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Analysis of the Acai Berry

Micromorphology Pollen Grain

Highlights

The Scope of Organic Farming

Evaluation of Pot Type Marigold

Discovering Thoughts, Inventing Future

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Competitiveness Analysis of the ACAI Berry Producers of Northeastern of PARÁ

By Dinaldo do Nascimento Araujo, Marcelo de Souza Correia & Alexandre Jorge Gaia Cardoso

Abstract- The purpose of this study is to identify what the perspectives of competitiveness by rural production of acai are, from terra firme and várzea in northeast Pará. Region considered the one that produces the most acai in Brazil. The main objective is to describe a certain sample of producers and to identify and evaluate the competitiveness perspectives of this sample in relation to the competitiveness factors defined in the research, starting from the null hypothesis that there are no significant differences in perspectives between terra firme and várzea producers. The theoretical basis considered for the research is composed of an approach on agrichain and factors of competitiveness. The method used for the execution of the research was the Rapid Appraisal, where a semi-structured questionnaire was prepared for the agents of the acai production chain. The main key agents taken into consideration and characterized were: Producers of acai; intermediaries and representatives of some organizations.

Keywords: *agribusiness chains. factors of competitive-ness, acai chain.*

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Competitiveness Analysis of the ACAI Berry Producers of Northeastern of PARÁ

Dinaldo do Nascimento Araujo [α], Marcelo de Souza Correia [σ] & Alexandre Jorge Gaia Cardoso [ρ]

Resumo- A proposta do trabalho é identificar quais são as perspectivas de competitividade dos produtores de açaí, de terra firme e de várzea, no nordeste paraense. Região considerada como a que mais produz açaí no Brasil. O objetivo principal é descrever uma determinada amostra de produtores e identificar e avaliar as perspectivas de competitividade dessa amostra em relação aos fatores de competitividade definidos na pesquisa, partindo-se da hipótese nula de que não há diferenças significativas de perspectivas entre os produtores de terra firme e de várzea. A fundamentação teórica considerada para a pesquisa é composta de uma abordagem sobre cadeias agroindustriais e fatores de competitividade. A metodologia utilizada para a execução da pesquisa foi o método *Rapid Appraisal*, onde foi elaborado um questionário semi-estruturado para os agentes do elo de produção da cadeia do açaí. Os principais agentes-chaves considerados e caracterizados foram: produtores de açaí; intermediários e representantes de algumas organizações. Os fatores de competitividade definidos para o referido estudo foram: insumos, tecnologia, estrutura de mercado, estrutura de governança e coordenação da cadeia, armazenamento e transporte e ambiente institucional. Como principal resultado do trabalho, observou-se que em ambos os tipos de produção, as perspectivas de competitividade são favoráveis para o aprimoramento da cadeia e não há diferenças significativas entre as percepções de competitividade dos produtores de terra firme e de várzea.

Palavras-chaves: cadeias agroindustriais. fatores de competitividade. cadeia do açaí.

Abstract- The purpose of this study is to identify what the perspectives of competitiveness by rural production of acai are, from terra firme and várzea in northeast Pará. Region considered the one that produces the most acai in Brazil. The main objective is to describe a certain sample of producers and to identify and evaluate the competitiveness perspectives of this sample in relation to the competitiveness factors defined in the research, starting from the null hypothesis that there are no significant differences in perspectives between terra firme and várzea producers. The theoretical basis considered for the research is composed of an approach on agrichain and factors of competitiveness. The method used for the execution of the research was the Rapid Appraisal, where a semi-structured questionnaire was prepared for the agents of the acai production chain. The main key agents taken into consideration and characterized were: Producers of acai; intermediaries and representatives of some organizations. The competitiveness factors defined for this study were: Inputs, technology, market structure, governance structure and chain coordination, storage and transportation, and institutional environment. As the main result of the work, it was observed that in both types of production, the perspectives of competitiveness are favorable for the improvement of the chain and there are no significant differences between the perceptions of the types of producers from terra firme and várzea.

Keywords: agribusiness chains. factors of competitiveness, acai chain.

I. Introduction

In 2019, the Brazilian production from vegetable extraction and from Brazil food forestry corresponds to the amount of 679,298 tons, of which 362,545 tons or 53.37% are from the production of yerba mate and 222,706 tons or 32.78% are from the extraction of the acai berry. From the portion of acai production in 2019, the North region is the largest producer with 205,116 tons and from this North production, the state of Pará has a share of 74% and produces 151,793 tons and the state of Amazonas produces 43,855 tons or 21.38%. Between 2002 and 2019, in Pará, the average production was 80.18% compared to the North of the country (IBGE, 2021).

The extractive production of acai in the North Region increased by 24.09% between 2002 and 2019. In the State of Pará, in the same period, the production increased from 122,322 tons to 151,793 tons, with an average of 80.18% of the production of the North Region during the period. In Pará, the main producing mesoregions from 2002 to 2019 are in the Northeast with an average of 70,072 tons (which represents an average share of Pará production of 59.88%), followed by the Marajó mesoregion with an average of 33,975 tons (which represents an average share of Pará production of 30.11%) according to IBGE (Brazilian Institute of Geography and Statistics) data. This fact was identified in the studies by Cardozo et al (2015) where the acai palm tree is point out as the most representative species in the agroforestry systems of the Amazon with a percentage of 25.9% of representativeness.

The data presented demonstrate a strong growth in production in order to serve both the domestic and foreign markets. They also demonstrate that the acai production chain has been able to meet the growing demand and, therefore, indicate its ability to remain competitive in the market. That is, the production growth in this chain reveals a “performance”, which can

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be interpreted as an indicator of revealed competitiveness.

In this chain, there are several economic agents, such as acai producers, intermediaries or middlemen, processing industries, organizations linked to these agents and the government with its policies. According to Nogueira, Figueiredo e Muller (2005), the production of acai berries, originated almost exclusively from extractivism. As of the 1990s, it also began to be obtained from acai plantations native to várzea, from cultivation located in várzea and terra firme areas. The terra firme production has been obtained in regions with higher rainfall, in sole and multiple systems, with and without irrigation. And for Homma (2012) the acai berry can come from the following origins: From native acai plantations existing on the banks of rivers mixed with other trees (extractive); from várzea areas that have undergone management and from areas of terra firme production with irrigation and without irrigation.

The acai producers are those who carry out some type of management in the acai plantations and somehow benefit the acai plantation, taking better advantage of the collection of the berry even in the off-season, as well as extracting the heart of palm.

Most producers work and live on the banks of rivers (known as riparian people). After collecting the berry, the producers allocate the acai to: Intermediaries, associations, cooperatives or processing industries. After processing the berry, the industry sells the pulp to distributors that are located in several states of Brazil, mainly in the Southeast and South regions. With respect to international market, there are few companies in the Northeast region of Pará that export, and according to the data prepared by the National Supply Company – CONAB (2019), the United States of North America with an average representation of 60% and Japan with an average representation of 35%, are the countries that from 2012 to 2019 are the top importers of acai pulp.

In the face of this context, the importance of the competitiveness study of the respective production chain in the Northeast of Pará is revealed, arising as a fundamental question: What were the changes in the perspectives of competitiveness by the producers of terra firme and várzea in the acai berry production chain? Thus, this study presents as a general objective to describe a certain sample of producers and identify and assess the perspectives of competitiveness of this sample in relation to the competitiveness factors defined in the research.

