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Promoting the New Superior Variety of National Hybrid Maize: Improve Farmer Satisfaction to Enhance Production

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Abstract: Farmers' satisfaction with new superior varieties (NSVs) is a critical strategy for boosting their adoption. Out of 48 national NSV hybrids produced, only three, including Nasa-29, JH-37, and Bima-10, have been widely distributed at the farmer level. However, no studies have been carried out to establish farmers' satisfaction of any of the three hybrid maize varieties. As a result, the main aim of this study is to establish farmers' satisfaction of three-hybrid maize. The survey was conducted in three South Sulawesi maize production districts: Bone, Gowa, and North Luwu, representing the east, west, and transitional zones. A total of 150 farmers from three districts were then deliberately chosen as respondents. Variables such as seed availability, cultivation technology, post-harvest, and product marketing were monitored during our assessment. The data were then analyzed using the importance performance analysis (IPA) method. The findings indicate that seed quality and quantity, disease resistance, low yield, and productivity are the variables that require intervention to improve farmer satisfaction with the superiority of the national hybrid maize NSV. The low price of seeds, the ability to grow at 15 days, the small size of the cob, ease of harvest, and the accessibility of marketing the product at the best price were then deemed adequate variables.

Keywords: new superior variety; hybrid maize seed; competitiveness

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1. Introduction

Maize, as one of the staple food commodities in Indonesia, plays a strategic role in the economy, society, culture, and politics [1–3]. It has been reported that demand for national maize is steadily increasing year after year; for instance, in 2018, demand was 14.37 million tons, rising to 23 million tons in 2021 and 23.1 million tons in May 2022 [4–7], and it is predicted that in 2025 it will reach 33.13 million tons [8,9]. South Sulawesi is designated as a national maize production hub. The average cultivated area exceeds 300 thousand ha, contributing to an annual production of more than 1.5 million tons [10]. Generally, maize cultivation regions are often divided into three major zones based on the rainfall pattern: the east zone, the west zone, and the transitional zone. The rainy season in the eastern zone lasts from April to September, and the dry season lasts from October to March. In the west zone, the rainy season lasts from October to March, and the dry season lasts from October to March. The transitional zone, in contrast, is an area of indifference between the rainy and dry seasons. This potential rainfall pattern is ideal for maize production in South Sulawesi all year round. To boost national maize production, the government encourages farmers to use superior hybrid seeds, and this will lead to an increase in maize productivity and lead to farmer satisfaction [11–14]. Studies have shown that factors such as availability of seeds, the quality of seeds, growth rate, resistance to pests and diseases, and higher

yield have a greater impact on maize productivity and influence the farmers' choice of maize varieties [15–17]. As a result, several research findings revealed that the factors influencing farmers' selection of the right NSV includes (1) its availability and maintained continuity [18,19]; (2) the quality, seed appearance, cleanliness, the uniformity, and seed treatment [20,21]; (3) the seed price, since farmers with a minimum budget will use F2 or F3 but farmers with higher budgets will opt for F1 varieties [22,23]. Recently, it has been reported that most farmers are dissatisfied with malformed/irregular appearance and shape, as well as stunted maize seeds [24,25]. Another cause of farmers' dissatisfaction is severe pest attack and disease [26,27]. However, with introduction of the NSV this can be prevented or eliminated by 45% [28,29]. According to the FAO, caterpillars were the major invasive pest that hindered maize yields by 15–73% in 2018. In addition, another major challenge for the maize yield is rampant pests and diseases which have resulted in a 40% decline in crop yields globally [30–32]. In addition, studies have reported that the NSV drought-resistant trait adapted to marginal soil conditions is the preferred maize variety cultivated in nearly 91.9 million ha [33,34]. Other major factors that affect maize productivity include the shape of the cobs, yield, and productivity. It has been reported that farmers prefer large, long cobs covered in cobwebs and small lumps which facilitate shelling and produce high yields [35]. Therefore, in this study, our objective is to establish farmers' satisfaction with three hybrid maize varieties, namely, Nasa-29, JH-37, and Bima-10, in South Sulawesi.

The rest of the paper is organized as follows. First, in Section 2, we provide a brief review of the related literature. Second, in Section 3, we describe the concepts we propose for this study. Following this, in Section 4, we present our results and discussions. Finally, in Section 5, we give our conclusion and recommendations.

2. A Brief Literature Review

The quality of seed has a significant impact on crop productivity [36]. In addition, it has been reported that seed quality has a direct and positive impact on crop yields [36,37]. Corn seeds are generally classified into two types, namely, composite and hybrid. Both types have advantages and disadvantages according to the growing conditions and region. For example, the advantage of composite corn varieties is that they can resist a wide range of environments but have a low productivity. Hybrid corn, on the other hand, has a high production despite being particularly sensitive to biotic and abiotic influences. As a result, for maximum yield, the hybrid corn type must be supplemented with proper fertilizers, pesticides, and irrigation [38–40]. Based on these facts, the adoption of hybrid maize seeds is the key option for increasing maize production at the farmer level [41–43]. The introduction of hybrid maize in Indonesia began in 1981 by international corporations (PT. Cargil, PT. Syngenta, PT. Bayer, PT. Dupont) and lasted until the 2000s, when they dominated around 90% of the market [44]. Because maize cultivation is highly beneficial for farmers, the government, through the national research institute, has introduced 52 types of hybrid maize varieties [45], each with distinct characteristics such as drought resistance, adaptability to highlands, medium, and lowlands, and marginal soils, and market support [46–49]. Studies have shown that popularity of variety is one of the characteristics that determine farmer satisfaction. Furthermore, two elements influence farmer satisfaction: technical aspects such as productivity, adaptability, pest and disease resistance, and fertilization response, and nontechnical factors such as land ecology and climatic state of the farming area [50,51]. Other technical factors include the size of the cob, the ease of peeling, and the early maturing age, as well as the color of the seeds [52]. The nontechnical factors that influence farmer satisfaction are the availability of seeds and the ability to access seeds at the farmer level which include quality, quantity, continuity, price, and packaging in supporting seed sustainability [52,53]. Service is another nontechnical factor that has a significant impact on farmer satisfaction with seed variety. Seed suppliers must ensure that their products are available on time, in the correct place, at the right price, and of good quality [54–56]. Seed suppliers must be able to interact with farmers, as well as identify and

