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Original article

Participatory Varietal Selection (PVS): a rice breeding approach aimed at the target population

Selección Varietal Participativa (PVS): un enfoque de mejoramiento en arroz dirigido a la población meta

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ABSTRACT: Participatory Varietal Selection combines the interests of producers and breeders to obtain and adopt promising rice genotypes that respond better to different soil and climatic conditions. The work was carried out in Los Palacios municipality, Pinar del Río Province, Cuba, with the objective to identify the cultivars with greater acceptance and the agronomic criteria of greater consideration from the perspective of the participants. The participatory selection was carried out at the Agrodiversity Fair where 18 cultivars were exposed and researchers from Paraguay and Panama participated, as well as Cuban actors from both sexes linked to the rice productive chain. The cultivars with the greatest acceptance and the most relevant agronomic criteria were identified. The most selected cultivars were Anays LP-14, Nenita LP-25 and Isra LP-24 and the characters most taken into account at the time of the participatory selection were: plant erection, number of panicles/m^2, number of grains/panicle, pest resistance and cycle. These activities constitute an excellent space for training and feedback in order to stimulate and strengthen the learning and interaction process of various stakeholders, as well as to accelerate the adoption of cultivars, enrich and maintain the genetic diversity of this crop and at the same time to increase yields.

Key words: selection criteria, grain, production, fair, *Oryza sativa* L.

RESUMEN: La Selección Varietal Participativa combina los intereses de productores y mejoradores para la obtención y adopción de genotipos de arroz prometedores que respondan mejor a las diferentes condiciones edafoclimáticas. El trabajo se llevó a cabo en el municipio Los Palacios, provincia Pinar del Rio, Cuba, con el objetivo de identificar los cultivares con mayor aceptación y los criterios agronómicos de mayor consideración desde la perspectiva de los participantes. La selección participativa se realizó en la Feria de Agrodiversidad donde fueron expuestos 18 cultivares y en la cual participaron investigadores de Paraguay y Panamá, así como actores cubanos de ambos sexos vinculados a la cadena productiva de arroz. Se identificaron los cultivares con mayor aceptación y los criterios agronómicos de mayor relevancia. Los cultivares más seleccionados resultaron ser Anays LP-14, Nenita LP-25 e Isra LP-24 y los caracteres que más se tuvieron en cuenta en el momento de la selección participativa fueron: porte, cantidad de panículas/m^2, cantidad de granos/panícula, resistencia a plagas y ciclo. Estas actividades constituyen un excelente espacio para la capacitación y la retroalimentación en función de dinamizar y fortalecer el proceso de aprendizaje e interacción de diversos actores claves, así como para acelerar la adopción de cultivares, enriquecer y mantener la diversidad genética de este cultivo y al mismo tiempo aumentar los rendimientos.

Palabras claves: criterios de selección, granos, producción, feria, *Oryza sativa* L.

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INTRODUCTION

In breeding programs for crops of agricultural interest, it is necessary to have a broad genetic base to ensure sufficient variability to have a chance of selecting the desired genotypes. Crop breeding based on decentralized selection may continue to miss its objectives if it does not take into account farmers' preferences and knowledge, as well as the influence of the environment. The last two decades have been characterized by increased integration of participatory evaluation methods, which were developed as an alternative to centrally controlled breeding methods to better incorporate end-user perspectives into the varietal development process and more effectively address farmers' desires to increase food security and improve farmers' livelihoods (1).

Crop breeding research has created a continuous flow of new and breeded germplasm for the benefit of farmers and consumers during and after the Green Revolution. Understanding farmers' heterogeneous preferences for varietal traits in different market segments and incorporating the most prominent ones into crop breeding programs is expected to facilitate more rapid dissemination of these new cultivars (2).

Cultivars with new traits or trait combinations provide farmers with options to succeed and adapt to changing agroecological and socioeconomic conditions worldwide. However, production goals, access to resources, as well as corresponding varietal traits vary for different groups of farmers, with gender differences often being critical (3). In this regard, participatory breeding research approaches have been proposed as a way to increase farmers' adoption of new cultivars. The idea is to generate information on the target population's knowledge and opinions about their production system and to use the information to design and manage future breeding projects (4).

