Stakeholder preferences on major characteristics of promising rice lines

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Abstract. The main purpose of plant breeding programs is to improve varieties acceptable to rural communities. Participatory crop improvement for rice lines was initiated using techniques which were designed with the purposes to strengthen the collaboration between breeders and stakeholder especially farmers to produce varieties. Before the promising rice lines released and adopted by farmers, it is necessary to study the preferences on characteristics, especially its quality, because farmers have their own criteria or considerations before adopting a new variety. A bottom-up preferences in this study is to understand the major phenotypic performance, sensory quality, and provide recommendations for improving promising rice lines (Oryza sativa L.). The respondents are farmers, extension workers, members of academic institutions, and local government officers, came from four Regencies (Banyumas, Magelang, Batang, Klaten) that representing the main rice production areas in Central Java province. The attribute data on rice characteristics showed that grain size, plant age, and lemma shape of apiculus was essentially regarded as a major factor for better performing varieties. The respondents’ preference provides recommendations for breeders to release promising rice lines GM 8 and GM 2 into commercial varieties.

Keywords: preference, characteristics, Oryza sativa L., lines, participatory.

1. Introduction

Rice is a major crop in the world [1]. Indonesia is the third rice world’s producer, with its production 74.5 million ton in 2018 with double crops per year [2]. Central Java province, one of the main rice producers, yields 11.4 million tons in 2018 [3,4]. Most of the new rice varieties are produced in high-input production systems, but the variety replacement rate is low. New varieties that aim to replace the mega varieties, like IR64, must offer a clear advantage, such as improved stress tolerance or higher yield [5]. Breeders must consider farmers’ preferences and understanding their needs before setting the goal of breeding programs, to development varieties adoption process [6]. The participation of farmers in the early stages of selection offers a solution to the problem of fitting the crop to a multitude of both users’ preferences and target environments [7].

Participatory crop improvement project for rice lines was initiated using processes whereby farmers are involved in selecting lines that they judge to be most appropriate for their own uses. Witcombe et al.
[8] mention that participatory attempts to exploit the variation found in lines in advanced stages of testing and can be rapidly obtained. Farmers' involvement could define breeding goals and priorities, select lines for further varieties, and discuss results with the scientists [9]. It is a rapid, effective, and reliable way in real time to identify farmer-preferred varieties [10]. The effectiveness of participatory includes fast time configured cultivars and well characterized material. Participatory efficiency is assessed by preferred phases i.e. identifying farmers' needs and searching for suitable material to test with farmers [11]. The objectives of participatory also are empowering farmers and farmers' organizations [12].

A bottom-up preferences approaches allow farmers to select technologies process to social, economic and cultural dimensions, using indigenous knowledge as well [13;14]. Participatory collaboration is useful to understand the needs of the producer and consumer, and general cultivation [15]. The purpose of this study is to understand the major phenotypic performance, sensory quality, and provide recommendations for improving promising rice lines (Oryza sativa L.).

2. Material and Methods

This study is a combination of preferences by farmers and stakeholders through the survey, and evaluation phenotypic performance by breeders on promising rice lines in the field experiment. This research was conducted in researcher-managed trial at Magelang, Central Java, Indonesia (7°27'51" N latitude and 110°11'34" E longitude). Participatory research conducted in the generative stage of rice, in the field during the day, June 2019. The respondents were male and female farmers (represent different family’s socio-economic groups), extension workers, members of academic institutions, and local government officers, which came from four Regencies (Banyumas, Magelang, Batang, Klaten) that representing the main rice production areas in Central Java province, Indonesia. A total of 53 randomly respondents were selected across regencies, who are cooperative and interested to participate in the study.

