Effectiveness of Participatory Varietal Selection in Corn Cultivar Establishment

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***Abstract*—Corn ranked in the second position of important cereal crops after paddy rice in Indonesia. Although this commodity is still imported from other countries in almost recent year, it is considered to be main crop as a food, feed and industrial material. Hybrid cultivars are the key point to echieve self-sufficient national target. To establish prosperous hybrid cultivars a participatory variety selection has been implemented in the breeding program of corn by researchers of Brawijaya University. Such approach was developed to ensure that new cultivars satisfy farmer's preferences and suit industrials or economic trades. In the first season, three farmer groups from different regency with 20 persons in each, i.e., Nganjuk, Blitar and Sumenep, were separately encouraged to select 10 best candidates from a pool of 200 F1 Hybrids in the research station managed by Brawijaya University. Selection was mainly based on agronomic traits such as time to maturity, height, disease resistance, and grain yield and grain performance. The candidates selected by every farmer goup were then re-planted and re-evaluated by themself in their own land with different agroecological areas. Statistical analysis was applied to deduce which cultivar(s) were most preferable by farmers and considered to be prospective new cultivars in advance. The results of the study showed that three candidates selected by farmer group's have been consistently succeded in the position of five most preferable candidates in each regency. A bit different criteria based on plant height and disease resistance was found in relatively drought region, Sumenep. Eastern Java. Indonesia.**

***Index Terms*—participatory varietal selection, corn, cultivar establishment, Indonesia**

I. Introduction

Among the cereal crops, corn is one of the primary commodities in Indonesia. It ranks in the second position of agricultural products after paddy rice. Since last decade, National production of this country has been targeted to increase about 5% per year with about 6100 kg.ha^{-1} in productivity average. Although Indonesia is still importing corn from US and Latin Amerika, it's production of the current year reaches about 19.6 million tons or in the tenth biggest country. Some purposes are developed form corn, besides for food, it is also used for feed and industrial derivates of grain as well.

Java consisting of three provinces, in spite of very populated island so far, is the main contributor for more than 60 % national corn production. Of those, almost 80% existing production is utilized as animal feed, while the remain is for human consumption and other industrial means. Since the demand of corn for feed industries where mainly occupied in this island has been increased higher than the supply, about 3.5 million matric tons were imported every year from several other countries. By such situation, there is no choice to increase yield productivity of corn in Java island. So far, Indonesian government stated on some skim policies of corn breeding development for supporting self-sufficient achievement in national production. Now, several researchers repoted that corn yield potential in Indonesia was reached more than 8000 kg.ha^{-1} [1].

Hybrid cultivar is supposed to be a key point to echieve self-sufficient national target. However, to establish prosperous hybrid cultivars, high labor cost and time consuming in breeding process have to be paid for uncertainly results when getting a preferred new cultivar that compatible in free market of corn seed trade system. Another example of the breeding problem, is that selection to perform new candidates of maize variety in Indonesia has usually been focused on grain yield. Consequently, huge numbers of breeding lines have to be developed and evaluated at several research stations by even multi-location tests over several years. Nevertheless, only a few candidate is finally usable for public or commercial variety.

As the common plant breeding goal done by researchers is the new varietal released that used by farmers, the problem faced so far is that the speed of achiement or their dissemination afterwards did not lead to the expectation. Even many new varieties released could be disappointing to farmers where undesirable traits go undetected during process of breeding. Breeding

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accident likes as that is breeders can discard many collection crosses and lines during the selection process because of traits considered undesirable, but such traits may actually be of interest to farmers is commonly faced. Such occurs proven that communication gap between breeders and farmers in breeding process must be taken into consideration so far.

Participatory Plant Breeding (PPB) is a collaboration between breeding institutions and farmers that aims to develop cultivars relevant to farmers needs. It involves scientists, farmers, and others, such as consumers, vendors, industry, and rural cooperatives in plant breeding research [2]. In PPB, there is the process by which farmers are routinely involved in a plant breeding program with opportunities to make decisions throughout. Farmers' involvement can take many forms i.e., defining breeding goals and priorities, selecting or providing sources of germ plasm, hosting trials on their land, selecting lines for further crossing or selecting varietal candidates, multiplying and commercializing the seed of the selected varieties and other breeding activities that can do shared together.