adapt to changing customer trends. Customer complaints must be addressed as soon as possible to ensure customer satisfaction and attentiveness [57]. Extension officers assigned to the target area, and the seed suppliers, must play a role in articulating and addressing farmers' concerns about seed varieties [36]. As a consequence, it is anticipated that the new superior variety (NSV) of hybrid maize will enhance farmer satisfaction through efficient agricultural extension services and suitable agroecological practices that will enhance maize productivity.

Theoretical Framework

The theoretical framework in this study was based on our previous related studies. As results, all essential variables investigated in this study were found to have a significant impact on farmer satisfaction on adopting NSV maize variety and enhancing national maize production in South Sulawesi, which served as a case study region. Figure 1 shows the theoretical framework utilized during the study.

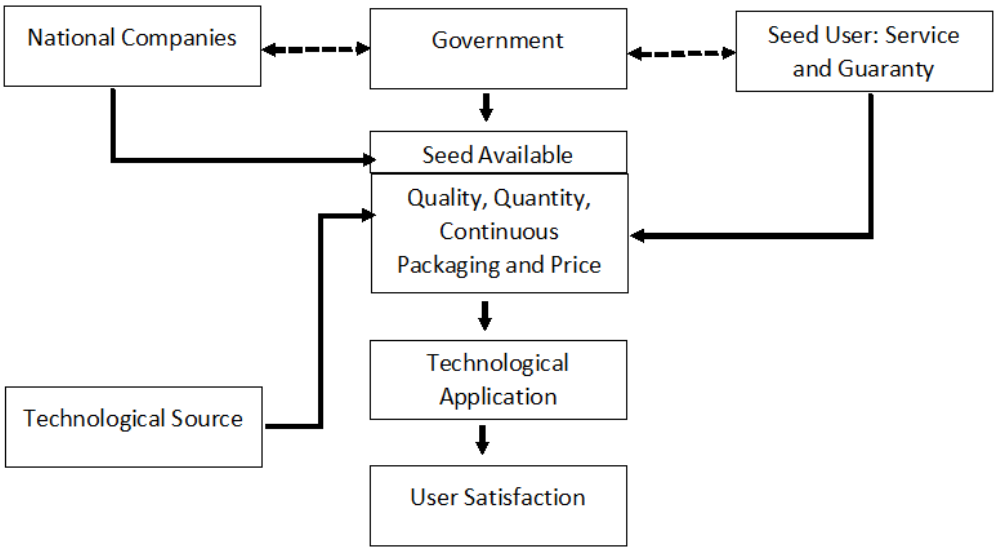

Figure 1. A theoretical framework for surveying farmer satisfaction regarding national hybrid maize NSV.

3. Materials and Methods

3.1. Field Survey and Data Collections

This survey took place in three districts of South Sulawesi's maize-production centers, namely, Bone, Gowa, and North Luwu. The selection of study are was based on (1) regional zones, namely, the eastern zone (Bone), the western zone (Gowa), and the transitional zone (North Luwu). The area has different rainfall times, and this is closely related to the success of maize farming [58]; (2) the dominant districts receive Direct Assistance for Superior Seeds (DASS) from government programs; (3) the Indonesian Cereal Research Institute (ICERI) assists dominant districts with seed distribution. Respondents deliberately selected 50 farmers in each district based on their past experience planting national hybrid maize seeds through the DASS program and ICERI dissemination program. The observed variables comprised two major components, namely, the element of hope (importance) and the element of reality (performance). These elements were discovered in seed availability, plant growth performance as a result of cultivation technology, cob appearance related to productivity, and the marketing strategy. Each aspect was further defined by its attributes and benefits, which served as a guide for interviews and discussions with respondents. The statement on the NSV attribute is based on observations of dissemination activities and the NSV licensing partner's evaluation results (see Table 1). Expressions of expectations and respondent assessments were given a score of 1 to 5 based on a Likert Scale with the following intervals: Score: 1.00–1.80 = very not good; 1.81–2.60 = not good; 2.61–3.40 = rather

good; 3.41–4.20 = good; and 4.21–5.00 = very good [59]. The scoring results are analyzed using importance performance analysis (IPA) calculations to determine the difference between expectations and performance/reality [60], and the customer satisfactory index (CSI) analysis determines the difference between expectations and performance/reality using the formulas given below.

Table 1. Farmers' suitability and satisfaction with the national hybrid maize NSV in the western zone, South Sulawesi.