Participatory Varietal Selection (PVS) combines the perspectives of farm households and the interests of breeders to obtain promising rice lines. The participatory approach highlights farmers' preferences as feedback to strengthen crop breeding (5). These methods open up opportunities to create farmer-preferred lines, assist in rapid release, and facilitate adoption. This approach has been effective because it takes into account the socio-technological context of end users during the evaluation, confirmation, and promotion of new rice lines (6). It is able to expose breeding material to a variety of target environments, including locations, years, agronomic managements, and social contexts, and quickly switch to new ones when necessary (7), demonstrated the potential to increase varietal diversity and on-farm adoption rates (1).

In Cuba, the participatory selection of cultivars that is generally carried out in the "Diversity Fairs" has been very successful; this methodology has contributed to the introduction of new technologies and diversity of different crops to farmers' farms (8-11).

Considering this background, the objective of this work is to identify the cultivars with greater acceptance and the agronomic criteria of greater consideration from the perspective of the participants in the participatory selection of rice cultivars in the conditions of Los Palacios municipality, Pinar del Rio province, Cuba.

MATERIALS AND METHODS

Location

The work was carried out in the municipality of Los Palacios, Pinar del Río Province, Cuba. The garden of rice cultivars for the development of the Diversity Fair was located in areas of the Scientific and Technological Unit of Los Palacios Base, belonging to the National Institute of Agricultural Sciences (INCA), where the Participative Selection of Cultivars was subsequently carried out.

General aspects for the assembly of the Cultivar Garden

An area was selected that would allow conditioning in order to achieve adequate establishment of the crop. For the assembly of the plots, the soil uniformity was sought to avoid differences among the cultivars as a consequence of factors unrelated to the characteristics of each one of them. The cultural tasks during the crop cycle (soil preparation, sowing, fertilization, irrigation and phytosanitary treatments) were carried out according to the indications established in the Technical Instructions for Rice Cultivation (12).

A total of 18 genotypes were planted, 16 commercial cultivars from the institution's own germplasm bank and two new materials obtained within the framework of this project (Isra LP-24 and Nenita LP-25) were included. These were identified with a consecutive number (1 to 18) and not with their name, since this and the origin are informed after the selection is made so that it does not influence the participants during this process, since it could bias the results of the selection.

The cultivars were planted in plots of 1 m^2 and a space of 50 cm was left between them to avoid the possible effect of competition between them, to facilitate the attention to the crop, the selection and the planned evaluations. These are shown in Table 1 and the selection criteria that integrated the survey in Table 2.

PVS Surveys

The methodology was explained, the surveys were handed out (Figure 1) and participants were given the opportunity to select up to five cultivars from the 18 on display.

Participants

Producers from Los Palacios municipality participated, both from the State Sector and the Cooperative and Peasant Sector, belonging to different productive forms, as well as four foreign researchers, two from the Multidisciplinary Center for Technological Research (CEMIT-UNA, according its acronym in Spanish) belonging to the National University of Asuncion in Paraguay and two from the Institute for Agricultural Innovation of Panama (IDIAP, according its acronym in Spanish), in addition to specialists, technicians, researchers and decision-makers from the territory.

Table 1. Rice cultivars exhibited at the Diversity Fair for participatory selection.

No.	Cultivar	No.	Cultivar
1	INCA LP-1	11	Eduar LP-21
2	INCA LP-4	12	IACuba -29
3	INCA LP-5	13	IACuba -30
4	INCA LP-6	14	IACuba -35
5	INCA LP-7	15	IACuba -41
6	Anays LP-14	16	IACuba -42
7	Roana LP-15	17	Isra LP-24
8	Ginés LP-18	18	Nenita LP-25
9	Guillemar LP-19		
10	José LP-20		

Table 2. Selection criteria that made up the field survey applied.