Participatory Variety Selection (PVS), in easy speaking, is as a part of PPB. It refers to processes whereby farmers are involved especially in selecting lines or varieties that they judge to be most appropriate for their own uses from among a range of candidates that are being field tested [3]. PVS was implemented for cereal crop selection of several purposes likes, corn drought resistance by [4] corn protein maize (QPM) by [5] and elite sorghum by [6]. Advanced lines in yield trials or at pre release stage of later generations have been used in PVS approaches. Such approach can also be developed by obtaining farmers' input and feedback on the selection of new candidates of maize variety that are in an advance stage of development or ready for release.

Several researcher reported that PVS has revealed success in identifying more number of preferred varieties by farmers in shorter time and in lower research cost compared to conventional selection system [7], [8]. As self-sufficient of national corn production has been underlined by government program for next decades dealing with food safety where use of hybrid cultivars is strongly recommended, a PVS is, therefore, very prospective to be implemented for cultivar development in this country. The research aims are to select prosperous hybrid cultivars of corn and to ensure that the promoted cultivars satisfy farmer's preferences and suit industrials or economic trades as well.

II. Materials and Method

The researches were conducted in two planting seasons. In the first season, three farmer groups consisted of 20 persons in each, from the three different regions i.e, "Usaha Makmur" from Nganjuk, "Tani Maju" from Blitar and "Tani Jaya" from Sumenep, were separatedly invited for two weeks and encouraged to select 10 best varietal candidates from a pool of 200 F1 Hybrids grown in the research station managed by University of Brawijaya (UB). Selection criteria were mainly based on potential yield productivity of commercial variety combined with relatively different agronomic traits and performances such as Time to Maturity (TM), Plant Height (PH), Ear Height (EH), Downy Mildew (disease) Resistance (DMR), Grain Yield (GY) and Grain Colour (GC) and, tip Kernel Filling (TKF). Evaluation was conducted under guidance of field research assistants to fill the quesionare forms prepared. Each farmer then evaluated all variety candidates and helped to compile what they thought were the impotant trait criteria. Each criterion was scored from 1 to 5 (1 = very good, 2 = good, 3 = average, 4 = poor and 5 = very poor) for each traits. Farmers were also encouraged to rank an overall performance on 10 nominees as variety candidates.

Based on Farmer's selection, F1 Seeds of the 10 variety candidates (named with UB1, UB2 to UB10) and two commercial hybrid varieties (named with C1 and C2) were given to each farmer groups for the validation trials at their own field. Totally 2.400 g seed or about 200 g of each variety was given to farmers for conducting trials where corporately managed by each group using locally agronomic behavior system. Researchers did not decide any agronomic treatment in this matter but teach participatory research design, preserve numbers of fertilizers and other farming materials they need. Researchers also did trials in the same way at the Research Station belonged to Brawijaya University (UB Station), Malang, Indonesia.

A Randomized Complete Block Design with three replications was aplied in all trials. Each unit plot was set by 30 m2 (500 x 600 cm) so that effective plot width needed was about 1080 m^2 (30m^2 x 3 rep. x 12 Var.) in total at every group region. ANOVA continued by mean's separation of LSD test was used to trace the differences of candidates. Spearman Rank-Order Correlation analysis was applied to observe the correlation between ranking selected nominees by farmer's group and traits observed. The basic formula of The Spearman Rank-Order Correlation coefficient ($r_{s)}$ is

$$r_s = 1 - \left(\frac{6 \sum d^2}{n(n^2 - 1)} \right)$$

where:
r_s = Spearman's Rank coefficient of correlation
d = Difference from rank in trait 1 to trait 2
n = No. of treatment
To measure similarity of rank order made by farmer's group we use Jaccard's similarity coefficient with the formula :

$$J(A,B) = \frac{A \cap B}{A \cup B}$$

where:
A = Rank order of group A
B = Rank order of group and,
$B0 \leq J(A,B) \leq 1$