Attribute	Y. Average	F.S.	X. Average	WS	GAP	Tk_i(%)
Seed quality (1)	4.7	4	2.8	11.3	−1.9	59.9
Seed quantity (2)	4.7	3.9	2.8	10.9	−1.9	58.7
Seed continuity (3)	4.6	3.8	2.8	10.8	−1.7	61.8
Seed availability (4)	4	3.4	2.6	8.7	−1.4	64.7
Seed packaging (5)	4.2	3.5	4.3	15.4	0.1	102.4
Seed price (6)	3.8	3.2	4.3	13.7	0.6	114.8
Plant population (7)	3.6	3	4.1	12.2	0.5	112.8
Growing power (8)	4.8	4	4.1	16.6	−0.6	86.6
Fertilization response (9)	3.9	3.3	4.2	13.8	0.3	107.7
Disease resistance (10)	4.8	4	3.4	13.7	−1.4	71.5
Pest-resistant (11)	3.4	2.8	4	11.3	0.6	117.8
Fertility (12)	4.4	3.7	3.9	14.3	−0.5	89
Evenness (13)	3.7	3.1	3.1	9.7	−0.6	83.9
Resistant to fall (14)	3.4	2.8	4.2	11.8	0.8	123.7
Drought resistance (15)	3.4	2.8	4.4	12.3	1	129
Harvest age (16)	3.6	3	3.5	10.5	0	99.4
Cob closure (17)	3.7	3.1	4.3	13.4	0.7	117.9
Cob length (18)	3.6	3	3.7	11.3	0.1	103.9
Cob diameter (19)	3.7	3.1	3.6	11.1	−0.1	98.4
Clump size (20)	4.6	3.8	4.9	18.8	0.3	106.1
Ease of urination (21)	4.5	3.8	4.7	17.5	0.2	103.6
Seed weight (22)	4.5	3.8	4.2	15.9	−0.3	93.8
Seed color (23)	4.4	3.6	4.3	15.8	0	99.1
Yield (24)	4.7	3.9	4.4	17.1	−0.3	93.2
Productivity (25)	4.4	3.7	3.8	14	−0.7	84.7
Warehouse pests (26)	3.4	2.8	3.6	10.2	0.2	106.5
Buyer (27)	4.3	3.6	4	14.6	−0.3	93.5
Yield price (28)	4.4	3.7	4.4	16.2	0	100.9
Payment (29)	4.5	3.7	4.3	16	−0.2	96
Amount	119.5	100	112.9	388.8	−6.6	2781.2
Average	4.1		3.9		−0.2	95.9

3.2. Attribute Mapping with IPA Analysis

Step 1: Determine the level of conformity between expectations (Y) with performance/reality (X) using the formula:

$$Tk_i = \frac{X_i}{Y_i} \times 100, \quad (1)$$

where Tk_i is the level of conformity between expectations (Y) and performance/reality (X). X_i is the farmer's assessment score on the performance of the national hybrid maize NSV; Y_i is the farmer's expectation score for the national hybrid maize NSV.

Step 2: Set the average of all the attributes of expectation (Y) and performance (X) as the limit in the Cartesian diagram using the following formulas:

$$\hat{X} = \sum \frac{X}{k} \quad (2)$$

and

$$\hat{Y} = \sum \frac{Y}{k}, \tag{3}$$

where $\hat{X}$ is the average score of farmers' assessment of the performance of the national hybrid maize NSV.

$\hat{Y}$ is the average score of the farmers' expectations of the superiority of the national hybrid maize NSV. Here, k is the number of attributes.

Step 3: Assign each attribute to the Cartesian diagram (see Figure 2) for the interpretation of each quadrant [61] as follows:

Quadrant A: Attributes that have high expectations from farmers but whose performance is still lacking need to be improved in quality by taking corrective actions;

Quadrant B: Attributes that have high expectations from farmers and high performance need to be maintained or maintained so that conditions remain stable;

Quadrant C: Attributes with low farmer expectations and low performance are ignored because they do not affect farmer satisfaction.

Quadrant D: Attributes that have low expectations of farmers but high performance need to transfer assets or energy to reinforce the condition of elements that are in Quadrant A.

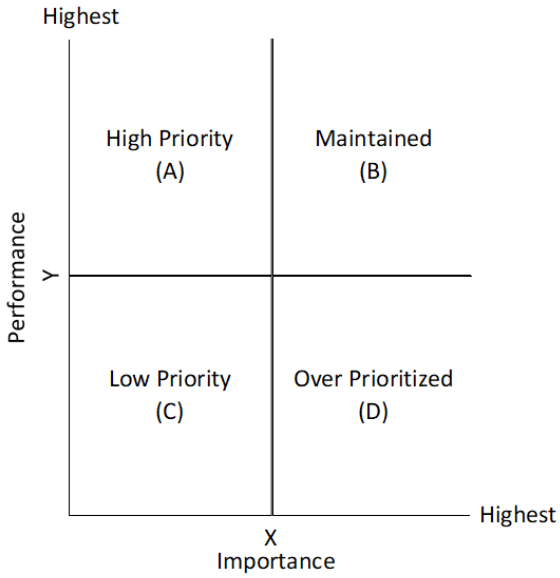

Figure 2. Cartesian diagram.

3.3. Determination of Farmer Satisfaction with CSI Analysis

Farmer satisfaction is calculated using the CSI method [62,63], with the following steps:

Step 1: Calculate the weighted factor (W.F.) by converting the average value of the importance level to a percentage so that the total weighting factor is 100%.

Step 2: Calculate the weighting score (W.S.) by multiplying the average value of the performance level by the weighting factor.

Step 3: Calculate the weighted total by adding up the weighted score of all attributes.

Step 4: Calculate the satisfaction index by dividing the weighted total by the maximum scale used (H.S.) and then multiplying it by 100%.

$$CSI = \sum_{k=1}^{p} \frac{WS}{HS} \times 100\% \tag{4}$$

The interpretation of CSI values according to [64] is defined as follows:

<65% = Very poor;

65–71% = Poor;

72–77% = Cause for concern;
78–80% = Borderline;
81–84% = Good;
85–87% = Very good;
>87% = Excellent.

Furthermore, a GAP analysis is carried out to determine which attributes will be prioritized using the formula:

$$GAP = X - Y, \quad (5)$$

where X is the performance and Y is the importance, and the highest GAP value is prioritized.

4. Results and Discussion

4.1. Regional Characteristics

In South Sulawesi, the mountains of Latimojong, Bawakaraeng, Rantekombala, and Balease divide the South Sulawesi region, resulting in three regions with different rainy seasons, namely, the east zone, the west zone, and the transitional zone (see Figure 3). The rainy season in the eastern sector is from April to September, covering Bulukumba, Sinji, Bone, Wajo, and parts of Soppeng Regency. In the western sector, the rainy season takes place in October to March, covering several regencies on the west coast of South Sulawesi, starting from Pinrang, Barru to Gowa, Takalar, and Jenepontoh. Moreover, there are areas with unclear boundaries for the rainy season, known as the transitional sector, covering the Luwu area, Tana Toraja, parts of Bantaeng, and Enrekang Regency, as shown in Figure 3. The division of the area is very vital in managing cropping patterns because rainfall and temperature patterns determine the success of plant growth [65–67].