The interviewed designed to capture information on rice characteristic attributes in the main rice production areas. The respondents were interviewed using structured questionnaires concerning assessment and preference of fifteen lines rice and two varieties (Oryza sativa L.) (Table 1).

| No. | Lines                     | No. | Lines                      |
|-----|---------------------------|-----|----------------------------|
| 1   | GM 11                     | 10  | Mutan Rojolele 30 Pendek   |
| 2   | V11                       | 11  | Mutan Rojolele 30 Tinggi   |
| 3   | V12                       | 12  | Mutan V12T                 |
| 4   | V12 Inpari                | 13  | Mutan Mayangsari           |
| 5   | GM 28                     | 14  | Mutan Lakatesan            |
| 6   | GM 2                      | 15  | Mutan Batan                |
| 7   | GM 8                      |     | Varieties                  |
| 8   | Inparo 6 Mayangsari       | 16  | Inpari 33                  |
| 9   | Mutan Lampung Kuning      | 17  | Inpari 30 Ciherang Sub 1   |

The study identified factors influencing farmers' preferences and were ranked for rice line traits. The ranking was evaluated to assess the attributes that is most preferred by the farmers. The level of farmers' preferences for rice characteristic was measured using the Perceived Quality calculation technique. The level of farmers' preferences for rice characteristic attributes is known by calculating the importance of characteristic attributes through scoring (5=very important, 1=very unimportant), the mean characteristic attributes per respondent, and the level of respondent farmers' preferences for the characteristic attributes of varieties (5=most preferred, 1=least preferred). The average preference level per characteristic attribute of all varieties is the sum of the scores of the average preference level per respondent per characteristic attribute of all varieties divided by the number of varieties. The level of
total preference of farmers for each variety is the sum of the scores of all the characteristic attributes of a variety [16].

Major phenotypic performance of fifteen lines rice and two varieties (*Oryza sativa* L.) were evaluated by breeders in February-July 2019. The fifteen promising rice lines used in the research are the advanced generation that already have stable properties to become commercial varieties. The study was carried out in a randomized complete block design with three replications (Table 1). Each rice lines sowed in the nursery, transplanted at the age of 15 days. Each plot has a size of 5 m × 5 m, plot to plot distance was kept at 0.5 m. Row to row and plant to plant spacing were maintained at 20 cm and 20 cm respectively, two plants per holes. The recommended agronomic practices and control of pests/diseases in fields were followed to raise a good crop [17;18;19].

Quantitative and qualitative traits are useful for the identification of rice lines based Descriptors for Wild and Cultivated Rice (*Oryza spp.* [20]. Statistical parameters such as the mean and standard deviation among lines were analysed using the method described by Singh and Chaudhary [21].

### 3. Results and Discussion

#### 3.1. Preference Level for New Rice Lines

The respondents for bottom-up preferences came from Central Java provinces (Banyumas, Magelang, Batang, and Klaten regency), involving the members of academic institutions, extension agents, government official, and farmers’ participants in the field days. Characteristics of the respondents’ research were aged 29-70 years on the average a farmer is aged 48.71 years. The youngest participant from Banyumas (29 years) and the oldest from Klaten (70 years). In general, 100% stakeholders had formal education, at least elementary school and the average is high school (11.86 years). The farmers have 17 years of farming experience (range 3-50 years). The distribution varied across the regency with Banyumas having about 13.13 years, Magelang exactly 16.4 years, Batang 19.17 years, and about 20 years of farmers with farming experience in Klaten. Overall, they have land area (owned and rented) of 0.56 ha and on the average is 0.1-2 ha across regencies (Table 2).

| Regency   | Age (years) | Education (years) | Farming experience (years) | Land area (owned and rented, ha) average (range) |
|-----------|-------------|-------------------|----------------------------|-----------------------------------------------|
| Central Java | 48.71 (29-70) | 11.86 (6-18) | 17.00 (3-50) | 0.56 (0.1-2) |
| Banyumas  | 44.00 (29-57) | 12.00 (6-16) | 13.13 (5-20) | 0.44 (0.125-1.5) |
| Magelang  | 47.79 (34-63) | 11.12 (6-16) | 16.40 (3-39) | 0.39 (0.1-1) |
| Batang    | 49.13 (42-56) | 12.00 (9-18) | 19.17 (10-30) | 1.00 (0.5-2) |
| Klaten    | 53.43 (42-70) | 12.75 (6-18) | 20.00 (4-50) | 0.65 (0.18-1) |

