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Identification of Gendered Trait Preferences among Rice Producers Using the G+ Breeding Tools: Implications for Rice Improvement in Ghana

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Abstract: Rice is the main staple for more than half of the world's population. In Ghana, rice is the fastest growing food commodity, and it is consumed by almost every household. However, yields continue to be low, as the pace of adoption of new varieties is low. The low rate of adoption has been attributed to failure of modern breeding to incorporate preferred traits for end users. This study thus employed an innovative set of breeding tools, the G+ tools, in identifying gendered trait preferences to develop a robust product profile through a mixed-method approach. The assertion that "men focus more on production and marketing related traits as women focus on production and cooking qualities" was also ascertained. Descriptive, inferential and content analyses were conducted, and the results indicate ecological differences in varietal choices. Production and marketing traits are jointly preferred by the gender groups. However, women and young women paid attention to post-harvest and cooking quality traits. The gender impact scores generated indicated there are tradeoffs in the traits preferred. These findings highlight the significance of recognizing geographical differences and gender heterogeneity in relation to varietal and trait preferences. In conclusion, the outcomes emphasize the necessity of gender-sensitive breeding work that considers the various needs and trait priorities of targeted men and women rice farmers in breeding decisions for a robust rice product profile.

Keywords: *Oryza sativa*; qualitative; product profile; plant breeding

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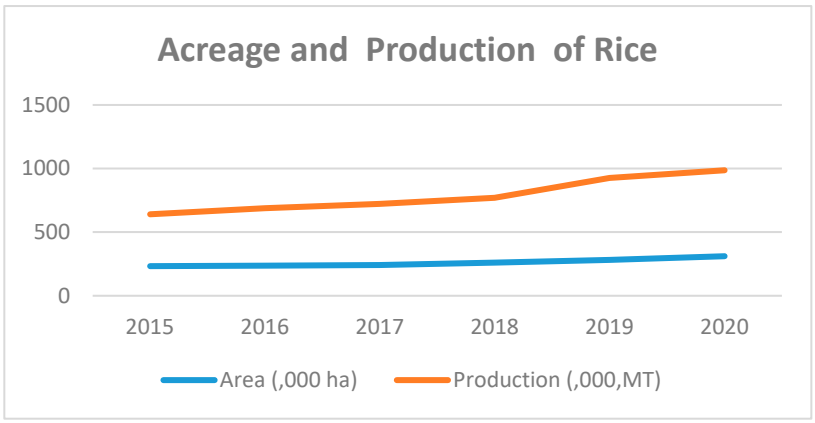
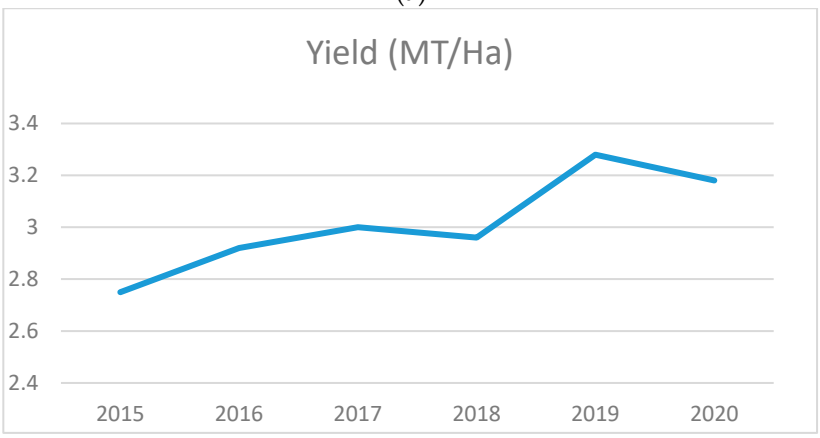
1. Introduction

In order for nations to achieve their socioeconomic development objectives, rice is essential [1]. As a result, according to the FAO [2], rice is the second-most consumed grain in the world after maize and the most important staple food for a significant portion of the global population. In Ghana, rice is the fastest growing food commodity, as it is consumed by almost every household, with an increasing annual per capita consumption of 40 kg per person [3]. However, Ghana is a net importer of rice, and about 42% of its demand is met through imports totaling over USD 200 million per annum [3]. Since 2010, production levels and areas under cultivation have increased by over 30%; however, genetic gains on farmers' fields have been largely static. Average yields are still low: 3.3 MT/Ha as against

the potential of 6–7 MT/Ha [4]. Figure 1a,b show rice production trends and the level farmers are achieving in terms of yield per hectare in Ghana.



(**a**)



(**b**)

Figure 1. (**a**) Rice production trends: area under cultivation (2015–2020). (**b**) Rice yields from 2015–2020. Source: [4].

Agricultural technologies have been identified as one of the primary determinants of productivity, profitability, and sustainability in the food production sector [5,6]. Modern-day breeding efforts in sub-Saharan Africa, and for that matter, Ghana, have led to releases of over thirty-five (35) rice genotypes, such as Digang, Gbewaa rice, CRI-Mpuntuo, CRI-Kantinka, CRI-AGRA Rice, CRI-Amankwatia, Legon1, Sikamo, Wakatsuki, CRI-Dartey and CRI-Enapa, to mention but a few by Ghanaian scientists, but uptake of these new cultivars is still at a slow pace considering the year of release and the numbers exhibited publicly. When varieties and technologies are developed but not widely used by end users, it is a waste of efforts and resources given the cycles a variety goes through to be developed. Ref. [7] attributed the slow rate of adoption of new varieties to modern breeding's failure to incorporate end users preferred varietal characteristics. End users from various socioeconomic classes, demographic characteristics, and positions have different varietal options that must be taken into account during the breeding process [8]. There is an urgent need to increase genetic gain on rice farms and make the rice breeding program in Ghana more responsive to the needs of stakeholders in the rice value chain. Since 2020, the rice breeding program at the CSIR–Crops Research Institute has been undergoing a modernization effort with the support of the CGIAR Excellence in Breeding (EiB) program. A major part of this effort is the definition of rice market segments and development of a robust product profile for rice breeding in Ghana. A product design team consisting of actors along the rice value chain, including a gender specialist, was established to develop a product profile. Although the actors identified six major traits that they desired that

breeders focus on, they found all six traits to be gender neutral. Moreover, previous work on varietal preferences in Ghana has not been robust on gendered trait preferences and has been limited in scope mainly to the Ashanti region, which accounts for only 5% of the country's rice production [3,9–11]. Before the inception of the research, the team reviewed fifteen research articles in related areas to identify gaps that could be addressed. The summary of the literature findings is presented in Appendix A.

Consequently, there was a need for in-depth research using robust tools to incorporate gendered trait preferences into the existing product profile and expanding the study horizon for findings more representative of the country's situation. The G+ product profile tool, which is an innovative gender-responsive breeding tool, was tested in the study. This research, therefore, sought to identify gendered trait preferences among rice producers using the G+ tools.

Specifically, this research sought to identify gendered trait preferences among rice producers, develop a rice product profile using the G+ tools, compare the use of the G+ tools versus the conventional tools, and discuss the implications of the findings for rice breeding in Ghana. Another objective was to confirm an assertion in the literature that "men focus more on production and marketing related traits as women focus on production and cooking qualities" and apply modern tools to conduct gender impact analysis to ascertain how these traits affect the various gender groups.

The G+ tools were developed by the CGIAR Gender & Breeding Initiative (GBI) in 2018 as part of an effort to complement work initiated by EiB on developing product profiles to make breeding programs more responsive to the needs of crop value chains. The tools have been created to assist social scientists and breeders in collaborating to incorporate gender issues into breeding programs from conception to implementation, increase the uptake of crop varieties, and have a greater social impact. In determining whether a product should be advanced, the tools are used to assess the gender dimensions of plant or animal traits. They help to determine whether a product profile has implications for gender equity or whether a trait satisfies minimal "do no harm" standards in accordance with an evidence-based gender analysis. They also describe the favorable benefits of a trait for end users.

The results of this study will provide GBI feedback on the effectiveness and difficulties involved with the application of the tools, since they are new and have not been widely used in the scientific community.

Secondly, given that the initial piloting of G+ tools focused on other crops rather than rice and reported gender impact generally without disaggregating the findings [12] and the deficit in data on gendered trait preferences in rice production, this research is extremely vital for improving rice production and the adoption of rice technologies through an enhanced gendered approach to trait identification. This has implications for adoption and marketing of rice varieties and its attendant impacts on the welfare of women and men farmers in Ghana. This study is also a contribution to policy on efficient ways to reduce the rice import bill and work toward self-sufficiency.

2. Materials and Methods

2.1. Definition of Gender-Related Concepts

i. Gendered trait preferences: Important traits disaggregated by gender.
ii. Gender-sensitive traits: Traits distinctively preferred or ranked by a particular gender group.
iii. Gender-neutral traits: Traits jointly preferred by all gender groups and not related to a specific gender.
iv. Gender-relevant traits: Essential traits specific to a particular gender group.
v. G+ tools: These are gender-responsive customer and product profile breeding tools.
vi. Gender trait impact analysis: An analysis of preferred traits to identify the likelihood of negative consequences associated with the trait choices for a particular gender group. Conclusions are based on the scores generated.