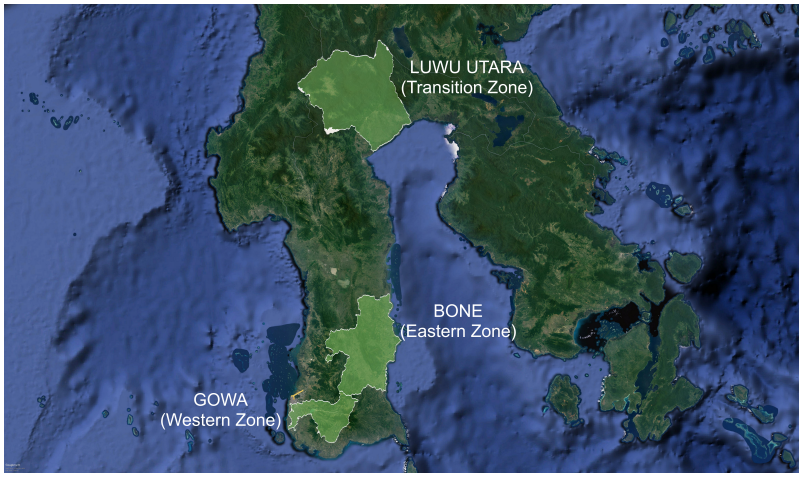

Figure 3. Study site by zones in South Sulawesi: Bone (eastern zone), Gowa (western zone) and Luwu Utara (transition zone).

Based on field observations, maize is cultivated on various types of land, such as irrigated paddy fields in the dry season, rain-free rice fields in the rainy and dry seasons with pumping facilities, dry land in the rainy season, under shaded land in the rainy season, and on mountainous land, flat and wavy to sloping. The optimization of these planting areas results in maize crop production reaching 1.82 million tons from 377.7 thousand ha [68]. This potential explains the increasing public interest in growing maize and increasing investor interest in establishing an animal feed industry in South Sulawesi. The results showed that farmers grow maize in various land ecologies and are in dire need of quality seeds and the availability of fertilizers, especially nitrogenous fertilizers [69]. The development of maize farming in the three zones offers an encouraging trend, and the maize harvesting area in the Bone district reached 48,541 ha with a production yield of 321,944 tons [70]. The increase in the planting area in North Luwu recorded in 2017 reached 21,573 ha with a production of 129,483 tons [71]. In Gowa Regency, maize plantation

expanded during 2004–2018, and an increase in production of 11.39 thousand tons per year is predicted [72,73]. The varieties favored by farmers in all regions are varieties produced by multinational companies whose prices continue to increase, so only a small number of farmers use them, and they expect that these varieties will be included in the DASS program. The quality of seeds from multinational companies is the basis used by farmers to determine their assessment of the NSV produced by national companies utilized in the DASS program.

4.2. Importance Performance Analysis

4.2.1. The Western Zone of South Sulawesi

Farmers in the western sector have been growing maize for a long time and applying more advanced technology, especially in the use of fertilizers and insecticides. Because of this, farmers require quality seeds to minimize the use of pesticides. The average score of the evaluated attributes shows that the importance value is 4.12, which means that the farmers' expectations of the national hybrid maize NSV are good, although the performance value is slightly lower at 3.89, but is still quite good (see Table 1).

Based on the surveys, the national hybrid maize NSV has great prospects in the western part of South Sulawesi because of the level of conformity between expectations and reality shown by T_{ki} (95.9), and the level of farmer satisfaction shown by CSI was as large as (388.8:5) × 100% = 77.8, which means that satisfaction is classified as moderate. The three analyses indicate that a little effort is still needed to improve the attributes that are not in line with expectations. Based on the gap analysis, it is clear that the priority attribute that needs to improve is the availability of seeds in terms of quantity, continuity, and quality (see Table A2).

4.2.2. The Eastern Zone of South Sulawesi

The response of farmers in the east sector area is almost the same as the response of farmers in the west sector. Farmers expected the availability of good-quality seeds with low-price seeds because of hybrid-minded farmers. Based on the interviews, farmers prefer the quality seeds, but the budget limitations forced several farmers to use F2 of previous maize planting. The data indicated that the farmers' expectations of the evaluated attributes are high. On attributes related to seed availability, the scores ranged from 4.1 to 4.6, with an average of 4.06, which means good to very good, and the farmer's assessment of the performance of hybrid maize NSV is in the range of 3.1–4.3 with an average of 3.6, which means it is classified as good. The correspondence between expectations and reality is 93.8 % (see Table 2).

According to the results in Table 2 above, it can be seen that the farmer satisfaction index is (379.8:5) × 100% = 76.0. This figure, according to [74], is classified as lacking or poor, and great effort is needed to improve the national hybrid maize seed supply system in the eastern sector. Based on the gap analysis, it was found that the priority attributes to be addressed are those related to seed availability, quantity, quality, and continuity, while those related to yield potential were ease of fall, the weight of 100 seeds, and productivity, which was still below the farmers' expectations. Then, the attributes that follow farmers' expectations are relatively low seed prices, resistance to pests, cob size, and yields that can be sold as the same as the dominant varieties in the area (see Table A1).

Table 2. Farmers' suitability and satisfaction with the national hybrid maize NSV in the eastern zone, South Sulawesi.