As a whole, proportion of respondents from Central Java and each regency, consists of Official (9%), Extension (11%), and Farmers (79%) which can describe the ideal preferences of consumers for rice. The respondents included male (66%) and female (34%), who actively participated in the assessment of this new rice lines and was responsible for the average of a member household with an almost equal gender distribution. The male proportion is relatively balanced in Magelang and Klaten regency, whereas in Banyumas and Batang regency, the proportion of male are 73% and 88%, respectively, and remaining are female (Figure 1).

The attributes data on new rice lines characteristics showed that grain size was the most important attribute according to farmers (3.52). Farmers’ products such as rice are used for consumption and some are sold. The second priority preferred varietal characteristic of rice is the age of the plant (3.51), farmers are concerned about faster harvesting time (productions). Plant age is essentially regarded as a major factor for better performing varieties. The next preferred characteristic was lemma shape of apiculus (3.50), this is another important rice characteristic. This study also evaluated grain quality traits of each
line (rice quality, texture, aroma, stickiness and color) to test the acceptability of rice lines and the respondents’ perception of a good line for eating. The quality of rice is defined as the ability of rice grain to stand milling without breakage, have average attribute 3.18. Preferences were mainly based on a sensory test and visual rating to evaluate eating qualities of their best rice lines and reflect the variability in the quality of seeds. Overall, average attribute of rice texture, aroma, stickiness and color are 3.23, 3.22, 3.16 and 3.36, respectively (Table 3).

**Figure 1.** Proportion of percentage respondents

| Characteristics                                      | Value of average attribute | Characteristics                                      | Value of average attribute |
|------------------------------------------------------|-----------------------------|------------------------------------------------------|-----------------------------|
| Culm length                                          | 3.39                        | Grain size                                           | 3.52                        |
| Productive tillers                                   | 3.32                        | Lemma and palea colour                               | 3.40                        |
| Panicle length                                       | 3.43                        | Rice quality                                         | 3.18                        |
| Plant age                                            | 3.51                        | Caryopsis pericarp colour                            | 3.18                        |
| Culm habit                                           | 3.46                        | Rice Texture                                         | 3.23                        |
| Resistance to diseases and pest                      | 3.18                        | Rice aroma                                           | 3.22                        |
| Tolerance to abiotic stresses                        | 3.31                        | Rice stickiness                                      | 3.16                        |
| Lemma shape of apiculus                              | 3.50                        | Rice colour                                          | 3.36                        |

The total preference level is known to look for the average preference level and the average per attribute characteristic of all lines. The relative preference level of farmers showed that each lines had different advantage characteristics. In general, the new tested lines have their own advantages. There are several characteristics that are similar or nearly the same between one line to another. The value of total preferences level indicates the variety that is the most general preferred by farmers. The calculation of the total preference level is obtained by summing the value of the weighted relative preference level of each lines. The value of relative attributes shows the perception of how important an attribute is to farmers' preferences, included in the sensory test. The level of total preference is a combination of how important plant characteristics are and indicative degree for each line. The aim was to analyze shed light on the importance of rice characteristics in decision making for breeding rice lines. The results of the analysis showed that based on the overall characteristics of rice, number 7 (2.34) and 6 (2.23) were the most preferred, this gave an opportunity for the development of new lines into commercial varieties. The next most total preference level is lines 17 (2.22) and 16 (2.17), which are varieties commonly used.
by farmers. The next varieties preferred by respondents are lines 15 (2.16) and 4 (2.13). Based on both farmers’ and breeders’ opinions, the test provided setting for breeding targets to improve lines 7 (GM 8) and 6 (GM 2). Higher variety values above the average preference value of all varieties have a greater chance to be preferred by farmers. With preferences, the probability of consumers using the product is expected to be higher (Table 4 and Figure 2).