III. Results and Discussion

A. Performance Rank in Early Season

To simplify selection process in the F1 hybrid pool, farmers were asked to select 10 variety candidates based on minimum grain yield obtained by commercial standardrs in early trial. Evaluation shown in Table I revealed a distinct statistical variation of quantitative agronomic traits likes plant height, ear height and grain yield. There was significant difference in standard checks and several candidates. As it was indicated in early trial shown in Table I, UB5 has the highest grain yield productivity (10,368 kg ha^{-1}) while C1 has the lowest yield (9,024 $kg.ha^{-1}$). However, the ranking position of such candidates for over all performance determined by farmer's groups showed different order of that for grain yied rank, where UB5 and C1 are in the 11^{th} and the second rank position, respectively. The highest rank of overall performance, by the way, was obtained by UB2 with yield productivity 1,0176 $kg.ha^{-1}$, while the lowest was showed by C1 with 9,024 kg. ha^{-1}. It is supposed that Indonesian farmers did not put the grain yield into the top consideration to estimate agronomic performance of corn varieties. This also proved that farmers prefered to determine corn performance in different perspective from common breeder did who still focusing on grain yield.

Table I also showed that it was different order of ranking position in among farmer's group (RFGn). After analysis using Jaccard's similarity coefficient as shown in Table II, the results clarified that the similarity among groups varied from 0.15, 0.60. It could be said that out of 12 rank position of candidates, there were three to nine similar rank position between the groups. This results discribed to the fact that different perspective between farmer's groups for determining ideal corn variety is because of different environment and agro-ecological situation at the place.

Spearman correlation analysis in Table III revealed that farmer's behaviors in two out of three groups i.e., Blitar and Nganjuk, have only significantly engaged in character of Downy Mildew Resistance (DMR) with <p.05. The result implied that farmers have firstly more considered on the matter dealing with cost and beneficial cultivation practices rather than a bit difference of grain yield or other traits. Farmers in Java usually did not harvest corn by themself but they preferred to get the fresh money trough direct selling to collecting holder by which price to yield harvest estimation in the field regardless yield weighing. This behavior phenomenon describes farmers neglect to additional price and benefit that probably can be taken from little different yield in among varieties when they harvest and sell corn kernel to corn store. Farmers thought that such way is more simply and can get better benefit without additional cost for trashing, drying, cleaning and packing that laborious and costly. Additionally, as labor and pesticide cost in Indonesia have been tremendously increasing for last decade, easy to control plant disease by using disease resistant cultivar is the best choice to reduce cost in agronomical practices. More over, downy mildew is currently to be the most important corn disease that frequently attack and cause 30 to 100 % harvest lost. We found that the farmer's group in Sumenep, an area with relative drought area where fungal disease is rare and hard to spread abundantly (data unpublished), did not take a look on DMR into a considerable trait since there was no endemic downy mildew in this place.

Regarding with correlation of other characters, only the good combination of two to three characters mainly with DMR, i.e., DMR+SG+GC and DMR+SG were significantly met with farmers choice. Although ear height (EH) as in solitary trait was not a farmer's choice, it's combination with another trait likes grain color (EH+GC) or with tip kernel filling (EH+TKF) had correlation with farmers choice. This interesting results gave us a clear description of farmer perspectives to measure how ideal prerequisite traits within variety they need. Seemingly, the trait's perception taken a look by farmers for varietal selection of corn in Indonesia is consecutively determined as Downy Mildew Resistance, Ear Height and Grain Color, and Ear Height and Tip Kernel Filling.

Fig. 1 showed that there were slightly different performances of plant height and grain yield between held early trial and in farmer's group. Generally, the farmer's group trial in any region tend to decrease from the early trial. There was change to be higher ranking of almost all Downy Mildew Resistance (DMR) trait, especially in Sumenep. The reason is might be caused that the new place where Sumenep was not included as such disease endemic. Similar to the change of plant performance, ranking position by farmer's group also tend to change in some candidates.

