOCBA had eaten iron bean foods more than any other demographic group, demonstrating that iron beans can be a useful food vehicle to increase iron intake by WOCBA – promotional messages under the LFSP and other projects encouraged WOCBA and under-fives, to eat iron beans. The lower percentage of children under five who had eaten iron beans in the 7 days preceding the survey suggest the need to double efforts to increase consumption by this demographic group. These results therefore demonstrate overall success in targeting the WOCBA demographic group but less so for the under-fives group.

[7] Note that the percentages in fig 11 do not add up to 100% because graph doesn't include those who didn't consume beans.

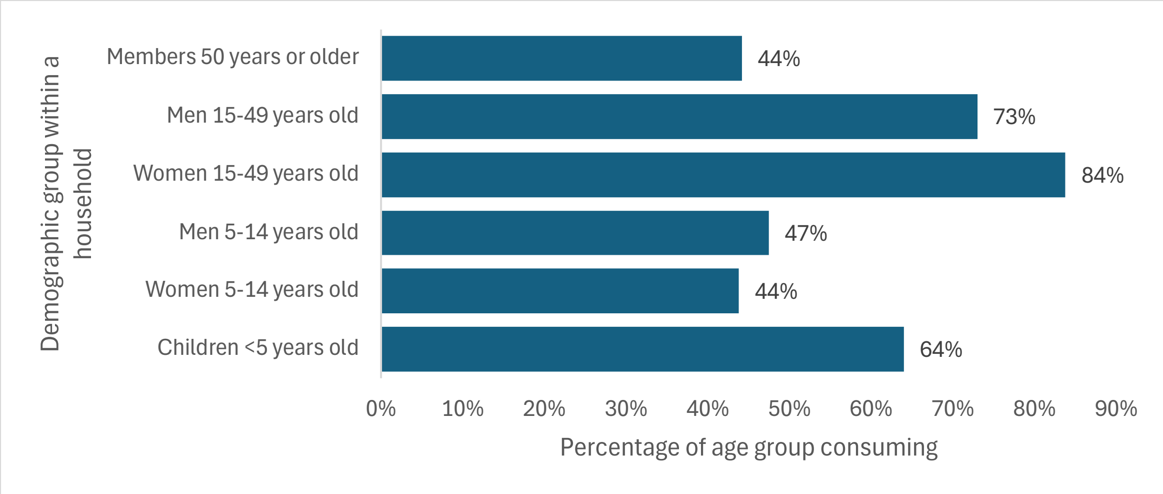

Figure 9: Intra-household allocation of iron beans.

3.2.8. Bean Markets in Zimbabwe

Respondents who had reported having sold their bean grain were asked about where they had sold their beans, Fig 12. Although the proportion of non-adopters that were selling beans at local market was higher than that of adopters that sell to the same market, the regression analysis showed that availability of a local market is positively correlated to increased adoption (annex 8). However, there is need for additional studies to understand the market dynamics of adopters and non-adopters.

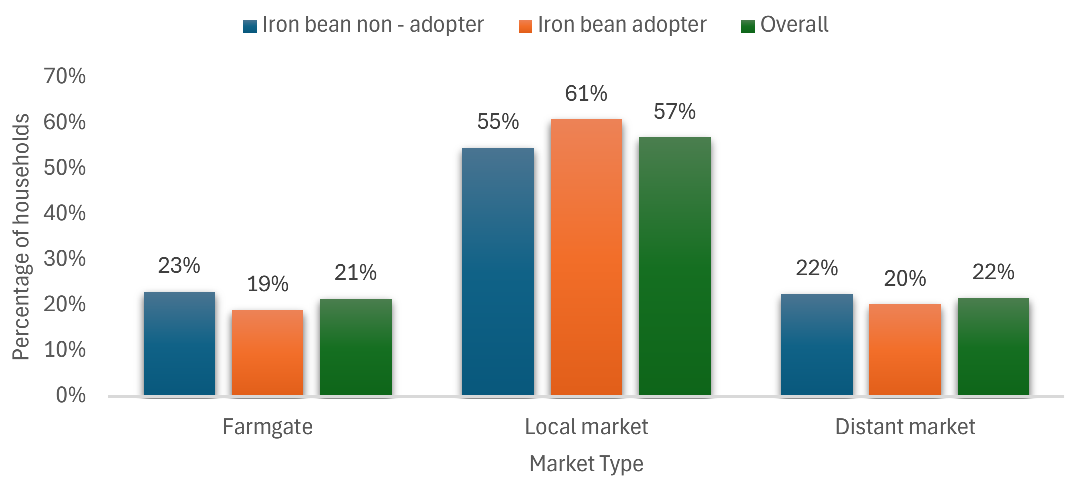

Figure 12: Percentage of farming households who sold their beans at different marketplaces, by adopter (**note:** local market is within the ward and distant market is outside the ward)