**Table 4. The relative preference level**

| Characteristics                  | Lines       |
|----------------------------------|-------------|
|                                  | 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17 |
| Culm length                      | 0.15 0.13 0.13 0.16 0.16 0.16 0.18 0.10 0.14 0.14 0.14 0.12 0.12 0.16 0.16 0.16 0.16 |
| Productive tillers               | 0.13 0.14 0.14 0.14 0.16 0.17 0.17 0.10 0.16 0.14 0.13 0.14 0.12 0.15 0.15 0.15 0.14 |
| Panicle length                   | 0.16 0.15 0.13 0.15 0.16 0.17 0.18 0.10 0.16 0.13 0.14 0.14 0.14 0.14 0.14 0.14 0.14 |
| Plant age                        | 0.16 0.12 0.16 0.16 0.15 0.16 0.18 0.12 0.12 0.13 0.16 0.13 0.15 0.16 0.17 0.15 0.16 |
| Culm habit                       | 0.15 0.15 0.12 0.14 0.16 0.16 0.17 0.09 0.16 0.16 0.14 0.14 0.12 0.14 0.15 0.15 0.16 |
| Resistance to diseases and pest  | 0.12 0.16 0.09 0.11 0.16 0.16 0.17 0.10 0.16 0.16 0.12 0.14 0.11 0.11 0.11 0.14 0.15 |
| Tolerance to abiotic stresses    | 0.14 0.15 0.12 0.13 0.16 0.15 0.17 0.10 0.15 0.16 0.14 0.13 0.11 0.13 0.14 0.14 0.16 |
| Lemma shape of apiculus          | 0.13 0.10 0.12 0.13 0.12 0.13 0.13 0.12 0.10 0.08 0.08 0.12 0.12 0.13 0.13 0.13 0.13 |
| Grain size                       | 0.13 0.10 0.13 0.13 0.12 0.13 0.13 0.12 0.10 0.09 0.08 0.12 0.12 0.13 0.13 0.13 0.13 |
| Lemma and palea colour           | 0.13 0.09 0.12 0.13 0.12 0.12 0.13 0.11 0.09 0.08 0.08 0.11 0.13 0.12 0.13 0.13 0.13 |
| Rice quality                     | 0.09 0.08 0.10 0.13 0.11 0.12 0.12 0.09 0.10 0.09 0.09 0.09 0.13 0.10 0.13 0.12 0.13 |
| Caryopsis pericarp colour        | 0.08 0.08 0.11 0.12 0.10 0.12 0.12 0.10 0.11 0.09 0.09 0.09 0.13 0.09 0.13 0.13 0.13 |
| Rice texture                     | 0.09 0.08 0.10 0.12 0.12 0.12 0.12 0.10 0.11 0.09 0.08 0.09 0.13 0.10 0.13 0.13 0.13 |
| Rice aroma                       | 0.09 0.09 0.10 0.12 0.11 0.12 0.11 0.11 0.10 0.10 0.09 0.10 0.13 0.11 0.12 0.12 0.12 |
| Rice stickiness                  | 0.09 0.09 0.10 0.12 0.10 0.11 0.12 0.10 0.11 0.10 0.08 0.09 0.12 0.10 0.12 0.12 0.13 |
| Rice colour                      | 0.08 0.08 0.10 0.13 0.12 0.13 0.13 0.12 0.10 0.12 0.11 0.11 0.09 0.13 0.09 0.13 0.13 |

| Total preference level            | 1.91 1.80 1.86 2.13 2.12 2.23 2.34 1.64 2.00 1.88 1.75 1.84 2.02 1.95 2.16 2.17 2.22 |
| Rank                              | 11 15 13 6 7 2 1 17 9 12 16 14 8 10 5 4 3 |