B. Yield and Performance Rank in the Second Season

Result of trial in UB station of the second season was not clearly different from that in the first season (Fig. 1). Table IV showed that yield production of the second season in general was significantly different for among the places. However, out of the farmer's groups, Blitar's reached the highest productivity (9449.25 kg. ha^{-1}) and did not differ from that in UB station (9497.58 kg. ha^{-1}). As Sumenep is predominantly occupied by rain fed area and no irrigation available, so that, farmers in this place contributed the lowest productivity (8651.25 kg. ha^{-1}). According to Indonesia Statistic 2016, the average yield productivity of this place reached only below 3 $ton.Ha^{-1}$. As in the second season downy mildew attack was not so heavy (Fig. 2), there was an alter ranking position of variety candidates compared to that in early season for all places. So far, the position of candidates ranked by all farmer's group was not precisely matched in among each other, but interestingly, all they have positioned five candidates, i.e., UB2, UB4, UB5, UB7 and UB8 within the same top five rank (shaded cell of Table IV). It is supposed that due to different agronomical environment there is confusing of farmers to determine exactly perception of the most favorable candidate for any place and any time, but all farmers have agreed to select five candidates mentioned above as the best five nominees.

TABLE I. FAMER'S GROUP EVALUATION ON 10 VARIETY CANDIDATES AND TWO COMMERCIAL STANDARDS

NO	VAR. NAME	OBSERVED TRAIT								PERFORMANCE RANK		
		DMR	PH	EH	TM	SG	GY	GC	TKF	RFG-B	RFG-N	RFG-S
1	UB1	5	176.2	66.6[a]	99.3	4	9344[ab]	4	5	3	4	3
2	UB2	4	168.8	94.7[b]	103.7	4	10176[c]	5	5	11	12	11
3	UB3	5	172.4	100.2[b]	104	4	9472[ab]	4	5	5	5	5
4	UB4	5	159.5	72.4[a]	98.7	5	10016[c]	4	5	8	9	10
5	UB5	5	170.3	82.3[ab]	105	4	10368[c]	4	4	10	10	12
6	UB6	4	165.9	87.1[ab]	103	4	9824[bc]	5	4	4	3	4
7	UB7	5	174.2	84.2[ab]	105.3	4	9664[b]	5	5	9	11	8
8	UB8	4	166.1	66.4[a]	103.7	4	9248[a]	4	3	12	8	9
9	UB9	5	177.6	88.5[ab]	103.3	4	9044[a]	4	5	7	7	6
10	UB10	5	171.1	70.2[a]	104.3	5	9536[b]	5	5	6	6	7
11	C1	4	170.9	83.7[ab]	104	4	9024[a]	5	5	2	1	2
12	C2	5	168.5	77.1[a]	105	4	9216[a]	5	5	1	2	1

Note: Means followed by the same letter within the same column are not significantly different (p.0.05)

DMR : Downy Mildew Resistanca (Scored : 1-5)
PH : Plant Height (Cm)
EH : Ear Height (Cm)
TM : Time to Maturity (Days)
SG : Stay Green (Scored: 1-5)
GY : Grain Yield (kg.Ha^{-1})
GC : Grain Color (Scored: 1-5)
TKF : Tip Kernel Filling (Scored: 1-5
RFG-B: Ranked by Famer'sGroup of Blitar
RFG-N: Ranked by Famer'sGroup of Nganjuk
RFG-S: Ranked by Famer'sGroup of Sumenep

TABLE II. JACCARD'S SIMILARITIES COEFFICIENCE BASED ON RANK ORDER

	FGB	FGN	FGS
FGB	1		
FGN	0.33	1	
FGS	0.60	0.14	1

Selection is the key important role in any crop breeding and it occurs at all stages of the breeding process including choosing of breeding materials, parentals for crossing, selecting progenies and variety candidates. This breeding work is often conducted for several traits simultaneously where needs consideration of economic importance and their breeding chances. Each of these selection stages is normally conducted at experiment stations where uniform conditions and facilities for handling large numbers of test materials exist.