3.2.9. Intra-household decision making and participation in bean production and utilization

Women's active involvement in decision-making processes within the agricultural sector has been found to significantly influence food choices, household food security, and dietary diversity (Kassie et al., 2020; Wei et al., 2021). Biofortification is designed to improve nutrition, particularly the intake of the 3 most limiting micronutrients, iron, zinc, and vitamin A. The study assessed the role of men and women in decision-making, along the bean crop management, Table 24. The results show that most of the decisions about the production and harvest utilization of beans are made jointly by spouses, for households of married couples. The results present an excellent entry point for designing future projects and targeting which aspects of the value chain should have more involvement of women in decision-making.

Table 24: Decision making in bean crop management, by household members.

Decision Maker	What is planted	Take care of the plot	How plot harvest is used	Proceeds from the plot are used	Quantity allocated for home consumption
Husband	26.28	22.69	21.87	20.97	17.50
Male single	1.28	1.28	1.34	1.28	1.34
Male divorced	0.25	0.25	0.25	0.25	0.37
Widower	3.64	3.47	3.70	3.70	3.70
Wife	12.26	12.44	11.97	12.07	16.32
Female single	1.38	1.44	1.56	1.44	1.44
Female divorced	0.51	0.52	0.52	0.52	0.53
Widow	8.92	8.67	8.71	8.71	8.72
Joint decision	44.86	48.54	49.60	50.57	49.55
Other plot owners	0.62	0.70	0.49	0.50	0.53

Information sources

Respondents were asked about the sources of information that were deemed to be key drivers of adoption of new varieties. Figure13, shows that extension agents are the most preferred source of information explaining why information on crop management (Figure 14) was the most widely received information type by bean growers. The results suggest the need to strengthen the capacity of extension agents to enable them to provide information on crop prices and produce markets to accelerate adoption of iron beans.

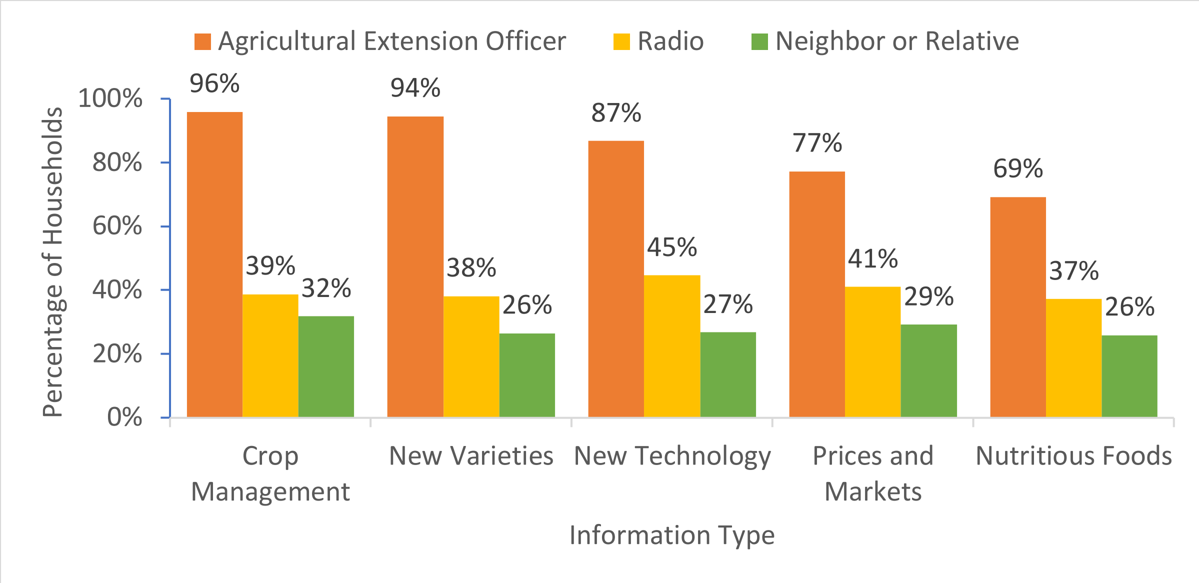

Figure 13: Most preferred top three information sources for bean growers. *Note: percentages in the figure may add up to >100% because this was a multiple response question*