The studies already carried out by Canto (2001); Nogueira, Figueiredo and Muller (2005); Sant'ana (2006); Lewis (2008); Corrêa (2010); Nogueira (2011), Batista (2013) and Cardozo et al (2015) present an approach on the palm tree of acai, on the properties of the berry, on the management techniques and on some economic aspect of certain locations. An analysis of the main factors of competitiveness by producers enables to identify the strengths and weaknesses of the production link of the acai chain.

II. Theoretical Basis

a) Production chain systemic approach

The two main aspects that contributed to this analysis of the acai chain, although distinct, but with a common ground, are: (a) *CSA-Commodity System Approach*, which considers the transformations that a raw material undergoes until it reaches the final consumer; and (b) the analysis of *filière*, which analyzes the succession of transformation processes of a given product of a given agro-industrial sector, in a vertical layout.

Usually, the approaches of competitiveness find their privileged space for analysis in the firm. Thus, the competitiveness of a given sector or nation would be the sum of the competitiveness of the agents (firms) in it. In the case of agricultural or agro-industrial products, there is a set of specificities that result in the definition of a space of analysis different from those conventionally admitted in competitiveness studies. This space of analysis is the agro-industrial production chain.

Competitiveness studies in agro-industrial chains should privilege a vertical cut in the economic system for defining the field of analysis. In these cases, the competitiveness of this open system, defined by a given agro-industrial production chain, cannot be considered as the mere sum of the individual competitiveness of its agents. This consideration refers to the analysis of competitiveness of agro-industrial systems, which implies the incorporation of the notion of system (BATALHA; SOUZA FILHO, 2009).

For Batalha e Silva (2007), an agro-industrial production chain can be segmented from downstream to upstream into three macro segments. However, this task is not so easy, since this division can vary greatly from product to product and according to the proposed objective of the analysis. The first segment would be trading, where companies responsible only for distribution logistics can be included, that is, companies that relate directly to the end customers of the production chain and that enable consumption and trading. In the second segment would be industrialization, including the raw material processing industries in final products intended for buyers (which can be final consumers or other agro-industries). The third segment, the production of raw materials would be the cluster of companies that supply the raw material to the processing industry.

Batalha e Souza Filho (2009) emphasize that efficiency along the distribution channel can be improved through information sharing and joint planning among its several agents. Distribution channel mentioned here could be understood, for example, as the path taken by the acai berry, from the extraction of

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the berry of the palm tree to the table of the final consumer. This concept is relevant to the study of production chains, as it focuses on the coordination and integration of activities related to the flow of products, services and information between the different agents of the chain.

In this sense, a specific analysis was made in the production link, with the main key agents, considering the perspectives of producers and the opinions of intermediaries and representatives of organizations that are somehow linked with the production of the berry, and with their experiences and expertise in the subject, helped to clarify important points about the chain.

b) Competitiveness in agro-industrial systems

For Farina (1999), the systemic analysis of a given agro-industry is justified due to the fact that the performance that is proposed to be studied is not of an individual firm, but of a set of segments/players that are directly or indirectly interrelated with a particular purpose and in a systemic way. These players segments can exhibit different degrees of mutual dependence.

Considering the concept of competitiveness applied in an agro-industrial system, there is a first difficulty, which is to know the level of aggregation of the links that make up a given system, since it is not just a question of understanding the concept of competitiveness horizontally (from the firm to the industry), but also of understanding competitiveness vertically (from industry to the production chain).

For Farina & Zylbersztajn (1998) and Batalha e Souza Filho (2009), agro-industrial systemic analysis becomes feasible when focusing on specific agro-industrial systems (SAG) such as milk SAG, sugarcane SAG, etc.. From the point of view of Farina (1999), the analysis of competitiveness of SAGs should ask: Whether a given agro-industrial system shall grow or, at least, not decrease in current markets and whether it has the capacity to add new markets; whether its composition will change or not, that is, whether the competitiveness of the participants of the links will undergo changes or not; Which governance structures make this competitiveness feasible and in which direction it shall change.

As a result of these explanations, we identify that the acai chain generates added value, and the analysis that this work proposes may become a start line for the local and regional improvement of the acai chain in the future, contributing with knowledge on the functioning and interaction of their respective chain agents and links.

c) Competitiveness factors

The company that acquires greater competitive advantage, compared to the others, stands out, obtaining more positive results in terms of profitability and growth. For such a favorable position in competitiveness, companies should know and master the factors of competitiveness.

Roman et al (2012) understand as a factor of competitiveness what is configured as a real concern and reason for being of each activity of the company. It can be said that the competitiveness factor corresponds to the variables in which the organization needs to have a good performance in order to survive and stand out in relation to the market.

Thus, in the present study of competitiveness factors in the production link of the acai chain, we agree with the proposal of Roman et al (2012) in which the knowledge of competitiveness factors will enable to identify the environmental requirements, the internal structure and the levels of uncertainties in that link.

According to Batalha e Souza Filho (2009), the determinants of competitiveness in production chains involve a wide variety of dimensions, which, for analytical convenience, can be aggregated into drivers, such as technology, inputs and infrastructure, management, institutional environment, market structure and governance structure. They ultimately reflect the competitive and sustainable positioning of the system under analysis. The measurement of these drivers can be done objectively through the use of public or private domain statistical information and/or data collected directly from the agents participating in the agro-industrial system.

In this study, we considered six dimensions of competitiveness factors described in Batalha e Souza Filho (2009) and each factor is composed of subfactors according to the specificities of the analyzed chain, as listed below.

1) Input factor: Labor training, land availability, land price in Pará, labor cost, production cost, storage cost and weather conditions;
2) Technology Factor: Management, várzea cultivation and terra firme cultivation;
3) Market Structure factor: Number of industries, acai berry price, product differentiation, capacity to increase and production scale, idleness in processing and quality certification;
4) Governance and Coordination Structure Factor: Existence and action of associations and cooperatives, participation of intermediaries, dissemination of information, intermediary/producer relationship, producer/industry relationship;
5) Storage and Transportation Factor: Berry storage capacity, pulp storage capacity, the conditions of ports, the capacity of ports, the conditions of highways, the capacity of highways and the safety of ports and highways;
6) Institutional Environment factor: Credit availability, access to credit, differentiated interest rates, partnership with research centers, legalization of production areas, governmental actions, health legislation, action of the inspection service, berry

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handling training, use of straw baskets (sieves), use of plastic crates and chagas disease.

III. Methodology

Regarding the approach and nature of the research, it is classified as qualitative and quantitative descriptive, aiming to investigate the perspectives of key agents related to the links of production of the acai berry in relation to competitiveness factors.

In this study, we decided to delimit the analysis in the Northeast mesoregion of Pará, which was the region with the highest volume of extractive production in the last twelve years.

For this research, the method *Rapid Appraisal* (RA) was used, which had been used in previous works by Pinazza (2008), Batalha e Souza filho (2009), Melz (2010) and Barchet (2012). The RA also known as rapid rural appraisal, has been applied to respond to the disadvantages of traditional research approaches applied in the studies of production chains. This method is widely used in analysis of agro-industrial systems, mainly in the execution of short-term and comprehensive studies, limitation of financial resources and primary data.