Farmers' visits to experiment stations are usually limited to viewing demonstration plots of a few highly selected advanced varieties. Feedback from farmers on these displayed options is usually not sought, and opportunities for their input into the selection process are thus extremely limited, which should not be the case, if breeders want quick adoption and dissemination of varieties among farmers [9]. However, the possibilities for farmers' participation in selection are as diverse as the nature of selection itself, for example, selection among single plants, progeny rows, experimental varieties, selection on- station, or selection on-farm.

Farmer participation in the breeding of crop varieties for low-resource farmers is regarded by some as necessary to ensure acceptance and eventual adoption [10], [11]. In Africa [12] reported that trained and experienced farmers influenced the result of adoption level for breeding program made by researcher. In this research we encorporated with corn special farmers and made training to them prior to undergoing research, the information of varietal selection gained form them seemed to be naturally represented to corn market trader preferences. Therefore, Participatory varietal selection here can be used effectively to identify farmer-acceptable varieties and thereby overcome the constraints of plant breeder faced in varietal release.

Participatory research increases the research thought and efficiency and farmers' knowledge that enables it to be retained effectively from year to year [13]. Research costs can also be decreased and adoption rates increased if farmers are allowed to participate in varietal testing and selection [14]. In addition, [15] also reported that production increases when farmers adopt new varieties identified in participatory research. In this research, selection result of the farmers to choose the new varieties were not much different than that of the plant breeders especially by way on principal characters such as productivity and disease resistant. Although we did not measure precisely how big cost reducing in in undergoing participatory selection, involving corn farmers in selection of variety candidates and corporation with them in research is the natural way to build market networking. Moreover, information regarding to varietal description in their point of view is important to direct breeding program correctly.

Factors such as production stability, performance in different agro-climatic zones, fit to household schedules may also contribute to selection of local varieties instead of or along with the modern varieties [16]. Joshi [14] reported that even if the varieties were high yielders, farmers reject them if they possess poor cooking quality,low milling recovery, short height, poor taste and difficulty in threshing. Agreed with report of [17] worked on PPBs of sweet corn in USA, there was a note that local farmers in East Java, especially in Madura have also considered on eating quality diseas resistant along with common consumer preferences of field corn in Indonesia i.e., high productivity, early harvest and kernel color as their consideration on selection.

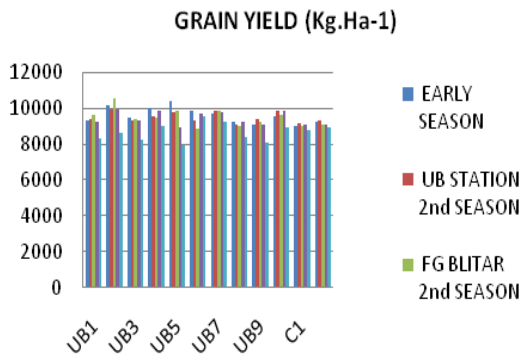

Figure 1. Average of grain yield in early and farmer's group trials

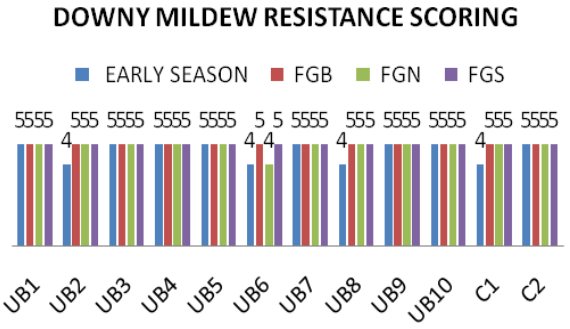

Figure 2. Comparison of downy mildew resistance in early season and second season (FGB, FGN, FGS)