Attribute	Y. Average	WF	X. Average	WS	GAP	Tk_i(%)
Seed quality (1)	4.5	3.8	3.6	13.7	−0.9	79.6
Seed quantity (2)	4.5	3.8	3.3	12.3	−1.2	73.1
Seed continuity (3)	4.1	3.5	3.4	11.7	−0.8	81.6
Seed availability (4)	4.6	3.9	3.3	12.8	−1.4	70.3
Seed packaging (5)	3.9	3.3	4.2	13.9	0.3	107.7
Seed price (6)	4.2	3.6	4.4	15.8	0.2	103.8
Plant population (7)	4.4	3.7	4.3	15.8	−0.1	97.7
Growing power (8)	4.3	3.6	3.9	14.2	−0.3	92.3
Fertilization response (9)	4.6	3.9	4.3	16.9	−0.3	93.1
Disease resistance (10)	4.1	3.5	3.8	13.4	−0.3	92.3
Pest-resistant (11)	4.2	3.5	4.3	15.1	0.1	101.9
Fertility (12)	4.3	3.6	3.8	13.7	−0.5	87.9
Evenness (13)	4.3	3.6	4.2	15.2	−0.1	96.7
Resistant to fall (14)	4.1	3.5	4.1	14.2	−0.1	98.5
Drought resistance (15)	4.2	3.5	4.1	14.6	0	99.5
Harvest age (16)	3.7	3.1	4	12.3	0.3	108.2
Cob closure (17)	3.7	3.1	4.2	13	0.5	113
Cob length (18)	3.6	3.1	3.7	11.2	0.1	102.2
Cob diameter (19)	4	3.4	3.6	12.3	−0.4	91.2
Clump size (20)	4	3.4	3.5	11.9	−0.5	88.4
Ease of urination (21)	4	3.4	3.2	10.9	−0.8	80
Seed weight (22)	3.9	3.3	3.1	10.3	−0.8	80
Seed color (23)	4	3.4	3.9	13.2	−0.1	97.5
Yield (24)	3.6	3	3.3	10.1	−0.3	92.8
Productivity (25)	4	3.4	3.3	11.3	−0.6	83.7
Warehouse pests (26)	3	2.5	3.3	8.4	0.3	109.6
Buyer (27)	4.2	3.6	3.9	13.9	−0.3	91.8
Yield price (28)	4	3.4	4.2	14.1	0.2	104
Payment (29)	4	3.4	4	13.6	0	100.5
Amount	117.9	100	109.9	379.8	−7.9	2718.8
Average	4.1		3.8		−0.3	93.8

4.2.3. The Transitional Zone of South Sulawesi

The intensity of maize cultivation in the transitional sector exceeds the east and west zones. This is supported by rainfall patterns and becomes an opportunity for farmers in maize planting. There are two possible for planting maize in dry land conditions [75]. Along with the sufficient rainfall factor, there is the need for a chain of purchasing maize harvests in remote areas at appropriate prices (IDR 3500/kg when the survey was conducted); this encourages farmers to cultivate NSV maize.

The farmers assessment of the national hybrid maize NSV in transitional areas was low. Expectation scores ranged from 3.0–4.0 with an average of 3.6, which means good. At the some time, the national hybrid maize NSV performance only achieved 2.0–3.9 with an average of 3.0, which means it is in the medium category. The results of the analysis of conformity between expectations and reality ranged from 50–111% with an average of 83.9%, which means good (see Table 3). This is because most of the farmers in this area received low-quality DASS seeds, so they had low expectations. This is different to farmers who participate in the national hybrid maize NSV demonstration plot, where they closely evaluate it and hope that it will be developed [76]. According to the results in Table 3, the level of farmer satisfaction with attributes related to efforts to accelerate the expansion of the use of national hybrid maize VUB was (302.1:5) × 100% = 60.42, which means it is very low and requires hard work to increase satisfaction, but farmers' priority is to improve on aspects of seed availability such as quality, quantity, and continuity. Currently,

the attributes that need to be improved in terms of yield potential are the even distribution of growth in the field and resistance to pests and diseases (see Table A1).

Table 3. Farmers' suitability and satisfaction with the national hybrid maize NSV in the transition zone, South Sulawesi.

Attribute	Y. Average	W.F.	X. Average	WS	GAP	Tk_i (%)
Seed quality (1)	4	3.8	2	7.7	−2	50
Seed quantity (2)	3.9	3.7	2	7.5	−1.8	52.3
Seed continuity (3)	3.7	3.5	2	7	−1.7	54.6
Seed availability (4)	3.8	3.6	2.5	9.2	−1.3	66.3
Seed packaging (5)	3	2.9	3.3	9.5	0.2	107.3
Seed price (6)	3.7	3.5	3.9	13.8	0.2	106.3
Plant population (7)	3.3	3.1	3.4	10.6	0.1	102.4
Growing power (8)	3.7	3.6	3.4	12.2	−0.3	90.9
Fertilization response (9)	3.7	3.5	3	10.5	−0.7	80.6
Disease resistance (10)	3.5	3.3	2	6.8	−1.4	59.2
Pest-resistant (11)	3.3	3.2	2.7	8.5	−0.6	81.5
Fertility (12)	3.3	3.1	2.5	7.8	−0.8	75.9
Evenness (13)	3.6	3.4	2.1	7.3	−1.4	59.8
Resistant to fall (14)	3	2.9	2.3	6.7	−0.7	77.8
Drought resistance (15)	3	2.9	2.2	6.3	−0.8	73.5
Harvest age (16)	3.3	3.1	2.4	7.6	−0.9	73.5
Cob closure (17)	3.7	3.5	3.9	13.6	0.2	104.9
Cob length (18)	3.5	3.3	3.9	13	0.4	111.6
Cob diameter (19)	3.6	3.5	3.5	12.3	−0.1	96.8
Clump size (20)	3.6	3.4	3.4	11.7	−0.1	96
Ease of urination (21)	4	3.8	3.7	14.1	−0.3	91.6
Seed weight (22)	3.9	3.7	3.4	12.6	−0.5	87.4
Seed color (23)	3.4	3.3	3.7	12.3	0.3	109.5
Yield (24)	4	3.9	3.2	12.3	−0.8	79.7
Productivity (25)	3.6	3.5	3.2	11.3	−0.4	88.6
Warehouse pests (26)	3.4	3.2	3.3	10.8	0	99
Buyer (27)	4	3.8	3.8	14.8	−0.2	96.2
Price (28)	4	3.8	3.4	12.9	−0.6	84.3
Payment (29)	4	3.8	3	11.6	−1	75.7
Amount	104.3	100	87.2	302.1	−17.1	2433.2
Average	3.6		3		−0.6	83.9