No.	Characters
1	Plant size
2	Height
3	Number of offspring
4	Number of panicles/m^2
5	Number of grains per panicle
6	Resistance to pests
7	Cycle

Exchange of Experiences

Within the framework of the Diversity Fair, a talk was given on "Participatory Plant Breeding and the importance of Participatory Cultivar Selection" as an effective, easy-to-implement, low-cost way of valuing available germplasm and generating results in the short term. In addition, the characteristics of the cultivars exhibited in the garden were discussed and the results of similar trials carried out in Cuba and other countries were discussed. Participants had the opportunity to exchange experiences and discuss criteria among producers and between them and researchers, decision-makers and other actors in the production chain present at the activity.

Information analysis

Information was collected from the list of participants, which included: name, sex, occupation, place of origin, work center or production unit, address and telephone number, as well as the surveys prepared for this purpose, which included both the cultivars selected and the selection criteria, based on visual observation of the overall behavior of the cultivars. Descriptive statistics were used to analyze the indicators evaluated, by counting and summing the number of votes cast for each one, in order to know the cultivars of greatest interest to the participants and likewise for the most important selection criteria.

The tabulation of all the information was done using Microsoft Excel 2019 and graphs were drawn to illustrate the results. At the time of analyzing the information, specialists, technicians, researchers and extensionists were included in the category of "technicians".

RESULTS AND DISCUSSION

Thirty-two people participated in the selection of rice cultivars at the Diversity Fair and 87.5 % corresponded to the categories of producers and technicians, while 25 % of the total were women (Table 3). The participation of women in this process is considered of utmost importance because the inclusion of complementary trait preferences of women and men in a given cultivar will facilitate the response to the full range of household needs (3).

Female participation was higher in the group of technicians, but was nil in the group of producers, which shows that there is still a great potential to increase the presence of women in the sector, based on the application of the gender approach in local development. This becomes important if it is taken into account that studies of the same type carried out in other countries report that women farmers are open to experimentation with new cultivars and are willing to pay for breeded varietal traits; for this reason, the gender differentiation for varietal trait preferences, the patterns and underlying causes of these differences are investigated and

PARTICIPATORY SELECTION OF RICE

Name _____ **AGE** ____ **SEX** ____

Occupation _____

CPA _____

CCS _____

UBPC _____

OTHER _____

SELECTION CRITERIA	Var. #	Var. #	Var. #	Var. #	Var. #
Plant size					
Height					
Number of offsprings					
Number of panicle/ m^2					
Number of grains					
Resistance to pests					
Cycle					
Others (as you consider)					

Figure 1. Field survey applied during the participatory selection of rice cultivars.

Table 3. Number of participants per group in the participatory selection of rice cultivars.

Groups	Quantity	Percentage (%)	Men	Women
Producers	10	31.25	10	-
Technicians	18	56.25	11	7
Decision makers	2	6.25	2	-
Press	2	6.25	1	1
Total	32	100	24	8

analyzed, as well as how this knowledge can be used for gender-sensitive breeding (2,3).

Women are a key sector for rural development and hunger eradication, so it is urgent to achieve equity and encourage their full and effective participation in production processes. Agricultural development programs are increasingly aimed at promoting women's participation in agricultural extension in countries and regions where women are marginalized and their access to extension is limited by sociocultural and institutional barriers. Some results reveal that women's access to extension changes household farming practices by increasing the number of main and secondary crops as well as the number of plots. In addition, they found a significant negative correlation between women's access to extension and adoption of a breeded cultivar (13).

Participatory selection of rice cultivars revealed that the most selected cultivars turned out to be Anays LP-14, Nenita LP-25 and Isra LP-24, with percentage higher than 68 (Figure 2).

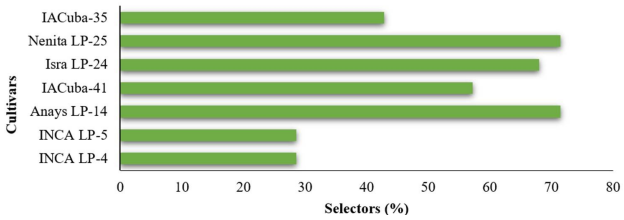

Figure 2. Cultivars selected by participants in the Rice Diversity Fair.