TABLE III. SPEARMAN RANK-ORDER CORRELATION COEFFICIENT (R_S) BETWEEN FARMER'S GROUP RANK AND TRAITS

No	GROUP NAME	CORRELATION COEFFICIENT (r_s)											
		DMR	PH	EH	TM	SG	GY	GC	TKF	DMR+ SG+GC	DMR+ SG	EH- TKF	EH- GC
1	RFG-B	-0.61* p0.017	-0.15 p.0.324	0.56 p.029	-0.21 p.0.256	-.0.45 p.0.069	0.33 p.0.465	-0.19 p.0.274	-0.28 p.0.192	-0.87** p0.0001	-0.67** p0.005	-0.787** p0.001	-0.802** p.0.0008
2	RFG-N	-0.61* p0.009	-0.14 p.0.331	0.50 p.0.056	-0.31 p.0.166	-0.39 p0.106	0.47 p.0.415	-0.19 p.0.275	-0.28 p.0.192	-0.84** p0.0003	-0.68** p0.002	-0.733** p0.003	-0.755** p.0.002
3	RFG-S	-0.56 p0.028	-0.13 p.0.341	0.50 p.0.050	-0.12 p.0.352	-0.39 p.0.106	0.15 p.0.320	-0.24 p.0.224	-0.32 p.0.0151	-0.87** p.0001	-0.60 p0.004	-0.813 p0.0006	-0.838** p0.0003

Note:
DMR : Downy Mildew Resistance (Scored : 1-5)
PH : Plant Height (Cm)
EH : Ear Height (Cm)
TM : Time to Maturity (Days)
SG : Stay Green (Scored: 1-5)
GY : Grain Yield (kg.Ha^{-1})
GC : Grain Color (Scored: 1-5)
TKF : Tip Kernel Filling (Scored: 1-5)
RFG-B: Ranked by Famer'sGroup of Blitar
RFG-N: Ranked by Famer'sGroup of Nganjuk
RFG-S: Ranked by Famer'sGroup of Sumenep

TABLE IV. AVERAGE YIELD PRODUCTIVITY OF CORN GRAIN AND THEIR PERFORMANCES RANKED IN THE SECOND SEASON

VAR. NAME	GRAIN YIELD				PERFORMANCE RANK **		
	UB FIELD	FFB	FFN	FFS	FFB	FFN	FFS
UB1	9422	9632	9266	8310	4	6	2
UB2	9899	10511	9912	8644	***10***	***8***	***11***
UB3	9288	9360	9288	8212	6	3	1
UB4	9566	9438	9824	9032	***9***	***12***	***7***
UB5	9790	9842	8915	7888	***12***	***11***	***9***
UB6	9284	8856	9716	9574	1	4	3
UB7	9860	9812	9742	9211	***11***	***9***	***12***
UB8	9104	9038	9243	8354	***8***	***10***	***10***
UB9	9420	9212	9056	8046	5	5	6
UB10	9868	9614	9859	8892	***7***	***7***	4
C1	9160	8968	9102	8756	3	2	***8***
C2	9310	9108	9044	8896	2	1	5
Means*	9497.58 a	9449.25 ab	9413.92 b	8651.25 c			

Note: *: Values followed by the same letter in the same row are not significantly different, p=0.05
**: Shaded cells are the top 5 ranks selected by farmer's group
FFB: FARMER FIELD, BLIRAR
FFN: FARMER FIELD, NGANJUK
FFB: FARMER FIELD, SUMENEP

IV. CONCLUSION

PVS involving three farmer's group has proven to be effective for selecting of several prosperous corn varieties. Criteria for selection by farmer's group were slightly different from those by researchers especially on qualitative attributes. All farmers agreed to select five hybrid candidates, i.e., UB2, UB4, UB5, UB7 and UB8 within the top five rank. These results lead to propose them to be release as new prosperous corn hybrids that expected to be used broadly by Indonesian farmers and succeeded for national seed market.