### 3.2. Phenotypic Performance

Quantitative and qualitative data showed the value of plant characteristics in the field which are considered by farmers. Sufficient variation was found among rice lines for culm strength, productive tillers, panicle length and plant age. These characteristics with relative preference values are quite important by farmers. The observed phenotypic performance of culm length, ranges between 83.05±5.32 cm (line 3) and 132.5±12.85 cm (line 2). Variation among the genotypes was observed for productive tillers, the lowest value was in line 1 (10.55±2.85) and the highest was in line 11 (16.65±4.05), among other lines. Panicle length is a characteristic that is also considered by farmers. Panicle length among the rice lines varied from 18.09 to 25.99 cm, line 4 showed minimum value (18.09±8.62 cm), whereas line 1 exhibited maximum (25.99±2.52 cm). Proper recording of the mature time of rice lines is very vital for being developed into commercial cultivars in rice breeding programs. According to the study, the rice lines were ready to harvest from 107 to 151 days. Minimum plant age (107 days) was observed for the line 16, followed by the line 1, 3, 13, and 14 which showed similar plant age (114 days), while lines 10 and 11 showed maximum plant age (151 days) (Table 5).

Line number 7 (GM 8) and 6 (GM 2) which were the most preferred by respondents had higher culm length and productive tillers characteristics (118.97±4.56 cm, 12.98±2.73 and 99.18±5.34 cm,
14.65±2.69, respectively). While the panicle length of this lines (22.74±3.25 cm and 22.09±1.99 cm, respectively) is lower than the average of all lines (23.05±3.74 cm). Plant age is prominent regarded as a major factor for farmers reaches 120 days (line number 7) and 123 days (line number 6) (Table 5).

Table 5. Quantitative characteristics of new rice lines

| Lines | Culm length (cm)* | Productive tillers* | Panicle length (cm)* | Plant age (days) |
|-------|-------------------|---------------------|----------------------|------------------|
| 1     | 115.73±4.92       | 10.55±2.85          | 25.99±2.52           | 114              |
| 2     | 132.5±12.85       | 12.85±2.24          | 22.35±2.28           | 118              |
| 3     | 83.05±5.32        | 15.55±3.06          | 20.66±2.19           | 114              |
| 4     | 95.58±6.09        | 14.92±3.27          | 18.09±8.62           | 127              |
| 5     | 108.92±4.47       | 13.93±3.09          | 25.28±3.18           | 127              |
| 6     | 118.97±4.56       | 12.98±2.73          | 22.74±3.25           | 123              |
| 7     | 99.18±5.34        | 14.65±2.69          | 22.09±1.99           | 120              |
| 8     | 121.35±4.63       | 12.72±2.81          | 24.88±3.51           | 116              |
| 9     | 121.98±3.38       | 15.57±2.81          | 24.73±2.30           | 133              |
| 10    | 126.78±2.92       | 14.17±2.66          | 23.48±2.22           | 151              |
| 11    | 91.35±3.41        | 16.65±4.05          | 22.07±2.09           | 151              |
| 12    | 130.53±4.90       | 15.98±2.93          | 23.83±2.03           | 130              |
| 13    | 121.07±3.45       | 16.37±3.85          | 22.46±3.36           | 114              |
| 14    | 90.88±6.90        | 15.95±2.92          | 20.59±2.11           | 114              |
| 15    | 102.6±4.99        | 14.73±2.88          | 24.90±1.81           | 116              |
| 16    | 101.62±3.91       | 15.60±3.48          | 22.98±1.99           | 107              |
| 17    | 102.35±6.05       | 14.42±3.03          | 24.69±2.51           | 111              |

Note: * = mean±standard deviation

Qualitative traits are useful for the identification of new rice lines. All rice lines displayed erect (<15°) culm habit types. The seventeen lines indicated the nature of pointed lemma shape of apiculus, non-waxy rice texture, and non-glutinous rice stickiness. The morphological characteristics of all rice lines in lemma and palea color were different based on brown tawny, except line 9 (brown furrows). The studied rice lines were characterized for caryopsis pericarp color and rice color with two different characteristic categories, followed by white color (line 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 16, 17) and red color (line 2, 12, 14) (Table 6 and Figure 2). Lines 7 and 6 were the most preferred and have similar characteristics i.e. erect culm habit (<15°), pointed lemma shape of apiculus, brown tawny lemma and palea color, white caryopsis pericarp and rice color, non-waxy rice texture, also non-glutinous rice stickiness (Table 6).