The RA is also characterized by the application of a semi-structured questionnaire, which is designed to generate a quick documentation that aims to evaluate the most important components to be considered, as well as reduce the costs of research with large volumes of data (SILVA; SOUZA FILHO, 2007).

The research was applied in the period from July to September 2016 and the sampling process adopted was the intentional non-probability (convenience sampling) for acai producers, whose population is unknown.

Table 1 shows the number of producers who were interviewed and provided information for the analysis. In addition to the producers, five intermediaries selling the berry and nine representatives of organizations directly or indirectly related to the chain were interviewed to provide further information on the above-mentioned chain.

Table 1: Sample of interviews conducted with producers of the chain

Key agents	No. of interviewees	Location/city
Terra firme producers (with or without irrigation)	10	Tomé-Açu; Inhangapi;
Várzea producers	10	Cametá; Igarapé-Miri
Total number of producers interviewed	20	

Source: Own authors

The semi-structured questionnaire was composed of competitiveness drivers that enable the understanding of the aggregate effect and that can be measured through performance indicators or competitiveness subfactors, where, the interviewee assigned an assessment by a *likert* scale for each question related to a competitiveness subfactor.

The *likert*-type scale has a variation from "very unfavorable" (VU) = -2 to “very favorable” (VF) = +2 to competitiveness. Intermediate values are: "unfavorable" (U) = -1, “neutral” (N) = 0 and “favorable” (F) = 1, as shown in Figure 1. Thus, the subfactors can be assessed qualitatively and quantitatively, considering equal importance weights for all, since the interviewees could have little systemic view of the chain or little knowledge (expertise) about other links in the chain.

Very Unfavorable	Unfavorable	Neutral	Favorable	Very Favorable
VU ≤ -1.5	-1.49 ≤ U ≤ -0.5	-0.499 ≥ N ≤ 0.499	0.5 ≤ F ≤ 1.499	1.5 ≤ VF

Source: Own authors

Figure 1: Scale *Likert* for the assessment of competitiveness factors and subfactors

The assessment of competitiveness factors corresponds to the average sum of subfactors of the same type, and using the same *likert* scale from Figure 1, the factors qualitative assessment was obtained.

IV. Results

This section presents the perspectives of terra firme and várzea producers on the competitiveness of the acai chain, according to the competitiveness factors established in this work.

a) Inputs

According to Figure 2, in the final competitiveness assessment of the input factor, terra firme producers consider neutral (N) = 0.41 and várzea producers as favorable (F) = 0.61 for competitiveness.

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Inputs	Terra firme	Várzea
Labor Capacity	0.10	0.60
Lands availability	0.90	1.10
Land price in PA	1.00	0.40
Labor cost in production	-0.70	-0.20
Production cost	0.20	0.60
Storage cost	1.00	
Weather conditions	0.40	1.00
Assessment	**0.41**	0.80 **0.61**

Source: Field research

Figure 2: Competitiveness assessment of the Inputs factor and subfactors

b) Technology

According to Figure 3, in the final competitiveness assessment of the technology factor, terra firme producers consider favorable (F) = 0.87 and várzea producers as favorable (F) = 1.03 for competitiveness.

Technology	Terra firme	Várzea
Management	1.30	1.10
Várzea cultivation	1.60	1.80
Terra firme cultivation	-0.30	0.20
Assessment	0.87	1.03

Source: Field research

Figure 3: Competitiveness assessment of the Technology factor and subfactors

c) Market structure

According to Figure 4, in the final competitiveness assessment of the market structure factor, terra firme producers consider favorable (F) = 0.57 and várzea producers as favorable (F) = 0.55 for competitiveness.

Market	Terra firme	Várzea
No. of processing industries	0.40	0.20
Acai berry price	1.40	1.70
Product differentiation	0.40	0.70
Capacity to increase the production scale	1.00	0.70
Idleness in berry processing	-0.70	-0.90
Quality certification	0.90	0.90
Assessment	0.57	0.55

Source: Field research

Figure 4: Competitiveness assessment of the Market structure factor and subfactors

d) Governance and coordination structure

According to Figure 5, in the final competitiveness assessment of the governance structure and coordination factor of the chain, terra firme producers consider favorable (F) = 0.52 and várzea producers as neutral (N) = 0.46 for competitiveness.

Governance and Coordination	Terra firme	Várzea
Existence and action of Associations/cooperatives	0.60	0.20
Participation of intermediaries	-0.20	1.00
Dissemination of information	1.00	0.30
Intermediary relationship	0.20	0.60
Producer/industry relationship	1.00	0.20
Assessment	0.52	0.46

Source: Field research

Figure 5: Competitiveness assessment of the Governance and coordination structure factor and subfactors

e) Storage and transportation

According to Figure 6, in the final competitiveness assessment of the storage and transportation factor, terra firme producers consider neutral (N) = 0.33 and várzea producers as neutral (N) = 0.13 for competitiveness.

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Storage and transportation	Terra firme	Várzea
Berry storage capacity	0.80	1.10
Pulp storage capacity	0.70	0.10
Industry location	0.50	0.10
Transportation of natural berry	0.80	1.10
Transportation cost of the domestic M. berry	1.00	0.20
Transportation cost of the foreign M. berry	0.00	-0.20
Ports conditions	-0.20	-0.20
Ports capacity	-0.20	-0.20
Highways conditions	0.80	0.20
Highways capacity	0.40	0.20
Safety of highways/ports	-1.00	-1.00
Assessment	0.33	0.13

Source: Field research

Figure 6: Competitiveness assessment of the Storage and transportation factor and subfactors

f) Institutional environment

According to Figure 7, in the final competitiveness assessment of the storage and transportation factor, terra firme producers consider neutral (N) = -0.04 and várzea producers as neutral (N) = -0.15 for competitiveness.

Institutional Environment	Terra firme	Várzea
Credit availability	- 0.40	0.00
Access to credit	-0.90	-0.40
Differentiated interest rates	-0.10	-0.20
Partnership with research centers	0.70	0.30
Legalization of production areas	-0.90	-1.40
Governmental actions	-0.30	-0.50
Health legislation	0.30	0.00
Action of the inspection service	-0.20	-0.20
Berry handling training	0.80	0.90
Sieves/Rasas	0.50	0.20
Plastic crates (plastic boxes)	1.10	0.90
Chagas disease	-1.10	-1.40
Assessment	- 0.04	-0.15

Source: Field research

Figure 7: Competitiveness assessment of the Institutional environment factor and subfactors

V. Final Considerations

Within the perspectives of terra firme and várzea producers, the competitiveness factors with a positive impact on the chain are inputs, technology, market structure and governance and coordination structure. The factors with neutral impact for competitiveness are storage and transportation and the institutional environment.

The results point out an important aspect in socio-environmental management learning, both types of producers indicate a favorable competitiveness in the production link of the chain and enable both types of production, terra firme and várzea, to complement each other. Although production costs are different, and more expensive in terra firme planting, from new investments and new public policies to increase the scale of terra firme production, this type of development could increase the sustainability of the chain, which is currently satisfactory in the várzea environment.

Also as a result of the effort to understand part of the acai chain, positive and negative aspects can be observed, according to the perceptions of the agents interviewed. The positive aspects are: Producers have better access to health care and education; acai is the main source of income of producers; most producers carry out management, providing an increase in the amount produced; new techniques of berry collection in terra firme acai plantations are being widespread; associativism and cooperativism, although incipient, have shown favorable results for producers and the trading centers are defined.