Anays LP-14 is the first cultivar obtained in Cuba through the cultivation of rice anthers with resistance to *Pyricularia grisea* Sacc and excellent behavior of agronomic characters, this is already registered in the Commercial Register of Cuban Cultivars for crop breeding and although it has not been very extended in state enterprises, it is well accepted in the peasant cooperative sector (14), while Isra LP-24 is a cultivar of medium cycle, which has shown excellent agricultural and industrial yields. Likewise, Nenita LP-25 stands out for its earliness, compact panicles and high number of grains per panicle (9). Both were obtained through the use of hybridizations and show tolerance in the field to the main pests that affect the crop; their behavior has been validated in areas of small producers of the Cooperative Sector and in Cultivar Gardens for participatory selection. Work is underway to obtain basic seed and the process for registering it.

Rice production and productivity have not adapted as much as required with the traditional system of cultivation despite the many efforts being made. By inviting farmers to make decisions in the research process, it is assumed that they will not only adopt, but more importantly, adapt the available technology to their own needs and environment (15).

Also among the materials for which the breeders showed interest were the cultivars IACuba-41 and IACuba-35 with more than 45 % preference. INCA LP-4 and INCA LP-5 also stood out, all with percentages above 28 %. The lack of information on cultivar preference may lead to low adoption of cultivars by farmers (5).

Surveys on selection criteria indicated that the characters that were most taken into account at the time of cultivar selection were: growth habit, number of panicles/m2, number of grains/panicle, resistance to pests and cycle, all with percentages higher than 70 %, while height and number of progeny were less taken into account (57.15 %) (Figure 3).

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The surveys on selection criteria indicated that the characters that were most taken into account at the time of cultivar selection were: size, number of panicles m^2, number of grains/panicle, resistance to pests and cycle, all with percentages higher than 70 %, while height and number of children were less taken into account (57.15 %) (Figure 3).

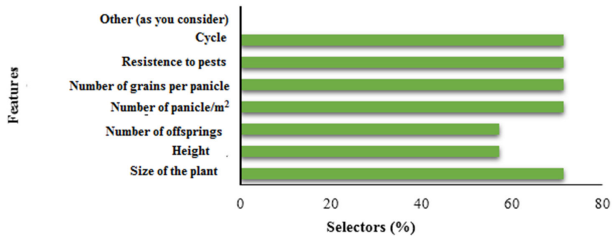

Figure 3. Rice cultivar selection criteria by participants in the Rice Diversity Fair in Los Palacios municipality.

In this sense, it has been reported that yield, in almost all crops, is a complex trait that manifests itself from multiplicative interactions of several other traits that are called yield components. It is known that yield is based on the balance or overall net effect produced, directly or indirectly, by several of its components interacting with each other. This suggests that yield selection alone would not be as important unless it is accompanied by the selection of other yield-influencing traits. Consequently, the identification of important characters and their association with yield and with each other are very useful to develop an efficient breeding strategy to obtain high yielding cultivars (16), however, it is opportune to remember that the phenotype is considered as a result of the genotype, the environment and the interaction of genotype by environment. This interaction is one of the most researched topics in the field of plant breeding, due to its great effect on genetic gains and considerably complicates the work of the breeder, particularly when it is of a qualitative type (7). Consequently, the latter interferes in the recommendation of the cultivar due to the inconsistency of its performance in the environments (locations and years) and in the estimation of genetic parameters. The presence of this interaction is usually considered a disadvantage for the breeder; however, it can be exploited by identifying specific cultivars for each environment, selecting cultivars with greater phenotypic stability and performing environmental stratification or agroecological zoning (17).

As could be seen, breeders showed interest in criteria related to productivity, such as number of panicles/m2 and grains per panicle, and in this sense it is affirmed that grains per panicle have a highly significant and positive correlation with yield, and the number of panicles is also identified as another important character with direct effect on grain yield in rice (18,19). Consequently, these traits should be given attention in rice breeding programs because of their strong influence on crop yield.

For example, in Nepal, farmers were mainly interested in traits such as plant height, days to maturity (cycle), pest and disease resistance along with yield components (20), while in Indonesia, the results of farmer interviews in three locations indicated that rice productivity and disease and pest resistance were the most preferred traits (21). Research of the same type in Cuba revealed that most farmers identified the number of panicles per square meter, number of grains per panicle, yield, pest tolerance, and resistance to lodging and shattering as the most important traits (22).