The farmers' assessment of the national hybrid maize NSV in transitional areas was low. Expectation scores ranged from 3.0–4.0 with an average of 3.6, which means good. At the same time, the national hybrid maize NSV performance only achieved 2.0–3.9 with an average of 3.0, which means it is in the medium category. The results of the analysis of conformity between expectations and reality ranged from 50–111% with an average of 83.9%, which means good (see Table 3). This is because most of the farmers in this area received low-quality DASS seeds, so they had low expectations. This is different to farmers who participate in the national hybrid maize NSV demonstration plot where they closely evaluate it and hope that it will be developed [76]. According to the results in Table 3, the level of farmer satisfaction with attributes related to efforts to accelerate the expansion of the use of national hybrid maize VUB was (302.1:5) × 100% = 60.42, which means it is very low and requires hard work to increase satisfaction, but farmers' priority is to improve on aspects of seed availability such as quality, quantity, and continuity. Currently, the attributes that need to be improved in terms of yield potential are the even distribution of growth in the field and resistance to pests and diseases (see Table A1).

4.3. Attribute Mapping

The success of maize farming is determined by many factors, including the quality of the seeds, the applied cultivation and post-harvest technology, and the biotic and abiotic conditions, along with their marketing [77–79]. The roles of these factors need to be mapped to determine the actions needed to increase farmer satisfaction in the three regions/sectors in South Sulawesi. The match between expectations and reality gives rise two possibilities, namely, if the reality exceeds expectations, the action that must be taken is to maintain the condition of these attributes in order to maintain the current level of satisfaction; however, if the reality is worse than expectations, then corrective action must be taken on these attributes to increase user satisfaction [80,81]. In marketing, it is obvious that the satisfaction of a product user occurs when the product is available in good condition and sufficient quantities when needed [82], easy to obtain, in the right size, and is an affordable price [83,84], and it has the benefits of convenience, success, and profit [85,86]. Regarding national hybrid maize NSV seeds, the farmers' expectations in all the zones (east, west, and transitional zone) are high, e.g., good quality of the national hybrid maize NSV seeds, availability at the farmer level, and a low price affordable to farmers. However, in general, these expectations are unattainable except for the price, which is cheaper than the price of superior multinational varieties of maize seeds. Owing to the gap between expectations and reality, it has a negative value, except for packaging elements and prices, which are already positive, meaning that they receive a good response.

4.3.1. Eastern Zone of South Sulawesi

In the east sector, the national hybrid maize seed NSV performance is quite adequate. Of the 29 attributes that were assessed by farmers, 15 followed farmers' estimates (Quadrants B and D), more than half of these attributes (Quadrant B) were expected to be maintained, and the other six attributes (Quadrant D) could be ignored because of their contribution to increased satisfaction; the farmers' estimatesare not significant, as shown in Figure 4.

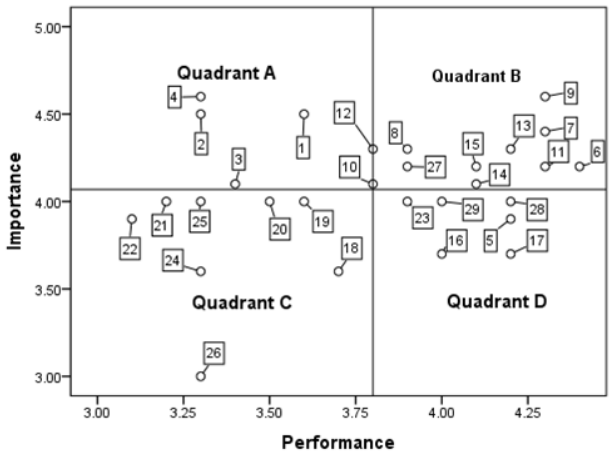

Figure 4. Cartesian diagram for eastern zone of South Sulawesi.

Note that six attributes need serious attention (Quadrant A) because the farmers' expectations are high, but the reality of performance in the field is still low. There were four attributes related to seed availability and two attributes related to cultivation. This condition provided good feedback for NSV owners to make improvements because farmers were waiting for their NSVs. Purchase prices from traders generally do not differentiate the varieties, but only the quality. Farmers in this area often complain about the price, especially at the peak of the harvest season in September. In addition to the drastic drop in prices, payments are also a bit late. The reason was the peak of the harvest season in the east sector along with the harvesting of some areas in the transitional sector and the west sector, which utilizes the pumping of rainfed rice fields and village irrigation areas during

the dry season. This condition causes maize production to be abundant in the industry but efforts to export maize have not yet reached the countryside [87]. Cooperation between marketing agencies and entrepreneurs is needed [88].

4.3.2. Western Zone of South Sulawesi

The satisfaction of farmers in the west zone with NSV for national maize seeds is lower than in the eastern zone. In the west sector, farmers are more advanced in terms of applying technology, and a water pumping system in paddy field areas is being developed. Close to the maize warehouse center that supplies the needs of the feed industry, traders have more advanced networks. Thus, maize is regarded as a very profitable commodity. Therefore, the selection of NSV hybrid maize seeds is of a higher standard. Out of 29 attributes, only 18 matched the farmers' expectation. Out of 18 attributes, only 11 attributes are expected to be maintained, while others can be ignored because they are considered less influential on farmer satisfaction, as shown in Figure 5. Next, the attribute that needs improving is the quality of the seeds so that they can match the quality of seeds from multinational companies, because farmers in this area are willing to make sacrifices to buy expensive seeds.