The negative aspects are: Threat to the environment through intensive and irregular management; there is still the use of child labor in the collection of the berry; the precariousness of property rights in production or extraction areas prevents new investments by the producer; intermediaries exert strong influence in determining the price of the berry; the roads and ports in the region have precarious conditions for transshipment and security; and there is still a smaller scale of contamination of acai by chagas disease in some locations in Pará that do not comply with health regulations.

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It was observed that acai producers work in difficult conditions, living in locations far from large urban centers and still need basic services such as sanitation.

During the research, the access to interviewees was difficult due to the restrictions of schedules and far location. Although the scientific rigor was followed to achieve the results, the study was limited to a limited sample of producers from some locations and the limited number of competitiveness factors and subfactors.

Thus, as a suggestion for future research and actions, the increase in the number of key agents to be interviewed in that chain and the identification of policy instruments and agents responsible for the execution are suggested. Thus, the study of the other links of the acai production chain can contribute systemically to the better understanding of its functioning.

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Micromorphology Pollen Grains of Five Species of the Genus *Salvia* L. (Lamiaceae) in Libya

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Abstract- In the present work, the pollen morphological features of five species, belonging to the genus *Salvia* (Lamiaceae: subfamily Nepetoideae: tribe Mentheae) *S. lanigera* Poir, *S. verbenaca* L., *S. fructicosa* Miller., *S. spinosa* L., *S. viridis* L., which were collected throughout Libya, have been intensively studied by using scanning electron microscopy(SEM). The basic shape of the pollen grains in most taxa is suboblate, oblate-spheroidal. oblate-spheroidal in one species(*S. lanigera*) and suboblate in four species others. Hexacolpate pollen is dominant in all studied taxa. All species medium size. The exine ornamentation of these four species is bireticulate-Perforate(the common type) with one exception in the case of (*S. verbenaca*), showing a reticulate-Perforate. The findings show that palynological characters such as pollen shape, aperture numbers, and types, and exine ornamentation exhibit remarkable differences amongst the studied species.

Keywords: *pollen grains, salvia, lamiaceae, libya.*

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I. Introduction

Lamiaceae is one of the largest Angiosperm families, comprising approximately 240 genera and more than 7,000 taxa distributed throughout the world, and is economically important (Myoung & Yuon, 2012). In the flora of Libya, is represented by 22 genera and about 65 species (JAFRI & El-GADI, 1985). The family is known for its fine ornamental or culinary herbs like basil, lavender, mint, oregano, rosemary, sage, and thyme and is a rich source of essential oils for the perfume industry (Kahraman *et al*., 2009 c). The genus *Salvia* L. is one of the largest genera in this family (Cvetkovikj et al., 2015). *Salvia* is a genus with about 1000 species (Walker and Sytsma, 2007; Kahraman et al., 2009 a,c; Özler et al., 2011; Saravia & Pinto, 2018; and Akta et al., 2020). In Libya, is represented by ten species; out of which, three are cultivated (JAFRI 1985). *Salvia* species are used in traditional medicines worldwide, possessing antioxidant, antidiabetic, antibacterial, antitumor, antiplasmodial, and anti-inflammatory features. Many Salvia species are used as herbal tea, and in food, cosmetics, perfumery, and the pharmaceutical industry. In addition, *Salvia* species are also grown in parks and gardens as ornamental plants (Kahraman et al., 2010a). Pollen morphologies for the family Lamiaceae have been investigated by several workers, such as (Harley et al.,1992; Celenk et al., 2008; Moon et al., 2008; and Doaigey et al., 2018). However studies on pollen morphology in *Salvia* have been conducted by many researchers worldwide (Kahraman et al., 2009 a,c,2010a,b; Özler et al., 2011,2013; Doaigey et al., 2018; Akta et al., 2020). In general, the shape of pollen grains is specific to the taxonomic ranks, such as family, genus, and species (Myoung & Yukon; 2012). Therefore, the main objective of the present study is to provide a detailed account of the pollen morphology of five species by using a scanning electron microscope (SEM).

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II. Materials and Methods

Pollen grains of five species of the genus *Salvia* (*S. lanigera* Poir, *S. verbenaca* L., *S. fruticosa* Mill, *S. spinosa* L., *S. viridis* L.) were studied by SEM. Pollen material was obtained from plant specimens collected from Libya between 2018 and 2020. The voucher specimens are listed in Table 1. Pollen grains were compared in their morphological characters by determining their size, shape, and exine ornamentation. The terminology used is by Punt *et al*. (2007), Özler *et al*. (2011), and AKTA *et al*. (2020). Size measurements for the pollen grains were taken according to Erdtman (1971) (very small < 10 µm in dimensions; small 10-25 µm; medium (25-50) µm; large (50-100) µm; very large (100-200) µm; huge > 200 µm) (Al-Watban *et al*. 2015).

Table 1: List of *Salvia* species used in this study and their locations

No.	Species	Locality	Date
1	*Salvia lanigera* Poir.	Busnib	20/Mar./2019
2	*S. verbenaca* L.	Wadi aleagr	23/Jan./2020
3	*S. fruticosa* Mill.	Albayadih	28/Mar/2018
4	*S. spinosa* L.	Garyounis	15/Mar/2019
5	*S. viridis* L.	Talmitha	13/Feb/2020

III. Results

a) Salvia lanigera Poir

The pollen grains are yellow in color, medium size, oblate-spheroidal shaped in outline. Pollen with hexa-colpate, exine ornamentation with bireticulate-perforate. The polar length is 34.64µm, equatorial length is 35.69µm; and polar axis/equatorial axis (P/E) is 0.97µm (Figure A, B and Table 2).

b) S. verbenaca L.

The pollen grains are yellow in color, medium size, suboblate shaped in outline. Pollen with hexa-

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colpate, exine ornamentation with reticulate-perforate. The polar length is 30.85µm, equatorial length is 35.88µm; and polar axis/equatorial axis (P/E) is 0.86µm (Figure C, D and Table 2).

c) S. fruticosa Mill.

The pollen grains are white in color, medium size, suboblate shaped in outline. Pollen with hexa-colpate, exine ornamentation with bireticulate-perforate. The polar length is 34.28 µm, equatorial length is 42.15µm; and polar axis/equatorial axis(P/E) is 0.81µm (Figure E,F and Table 2).

d) S. spinosa L.

The pollen grains are white in colour, medium size, suboblate shaped in outline. Pollen with hexa-colpate, exine ornamentation with bireticulate-perforate. The polar length is 36.82µm, equatorial length is 45.28µm; and polar axis/equatorial axis (P/E) is 0.81µm (Figure G,H and Table 2).

e) S. viridis L.

The pollen grains are yellow in color, medium size, suboblate shaped in outline. Pollen with hexa-colpate, exine ornamentation with bireticulate-perforate. The polar length is 29.02µm, equatorial length is 34.15 µm, and polar axis/equatorial axis (P/E) is 0.85µm (Figure I, J and Table 2).