The cycle and plant size were also considered important characters during selection, being variables to which breeders attribute a great value, taking into account that short cycle cultivars take better advantage of the sowing calendar, demand less fertilizers and consume less water, for which reason several researches are directed to the development of early cultivars (23,24). Regarding the plant size, it has been found that erect panicle cultivars with short flag leaves could show a higher photosynthetic rate in the maturation stage and, therefore, this trait could be a potential phenotypic marker to achieve high yields of rice with erect panicles (25).

Several factors may explain the limited adoption of new cultivars. First, the selection criteria of breeders or breeders sometimes do not coincide with the needs and preferences of producers (26). Unlike breeders, farmers often prefer cultivars with multiple traits. Even when a farmer's focus is a single trait, the farmer's evaluation may differ from that of a breeder. For example, whereas a breeder's evaluation of yield may be the output obtained per unit area, a farmer's evaluation may also include meal yield (27). Farmer selection criteria are often based on a number of characteristics such as active participation in technology development, cropping system, and family uses of the crop and market; however, they may differ depending on the gender and age of farmers, as well as socioeconomic situations (1).

In general, farmers have shown their own way to select a cultivar for their localities, therefore, taking into account their preferences in a cultivar selection process is of utmost importance (28), since the interaction effects of genotype and environment show that genotypes respond differently to variations in location, which indicates that it is necessary the verification of these in multiple locations (21).

In Cuba, diversity fairs, where participatory cultivar selection and field days are generally carried out, are considered a good tool to obtain immediate feedback from farmers; the participatory approach has an important role in the adaptation and diffusion of technologies in less time than the conventional mode.

PVS results are useful to obtain systematic feedback in the breeding program based on key traits, characteristics and preferences required by the end users; to improve the distribution of genetic material based on their appreciation; to obtain efficiency in the breeding process by increasing the probability of adoption and dissemination by the end user; and to reduce the time required for the release of a cultivar (29).

The exchange addressed the characteristics of the cultivars exhibited in the garden and discussed the results of similar trials carried out in Cuba and other countries. Participants had the opportunity to exchange experiences with the foreign specialists present at the activity, on the advantages of these methods that allow a rapid adoption of cultivars by the producers. The training of these key actors is a tool that is often overlooked, because many producers stick to the more traditional ways, valuing themselves more for their labor force and practical activity than for the capacity they can develop to undertake and specialize in new tasks.

The exchange workshop, which involved various key actors, was very useful and allowed the participants to broaden their knowledge of plant breeding and PVS. It was also a space to clarify doubts, identify new training needs, establish new goals and use the information generated to obtain feedback for future research and, above all, for rice breeding.

CONCLUSIONS

- The most selected rice cultivars at the Diversity Fair were Anays LP-14, Nenita LP-25 and Isra LP-24 with percentages above 68 %.
- The characteristics most taken into account at the time of cultivar selection were: size, number of panicles m^2, number of grains/panicle, resistance to pests and cycle, all with percentages above 70.
- The Diversity Fair is an excellent space for training in order to dynamize and strengthen the learning process and interaction of various key actors, as well as to accelerate the adoption of cultivars, enrich and maintain the genetic diversity of this crop, promote gender equity and at the same time increase yields.