2.2. Ethical Statement

Despite the lack of a formal ethical clearance committee at the CSIR-Crops Research Institute, all funded projects are approved using existing local protocols. According to local guidelines, studies that do not involve the collection of medical samples from subjects do not require formal approval, but must adhere to Ghana's Data Protection Act, 2012 (Act 843) and the Institute's governing Act, the Council for Scientific and Industrial Research Act, 1996 (Act 521). In the absence of an ethical standing committee, the project adhered to and passed the institute's research expectations, guidelines, and ethics, which were approved by the institute's administration before activities began.

Participants were also given a structured informed consent form that explained the study's objectives, the confidentiality of the data collected, voluntary participation, not revealing any respondent's identity in the results reporting, and the use of the local language they understood to elicit their responses.

2.3. Description of Study Areas

The study was conducted in four rice-growing areas that belong to the irrigated lowlands and rain-fed lowland rice ecologies. Ghana's Volta, Greater Accra, Central, and Ashanti regions were among the study's regions. In terms of rice usage and research activity, the regions picked were among the top rice-growing regions. Ashanti Region comes in fifth place in terms of rice production, with a 2017 production volume of 34,718.18 MT, behind Volta Region with production volume of 234,149.78 MT [4]. The Volta and Greater Accra regions have one of the oldest irrigation systems, where tenant farmers primarily grow rice in two seasons and only sporadically grow vegetables. All of these regions have closely collaborated with research and benefited from a number of varietal releases that have raised regional productivity. One of the major rice-growing districts was chosen from each region: Ketu North, Shai Osudoku, Assin North, and Ejura Skeyeredumase. The districts' profiles are summarized in Table 1. Ketu North district has the least amount of land, while Ejura Sekyeredumase has the most. Agriculture continues to be the primary source of income for farm families in all districts where the labor force is economically active, and workers are at least 15 years old. All of the districts have bimodal rainfall patterns, sufficient sunshine, and favorable weather for the growth of crops, particularly rice.

Table 1. District profile of chosen study districts.

Variables	Study Districts			
	Ketu North	**Shai Osudoku**	**Assin North**	**Ejura Sekyeredumase**
GPS Latitude	6°03′ N and 6°20′ N	5°45′ S and 6°05′ N	6°05′ N and 6°04′ S	7°9′ N and 7°36′ N
Longitude	0°49′ E and 1°05′ E	0°05′ E and 0°20′ W	1°05′ E and 1°25′ W	1°5′ W and 1°39′ W
Land mass	423.8 km^2	968.361 km^2	1150 km^2	1340.1 km^2
Population size	114,846	105,610	80,539	137,672
% economically active population	70.2	69.2	76.5	74.6
Rice ecology	Irrigated	Irrigated	Rainfed lowland	Rainfed lowland
% involved in agriculture	67.1	85.6	59.9	60.9
Common crops	Rice, maize, sweet potato, cassava and cowpea.	Rice, maize, cassava, vegetables, mango, sugarcane, coconut and citrus	Rice, vegetables, cocoa, plantain, oil palm, cassava, cocoyam and citrus.	Maize, yam, beans, rice, plantain, cassava, groundnuts and watermelon

Table 1. *Cont.*

Variables	Study Districts			
	Ketu North	**Shai Osudoku**	**Assin North**	**Ejura Sekyeredumase**
Soil type	Tropical Grey and Black Earths and tertiary formation with Savannah Ochrosols	Black clays classified as Akuse series	Granites and adamellites	Forest and savanna ochrosol groups
Annual mean rainfall (mm)	890–1270	762.5–1220	1500–2000	1200 and 1500.
Annual mean temperature (°C)	24–30	24.4–40	26–30	21–30

Source: [13–17].

2.4. Samples and Sampling Technique

The farmers targeted for the study were chosen using a multi-stage sampling technique. The first step involved selecting one administrative district within each region purposively chosen based on the amount of rice produced and utilized and the presence of research. These included the Ketu North District in the Volta region, the Shai Osudoku District in the Greater Accra region, the Assin North District in the Central region, and the Ejura Sekyeredumase District in the Ashanti region. Secondly, from a list of rice communities compiled by the district department of agriculture and the irrigation schemes, five rice communities per district were chosen randomly. Twenty communities in total were chosen for the study's quantitative phase.

Men farmers made up 70–75% of the sampling frame, while women farmers made up 25–30%. The research group decided to choose 70% men and 30% women. The total population for the study was 10,580. The sample size determination formula in [18] was used because a simple random sampling technique was used, and the sample came from a finite population.

$$n = \frac{N}{1 + Ne^2}$$

n = sample size

N = population size

e = margin of error (0.05)

$$n = \frac{10,500}{1 + 10,500(0.05)^2}$$
$$n = \frac{10,500}{1 + 10,500(0.0025)}$$
$$n = \frac{10,500}{27.25}$$
$$n \approx 385.32$$

The sample size calculation indicated that the targeted sample size was 385 rice farmers, but it was rounded up to 400 for greater predictive power. The next stage of sampling involved randomly selecting 20 farmers from each of the 20 communities, yielding a total of 400 respondents, 134 women and 266 men. Because not all of the men farmers showed up for field work, their positions were filled by other women farmers, changing the previously proposed proportions of 70% men and 30% women to 66.5% men and 33.5% women, respectively. Farmers were sampled at random without replacement, so

each farmer had one chance to be chosen. The qualitative stage involved 12 focus group discussions (FGDs), with 3 adult men, 3 adult women, 3 young men, and 3 young women groups participating. Separate discussions were held for adult men, adult women, young men and young women in the study districts. A young person was defined as a man or woman between the ages of 15–35 years, which is the definition accepted by the National Youth Employment Agency in the country [19], and an adult, above 35 years. In order to allow for effective interaction, each FGD had eight participants. There were 96 active individual rice producers in the groups as a whole.

The quantitative results combined adult men and young men into "men category" and likewise for women because of the high degree of similarity in their trait choices.

2.5. Data Collection Procedure

The research was conducted in the four districts from April to July 2022. An initial desktop review was carried out to identify gaps in the literature on the topic investigated and relevant approaches to data collection that previous studies had used. A summary of some of the reviewed articles and gaps identified is presented in the Appendix A. The study used a mixed-method approach, that is, a combination of qualitative and quantitative approaches to data collection. The qualitative approach involved participatory tools such as focus group discussions with separate gender groups and the application of the G+ product profile query tool. The data gathered were mostly primary with the two approaches. The quantitative approach was followed by a qualitative approach to gain in-depth understanding of the explanations given for the varietal and trait choice rankings, as well as the negative and positive effects of the trait choices. During the survey, trained enumerators administered a well-structured interview schedule to the respondents, and a checklist was used for participatory engagement. The qualitative data were collected through age- and sex-disaggregated focus group discussions led by a facilitator and note-taker. The proceedings were audio-recorded and transcribed afterwards. The quantitative data collection process was automated with the help of the online data programming tool Kobocollect, and the data were then downloaded into the STATA 15 software.

Field enumerators were chosen based on their field project experience, knowledge of rice production, and ability to communicate in the local dialect. Sixteen (16) experienced field assistants were trained on the designed instruments, the qualitative approach, and how to ask the G+ product profile questions prior to the formal field work. The enumerators were made to practice in dummies, one as the rice farmer and the other as the interviewer. The enumerators' roles were swapped, and the results were evaluated by the entire team. This was done to ensure that enumerators could ask the appropriate questions in the field. To assess the reliability, consistency, and validity of the questions, the survey instrument was pretested in a selected rice community, Besease in the Ashanti region, with farmers who shared characteristics similar to those of the sampled study farmers. During field administration, an interview guide written in English and translated into the local language was used to obtain the necessary information from the farmers. Individual face-to-face interviews for the quantitative and qualitative surveys were conducted at a central location within the study districts. Individual interviews lasted approximately 45 min, while focus group discussions lasting approximately 2 h. In the qualitative process, the research team was introduced, the mission was explained, the focus group discussion guidelines were established, and the participants' consent to record the process was requested. The team collaborated closely with the directors and extension officers of the district departments of agriculture, as well as with the managers of the two irrigation schemes, who provided the study's sampling frame and assisted during the field work.

The unit of analysis was specific rice farmers from chosen households, and the data gathered included their socio-demographics, farm level and institutional characteristics, varietal choices and related attributes, intensity of trait preferences, and trait preferences for each rice environment. The qualitative stage confirmed the varietal preferences, reasons for the choices and the disparity in the ratio of men to women rice farmers in the districts.

The negative and positive impacts of the "must have traits" were elicited during the focus group discussions using the G+ product profile query tool.