Figure 2. Phenotypic performance of new rice lines

Culm habit (erect<15°) Lemma shape of apiculus (pointed) Caryopsis pericarp colour (white)
Caryopsis pericarp colour (red) Rice colour (white) Rice colour (red)
Table 6. Qualitative characteristics of new rice lines

| Lines | Culm habit | Lemma shape of apiculus | Lemma and palea colour | Caryopsis pericarp colour | Rice texture | Rice stickiness | Rice colour |
|-------|------------|-------------------------|------------------------|--------------------------|-------------|----------------|-------------|
| 1     | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 2     | erect (<15°) | pointed                 | brown tawny            | red                      | non-waxy    | non-glutinous  | red         |
| 3     | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 4     | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 5     | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 6     | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 7     | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 8     | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 9     | erect (<15°) | pointed                 | brown furrows          | white                    | non-waxy    | non-glutinous  | white       |
| 10    | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 11    | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 12    | erect (<15°) | pointed                 | brown tawny            | red                      | non-waxy    | non-glutinous  | red         |
| 13    | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 14    | erect (<15°) | pointed                 | brown tawny            | red                      | non-waxy    | non-glutinous  | red         |
| 15    | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 16    | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |
| 17    | erect (<15°) | pointed                 | brown tawny            | white                    | non-waxy    | non-glutinous  | white       |

4. Discussion

4.1. Preference Level for New Rice Lines

A bottom-up preference method was carried out to widen the management of plant breeding, as well as exploring a range of technological innovations in rice varieties assembly. The combination of preferences by stakeholders on new rice lines needs to be further investigated in order to understand the major phenotypic performance, sensory quality, and provide recommendations for improving promising rice lines by breeders. The respondents of this study came from members of academic institutions, extension agents, government officials, and farmers’ participants in the field days. They have diverse gender proportion, age characteristics (29-70 years), education (elementary school up to master degree), and farming experience. In fact, they also have different land areas. This is the ideal expected proportion to describe information about the needs of rice varieties. Galawat and Yabe [22] argues that it is necessary to present diverse respondents to investigate consumer preferences, including distinctness in socio-economic characteristics, at the same time and place where actual decisions were made, in order to better elicit their true preferences.

Decisions about rice production are still dominated by males. The gender imbalance can limit the potential of this sector. The age of the actors involved in the rice production process also affects productivity. Younger farmer has the ability to work harder and invest in new technologies, including new varieties, and improve rice production. Levels of education, can increase the potential advantages of new technologies and interventions to ensure effective promotion of rice varieties [23;24;25]. Furthermore, differences in age, education, and farm size, also influences the adoption and farmers’ acceptability of new rice varieties [26]. The major characteristics and quality of new rice varieties are important because they determine the willingness of farmers to plant the variety and market their products. The quality attribute is not preferred by the farmer they will not adopt the new variety. The most critical criteria in predicting acceptable lines were based on visual observation. The result of the
study on new rice lines characteristics showed that grain size, plant age, and lemma shape of apiculus were the most important attribute according to farmers. Preferences are created from a set of characteristics that are known and valued relatively by consumers. Rice breeding needs to set goals, supported by notes regarding consumer preferences, variety characteristics, and farmers' criteria. These will be substantial for breeding rice lines. The opportunities of visiting program to the breeder experimental stations and viewing demonstration plots, intended to understanding of farmers' preferences for different varietal characteristics. Rahman et al. [27] argue that participatory can be efficacious to evaluate the nature of rice lines, identify acceptable rice lines and supplement breeders' observations.