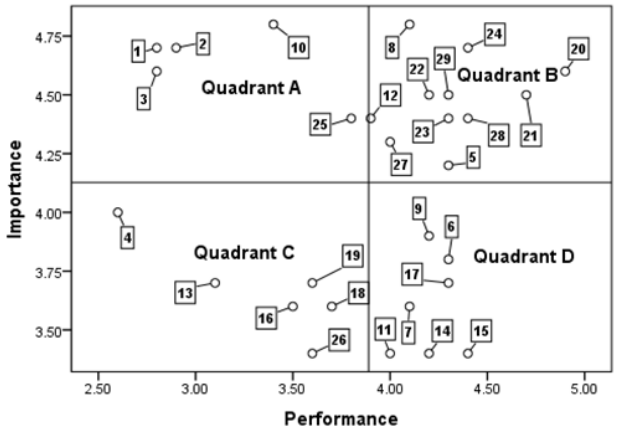

Figure 5. Cartesian diagram for western zone of South Sulawesi.

This situation was the main reason for slow distribution of national hybrid maize VUB in the western zone, because the productivity of multinational hybrid maize VUB reached an average of 9 t/ha, and in some locations it exceeded 9 t/ha. The response to fertilization includes residence complaints in this area because farmers in Gowa, Takalar, and Bantaeng districts tend to use high doses of fertilizer, namely, 50 kg of urea fertilizer per 1 kg of seed is equivalent to 1.0 t/ha, while the recommendations from the study only range from 0.3–0.4 t/ha. The effect of the excessive use of chemical fertilizers can be overcome by utilizing maize straw waste that has been processed into organic fertilizer; using this can reduce the recommended dose by 25% [89]. The problem is that innovation is slow to reach farmers. It is necessary to improve management from companies to anticipate market behavior that is very dynamic [90,91]. The appearance of VUB in a field, particularly in mountainous regions, is unsatisfactory for farmers because armyworms attack, especially in planted areas with high humidity during the rainy season. Both national and multinational hybrid maize types are affected. To address this, early insecticide spraying is recommended when the vegetative growth phase coincides with heavy rainfall [92].

4.3.3. Transitional Zone of South Sulawesi

The expectations of farmers in the transitional sector are almost the same as in the eastern sector. They liked 16 attributes, and there are even five attributes that exceeded their expectations (Quadrant D), namely, cob length, seed color, spacing with plant population above 67 thousand, resistance to warehouse pests, and attractive packaging. Then, the

attribute that needs serious attention is the availability of seeds, especially regarding quality, quantity, continuity, and time of availability, as shown in Figure 6.

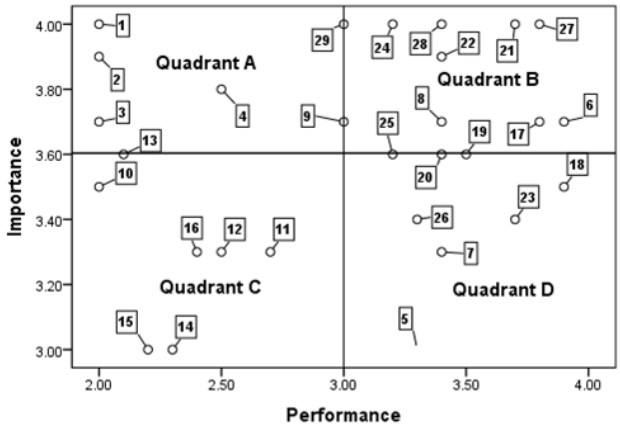

Figure 6. Cartesian diagram for transitional zone of South Sulawesi.

To maintain farmer satisfaction in the transitional zone, 12 attributes that must be maintained are productivity yields that match those of multinational seeds because they are supported by a good cob appearance. Then, a beneficial feature in the transitional sector is that the peak harvest is different from the harvest in the east and west sectors, so prices are more stable and relatively high. When the survey was conducted, the price reached IDR 4300/kg at the farm level. This means that it can potentially compete, but procedurally, the provision of national hybrid maize NSV seeds still requires improvement [76]. As a result, they intend to improve the seed supply system because seed quality is directly related to the results achieved [93,94]. This study is consistent with our previous findings, that the factors that influence farmers adopting new varieties are the agronomic potential and institutional means of production. The agronomic characteristics that are prioritized by farmers in choosing new varieties are high productivity, disease resistance, drought resistance, heat stress, early maturity, and marketability [52,53]. Related studies have shown that agroecological suitability, and also the availability and ease of access to seeds, have a substantial impact on farmer adoption rates [95]. As a result, efforts are needed to strengthen ties with institutions because strong institutions can facilitate the use of modern technology, encourage openness and cooperation with input providers, maintain communication, protect consumers, and regulate administrative and financial governance, rendering it easier to obtain government support [96].

5. Conclusions

In this study, we showed that the farmers in all surveyed regions of South Sulawesi expressed a strong willingness to adopt the national NSV hybrid maize, despite the fact that the NSVs performance and appearance fell short of their expectations. The concordance between expectations and reality on the existence of national hybrid maize NSV seeds was 95.9% in the west region, 93.8% in the east region, and 83.9% in the transitional region. Farmers' satisfaction with the national hybrid maize NSV seeds was classified as low to moderate, with each CSI value in the west region of 77.8% classified as moderate, 76.0% classified as inadequate, and 60.42% classified as very poor. The improvements to qualities that do not meet farmers' expectations are necessary to boost farmers' satisfaction with national hybrid maize seeds.

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Appendix A

The supplementary Table A1 shows the attributes and statements of advantages of national hybrid maize NSV, 2022, while Table A2 shows the priority of attribute improvement based on a GAP analysis in all regions of South Sulawesi.