BIBLIOGRAPHY

1. Begna T. Importance of Participatory Variety Selection and Participatory Plant Breeding in Variety Development and Adoption. Advances in Crop Science and Technology. 2022;10: 497. Available from: https://www.researchgate.net/profile/Temesgen-Begna/publication/359203518_importance-of-participatory-variety-selection-and-participatory-plant-breeding-in-variety-development-and-adoption/links/622e1c5b97401151d2172115/importance-of-participatory-variety-selection-and-participatory-plant-breeding-in-variety-development-and-adoption.pdf
2. Krishna VV, Veettil PC. Gender, caste, and heterogeneous farmer preferences for wheat varietal traits in rural India. PLoS ONE. 2022;17(8): e0272126. https://doi.org/10.1371/journal.pone.0272126
3. Weltzien E, Rattunde F, Christinck A, Isaacs K, Ashby J. Gender and Farmer Preferences for Varietal Traits. In Plant Breeding Reviews, I. Goldman (Ed.). 2019. https://doi.org/10.1002/9781119616801.ch7
4. Fatondji Y, Adoukonou H, Sognigbe N, Gandonou C, Vodouhè RS. Farmers' preferences for varietal traits, their knowledge and perceptions in traditional management of drought constraints in rice cropping in Benin: Implications for Rice Breeding. Journal of Agricultural Science. 2020;12(11). doi:10.5539/jas.v12n11p56.
5. Aristya VE, Taryono, Trisyono YA, Mulyo JH. Stakeholder preferences on major characteristics of promising rice lines. IOP Conf. Ser. Earth Environ. Sci. 2021; (686), 012056. doi:10.1088/1755-1315/686/1/012056.
6. Burman D, Maji B, Singh S, Mandal S, Sarangi SK, Bandyopadhyay BK, Bal A.R, Sharma DK, Krishnamurthy SL, Singh HN, *et al*. Participatory evaluation guides the development and selection of farmers' preferred rice varieties for salt- and flood-affected coastal deltas of South and Southeast Asia. Field Crops Res. 2018, 220, 67-77. https://doi.org/10.1016/j.fcr.2017.03.009
7. Ceccarelli S, Grando S. Return to Agrobiodiversity: Participatory Plant Breeding. Diversity 2022;14: 126. https://doi.org/10.3390/d14020126
8. Díaz S, Morejón R, Maqueira L, Echevarría A, Cruz A, Roján O. Selección participativa de cultivares de soya (*Glycine max*, L.) en Los Palacios, Pinar del Río, Cuba, *Cultivos Tropicales*. 2019; 40(4):1-13. Available from: https://www.redalyc.org/journal/1932/193263189002/193263189002.pdf
9. Díaz S, Morejón R, Maqueira L, Echevarría A, Cruz A. Selección participativa de cultivares de frijol (*Phaseolus vulgaris* L.) en Los Palacios, Pinar del Río. Cultivos Tropicales. 2021; 42(4). Available from: https://www.redalyc.org/journal/1932/193270002008/193270002008_2.pdf.
10. Viera FJ, Hernández L, Viera D. Fitomejoramiento participativo del frijol común (*Phaseolus vulgaris* L.) en el municipio Manatí, Cuba. Agronomía y Ambiente. Argentina. 2022; 22(1). Available from: http://agronomiayambiente.agro.uba.ar/index.php/AyA/article/view/200
11. Escalona L, Estrada A, Álvarez A. Selección participativa de cultivares de *Phaseolus vulgaris* L. en la Finca "La Victoria", municipio Guisa, Granma. Avances. 2023; *25*(1): 80-95. Available from: http://avances.pinar.cu/index.php/publicaciones/article/view/738/2065
12. MINAG. Instructivo Técnico Cultivo de Arroz. Instituto de Investigaciones del Arroz, MINAG. 2014. 73 p. Available from: https://isbn.cloud/9789597210863/instructivo-tecnico-cultivo-de-arroz/
13. Akter S, Erskine W, Spyckerelle L, *et al.* The impact of women's access to agricultural extension on cropping practices in Timor-Leste. Food Security 2020; 12, p. 449-463. https://doi.org/10.1007/s12571-020-01007-0
14. Pérez NJ, González MC, Cristo E. Diversidad fenotípica de cultivares cubanos de arroz obtenidos por el INCA en el período 1984-2020. Cultivos Tropicales. 2022; 43(4). Available from: https://ediciones.inca.edu.cu/index.php/ediciones/article/view/1717
15. Rice KG, Ashby JS. An efficient method for classifying perfectionists. Journal of Counseling Psychology, 2007; 54(1):72-85. https://doi.org/10.1037/0022-0167.54.1.72
16. Katiyar D, Srivastava KK, Prakash S, Kumar M, Gupta M. Study correlation coefficients and Path Analysis for Yield and its Component characters in Rice (*Oryza sativa* L.). Journal of Pharmacognosy and Phytochemistry. 2019; 8(1):1783-1787. Available from: https://www.phytojournal.com/archives/2019/vol8issue1/PartAD/8-1-424-708.pdf.
17. Acevedo MA, Silva R, Álvarez R, Torres O, Reyes E. Environmental stratification of rice by genotype x environment interaction analysis using five methods.Agronomía Mesoamericana. 2019; 31(1): 43-57. https://doi.org/10.15517/am.v31i1.35187