2.6. Method of Data Analysis

Quantitative data were analyzed using both descriptive and inferential statistics, such as means, frequency tables, percentages, charts and *t*-test. The descriptive statistics were used to summarize and describe the characteristics of sampled rice farmers. Inferential statistics such as the *t*-test were used to test the intensity of the preferences for the traits among men and women in the rice value chain. The *t*-test, however, was further used to test the difference between the men and women groups, while the chi-square test of independence was used to evaluate the distribution of preferences among the rice segments. The chi-square was used because of its ability to test the association between sets of categorical variables. The chi-square test statistics were computed by the expression:

$$\chi^2 = \sum \frac{(f_0 - f_e)^2}{f_e} \quad (1)$$

where:

χ^2 = chi-square

f_0 = the observed frequency (i.e., the observed counts in the cell)

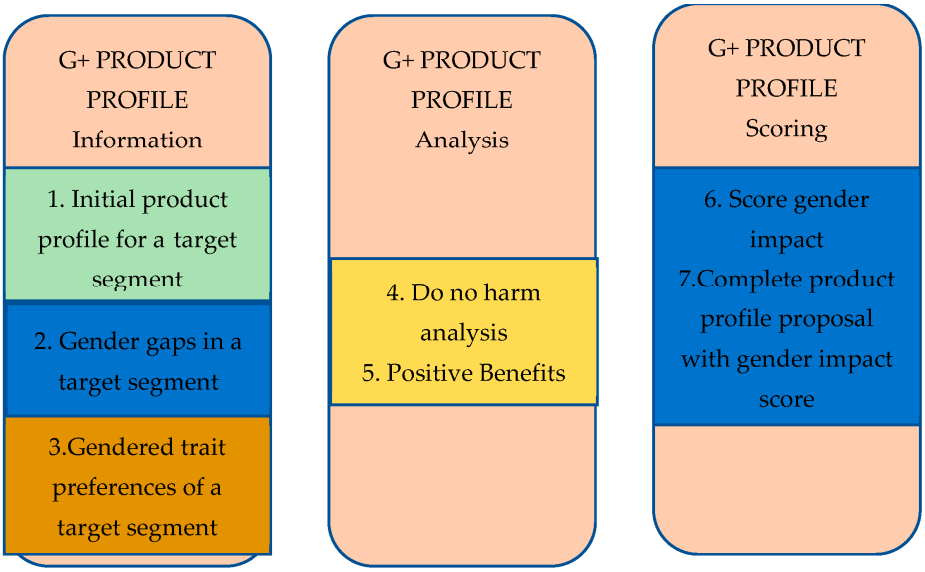
f_e = the expected frequency if the variables are independent

Thus, the chi-square was the difference between what was actually observed in the data and what would be expected if the variables were indeed independent. The results were evaluated by comparing the actual value with a critical value read in the chi-square distribution table after considering the degrees of freedom, which were calculated as the number of rows minus 1, by the number of columns minus 1. A four-point Likert scale (1 to 4; 1 = must have, 2 = important, 3 = nice to have, 4 = neutral) was presented to the respondents to elicit the essential traits that breeders needed to focus on, and during the focus group discussions, the pair-wise ranking was used to arrive at the top traits for consideration. An example of the pair-wise results is presented in Table A2 in Appendix A.

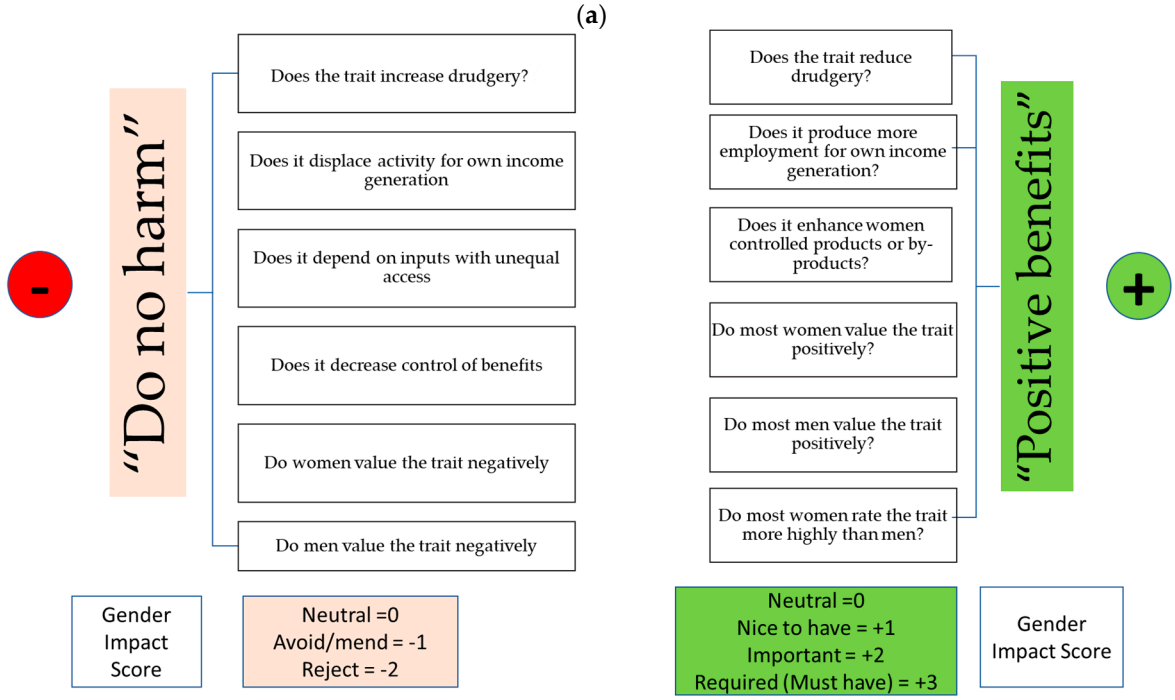
Additionally, qualitative data collected from each focus group were transcribed, coded, and analyzed to identify emerging themes and categorize them to generate patterns for analyses using content analysis, as described by [20] and adopted by [21]. For the qualitative data, the primary units of analysis were adult men, adult women, young men and young women in the rice growing communities. Both investigative and descriptive approaches were used to examine gendered adoption and trait preferences among rice producers in southern Ghana, and the G+ tool was used to conduct the "Do No Harm" and "Positive benefit analysis" to identify inequalities among the gender groups as a result of the presence of some particular traits.

The G+ tool is a decision support tool that complements the efforts earlier made by the Excellence in Breeding (EiB). The tool is employed for gender-responsive crop improvement programs. It assists the breeding team to be conscious of end users' needs and preferences and mainstream gender throughout the breeding cycle. The tool has two parts; the customer and product profiles. The customer profile identifies the end users of a new or existing product and analyzes their demographic and social differences that influence their choice of the product. The customer profile can be used to collect both primary and secondary data from a targeted market segment. Information collected can be triangulated through expert consultations. The product profile, on the other hand, investigates the attributes of a product and how these attributes could benefit or cause harm to men and women who use the product. With a set of designed questions relating to men's and women's perceptions of the product attributes, a decision is reached based on scores provided by the gender groups. Decisions in the form of impact scores for the preferred traits were reached by following the standard operating procedures (SOPs) outlined in seven steps, as schematically presented in Figure 2a. The first three steps involve information gathering on a proposed product profile for the targeted market segment, which, in this study, we

referred to as the "Conventional product profile", identifying gender gaps and collecting gender disaggregated data on preferred traits. The 4th and 5th steps analyze the negative impact or positive benefits associated with the traits. When it comes to the traits that breeders must avoid and the "positive benefits" that they should include in their breeding goals, "do no harm" tries to highlight all of the disparities in these areas. A gender analysis using standardized questions is used to determine the gender impact score. To better understand farmers and obtain their perspectives on the desired traits, the questions were further broken down in the field.



(**a**)



(**b**)

Figure 2. (**a**) Standard operating procedure for gendered trait preference. (**b**) Steps in generating the impact scores. Source: [22]. Copyright: Licensed for use under the Creative Commons Attribution 4.0 International License.

The gender impact score is calculated by conducting an evidence-based gender analysis based on standard questions. "Do no harm" on one part has six negative impact

questions. Each question is scored on a 3-point scale; 0 = Neutral; −1 = Avoid/ mend and −2 = Reject. The "positive benefits" side also has six questions framed in the reverse of the "do no harm" and each question scored on a 4-point Likert as 0 = Neutral; +1 = Nice to have; +2 = Important and +3 = Required (Must have) as shown on Figure 2b. The Appendix A contains sample scored sheets that can be used as a guide to better understand the justifications provided and the methodology used to determine the scores.

3. Results

3.1. Socioeconomic Characteristics of Rice Producers

Table 2 shows the summary statistics of the variables considered in rice farmers' trait preference and adoption decisions by men and women, as well as the *t*-test values of their mean differences. The *t*-test results for the variables years of education, residential status, marital status, off-farm income, rice farming experience, household head, and farm size for both major and minor seasons were statistically significant, indicating differences in these variables for men and women. The proportion of men (66.5%) rice farmers was higher compared to women (33.5%).

Table 2. Socioeconomic characteristics of farmers.