Table 2: Summary of pollen micromorphology for *Salvia* species examined using SEM

No.	Taxa name	mean value		P/E	Shape	Exine ornamentation	Type of aperture	Size
		P	E					
1	*Salvia lanigera* Poir.	34.64	35.69	0.97	oblate-spheroidal	Bireticulate-perforate	Hexa-colpate	medium
2	*S. verbenaca* L.	30.85	35.88	0.86	suboblate	Reticulate-perforate	Hexa-colpate	medium
3	*S. fruticosa* Mill.	34.28	42.15	0.81	suboblate	Bireticulate-perforate	Hexa-colpate	medium
4	*S. spinosa* L.	36.82	45.28	0.81	suboblate	Bireticulate-perforate	Hexa-colpate	medium
5	*S. viridis* L.	29.02	34.15	0.85	suboblate	Bireticulate-perforate	Hexa-colpate	medium

P/E ratio: oblate = 0.50–0.75; suboblate = 0.75–0.88; oblate-Spheroidal = 0.88–1.00 (Punt et al., 2007). E, equatorial axis; P, polar axis. All measurements in µm.

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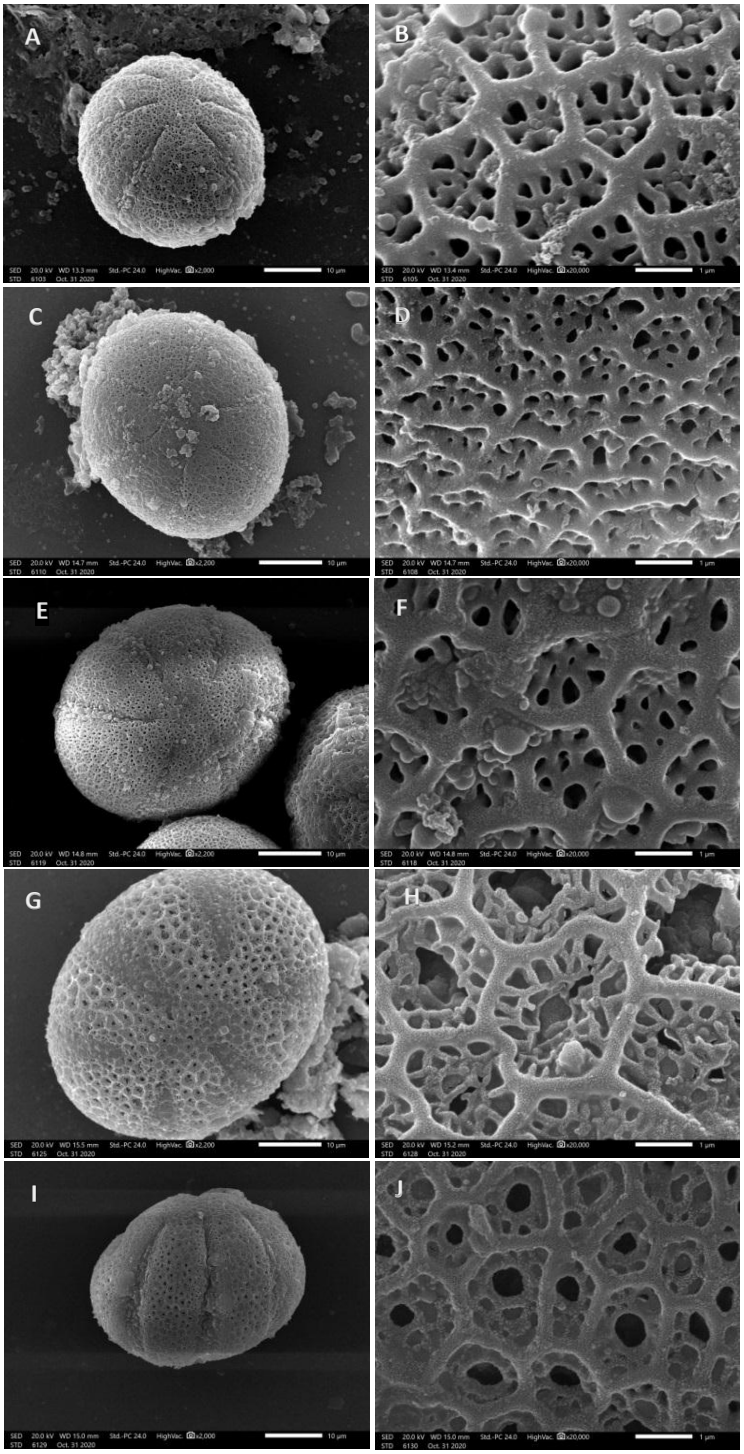


Figure 1: SEM photographs of the pollen grains of Salvia species. A-B Salvia lanigera, C-D S. verbenaca, E-F, S. fruticosa, G-H, S. spinosa, I-J, S. viridis.

IV. Discussion and Conclusion

Previous studies have shown that the pollen grains of Lamiaceae could be prolate-spheroidal, subprolate, prolate; tricolpate or hexacolpate, and exine ornamentation was observed as tuberculate, microreticulate, bireticulate, and polish (Myoung *et al*., 2012). Doaigey *et al*., 2018 reported in their study that 20 species belong to 16 genera of the Lamiaceae that have been investigated using a light microscope (LM), and SEM size of the pollen is variable between the genera but not among the species of the same genus. Characters of pollen grains size, shape, exine

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ornamentation, and the number of apertures are important and deciding factors for the systematic study of various genera under the family Lamiaceae. These results in our study pollen grains of five species belonging to genus of *Salvia* of the family Lamiaceae shown genus variation in the shape of the pollen grains varies from suboblate to oblate-spheroidal. The size of the polar axis (P) varies from 29.02 µm, in *S. viridis*, to 36.82 µm, in *S. spinosa*, while size of equatorial axis in same taxa (E) varies from 34.15, in *S. viridis*, to 45.28 µm, in *S. spinosa* (Table 2). (P/E) in (*S. fruticosa and S. spinosa* = 0.81 µm) – and (0.97µm in *S. lanigera*), oblate-spheroidal in one species(*S.lanigera*) and suboblate in four species(*S. verbenaca, S. fruticosa, S. spinosa and S. viridis*). medium size in all the species. The pollen grains are radially symmetric, isopolar, hexacolpate. The exine ornamentation of these four species is Perforate-bireticulate (the common type), with one exception in the case of *S. verbenaca*, showing a Perforate reticulate structure (Figure 1-F). *S. glutinosa* and *S. staminea* (Kahraman *et al*., 2009 a) were observed to be suboblate to prolate-spheroidal shaped pollen grains; While the sculpturing bireticulate-perforate. (Kahraman *et al*., 2009 c). The pollen in *S. indica* is hexacolpate, radially symmetrical and isopolar. Its shape is suboblate. The exine sculpturing is bireticulate-perforate. (Kahraman *et al*., 2010 a) *S. chrysophylla* has hexacolpate, radially symmetrical and isopolar, oblate-spheroidal; bireticulate-perforate. (Kahraman *et al*., 2010 c) examined pollen grains of *S. limbata* and *S. palaestina*, found some differences in their shape and size(oblate-spheroidal, prolate-spheroidal), respectively. Still they look similar in their exine ornamentation bireticulate-perforate. (Özler *et al*., 2011). Pollen grains of 30 taxa of the genus *Salvia*, belonging to sections *Salvia*, *Horminum*, *Drymosphace*, *Plethiosphace*, and *Hemisphace* from Turkey were examined by LM and SEM. Suboblate to subprolate often between oblate–spheroidal to prolate–spheroidal; hexacolpate, sometimes mixed with octacolpate grains, shows three distinct types of surface structures, reticulate–perforate (the common type), reticulate–granulate and bireticulate; (*S. fruticosa*) has the Reticulate–perforate type of exine sculpturing and bireticulate in *S. viridis*. Also (Özler *et al*., 2013) examined of 30 *Salvia* taxa in sections *Hymenosphace* and *Aethiopis* from Turkey using LM and SEM. All taxa examined are hexacolpate and rarely heptacolpate, suboblate to spheroidal in equatorial view, size is small to large. (Al-Watban *et al*., 2015) examined three *Salvia* species (*S. aegyptiaca*, *S. deserti* and *S. spinosa*); Sub-spheroidal, Bireticulate-Perforate, Prolate, Bireticulate-Perforate, and Sub-spheroidal, Bireticulate-perforate respectively; these three species is hexacolpate. (AKTA *et al*., 2020) examined pollen morphologies of twenty-one taxa belonging to the genus *Salvia* (*S. aethiopis* L., *S. argentea* L., *S. aytachii* Vural & Adigüzel, *S. blepharochlaena* Hedge & Hub.-Mor., *S. cadmica* Boiss., *S. ceratophylla* L., *S. cryptantha* Montbret & Aucher, *S. frigida* Boiss., *S. fructicosa* Miller, *S. halophile* Hedge, *S. napifolia* Jacq., *S. microstegia* Boiss. & Bal., *S. recognita* Fisch. & Mey. *S. sclarea* L., *S. smyrnaea* Boiss. *S. suffruticosa* Montbret & Aucher, *S. tchihatcheffii* (Fisch. & Mey.) Boiss., *S. tometosa* Bertol, S. *verbenaca* L., *S. viridis* L., and *S. wiedemanni* Boiss.) in Turkey using LM and SEM. all pollen grains are hexacolpate except *S. viridis* has both hexacolpate and octacolpate. Shows (*S. fructicosa* Mill) Bireticulate-perforate; (*S. verbenaca, S. viridis*) exine shows bireticulate; small size(*S. fructicosa*). To conclude, in agreement with previous investigations with few the differences in their result. The results of the present study show that palynological characters such as pollen shape, aperture numbers and types of exine ornamentation exhibit remarkable differences amongst the studied taxa, as already reported in previous studies, and may be significant in distinguishing the species.