18. Jeevula BN, Eswara NPR, Ramesh PB, Srividhya A. Correlation and path coefficient analysis of rice genotypes for their yield components under drought condition. Journal of Pharmacognosy and Phytochemistry 2019; 8(4): 784-787. Available from: https://www.phytojournal.com/archives/2019/vol8issue4/PartN/8-4-76-967.pdf
19. Mervat MA, Osman A, Zidan A, Nada AM. Path coefficient analysis and correlation for some yield and its attributes in rice (*Oryza sativa* L.). Journal Plant Production, Mansoura University. 2019; 10(7): 539- 542. Available from: https://jpp.journals.ekb.eg/article_53550_0bd7d3a1cf3ff808ffd7d87d678e75e4.pdf
20. Dhungana B, Gautam J, Adhikari A, Ale P, Adhikari A, Subedi S, Adhikari BB, Dhakal KH. Varietal evaluation and preference analysis of sixteen released rice varieties in Bhojad, Chitwan, Nepal. International Journal of Environmental & Agriculture Research. 2022; 8(3): 73-78. https://doi.org/10.5281/zenodo.6402287
21. Aristya VE, Trisyono YA, Mulyo JH. Participatory varietal selection for promising rice lines. Sustainability 2021 ;13, 6856. https://doi.org/10.3390/su13126856
22. Morejón R, Díaz S, Díaz GS, Pérez N, Ipsán D. Algunos aspectos del manejo de la semilla de arroz por productores del sector cooperativo campesino en dos localidades de Pinar del Río. Cultivos Tropicales2014; 35(2):80-5. Available from: https://www.redalyc.org/pdf/1932/193230070010.pdf
23. Ramchander S, Andrew MT, Souframanien J, Arumugam M. Genetic diversity, allelic variation and marker trait associations in gamma irradiated mutants of rice (*Oryza sativa* L.), International Journal of Radiation Biology. 2022; 98(1), 90-99, https://doi.org/10.1080/09553002.2021.1987568.
24. Bissah MN, Kotey DA, Tongoona P, Egbadzor KF, Gracen V, Danquah EY. Factors influencing rice production in the south-eastern belt of Ghana. Heliyon. 2022; 8 e12404. https://doi.org/10.1016/j.heliyon.2022.e12404.
25. Makino Y, Hirooka Y, Homma K, Kondo R, Liu TS, Tang L. Effect of flag leaf length of erect panicle rice on the canopy structure and biomass production after heading. Agronomy & Crop Ecology. 2022; 25(1). https://doi.org/10.1080/1343943X.2021.1908152
26. Tesfaye D. Participatory variety selection of field pea (*Pisum sativum* L.) and tools to understand farmer's selection criteria in major field pea producing areas of south Eastern Arsi Zone of Ethiopia. Research International Journal of Plant Science and Ecology. 2021: 001-006. https://doi.org/10.37179/rijpse.000002
27. Martey E, Etwire PM, Adogoba DS, Tengey TK. Farmers' preferences for climate-smart cowpea varieties: implications for crop breeding programs. Climate and Development, 2021;14(2), 105-120. https://doi.org/10.1080/17565529.2021.1889949
28. Goa Y, Bassa D, Gezahagn G, Chichaybelew M. Farmers Participatory Evaluation of Chickpea Varieties in Mirab Badwacho and Damot Fullasa districts of southern Ethiopia. *Hydrol* Current Res 2017;8: 264. https://doi.org/10.4172/2157-7587.1000264
29. De Haan S, Salas E, Fonseca C, Gastelo M, Amaya N, Bastos C, Hualla V, Bonierbale M. Selección participativa de variedades de papa (SPV) usando el diseño mama y bebe: una guía para capacitadores con perspectiva de género. Centro Internacional de la Papa, Lima (Perú), 2017, p. 82. https://doi.org/10.4160/9789290604754