Variable	Women (*n* = 134)		Men (*n* = 266)		Pooled (*n* = 400)		t-Stat
	Mean	SD	Mean	SD	Mean	SD	
Age	46.52	12.2	45.29	12.3	45.70	12.4	0.94
Years of formal education	5.55	5.2	8.6	4.8	7.59	5.1	−5.80 ***
Residential status (indigene) [a]	0.485	0.5	0.624	0.48	0.577	0.4	−2.67 ***
Marital status (married) [a]	0.731	0.44	0.88	0.25	0.832	0.37	−3.90 ***
Household size	5.97	2.76	6.57	3.53	6.37	3.30	−1.73
Off-farm activity (yes = 1) [a]	0.343	0.47	0.413	0.49	0.39	0.48	−1.35
Off-farm income (GH¢)	2582.93	325.0	5928.18	597.6	4941.76	694.8	−3.57 ***
Rice farming experience (years)	11.58	9.0	14.87	10.8	13.77	10.3	−3.02 ***
Total farm size (acres)	4.12	3.85	5.11	5.25	4.79	4.8	−1.88
Major season acreage	2.38	1.81	3.05	3.25	2.83	2.8	−2.17 **
Minor season acreage	1.74	3.0	2.05	2.96	1.95	2.9	8.73 ***
Extension access (yes = 1) [a]	0.582	0.49	0.616	0.48	0.605	0.48	−0.66
Times of visit by extension agent	15.78	10.3	9.67	7.27	11.67	3.8	0.57
FBO membership (yes = 1) [a]	0.402	0.49	0.492	0.50	46.25	49.7	−1.69
Years of FBO membership	4.68	4.1	5.80	5.98	5.48	5.5	−1.25
Credit access (yes = 1) [a]	0.343	0.47	0.338	0.47	0.34	0.47	0.09
Frequency of rice cultivation	1.51	0.50	1.52	0.54	1.52	0.5	−0.06
Distance to market (km)	18.48	8.77	12.79	6.23	14.69	7.1	0.73
Amount of cash received (GH¢)	2653.98	706.6	2489.15	345.6	2546.79	500.1	0.20
Agroecological zones:							
Coastal savanna	0.41	0.49	0.493	0.50	0.497	0.50	−2.48 **
Forest transition	0.589	0.49	0.458	0.49	0.502	0.50	2.48 **

Exchange rate: USD 1 = GH 12.2; as of 20/03/23. [a] Figures in percentages. The asterisks, ** and *** indicate the differences in means between men and women across the agroecological zones with significant levels at 5% and 1%, respectively. [a] = binary variable.

On average, rice farmers were 46 ± 12.3 years old. This implies that most of the respondents fell within the agricultural productive age range of 30–50 years [23]. This outcome supports the findings of [24], who found that the typical Ghanaian rice farmer is 45 years old on average. Most rice farmers only have a basic level of education. The average length of time spent in school for men rice farmers was nine years, compared to six years for women rice farmers. This difference was statistically significant at the 1% and 5% levels, respectively. Based on the respondents' responses, a larger percentage (58%) of the rice farmers were natives. In general, approximately 83% of respondents were married, with a household size of six members on average.

With an average annual off-farm income of GH 4941.76 (USD 405.06), 39% of rice farmers engaged in off-farm income activities. More men rice farmers (41%) participated in off-farm activities compared to women rice farmers (34%) who engaged in off-farm activities. With an average annual off-farm income of GH 5928.18 (USD 485.92), men rice farmers earned more than twice as much as women (GH 2582.9 (USD 211.74)). A typical rice farmer in the study area had an average of 14 years of rice farming experience and cultivated an average of 4.8 acres (1.92 hectare) of rice over two farming seasons per year; producing 2.8 acres (1.12 hectare) in the major season and 1.95 acres (0.78 hectare) in the minor season.

Again, access to agricultural extension services was available to 61% of men and 58% of women rice farmers. The sampled farmers averagely received 12 extension visits annually. Nearly 46% of the sampled rice farmers were members of a farmer-based organization that had been operating for about 5 years. With the disaggregated data, 40% women and 49% men had been members of an FBO for at least 5 and 6 years, respectively. The agricultural sector in Ghana is severely hampered by lack of credit access. Just about a third of the sampled respondents had access to credit, and they received an average of GH2546.79 (USD 208.75) in credit, as shown in Table 2.

3.2. Distribution of Varieties by Rice Production Ecologies among Men and Women Farmers

The distribution of all of the different rice cultivars among men and women farmers in the study area is shown in Figure 3. The quantitative findings indicate that across all rice ecologies, AGRA rice, Ex-baika, and Jasmine rice were the most widely cultivated improved rice varieties, though there were some minor differences within the geographical space as some varieties were cultivated solely by a particular gender group, as revealed in the participatory interactions. For instance, in Ejura Sekyedumase Municipal, rice farmers additionally cultivated "Lapez", "Amankwatia" and "Aflao" with different position rankings by adult men and adult women, respectively. Due to their distinctive qualities and ability to thrive in irrigated and rainfed lowland environments, these varieties are widely used. Men and women rice farmers adopted AGRA rice at rates of 47% and 41%, respectively. Ex-baika/Legon1 came in second with adoption rates of 27.6% and 32.1%, respectively. Figure 4 shows the different rice ecologies and the distribution of rice varieties among men and women rice farmers in the different rice environments. According to the findings, a majority of men and women cultivated the AGRA and Jasmine rice varieties in the rainfed lowland environments. The forest transition zone in Ghana is where these varieties are mainly grown. On the other hand, both men and women primarily grow the Ex-baika/Legon1 variety in irrigated lowland systems. It is the most common variety among farmers in the coastal savanna zones. The qualitative results revealed that men and women rice farmers cultivated other varieties in these environments, as shown on Table 3a. In the rainfed lowland, Lapez and Aflao are among the top varieties jointly cultivated. The specificities indicate Jasmine was mainly grown by adult men and Amankwatia by adult men and young men, as shown in Table 3a. Togo Marshall was another important variety cultivated by all genders in the irrigation belt, except by the young men. The young men cultivated only Ex-baika in the irrigated lowland ecology. Men and young women jointly cultivated AGRA rice.

3.3. Gendered Trait Preferences among Rice Producers

The study's goal was to find differences in gender-specific traits between men and women rice farmers. Each gender was asked to rate their preferred traits on a four-point Likert scale as 1 = "Must have"; 2 = "Important"; 3 = "Nice to have" and 4 = "Neutral", with a lower score indicating greater importance, for a variety of rice varietal characteristics. The results presented concentrated on the "must have" traits, as these would guide the breeding team on end-user product profiles to improve. To determine whether there was a significant difference between the means of the two groups, a *t*-test was run.

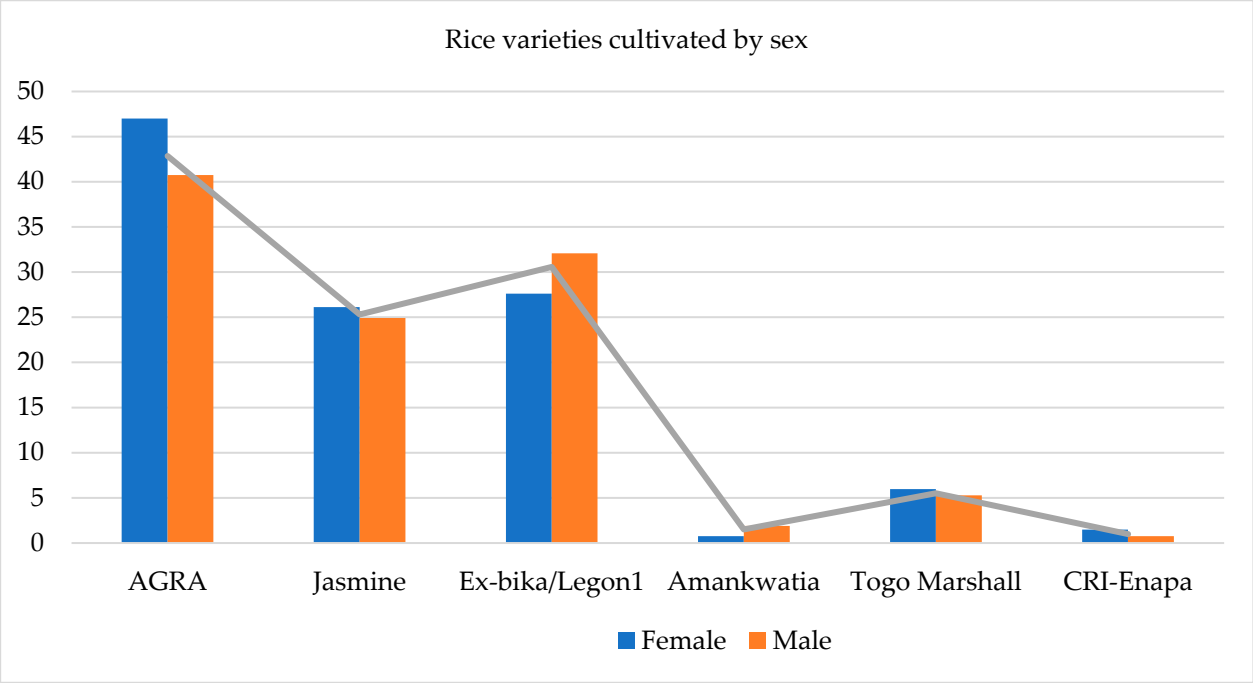


Figure 3. Distribution of rice varieties among men and women farmers.