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The Scope of Organic Farming in Environmental and Health Hazards: Modern Organic Farming vs. Traditional Models with Especial Concentration in Sudan

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Abstract- The organic farming system uses the concept of sustainability to produce safe food, fit nutrition, preserves of natural flora and livestock; and keeps social justice. The aim of this paper is to raise the awareness of the public about modern organic farming tools and limitation. Also which benefit, risks, limitation and problems face such practices in Sudan? In addition, as settlement how to address the traditional knowledge in organic systems and to correct existing problems and be competitive in the modern organic farming market nationally and internationally. This future competition can be concise in a phrase of farmers' motivations and formal regulations.

Keywords: *organic farming, public awareness, traditional knowledge, formal regulations.*

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The Scope of Organic Farming in Environmental and Health Hazards: Modern Organic Farming vs. Traditional Models with Especial Concentration in Sudan

Dr. Mai M. O. Deiab Ahmed [α] & Dr Eltayeb E. Ali Ahmed [σ]

Abstract- The organic farming system uses the concept of sustainability to produce safe food, fit nutrition, preserves of natural flora and livestock; and keeps social justice. The aim of this paper is to raise the awareness of the public about modern organic farming tools and limitation. Also which benefit, risks, limitation and problems face such practices in Sudan? In addition, as settlement how to address the traditional knowledge in organic systems and to correct existing problems and be competitive in the modern organic farming market nationally and internationally. This future competition can be concise in a phrase of farmers' motivations and formal regulations.

Keywords: organic farming, public awareness, traditional knowledge, formal regulations.

I. Introduction

The Philosophy of organic farming is to get an organic product, free from contamination from a farm, using natural resources and its biodiverse without exhausting the environment or in other way to keep it in a balance. The organic farming system uses the concept of sustainability to produce safe food, fit nutrition, preserves of natural flora and livestock and keeps social justice (Løes, 2014,). The simplest definition of organic agriculture is refraining from chemical fertilizers and pesticides (Løes, 2014) and the advantage from that is the biofertilization, biocontrol, bioproducts, soil rehabilitation and poor soil enrichment (Mohammed Osman, 2010). The aim of this mini-review to raise the awareness about modern organic farming and its scope in the environmental and health hazards and how to cope these with traditional models that already have been exited in Sudan; furthermore which benefit and risks to such practices is exiting now in Sudan and finally how to address the traditional knowledge and to correct the current existing problems to be competitive in the modern organic farming market inside and outside the Country.

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II. Organic Farming Tools

a) Organic farming inputs

1. Seeds bed which can be described in triangle of the living soil status, crop nutrition and seeds. Soil type, its fertility problems and the climate conditions must be considered. The selected different adapted crops must be in intercropping or rotation and/or accordance with farmer preference or business. Used seeds must be from organic sources and/or treated organically.
2. *Soil fertility:* The maintenance of soil fertility is important in sustainable land use. Since the organic farming system is less dependent on external input; the fertilization coming mainly from recycling and composting of food and farm wastes (manures and organic residues). In addition using sludge of waste water treatment (Bioremediation of sludge in Bioreactors). Adding C- enriched materials is fundamental concept in organic farming (Brevik *et al.*, 2015). Furthermore using natural and Biofertilizers is other arm of fertilization in such system (Mahdi et al., 2010.
3. *Weed, diseases and pest management (biocontrol):* Catch or cover crop is normally inserted in crop rotation to manage weed control. However using manure has positive effect in securing crops that are sufficiently competitive against perennial weeds (Olesen et al., 2007). Using natural and bioproducts for pests and diseases control (Berg, 2009)..
4. *Crop rotation:* The basic guidelines of rotation design for organic systems can be exclusively in ten points as below starting from that deep rooting crops should follow shallow rooting crops; nitrogen fixing crops should alternate with nitrogen demanding crops. Wherever possible, catch crops, green manures, and under sowing techniques should be used to keep the soil covered. In addition crops which develop slowly and are therefore susceptible to weeds should follow weed suppressing crops. Alternate between leaf and straw crops. Where a risk of disease or soil borne

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pest problems exists, potential host crops should only occur in the rotation at appropriate time intervals. Use variety and crop mixtures when possible. Alternate between autumn and winter sown crops. Furthermore suitability of individual crops with respect to climate and soil, balance between cash and forage crop, and the seasonal labor requirements and availability must be considered (Mohler and Johson, 2009).