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REFERENCES

[1] H. Kustanto, N. S. Arifin, N. Basuki, and K. Astanto, "Genetic diversities in the sixth - generation of selection (S6) of some inbred lines of maize based on the phenotypic characters and SSR," *Agrivita*, vol. 34, no. 2, 2012.
[2] B. R. Sthapit, K. D. Joshi, and J. R. Witcombe, "Farmer participatory crop improvement. III. Participatory plant breeding: A case study for rice in Nepal," *Experimental Agriculture*, vol. 32, pp. 479-496, 1996.
[3] J. Witcombe, K. Joshi, R. Rana, and D. Virk, "Increasing genetic diversity by participatory varietal selection in high potential

production systems in Nepal and India," *Euphytica*, vol. 122, pp. 575–588, 2001.
[4] G. Abebe, T. Assefa, H. Harrun, T. Mesfine, and M. A. Abdel-Rahman, "Participatory selection of drought tolerant maize varieties using mother and baby methodology: A case study in the semi arid zones of the Central Rift Valley of Ethiopia," *World Journal of Agricultural Sciences*, vol. 1, no. 1, pp. 22-27, 2005.
[5] Mbuya, K. K. Nkongolo, A. Kalonji-Mbuyi, and R. Kizungu, "Participatory selection and characterization of quality protein maize (QPM) varieties in Savanna agro- ecological region of DR-Congo," *Journal of Plant Breeding and Crop Science*, vol. 2, no. 12, 2010.
[6] K. K. Nkongolo, L. Chinthu, M. Malusi, and Z. Vokhiwa, "Participatory variety selection and characterization of Sorghum (Sorghum bicolor (L.) Moench) elite accessions from Malawian gene pool using farmer and breeder knowledge," *African J. of Agric. Res.*, vol. 3, no. 4, pp. 273-283, April 2008.
[7] D. M. Maurya, A. Bottrall, and J. Farrington, "Improved livelihoods, genetic diversity and farmer participation: A strategy for rice breeding in rainfed areas of India," *Experimental Agriculture*, vol. 24, pp. 311-320, 1988.
[8] E. Weltzien, M. E. Smith, L. S. Meitzner, and L. Sperling, "Technical and institutional issues in participatory plant breeding-From the perspective of formal plant breeding," A Global Analysis of Issues, Results, and Current Experience, PPB, 2003.
[9] L. Mbulwe, M. Lwaile, and M. Chisi, "Effectiveness of participatory breeding and variety selection for sorghum technology adoption in Zambia," *Net Journal of Agricultural Science*, vol. 3, no. 2, pp. 41-48, 2015.
[10] S. Gyawali, S. Sunwar, M. Subedi, M. Tripathi, K. D. Joshi, and J. R. Witcombe, "Collaborative breeding with farmers can be effective," *Field Crop Res.*, vol. 101, pp. 88-95, 2007.
[11] F. Mekbib, "Farmer and formal breeding of sorghum (Sorghum bicolor (L.) Moench) and the implications for integrated plant breeding," *Euphytica*, vol. 152, no. 2, pp. 163-176, 2006.
[12] K. Barnabas, G. K. Light, and R. M. Obadiah, "Participatory plant breeding and selection impact on adoption of improved sweetpotato varieties in Uganda," *J. of Agric. Sci. and Tech.*, vol. 2, pp. 673-681, 2012.
[13] E. Mulatu and K. Belete, "Participatory variety selection in lowland sorghum in eastern Ethiopia: Impact on adoption and genetic diversity," *Expe. Agric.*, vol. 37, pp. 211-229, 2001.
[14] K. D. Joshi, M. Subedi, R. B. Rana, K. B. Kadayat, and B. R. Sthapit, "Enhancing on-farm varietal diversity through participatory varietal selection: A case study for chaite rice," *Exper. Agric.*, vol. 34, pp. 201-210, 1997.
[15] J. R. Witcombe, S. Jones, and A. Joshi, "Farmer participatory crop improvement. The spread and impact of rice variety identified by participatory varietal selection," *Exper. Agric.*, vol. 35, pp. 471-479, 1999.
[16] S. T. Brush and E. Meng, "Farmers valuation and conservation of crop genetic resources, genetic," *Resources and Crop Evolution*, vol. 45, pp. 139-150, 1998.
[17] A. C. Shelton and F. T. William, "Recurrent selection and participatory plant breeding for improvement of two organic open-pollinated sweet corn (Zea mays L.)," *Pop. Sustainability*, vol. 7, pp. 5139-5152, 2015.

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