The preference value of each test line was calculated to understand the relative importance of each attributes in the development breeding system [28;29;30;31]. The farmers’ preference criteria for line selection was based on desirable phenotypes effective in identifying superior performance with those of breeders [32]. Participatory approach highlighted farmers’ preference data were quantified as feedback to enhance the research in rice breeding. The scarcity of resources for research outside increasing demands to provide evidence that the costs of participatory methods are justified by the results. This opens up opportunities for farmers’ choice. The cooperation between breeders with farmers become active partners in plant breeding [33]. Public-sector and governmental organizations are needed increasingly using participatory methods to widen the adoption and impact of a range of technology innovations in agriculture and plant breeding management. The growing scarcity of resources for research outside increasing demands to provide evidence that the costs of participatory methods are justified by the results. Opens up opportunities are well-adapted rice varieties, high productivity and farmer's choice. A participatory research and farmers’ preferences of new rice lines aim to be known and understand the characteristics of rice is important and affects the level of farmer adoption.

4.2. Phenotypic Performance

Rice lines are substantial reservoirs of useful genes and can be used to enrich the commercial rice varieties. The phenotypic performance (quantitative and qualitative characteristics) of new rice lines is a fundamental plant breeding strategy and it provides key information of the lines for its future use. These use to know genetically variable in morphological level of rice lines [34;35;36;37;38;39]. The attribute rice data showed that grain size, the age of rice, and form of grain was the most important quantitative characteristics according to farmers. The total preference level and phenotypic performance data showed rice lines 7 (GM 8) and 6 (GM 2) were the most preferred for breeding targets to be commercial varieties. These lines had higher culm length and productive tillers characteristics than other lines. The majority of respondents preferred higher culm length because it makes easier for farmers when they have to cut the panicles [6]. This suggest that rice breeders develop new lines that meet farmers’ needs. The result of the study is supported by the studies from Veasey et al. [40] and do-Nascimento et al. [41].

Panicle length has a high relative preference value according to farmers. Lei et al. [42] argues that diversity of rice is intuitively reflected in the diversity of their panicle traits. Panicle length is an important morphological characteristic and differences in rice were the most leading bases that could be utilized by breeders.

The major objective of rice breeding for commercial cultivation is in short plant age or number of days to maturity. Large amount of genetic variability related to this has been observed to occur in the original lines among sampled populations representing different geographic regions and climatic [43].

The qualitative characteristics of new rice lines are considered as morphological markers; they are less altered by environment [44;45;46]. Rice genotypes were characterized for culm habit traits at late vegetative and generative stages. There was no variation found for this trait. Rawte and Saxena [47] detected that culm habit is an indicator of the growth habit of a particular plant species. The performance of qualitative characteristics of new rice lines (rice quality, texture, aroma, stickiness and color) is related to the quality of cooked rice. Rice grains with non-glutinous stickiness
content possess are associated with harder cooked rice. Breeders have a mind for improving rice quality to command premium class in the market [48;49].

5. Conclusion

A bottom-up preferences are created from a set of characteristics that are known and valued relatively by consumers, and a concern for breeders in assembling superior varieties. The perspectives of farming households, including male and female members, professional (through the survey), and plant breeders (evaluation in the field experiment) were combined. These different perspectives complement one another. The promising rice lines is an important faced by practitioners of participatory breeding. This research showed that breeding focuses not just for specific types lines but further categorizing indicators (preferred traits and grain quality) to develop new more varieties in preferred combinations of traits. The use of a bottom-up method in allowing farmers to vote for their most-preferred lines was well appreciated, understood by them, and is recommended for onward use in rice lines development breeding programs. Promising rice lines 6 (GM 8) and 7 (GM 2) have characteristics preferences at the farmers’ levels and recommend into commercial varieties. These rice lines have similar characteristics i.e. erect culm habit (<15°), pointed lemma shape of apiculus, brown tawny lemma and palea color, white caryopsis pericarp and rice color, non-waxy rice texture, also non-glutinous rice stickiness, which are the best characters considered by farmers.

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