3.2.10. Access to different types of information and their effect on adoption

Access to agricultural information by farming households is a key driver for technology adoption, what crops to grow, when to plant and harvest, price negotiation, and where to sell (Van Campenhout et al., 2017). We asked respondents whether they had accessed information on (1) markets for crops, (2) crop produce prices, (3) new varieties, and (4) crop management. Kiiza et al. (2013) demonstrated that access to market information has a positive and significant impact on the adoption of improved maize. The results, Fig 14, show that nearly 67%, 61% and 58% of respondents had not accessed important information on new markets, crop prices and new crop varieties, respectively. We performed a logit regression for adoption of iron beans and access to information on markets (new markets and crop prices) and the results (annex 9) show that access to information on crop prices is positively correlated to ($p<0.01$) increased adoption of iron bean varieties. We concluded that limited access to information on markets for crops, crop produce prices, and new varieties might have been a barrier to accelerated adoption of iron bean varieties. The 58% of respondents that had accessed information on crop management may indicate the skewedness of skills sets of the current extension staff, towards agronomy and yet, they are the most preferred source of information by farming households, Fig 14.

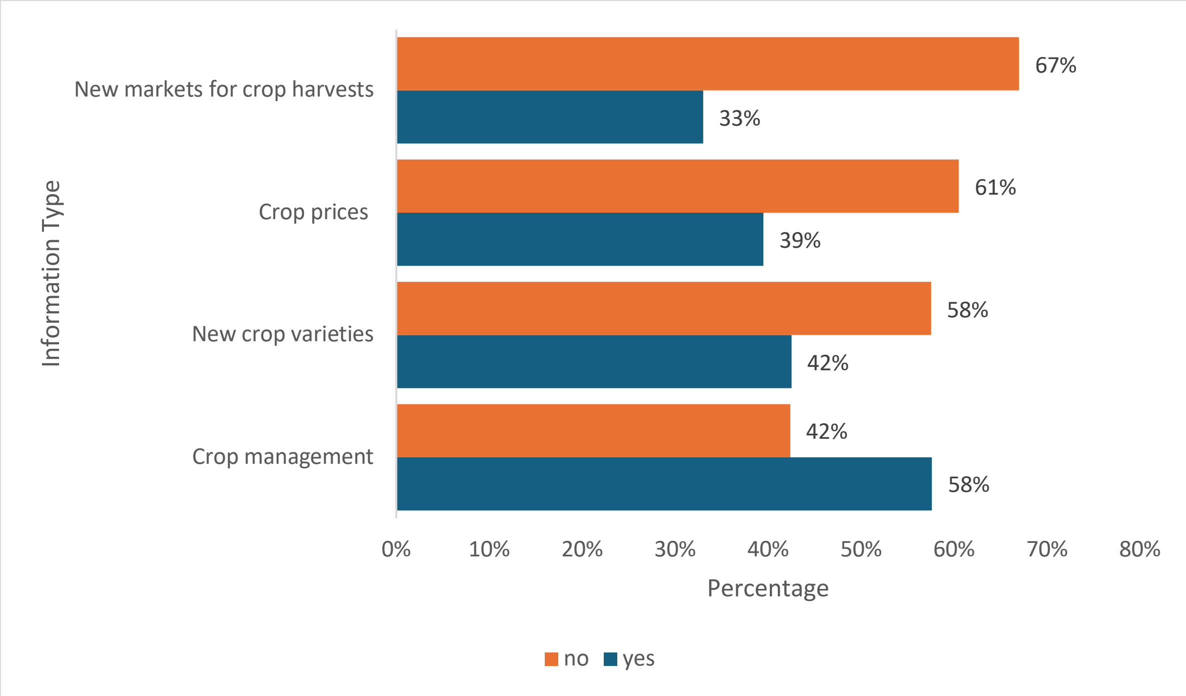

Figure 14: Access to bean-related information.

3.2.11. Overlap between iron bean and vitamin A maize (VAM) growers

We assessed the extent to which growers of iron beans were growing another biofortified crop, VAM. This is a useful input parameter for the tracking and forecasting models that HarvestPlus uses to estimate the number of households that grow biofortified crops, at any point. Only 8% of the iron bean growers were found to be growing VAM, suggesting a very low overlap between growers of iron beans and those of VAM, Fig 15.