Table A1. Attributes and statements of advantages of national hybrid maize NSV, 2022.

Variable	Attribute	Expert Statement
Seed availability	Quality (1)	National hybrid maize NSV seeds are of the same quality as the seeds used by farmers [51].
	Quantity (2)	The national hybrid maize NSV seeds are sufficient for the company.
	Continuity (3)	National continuous hybrid maize NSV seeds.
	Availability (4)	National hybrid maize VUB seeds available at the farm level.
	Packaging (5)	Available in 1 kg, 3 kg, and 5 kg packages.
	Price (6)	National hybrid maize NSV seeds are cheaper than other varieties [55,56].
Cultivation	Population (7)	Hybrid maize NSV can be planted with a population of 71,428 plants per hectare [35].
	Growing power (8)	National hybrid maize NSV growth capacity is above 85% [17].
	Fertilizer response (9)	National hybrid maize NSV response to nitrogen fertilization.
	Disease resistance (10)	National hybrid maize NSV is resistant to major maize diseases [36].
	Pest-resistant (11)	National hybrid maize NSV is resistant to major maize pests.
	Fertility (12)	National hybrid maize NSV fertile growth.
	Evenness (13)	NSV. The national hybrid maize grows evenly.
	Resistant to fall (14)	National hybrid maize NSV is resistant to fall.
	Dry resistance (15)	National hybrid maize NSV is classified as drought-resistant.
Cob shape appearance	Harvest age (16)	National hybrid maize NSV available early, medium, and deep.
	Closure cob (17)	National hybrid maize NSV fully covered on the cob [37].
	Cob length (18)	National hybrid maize NSV cob length 21.5 cm.
	D. cob (19)	The national hybrid maize NSV has a diameter of 4.7 cm.
	Clump size (20)	The size of the national hybrid maize NSV cob is relatively small.
Productivity	Ease of urination (21)	The national hybrid maize NSV is easy to peel and clean the shelled results.
	Seed weight (22)	The weight of 100 national maize NSV seeds reaches.
	Seed color (23)	The national hybrid maize NSV seed color is bright reddish.
	Yield (24)	The national hybrid maize NSV yield is high, reaching 87% [34].
	Results (25)	The national hybrid maize NSV production potential is high, reaching 9–12 t/ha.
	Warehouse pests (26)	National hybrid maize NSV seeds resistant to warehouse pests.
Results marketing	Buyer (27)	Buyers of dry-shelled maize do not distinguish the origin of the maize.
	Yield price (28)	The price of dry-shelled maize did not differ at the farm level [38].
	Payment (29)	Payment for maize sales is the same for all varieties 2–3.

Table A2. Priority of attribute improvement based on gap analysis in all regions of South Sulawesi.

	Priority for Handling Attributes by Zone					
Rank	**Eastern Zone**		**Transition Zone**		**Western Zone**	
1	Seed availability (4)	−1.4	Seed quality (1)	−1.5	Seed quantity (2)	−1.5
2	Seed quantity (2)	−1.2	Seed quantity (2)	−1.4	Seed quality (1)	−1.5
3	Seed quality (1)	−0.9	Seed continuity (3)	−1.2	Seed continuity (3)	−1.3
4	Ease of urination (21)	−0.8	Evenness (13)	−1	Seed availability (4)	−1.1
5	Seed weight (22)	−0.8	Disease resistance (10)	−1	Disease resistance (10)	−1
6	Seed continuity (3)	−0.8	Seed availability (4)	−0.7	Productivity (25)	−0.4
7	Productivity (25)	−0.6	Pest-resistant (11)	−0.5	Evenness (13)	−0.3
8	Fertility (12)	−0.5	Harvest age (16)	−0.4	Growing power (8)	−0.3
9	Clump size (20)	−0.5	Payment (29)	−0.4	Fertility (12)	−0.2
10	Cob diameter (19)	−0.3	Drought resistance (15)	−0.3	Yield (24)	−0.1
11	Buyer (27)	−0.3	Fertility (12)	−0.3	Yield buyers (27)	0
12	Growing power (8)	−0.3	Resistant to fall (14)	−0.2	Seed weight (22)	0
13	Fertilization response (9)	−0.3	Yield (24)	−0.2	Yield payout (29)	0.1
14	Disease resistance (10)	−0.3	Fertilizer response (9)	−0.1	Cob diameter (19)	0.1
15	Yield (24)	−0.3	Price of seeds (6)	0	Harvest age (16)	0.2
16	Evenness (13)	−0.1	Seed weight (22)	0.2	Seed color (23)	0.2
17	Plant population (7)	−0.1	Productivity (25)	0.2	Price of seeds (6)	0.3
18	Seed color (23)	−0.1	Growing power (8)	0.3	Seed packaging (5)	0.3
19	Resistant to fall (14)	−0.1	Ease of urination (21)	0.4	Cob length (18)	0.3
20	Drought resistance (15)	0	Clump size (20)	0.5	Warehouse pests (26)	0.4
21	Payment (29)	0	Cob diameter (19)	0.6	Ease of urination (21)	0.4
22	Seed price (6)	0	Yield buyers (27)	0.6	Fertilizer response (9)	0.5
23	Pest-resistant (11)	0.1	Warehouse pests (26)	0.6	Clump size (20)	0.5
24	Cob length (18)	0.1	Plant population (7)	0.7	Plant population (7)	0.6
25	Yield price (28)	0.1	Seed packaging (5)	0.8	Yield price (28)	0.7
26	Warehouse pests (26)	0.3	Cob closure (17)	0.9	Pest-resistant (11)	0.7
27	Harvest age (16)	0.3	Yield price (28)	1	Cob closure (17)	0.8
28	Seed packaging (5)	0.3	Seed color (23)	1	Resistant to fall (14)	0.9
29	Cob closure (17)	0.5	Cob length (18)	1.1	Drought resistance (15)	1

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