5. *Irrigation water:* The clean uncontaminated water with pesticides or biological pollutants is very important for irrigation. Here to mention the gap between conventional and organic farming systems is crucial especially when using underground water. When using recycling water type A water is only used for organic agriculture.
6. *Livestock Husbandry:* Insertion of animals in mixed farm can serve as biocontrol and adding values of its manure as organic fertilizers (Ducks, chicken and goats). No artificial materials in fodder have to be added (vitamins, hormones or drugs) to feed the animals. Freeland chicken and natural grazers livestock are examples of such husbandry (Soil Association organic standards EU, 2016).

b) Organic farming types farm design

In the different four main organic farm types namely, livestock systems, grassland and Fodder crops, arable land and horticultural crops, the idea beyond the modern organic farm is using the farm resources or less input from outside the farm to fulfill the highly different goals (Løes, 2014). To reach such goals, the farms history and biography must be studied. This study has to be linked with current resources and frame conditions to plan the future. The simplicity of farm management is the basement to comfort the family. The farm must be self-sufficient is term of animals fodder and bio-organic fertilizers in a balance with environment, have maximum output in human food , conserve the biodiversity in it and the surrounding environment, be suitable to run social activities on it, be specialized in a production and can include packing and processing and selling food too (Løes, 2014).

c) Organic farming impacts (output)

1. *Soil health and soil rehabilitation:* Organic farming gives a soil with higher humus and biota, higher soil water holding capacity and better aggregates in compare with conventional system. Sometimes these two farming systems are not that different in mineral contents but the organic ones are less contaminated with heavy metals, herbicides and pesticides residues (Maeder *et al.*, 2002). Furthermore organic farming have significant potential to accumulate soil carbon (Gattinger *et al.*, 2012); hence organic farming has good tools for soil rehabilitation (Poor soil enrichments and bioremediation of contaminated soil) (Maeder et al. 2002).
2. *Plant nutrition and health:* Foods from organic sources have better minerals content (Table1) and proteins quality. Higher flavonoids production (better autoimmune against pest and diseases) (Worthington, 2001). This also true for feeds stock (Haas et al., 2007)
3. *Water quality and water reservation:* Organic farming system has better quality of water that is less contaminated with pesticides and herbicides (Up to 97 % reduction). Less NO_2 especially in underground water. Less PO_4 so more water freshness (Pimentel et al., 2005). Soil moisture and water resources conservation is a major advantage of such system even with old traditional water harvesting technologies particularly under drought conditions (Pimentel et al., 2005).
4. Conservation, abundance and richness of taxa by prohibition of inorganic herbicides, pesticides and chemical inorganic fertilizers. Preservation of mixed farming. Sympathetic management of non crop habitats. The impacts of organic farming in pastoral and upland agriculture are limited (Maeder *et al.*, 2002). Step wise studies are needs to fill the gap of knowledge in appraisal the role of organic farming in Biodiversity (Hole *et al*., 2005).
5. *Environmental issues:* The most famous issue is less CO_2 uses and emission as the soil serves as major C sink. However soils managed by organic farming not only may emit less carbon dioxide (CO_2), but also nitrous oxide (N_2O), and methane (CH_4) compared to conventional system (Lorenz and Lal, 2016)
6. *Human health:* The healthier soil produce healthy crops, lead to health of animal and people. Better immunity and less allergic problems. Less carcinogenic because of less pesticides residues (EPRS, 2016). Heart health improvement is recognized because organic food has more salicylic acid in stressful natural growing plants (117 ppb compare to 20 ppb in conventional) (Willer.and kilcher, 2009). Better nutrients and antioxidants (EPRS, 2016). The biggest precaution comes from the contest is the contamination with human and animals feces that infected by bacterial and viral diseases but this issues will be declared later in this context. When it comes to livestock organic milk and meat has a higher omega3 compare to conventional system. Addition health values is the prevention of antibiotics in organic farming minimize the risk of antibiotic resistance (EPRS, 2016).

d) Processing and marketing

Products processed in organic scheme have no artificial food additives or coloring and careful clean

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handling and packing. For organic animals products free of diseases and parasites is a major task and has to be managed carefully (Lund and Algers, 2003). Organic market is limited by high prices added values. Price is the major perceived barrier to purchase organic products (Aschemann-Witzel and Zielke, 2015).

e) Converting to organic farming

At least Three years are needed for such conversion. Gap land is needed between organic farm and conventional system. Well trained labors are needed for modern organic farm practices and post harvesting and food processing (Acs *et al.*, 2007). Up to 20% reduction in productivity and has to be well planned to fill the gap in food production and profit. Also the organic farming needs more labors and the low labors income is one of the major constrains in such conversion (Acs *et al.*, 2007).Therefore in planning to conversion labors income has to be considered (Acs *et al*., 2007) Governmental and/or non-governmental financial support like civil society organization and small farmers' cooperation societies is required to cover this transit period (Aschemann-Witzel and Zielke, 2015).

f) Limitation (precautions) of organic farming

There is a debate that the organic products have more attachment to biological contaminants, therefore the organic food more contaminated. Nevertheless this phrase is absolutely wrong because the organic food developed more resistant mutagenic against biological diseases (EPRS, 2016). The alarm of existence of more mycotoxins especially alfalatoxins is also another thing has to lookout but the cited literature did not show that the organic is more contaminated (EPRS, 2016), and if the there is more contamination with compost from animals origin this means the immaturity of this compost or the manure age is less than 60 days (TECA, 2015).

The organic farm is less in the production to about 20% in compare to conventional system which lead to less food Security especially in the developing countries where there the lack in food production (Mohamed Osman, 2010). Another has to be considered that organic farming consumes less inputs and energy up to 35-55% (Pimentel *et al.,* 2005). Although this less productivity also give less economic return but the added values to organic products will fulfill and maximize the profit of such products (Løes, 2014).

III. Organic Farming in Sudan

a) Experience: modern organic farming vs. traditional models

There are little small modern organic farms for vegetables in and surrounding Khartoum state. Many of fruits producers for export seeking to get organic certificates (e.g. mangos and melons). The lack of official body giving organic certificates limited this experience to expand. In addition profit losses of the adding values of organic products.

The traditional models classically all are organic. The most famous model is rain-fed agriculture in small scale and in a large arable soil (Gadarif, Blue Nile, and Western Sudan). Also the irrigated narrow shallow in River Nile banks In Khartoum state, River Nile state and Northern state. In additional Flood Plain it is seasonally varied depending on the flooding of River Nile and its branches using it for cultivation and fishing (Zaroug, 2006). The forest natural products (Gum Arabic, Nabk , Gudiam, tabaldi, tamrinedus (Aradiab) in poor and rich Savanna sector) is very important system (Abdel-Rahman, 2011) that give cash crops such as gum Arabic and serve for a wide range of public as food and drink stuff (Abdel-Rahman, 2011).

Natural fodder grazing animals' products (dairy, meats and eggs) in many states (Zaroug, 2006). Even if the production is organic using pesticides for post harvesting preservation (Sesame) (Papadakis *et al.*, 2006), and artificial additives in food processing (esp. in meat) minimized the added values of organic processing products especially in exportation. More studies are needed to maximize the values of these traditional systems and getting the benefit of the added values of organic products and proper competitive processing for marketing.

b) Limitation of organic farming expanding in Sudan

There are many organic inputs existing in the local Sudanese market. Some are locally produced and some are introduced with varied quality especially in term of bio-organic fertilizers (Elhassan *et al.*, 2010). On the other hand, 7% of registered pesticides are biopesticides is about 18 trading mark, but about 5-6 active ingredients mostly are bacterial origin. The problem the farmer preferable is price wise and he used it in conventional system with other chemical fertilizers and pesticides (Hamad A. M.A, personal communication, 2017).

The traditional organic outputs (e.g. the forest natural products as mentioned before) most of the time is underestimated (Jens et al., 2002) because of bad packing, processing and handling and sometimes added artificial additives or colors. Furthermore, there is no good labeled system and most of the goods treated and managed traditionally and even getting worse (Osman, 2010).