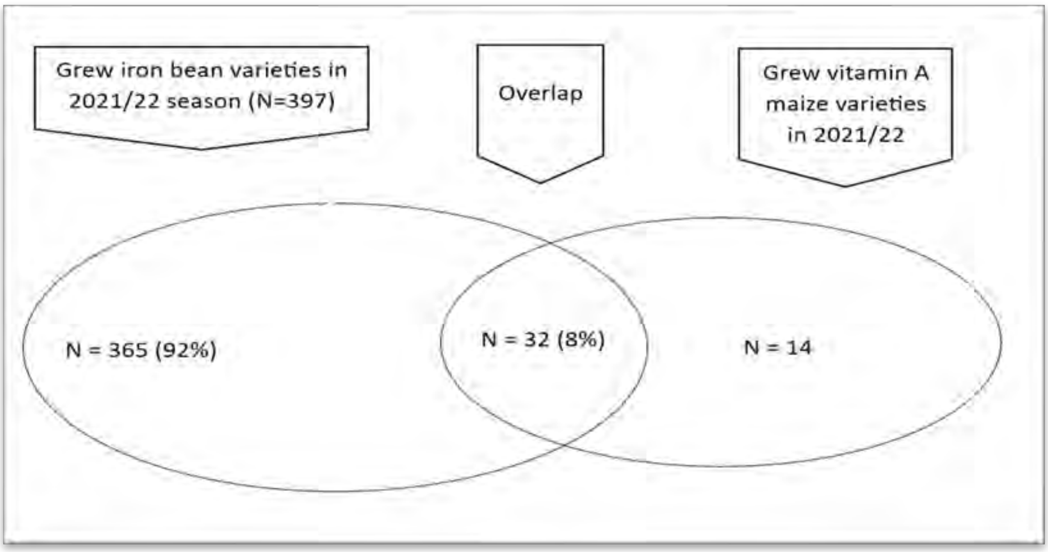

Figure 15: Overlap between growers of iron beans and VAM in 2021/22 season.

Conclusion

The iron bean adoption study was a nationally representative study carried out in 7 out of the 8 rural provinces and 31 out of the 61 districts. Using the listing exercise data, the study established an adoption rate of iron beans of 30%, lower than 47% adoption rate established by Maereka et al (2024) when they focused on the bean production corridor alone. However, this remains a high adoption rate, and it conforms to the 28% adoption rate established for iron beans in Rwanda by Asare Marfo et al (2016), nearly the same 6-year period after the start of dissemination. Overall, iron bean adopters replaced 84% of their bean area with iron beans, demonstrating a higher varietal replacement potential and confidence in the performance of iron bean variety. The results show that most of the respondents (57%) considered high yield as the main determinant factor, while nutritional quality and taste were considered the second and third most important factors driving adoption and sustained cultivation of iron beans, respectively. The study established that iron beans had a significantly higher average yield (1234kg/ha) compared to non-iron bean varieties (1107kg/ha), demonstrating the yield advantage of iron beans over non-iron bean varieties. Limited access to seed of iron beans was the main reason for discontinuing the production of iron beans over time, and only 8% of bean growers had discontinued growing iron beans between 2015 and 2022.

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Annexes

Annex 1 – adopted from Matondi P. B., (2020)

Table 4.1: Recommended and observed Maximum Farm Sizes under the Land Reform Programme

Natural Region	Farm Size Category	Statutory Instrument (Recommended) Farm size (HA)	Observed (Audit) Farm Size Range (HA)
I	Small scale	15-25	10-25
	Medium	100	26-100
	Large scale	250	101-1700
	Peri urban	15-50	1-350
IIa	Small scale	25-40	10-40
	Medium	200	51-200
	Large scale	400	200-1400
	Peri urban	15-50	1-350
IIb	Small scale	40-50	10-50
	Medium	250	51-250
	Large scale	400	251-8000
	Peri urban	15-50	1-350
III	Small scale	60-80	40-80
	Medium	300	80-300
	Large scale	500	301-4000
	Peri urban	15-50	1-350
IV	Small scale	150-200	6-200
	Medium	700	201-700
	Large scale	1500	701-7000
	Peri urban	15-50	1-350
V	Small scale	250-350	140-350
	Medium	1500	351-1500
	Large scale	2000	1501-4000
	Peri urban	15-50	1-350