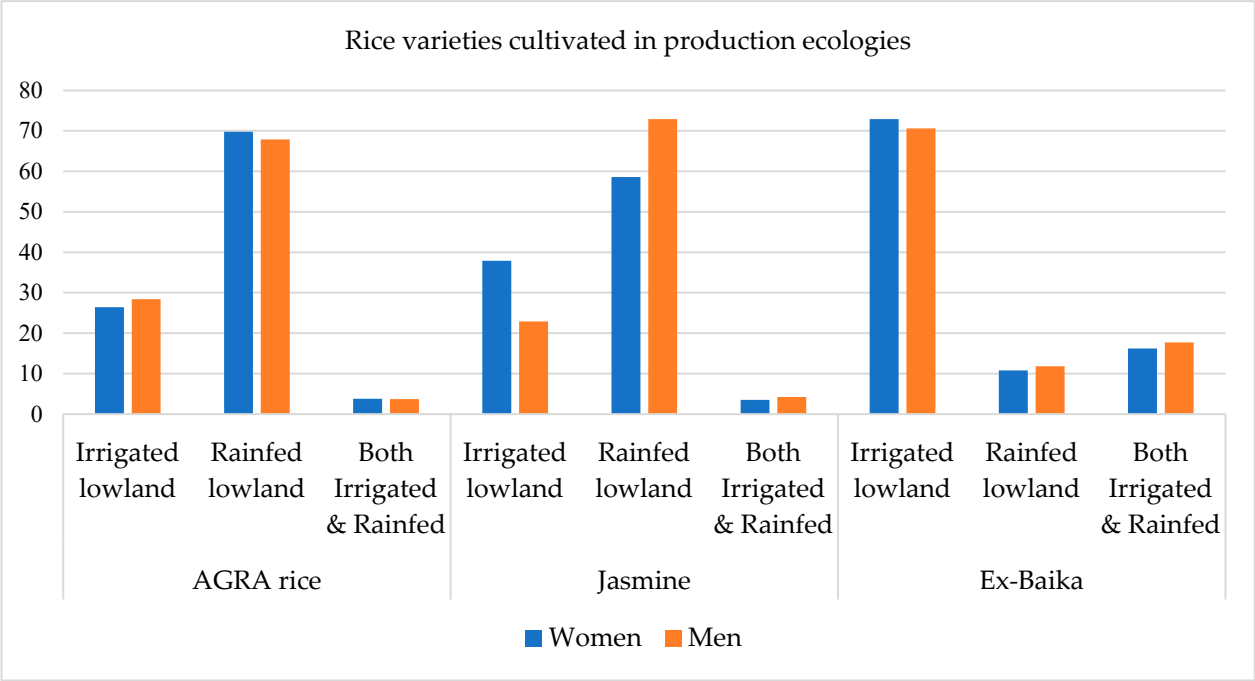


Figure 4. Distribution of top rice varieties by production ecologies among men and women farmers.

The literature has shown that men's and women's trait and varietal preferences are often different. In cases of similarities, the trait is often the same but prioritized differently due to diverse, intersectional categories [25]. The outcomes for the "must have" agronomic/production, marketing, and post-harvest-related traits are shown in Figures 5–7, respectively. According to the quantitative results, both men and women rice farmers considered high yield to be the most important characteristic, with roughly 97.7% of women and 93.9% of men placing it first. Men and women rated the trait differently, with a 5% significant difference shown by the *t*-test value of 2.1683. Early maturing came next, ranking as the second-highest ranked trait for both men and women that did not show a statistically

significant gender difference. Men and women homogenously ranked biotic and abiotic characteristics such as pest and disease tolerance, tolerance to drought and tolerance to lodging. Both the quantitative and qualitative approaches yielded somewhat different results, as the biotic and abiotic traits at the qualitative level were necessary characteristics for both adult men and young men. Adult women preferred medium- to tall-height plants to control weeds in addition to having high yield and early maturing traits. In the group discussions, women were once more specific in their definitions of yield and early maturing traits. They preferred rice that had about 15–20 tillers and matured in 90–120 days. This is not surprising considering that this is a productive role performed by women in Ghana rice production. Young women were more concerned about the yield attribute in terms of on-farm performance and the milling recovery rate, as depicted in Table A1 in Appendix A.

Table 3. Varieties cultivated in rainfed lowland, by gender.

(a) Varieties cultivated in rainfed lowland, by gender			
Adult Men	**Adult Women**	**Young Men**	**Young Women**
AgraRice Jasmine Amankwatia Lapez	AgraRice Lapez Aflao	Ex-baika/ AgraRice Aflao Lapez Amankwatia	AgraRice Lapez Aflao
(b) Varieties cultivated in irrigated lowland, by gender			
Adult Men	**Adult Women**	**Young Men**	**Young Women**
Ex-baika/ Legon 1	Perfume	Ex-baika	Ex-baika
Togo Marshall/ Perfume Marshall	Togo Marshall		Togo Marshall
AgraRice Jasmine	Ex-baika		AgraRice

Aroma, good taste, white color, long-slender grain, and high nutrient content are among the marketing-related qualities that both men and women value. Men prioritized long-slender grains and white grain color, whereas women gave more weight to aroma, taste, and nutrient content. There were no significant gender-based differences, according to the *t*-test results, as shown in Figure 6.

Men and women differed slightly in the rankings of traits related to post-harvest processing and culinary qualities. Both men and women placed great value on varieties with a lower brokenness percentage, but women gave more weight to traits that made it easier to process and prepare high-quality foods, such as short cooking times [26], as shown in Figure 7. The qualitative assessment revealed similar results for both adult women and young women, as both preferred rice with short cooking time, requiring less water during cooking and with high swelling capacity. Young men were also interested in rice with less starch so that it does not stick together during cooking. With a *t*-value of 3.2612, the results indicated a statistically significant difference between the groups at the 99% confidence level. Again, the study's findings showed that preferences for particular crop variety traits could arise from gendered roles or responsibilities in various stages of agricultural production [27,28]. For instance, since parboiling is primarily a woman's job, women rice farmers ranked milling without parboiling as the second most important post-harvest trait. Men farmers, however, ranked ease of threshing as their top desired post-harvest quality. At a 1% level of significance, the *t*-test results of 3.4449 and 4.3469 indicated a statistical difference between the two groups.

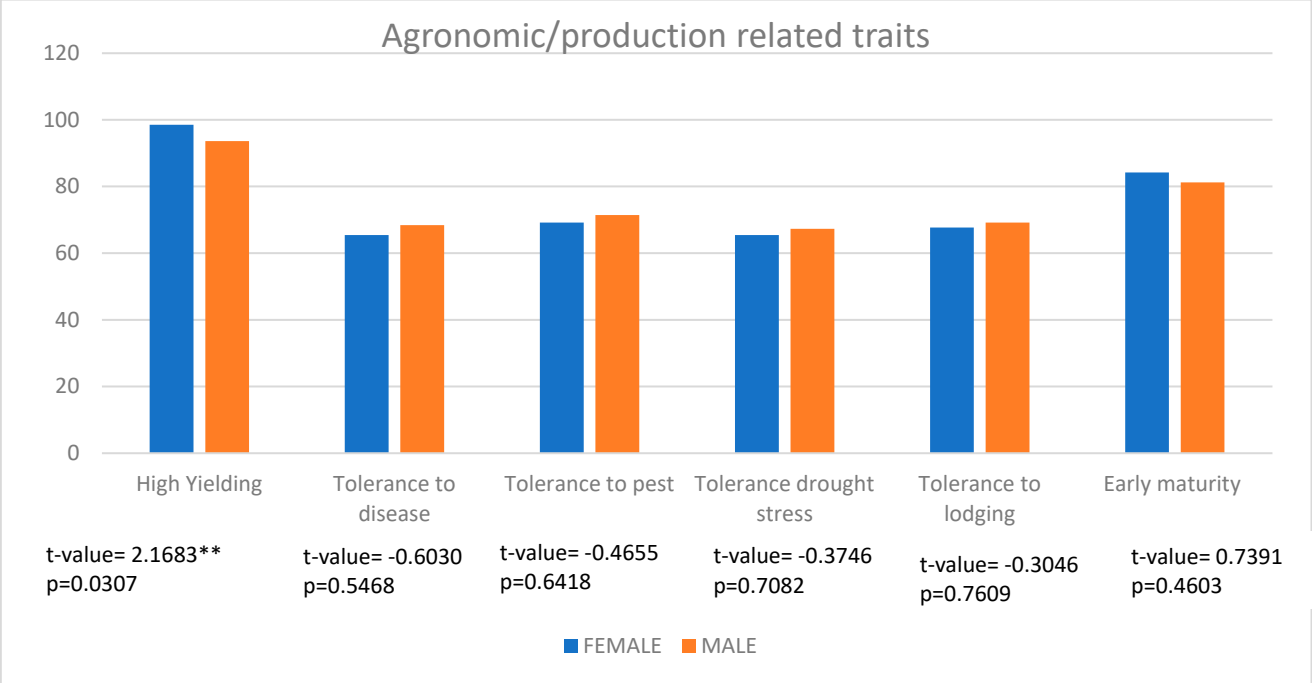


Figure 5. "Must have" production-related traits for men and women rice producers. ** indicates significance at 5% level.