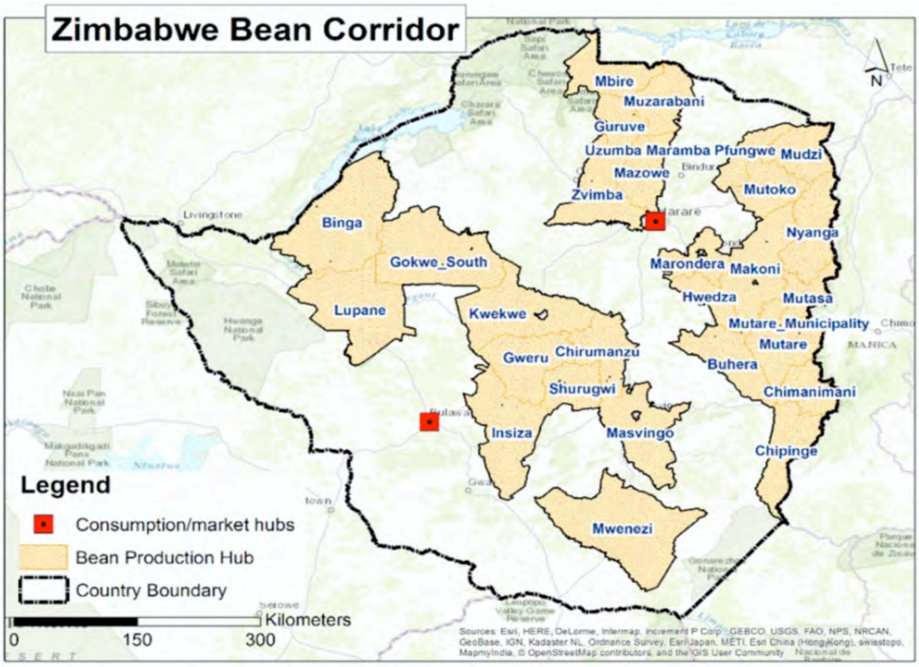
Source: GoZ (2009)

Annex 2: Maximum farm sizes by land use in Zimbabwe (incomplete) – adopted from Matondi P. B., (2020),

Type of Farm Averages	Specific typology	Farm sizes as per agro-ecological zones					
		1	**11a**	**IIb**	**III**	IV	V
Communal (customary system)	Residential plot	0.1-3	0.1-3	0.1-3	0.1-3	0.1-3	0.1-3
	Field plot	?	?	?	?	?	?
	Grazing	?	?	?	?	?	?
A1 model and the Old Resettlement areas (1980-1997)	Residential plot	6	6	6	6	6	6
	Field plot						
	Grazing						
A2 Model	Self -contained	250	500	500	700	1000	2000
SSCF[1]	Self contained	230	30	40	60	120	240
Commercial Farm Settlement Scheme model (medium scale)	Self-contained	100	200	250	300	700	1000
LSCF	Self-contained	250	500	500	700	1000	2000
Peri-urban	Self-contained	2-50	2-50	2-50	2-50	2-50	2-50

Source: Government of Zimbabwe (2001) and various research reports on FTLRP

Annex 3: The Zimbabwe bean production corridor



PABRA's Bean Corridor in Zimbabwe – from Deployment of High Iron Beans Technology in Zimbabwe – a TAAT Outcome Case Study Report

Annex 8: Effect of farming households participation in local markets on adoption of iron bean varieties (logit regression)

Variable	Coefficient	Std. Error	Marginal effects	P value
Local market (1 = participate, 0 otherwise)	0.5708088	0.1830733	0.1312023	0.002
Constant	-0.9881553	0.1640339		0.000
Number of obs = 820, LR chi2(1) = 10.20, Prob > chi2 = 0.0014, Pseudo R2 = 0.0095				

Annex 9: Effect of access to different information types on adoption of iron bean varieties (logistic regression)

Variable	Coefficient	Std. Error	Marginal effects	P value
Access to market information	.3839173	.1477151	.0829632	0.009
Access to crop management information	.0659322	.1437046	.0142477	0.646
Access to new varieties information	-.1093677	.1545514	-.023634	0.479
Constant	-.9145118	.0987785		0.000
Number of obs = 1,262, LR chi2(3) = 8.95, Prob > chi2 = 0.0300, Pseudo R2 = 0.0057				

Annex 10: re-classification of agro-ecological regions of Zimbabwe in conformity with climate variability and change

TABLE 3. Criteria used for the classification of Natural Regions in this study

Parameter	Natural region				
	1	2	3	4	5
Rainfall	>1000	1000-700	700-550	600-450	<500