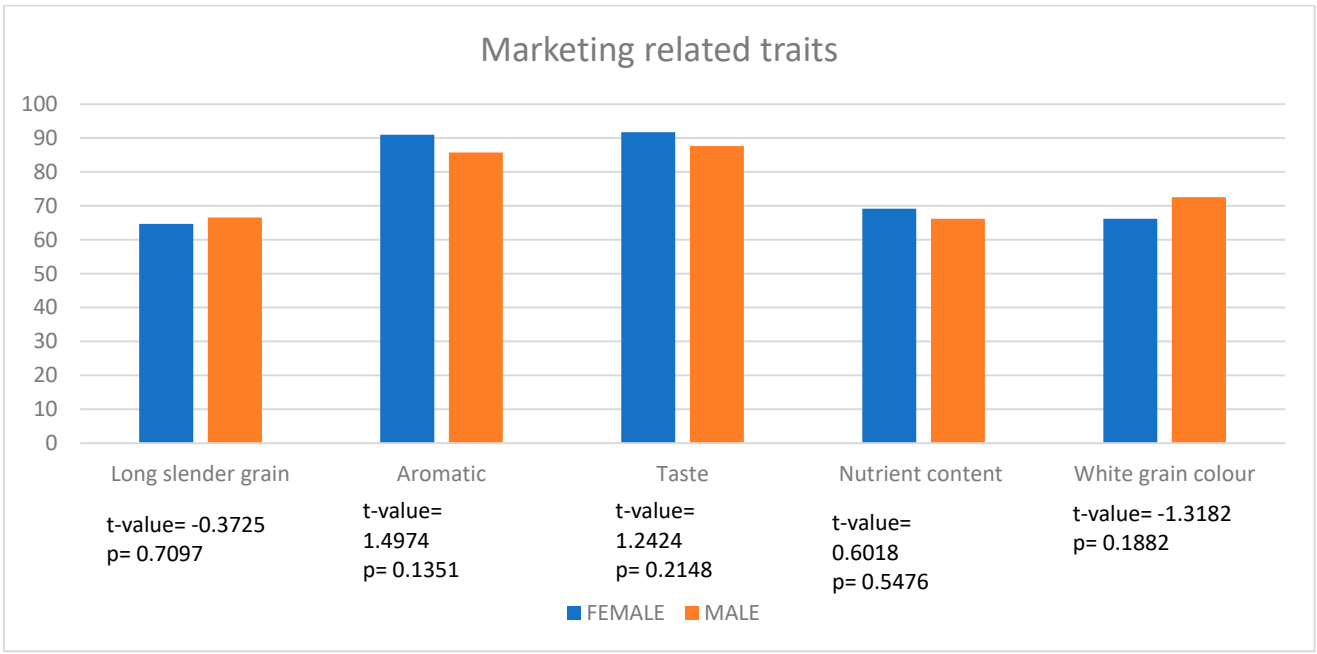


Figure 6. "Must have" marketing-related traits for men and women rice producers.

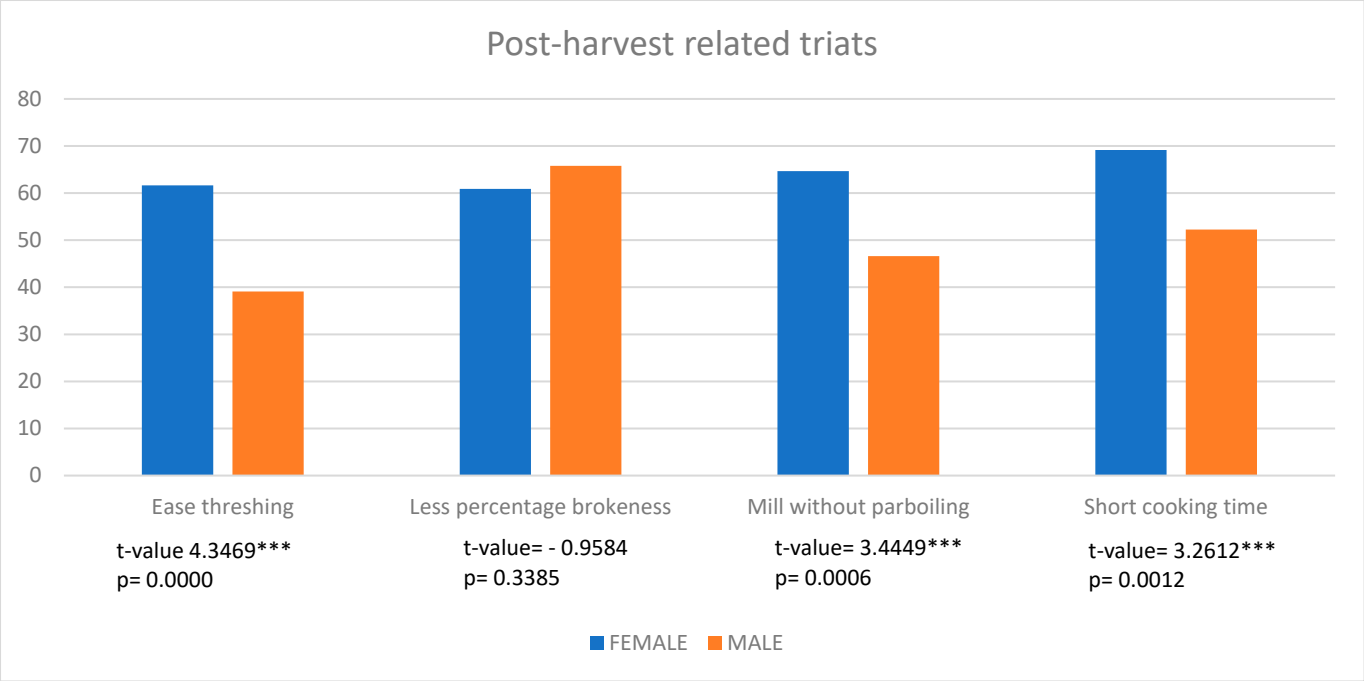


Figure 7. "Must have" post-harvest-related traits for men and women rice producers. *** indicates significance at 1% level.

3.4. Qualitative Results of Gender Analysis and Gender Impact Score

3.4.1. Top Preferred Traits Disaggregated by Sex and Age

The literature has shown that men's and women's desired traits and varietal preferences are often different. In cases of similarities, the trait is often the same but prioritized differently due to diverse, intersectional categories [25]. The field survey evidence indicated that the traits for men, women, young men, and young women were high yielding, marketability and early maturing. Men, women, young women and young men had the same, except young men preferred early maturing over marketability, as shown in Table 4. The marketability traits were further probed in the focus group discussions and in addition to taste and aroma, which were preferred by men, women and young women. Adult women and young women preferred translucent grains, which was mentioned as a strong selling indicator and described in verbatim language, as in Box 1. Young women also valued another marketability trait, which was the white grain color, also a market-demanded trait.

Table 4. Two preferred trait preferences of men and women farmers disaggregated by sex and age.

Gender Group	Traits 1	Trait 2
Men	High yielding	Marketability (good taste and aroma)
Women	High yielding	Marketability (good taste, aroma and translucent grains)
Young men	High yielding	Early maturing
Young women	High yielding	Marketability (good taste, aroma, translucent grains and white colored grain)

Box 1. Adult women and young women preferred translucent grains, which was mentioned as a strong selling indicator and described in verbatim language.

"The market likes rice that shines. It attracts customers even from afar and commands premium price in the market. Traders with their experience are able to differentiate between rice types based on its shininess . . . . . Adult women and Young women"

Although men, women, and young women identified marketability as the second-best rice trait during the focus group discussions, there were differences in the intensity of trait descriptions. Women producers had three descriptors of what marketability meant—good taste, aromatic, translucent, and men had two descriptors—good taste and aromatic. The young women had the highest descriptors of the marketability traits—good taste, aroma, shininess, and white color, while for young men, the second-best trait was early maturing. With the descriptions given, it is important to recognize that these traits may have different meanings for different social classes.

3.4.2. Gender Gap Analysis

Table 5 indicates the impact of the rice traits as viewed by women. Women would not mind drudgery and additional costs for yield-enhancing inputs as long as the monetary outcomes adequately compensate them and they retain control over their income and benefits. Good taste and aromatic and translucent attributes of the rice products earn premium prices, making the production profitable for women. Additional interventions in women-friendly/gender-responsive mechanizations can also reduce women's drudgery.

Table 5. Impact of preferred traits from the women's perspective.

Do No Harm
There is increased drudgery for women due to the increased time women spend drying and winnowing produce.
It is also a paid job because of their high involvement in post-harvest activities such as drying and winnowing.
Yields are enhanced by inputs, but women experience constraints on access because of low purchasing power.
Positive Benefits
Attractive because of the high incomes for both men and women, even though drudgery is an issue for women.
Creates business opportunities for women, increases women's participation in the market, and boosts sales and incomes.
Total control over incomes and other benefits resulting from higher yields and marketability.

Men's perspectives on the impact of the preferred traits is as shown in Table 6. Although high-yielding traits increased women's allocation of time to work and their need for land, which they face challenges in accessing, net benefits in terms of job creation, incomes and increased control of the benefits resulting from higher market demand offset negative gender implications of high yields and marketability traits (Table 6). There is a need to tackle access to resources in addition to breeding women's preferred traits.

Table 6. Impact of preferred traits from the men's perspective.

Do No Harm
More labor requirement disproportionately burdens women, who provide most of the production and post-harvest labor.
It takes much of women's time, displacing them from other duties related to the family and community.
Incentivizes land expansion, which women do not have access to equally with men.
Positive Benefits
Creates employment for both men and women.
Women have total control over generated benefits and gain decision-making power.
Increases men's and women's involvement in additional marketing functions.

According to Table 7, while high-yielding traits increase the time spent on production and post-harvest activities, marketability constrains them from carrying out other household chores. Nonetheless, it is worthwhile for women to venture into production because of economic returns. They sometimes do not benefit from the incomes incurred, so capacity-building on the importance of women's voice and bargaining power is important, in addition to breeding traits required by clients.

Table 7. Impact of preferred traits from the young women's perspective.

Do No Harm
Increases the amount of time women spend drying and winnowing produce. Requires land expansion and use of inputs to which young women do not have equal access compared to young men.
Positive Benefits
Creates employment for both men and women, even the youths. Women and young women sometimes have total control over generated benefits and gain decision-making power, but that is not in all cases. Market preferred traits result in time savings, thus enabling young women to attend to other homestead chores.

The storyline was similar to young men's assessment of the implications of breeding product traits for gender gaps, as shown on Table 8. The benefits of the high yields and marketability override the negative implications of the traits for gender if other interventions, such as gender-responsive mechanization, access to resources and increased bargaining power, are promoted. It is said that young men are more inclined to early maturing traits than their women counterparts.

Table 8. Impact of preferred traits from the young men's perspective.

Do No Harm
Increases amount of time women spend drying and winnowing produce. Requires land expansion and use of inputs to which women do not have equal access compared to men.
Positive Benefits
Creates employment for both men and women as well as young men. Young women have total control over generated benefits and gain decision-making power. Marketability is time-saving, enabling women to attend to other homestead chores.

The impact scores show that tradeoffs were critical, as presented in Table 9. Although the traits may cause harm through increased drudgery, they are required or important for men and women farmers and should be part of the product profile. If tradeoffs are impossible, then alternative interventions mentioned above can complement the breeding priorities.

Table 9. Impact scores, by gender.

Gender Group	Trait	Do No Harm	Benefits
Women	High yielding	−2	3
	Marketability	0	2
Men	High yielding	−2	3
	Marketability	0	2
Young women	High yielding	−2	2
	Marketability		2
Young men	High yielding	−2	2
	Marketability	−1	1

3.5. Comparison of the Application of G+ Tools Versus Conventional Approach

Table 10 shows the existing product profile the breeding team at CSIR- Crops Research Institute, Ghana is working on with the standard varieties as benchmark. This was developed through the conventional way of assembling stakeholders of rice value chain actors and soliciting their views on important traits to advance in the breeding program. From the stakeholders' assessment, some traits as evaluated by the team had gender relevance, and others did not. Gender-relevant traits are traits that relate to a particular gender group even if they are in the minority. On the other hand, the G+ approach granted the rice

producers the opportunity to openly express themselves in like groups and provide more details on the traits' relevance to each gender group and associated negative consequences. Thus, from the gender trait impact analysis score, all of the proposed traits identified were of gender relevance with the exception of yield and aroma, which were gender-neutral as they were preferred by all genders. The G+ tool was able to identify additional traits of gender relevance as listed in Table 10, including translucence, white grain color, early maturing, cooking time, swelling capacity and amount of water required during cooking, which breeders must add to their breeding objectives in order to meet the needs of all gender groups who depend on the crop as a source of livelihood and enhance adoption of released cultivars.

Table 10. Proposed product profile by CSIR-CRI breeding teams.

Trait Name	Gender Relevant Trait	Minimum Trait Score	Benchmark Variety	Additional Traits from G+ Assessment
Yield	Yes	≥	AGRA Rice	Translucence
Aroma	Yes	2	KDML 105	White grain color
Amylose	Yes	15–22%	KDML 105	Early maturing
RYMV	No	≤4	AGRA Rice	Cooking time
Blast	No	≤4	AGRA Rice	Swelling capacity
Drought	No	=	Enapa Rice	Amount of water during cooking Taste

4. Discussion

4.1. Profile of Men and Women Rice Farmers in Study Areas

Smallholder farmers' decision-making is influenced by their socio-demographic variables [29]. Men accounted for the majority of the sample based on the sampling frame retrieved. The men's dominance in rice production reflects the deeply rooted cultural settings of most typical Ghanaian rural communities, where men have access to production resources and thus own large farms and tend to participate in most farm activities, with the women in some cases assisting their men counterparts to undertake farming operations. Both men and women were within the economically active group and had attained primary education (1–6), which is consistent with the 2010 Population and Housing Census results for the chosen districts (GSS, 2010). This result, however, deviates from the norm, where previous studies have found low levels of education among rural folks [30]. Men, however, further continued after primary education, leaving the women behind. This may be due to the fact that after primary education, there may be some women dropping out of formal education for legitimate reasons.

The average rice farmer in the study area was 46 years old. This implies that most of the respondents fell within the agricultural productive age range of 15–60 years [23]. This outcome supports the findings of [24], who found that the typical Ghanaian rice farmer is 45 years old, on average. Household size is a proxy for family labor availability, which could affect the adoption of labor-intensive good agronomic practices [31,32]. A household size of six members suggests that farmers could receive support from their family when needed. Men farmers had more members within their household than women. This could affect women in carrying out activities that are labor-intensive.

On the other hand, women received more extension visits and had higher credit access than men. This may be due to the point that at the study locations, especially the irrigated schemes, farmers received in-kind credit in the form of seed, fertilizer and agro-chemicals. Personal conversations with extension agents revealed that they were comfortable dealing with women because of their high loan repayment rates. The results are consistent with a study conducted by [33].

Refs. [31,34,35], noted that smallholder farmers' membership in a farmer-based organization was important, as they were able to access quality information and new technologies from their groups. Ref. [29] reported that more than 50 percent of their respondents be-

longed to a farmer-based organization. The opposite result was recorded for this study, as less than 50% men and women belonged to an organization. This could affect the easy flow of information among farmers. In the study areas, farmers relied mainly on extension agents and sometimes research institutions for information on production practices and improved technologies. A similar observation was made by [29,36] in their studies. Ref. [37] discovered individual and demographic characteristics to be important in trait assessment, as they interact to reveal trait preference differences.

4.2. Farmers' Varietal and Trait Preferences across Rice Ecologies

Rice in Ghana is predominantly produced in diverse ecologies: upland, rainfed lowland, and irrigated lowland [38]. Each agro-ecology requires different varieties with specific adaptation requirements [38]. The top three varieties; AGRA, Jasmine and Ex-baika/ Legon 1 are all improved varieties cultivated by farmers. AGRA was more cultivated in the rainfed lowland, and Ex-baika was cultivated in the irrigated ecology. Jasmine was of more interest to men farmers. The qualitative stage revealed additional preferred varieties, such as Togo Marshall in the irrigated zone and Lapez and Aflao in the rainfed lowland. These varieties possessed unique traits that raised the interest of the producers to grow them.

Refs. [8,39] discovered that women explicitly justified some of their preferences for variety types based on concerns about food security. This discovery is in support of the findings from the current study. Relatively, there was no difference in production-related traits based on gender during the quantitative stage; however, few variations among the groups were noticed during the qualitative stage. Men and women placed high value on traits related to production, such as high yield, early maturity, tolerance to pests, tolerance to lodging, tolerance to disease, and tolerance to drought stress. Post-harvest traits were rated higher by women compared to men due to the fact that women are primarily responsible for processing and food preparation in most societies [27,28]. The rankings of market-relevant characteristics, such as flavor, aroma, translucence, good swelling capacity, and long, bold grain were generally agreed upon by both men and women. The findings of [9,40,41], which found that the presence of aroma and taste had a significant impact on consumers' decisions and attracted a good market, are consistent with this result. Ref. [29] identified grain yield, and [42] conducted a similar study in Tanzania and reported high grain yield, early maturity, drought tolerance, disease resistance, and marketability as the most farmer-preferred traits in the assessment of preferred wheat traits by farmers.

4.3. Robustness of the Gender-Responsive Breeding Tool (G+ Product Profile Query)

Six traits developed by rice stakeholders remained gender-neutral. However, application of the G+ product profile query in the field through qualitative data collection approaches to probe in detail men, women, young men and young women's trait preferences and perceptions revealed that some traits were more specific to some gender groups and thus essential and need not be taken for granted when developing new varieties. Cooking time, taste, translucence, white grain color and less brokenness were extra traits that were reported during both the quantitative and qualitative stages of the study with gender dimensions.

Author Contributions: Conceptualization, M.D.A., B.O.A. and B.N.F.; methodology, B.N.F., B.O.A. and G.M.; validation, G.M., N.Z., E.N. and H.T.; formal analysis, B.O.A., B.N.F. and S.J.A.; investigation, B.N.F., B.O.A., S.J.A. and B.S.; resources, E.N., G.M. and H.T.; data curation, B.O.A., S.J.A. and B.N.F.; writing—original draft preparation, B.N.F., S.J.A. and B.S.; writing—review and editing, M.D.A. and B.S.; supervision, M.D.A., N.Z. and H.T.; project administration, M.D.A. and B.N.F.; funding acquisition, M.D.A., B.N.F. and B.O.A. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: Since the research was carried out by a recognized government institution and did not involve the collection of medical samples from the subjects, a formal ethical clearance was not taken, but study was approved by the Institute's administration and followed all guidelines set by the Institution and the State's Data Protection Act, 2012 (Act 843).

Informed Consent Statement: All of the respondents gave informed consent and their permission for the study to be carried out. Their participation was, however, voluntary, and they could withdraw at any time if they felt uncomfortable with the questions.

Data Availability Statement: Data will be made available upon request by the corresponding authors.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Desktop literature review to identify gaps in studies conducted in Ghana.

Title of Paper	Extent of Gender Consideration	Market Segmentation	Scope of Work	Value Chain Analysis	Trait Preferences Considered
Grain quality and determinants of farmers preference for rice varietal traits in three districts of Ghana: Implications for research and policy	X (Respondents were only segregated by sex; No further gender considerations)	X (Respondents were all farmers)	X Study conducted in only one rice growing region	X (No value chain analysis done)	✓ (Trait preferences for all respondents considered and ranked)
Farmer and consumer preferences for rice in the Ashanti region of Ghana: Implications for rice breeding in West Africa	X (Respondents were only segregated by sex; No further gender considerations)	✓ (Respondents were farmers and consumers)	X Study conducted in only one rice growing region	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Consumer preference for rice quality characteristics in Accra and the effects of these preferences on price	X (Respondents were only segregated by sex; No further gender considerations	✓ (Respondents were sellers and consumers	X Data collected from nine urban markets in Accra only	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Consumer preferences for rice quality characteristics and the effects on price in the Tamale Metropolis, Northern Region, Ghana	X (Respondents were only segregated by sex; No further gender considerations	X (Respondents were sellers and consumers	X Data collected from markets/shops within the Tamale metropolis alone.	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Consumer Perceptions, Knowledge and Preferences for Aromatic Rice Types in Ghana	X (Respondents were only segregated by sex; No further gender considerations	X (Respondents were all consumers)	X Data collected from 390 respondents within the Accra metropolis alone	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Households' Preference for Local Rice in the Upper East Region, Ghana	X (Respondents were only segregated by sex; No further gender considerations	X (Respondents were all consumers)	X Data collected from 180 households within the Accra metropolis alone	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)

Title of Paper	Extent of Gender Consideration	Market Segmentation	Scope of Work	Value Chain Analysis	Trait Preferences Considered
Factors Influencing Consumers' Preference for Imported Rice in Kumasi Metropolis, Ghana	X (Respondents were only segregated by sex; No further gender considerations	X (Respondents were all consumers	X Data collected from 327 households within the Kumasi metropolis alone Study was only limited to imported rice	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Perceived Quality Characteristics Influencing Households' Preference for Local and Imported Rice and Their Effect on Price in the Northern Region, Ghana	X (Respondents were only segregated by sex; No further gender considerations	X (Respondents were all consumers	X Data collected from 327 households within the Kumasi metropolis alone	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Determinants of Consumer Preference for Local Rice in Tamale Metropolis, Ghana	✓ (Respondents only segregated by sex; with limited gender considerations)	X (Respondents were all consumers	X Study only focused on the Tamale metropolis	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Analysis of the Factors Influencing Consumers' Preferences for Rice: Locally Produced Versus the Imported in the Ga East Municipality of the Greater Accra Region of Ghana	X (Respondents were only segregated by sex; No further gender considerations	X (Respondents were all consumers	X Study only focused on the Greater Accra region	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Do Ghanaian rural consumers prefer imported rice to local rice? Evidence from Akuapem North Municipality.	X (Respondents were only segregated by sex; No further gender considerations	X (Respondents were all consumers	X Study focused only on rural consumers within the Akwapim North municipality	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)

Title of Paper	Extent of Gender Consideration	Market Segmentation	Scope of Work	Value Chain Analysis	Trait Preferences Considered
Factors that Influence Household Demand for Locally Produced Brown Rice in Ghana	X No data disaggregation and no gender analysis conducted	X (Respondents were all consumers	✓ Study was conducted in both the Volta and Greater Accra regions	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Assessing Quality Attributes that Drive Preference and Consumption of Local Rice in Ghana	X No gender considerations	✓ Respondents comprised traders, millers, corporate bodies, etc	✓ Study was conducted in Accra, Kumasi and Tamale	X (No value chain analysis done)	✓ Trait preferences for all respondents considered and ranked)
Gender Constraints and Rice Varietal Characteristics Preferences in Lowland Rice Ecosystem in Ghana	✓ Findings were sex disaggregated	X Only farmers were considered	X One rice growing region considered	X Not the value chain approach	✓ Considered varietal preferences of male and female farmers
Improving participatory varietal selection processes: participatory varietal selection and the role of informal seed diffusion mechanisms for upland rice in Ghana	✓ Allowed males and females to independently evaluate the plots and reported accordingly	✓ Partially segmented Included farmers in PRA and PVS and involved farmers and traders in sensory	✓ Study conducted in four rice growing regions within two agro-ecologies	X Not value approach	✓ Considered men and women varietal trait preferences
	2/15	**5/15**	**3/15**	**0/15**	**15/15**

Table A1. Trait preferences in the production rice ecologies, by gender.

(a) Table: Trait preferences in the irrigated lowland ecology by gender.				
Trait category	**Adult men**	**Adult women**	**Young men**	**Young women**
Production-related	High yielding (high tiller numbers and milling recovery); Resistance to diseases; Resistance to lodging; Bold grains; Early maturing and Ease of threshing	High yielding (15–20 tillers); Early maturing (90–120 days) and Medium to tall plant height to control weeds	High yielding (high tillers, longer panicles, long and bold grains); Early maturing; Tall plant height to compete with weeds; High milling recovery rate; Drought tolerant and Resistance to lodging	High yielding and Good milling yield
Marketing	Aromatic and Good taste	Nice aroma (commands premium price); Good taste and Nice appearance and shiny	Good taste; Aromatic and Shiny	Good taste; Aromatic; White grain color; Shiny and long and bold grains
Cooking		Nice aroma; Good taste; cooks fast and does not need much water	Short cooking time and not too much starch	Good taste and Nice aroma
(b) Table: Trait preferences in the irrigated lowland ecology by gender.				
Trait category	**Adult men**	**Adult women**	**Young men**	**Young women**
Production-related	High yielding; Long-bold grains (heavy panicles); Early maturing; Tolerant to drought and lodging and Medium-tall plant height			
Marketing	Good taste, Aromatic and Translucent	Good taste, Nice aroma and shines after milling	Aromatic	Nice aroma and Good taste
Cooking	Good taste ("Can be eaten without sauce"); Nice aroma ("It allows bad boys even stay home because their favorite rice is prepared"); and long grains ("Produces fine single grains when cooked and good for jollof and fried rice")			Swelling capacity

Table A2. Pair-wise ranking of varieties cultivated by women rice farmers in lowland ecology.

No.	**Varieties**	**Lapez**	**Aflao**	**AGRA**	**Amankwatia**	**Mr. Moore**	**Mr. Harry**	**Scores**	**Rank**
1	**Lapez**	-	Lapez	Lapez	Lapez	Lapez	Lapez	10	1
2	**Aflao**	Lapez	-	AGRA	Aflao	Aflao	Aflao	6	3
3	**AGRA**	Lapez	AGRA	-	AGRA	AGRA	AGRA	8	2
4	**Amankwatia**	Lapez	Aflao	AGRA	-	Mr. Moore	Amankwatia	2	5
5	**Mr. Moore**	Lapez	Aflao	AGRA	Mr. Moore		Mr. Moore	4	4
6	**Mr. Harry**	Lapez	Aflao	AGRA	Amankwatia	Mr. Moore	-	0	6

Sampled gender impact score sheets for adult women and young men.

Gender Impact of 1st preferred trait (Adult Female)

Product Profile scoring matrix for single trait of rice DO NO HARM							Product Profile scoring matrix for single trait of rice POSITIVE BENEFITS						
Target customer segment		Adult Female Rice Producers across rice ecology					Target customer segment		Adult Female Rice Producers across rice ecology				
Evidence source		Field Survey					Evidence source		Field Survey				
Trait name		High yielding					Trait name		High yielding				
Do No Harm Question		Score			Lacks info	Commentary	Do No Harm Question		Score			Lacks info	Commentary
No.	Part 1 "Gender Gap"	-2	-1	0	!!!	Notes on scoring/and or info needed	No.	Part 3 "	+2	+1	0	!!!	Notes on scoring/and or info needed
1	Increases drudgery		-1			High tillers means more paddy and this increases women's time in drying and winnowing	7.	Reduces drudgery			0		High yields increase the time spent to by women to perform some postharvest activities
2	Displaces women's activities			0		It creates more work for women for paid jobs as they are involved in postharvest activities of drying and winnowing	8.	More employment for own income	2				The trait increases the income of all genders and draws more to cultivating rice
3	Depends on inputs with unequal access		-1			Some varieties need more inputs to yield more. "Women have so much to do at home so do not farm bigger fields and can affect their financial resources to purchase needed inputs"	9.	Products under better control of women	2				Women have total control over the benefits generated and decide on what to use it for.

Gender Impact of 1st preferred traits (Male Youth)

Product Profile scoring matrix for single trait of rice DO NO HARM							Product Profile scoring matrix for single trait of rice POSITIVE BENEFITS						
Target customer segment		Male Youth Rice Producers across rice ecology					Target customer segment		Male Youth Rice Producers across rice ecology				
Evidence source		Field Survey					Evidence source		Field Survey				
Trait name		High yielding					Trait name		High yielding				
Do No Harm Question		Score			Lacks info	Commentary	Do No Harm Question		Score			Lacks info	Commentary
No.	Part 1 "Gender Gap"	-2	-1	0	!!!	Notes on scoring/and or info needed	No.	Part 3 "	+2	+1	0	!!!	Notes on scoring/and or info needed
1	Increases drudgery		-1			High tillers increase harvest time and more paddy increases drying and winnowing time	7.	Reduces drudgery			0		High yields increase the time spent of performing some field activities
2	Displaces women's activities			0			8.	More employment for own income	2				The trait increases both men and women interest to venture into rice farming
3	Depends on inputs with unequal access		-1			Expansion require land and women do not have access to bigger plots and men have the capital resources to purchase the required inputs than women. The youth is also constrained in access to irrigated lands	9.	Products under better control of women	2				Women have total control over the benefits generated and decide on what to use it for.

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