The lack of regulation, rules and guidelines for organic farming, the administrative control gap, inspection gap, extension gap, the food gap and lastly the profit or benefit limitation weak the expanding in the organic farm marketing (Mohammed, 2010).

The suspected farmers and consumers, and the receptor market for products (locally and outside) is exist but the lack of leading or organizing body in such direction is key lock for the organic products.

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c) *Problem shooting (false practices)*

The market is open and there are many immature and incompatible types of compost without any control (Elhassan *et al.*, 2010]). Water availability is major limiting factor in agriculture in Sudan (Malik, 2010). So, the late rainfall or lack of energy for irrigation systems let those who added organic fertilizers suffer from the dryness (burning of organic matter); therefore, the application of organic fertilizers is very limited especially in rain fed system (Osman and Ali., 2010). Contaminated water and handling is a major issue to solve to upgrade all agricultural systems including organic products. Manure misuses, immature young manure can refer to the poor trained farmer (Osman, 2010). Waste treatment in Sudan still in childhood and the added values of treated sludge as organic fertilizers is almost zero. Urban agriculture is another big catastrophe where extensive fertilization and pesticides are used to cover the gap of food without any visible control. Even to those are honest and having save organic products they lack the official body who can release the organic certificates.

d) *Future prospects*

Modern organic farming system is not a nightmare but it is a dream need a little organized effort in inspection; agricultural advices in extension pursues for the farmers and the producers. Raising the public awareness in this issue is the hottest spot and the role of recent official and social media cannot be ignored (). Animal insertion in urban agriculture (e.g. chicken and goats) animals' health and welfare is other left hand to upraise the organic farming. It concludes that in a phrase of farmers' motivations and formal regulations.

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Table 1: Nutrients Content of Organic Vs. Conventional Crops. (Worthington, 2001)

Vitamin C	+27	Iron	+21
Proteins	+12	Manganese	+28
Essential amino acids	+35	Copper	+34
Calcium	+56	Nitrate	-15
Potassium	+13	Phosphorus	+16
Magnesium	+49	Iodine	+50

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Evaluation of Pot Type Marigold (*Tagetus Patula*) Varieties for Commercial Value Traits at Three Different Locations of Kathmandu Valley, Nepal

By Januka Dahal, Sabina Tiwari, Suchit Shrestha & Umed Kumar Pun
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Abstract- Marigold has special values in Nepal as elsewhere. Especially during light festival (Depawali) huge quantity of this flower is consumed for home decoration. Consumer' prefers higher longevity, contrasting colors and variation in size whereas producers prefer higher yielding and types preferred by the consumers. Local varieties are monotonous, not compact and low yielding. Looking at the market demand, field trials were conducted to evaluate contrasting pot type marigold genotypes for vegetative growth, floral quality and yield attributes at three different locations (Bhaktapur, Kathmandu and Lalitpur district) of Nepal in 2019. These trials were designed in Randomized Complete Block (RCBD) with 11 pot type marigold genotypes (Sun Orange, Sun Gold, Sun Yellow, M-45 Orange, M-45 Gold, M-45 Yellow, SO-1 Orange, SO-1 Gold, SO-1 Yellow, K-Yellow and FO9 Orange) replicated three times. Genotypes M-45 Orange and FO9 Orange were taller in plant height and well spreading canopy type. Genotypes SO-1 Orange, SO-1 Yellow, SO-1 Gold and K-Yellow were dwarf type and had less spreading canopy.

Keywords: *bloom, bud, floriculture, morphological, phonological.*

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Evaluation of Pot Type Marigold (*Tagetus Patula*) Varieties for Commercial Value Traits at Three Different Locations of Kathmandu Valley, Nepal

Januka Dahal [α], Sabina Tiwari [σ], Suchit Shrestha [ρ] & Umed Kumar Pun [ω]

Abstract- Marigold has special values in Nepal as elsewhere. Especially during light festival (Depawali) huge quantity of this flower is consumed for home decoration. Consumer' prefers higher longevity, contrasting colors and variation in size whereas producers prefer higher yielding and types preferred by the consumers. Local varieties are monotonous, not compact and low yielding. Looking at the market demand, field trials were conducted to evaluate contrasting pot type marigold genotypes for vegetative growth, floral quality and yield attributes at three different locations (Bhaktapur, Kathmandu and Lalitpur district) of Nepal in 2019. These trials were designed in Randomized Complete Block (RCBD) with 11 pot type marigold genotypes (Sun Orange, Sun Gold, Sun Yellow, M-45 Orange, M-45 Gold, M-45 Yellow, SO-1 Orange, SO-1 Gold, SO-1 Yellow, K-Yellow and FO9 Orange) replicated three times. Genotypes M-45 Orange and FO9 Orange were taller in plant height and well spreading canopy type. Genotypes SO-1 Orange, SO-1 Yellow, SO-1 Gold and K-Yellow were dwarf type and had less spreading canopy. These highly spreading and spread not being able to cover vase type marigold varieties are not suitable for pot plantation by nursery growers. We found that varieties such as M-45 Gold (among gold color), M-45 Yellow (among yellow color) and Sun Orange (among orange color) were suitable for pot plantation due to good plant height, proper spreading type, enough number of nodes and branches, good number of flowers per plant, suitable flower diameter, flower weight and pedicel length.

Keywords: bloom, bud, floriculture, morphological, phonological.

I. Introduction

Floriculture is becoming one of the prominent sectors in Nepalese economy nowadays. But, use of flowers such as marigold has its long history in Nepal especially in the temples while worshiping god and goddess and during festivals like Deepawali (festival of light and sweets) when houses are decorated with garlands of marigold and for many other special occasions. Marigold is one of the most important flowers in Nepal because of its cultural and religious values. Marigold (*Tagetes patula*) can either be annual or perennial herbaceous ornamental plant under the family of Asteraceae. It is also called as French marigold. Marigold can grow up to 5 - 18 inches high (Dixit *et al.,* 2013). This type of marigold grows well in pots and is also used for edging flower beds in a garden and mass planting in the field. Marigold cultivation is becoming popular among flower nurseries and it is also becoming one of the most valuable pot flowering crops as it is easy to cultivate with wider adaptability. It requires mild climate for proper growth. It flowers within short crop duration producing wide range of attractive shapes, colors, sizes and long shelf life. Marigold flower is also used for extraction of 1-linauol, 1-linylaetate and 1-lemoene which is used as medicine for curing ulcer (Narsude *et al.,* 2010). Apart from this, it is also used for extracting essential oil that contains antioxidants (Perez *et al.,* 2006).

Varietal characterization and identification of specific traits have great role in any crops that helps in ensuring quality seeds and good management practices (Pramila *et al.,* 2011). Classification of different morphological traits is considered as the best method to characterize varietal differences that help to evaluate seed quality and varietal performance (Singh and Singh, 2006). With the improvement in the Nepalese economy, people started to invest on home gardening, roof-top gardening and landscaping. However, growing flower in a little space and small pots for home use especially for daily worship was a cultural practice in Nepal since time immemorial. Many nurseries have been recently established to supply the plantlets (seedlings) to the customer. But, the technical advancement in the floriculture sector is still a major issue in Nepal. Availability of suitable genotype with wider adaptability and improved traits has been a major problem in marigold which is an integral part of the garden. The local popular varieties are of low yielding, poor flower quality in terms of color, texture, uniformity (more than 50% off-type flowers. Even some hybrid varieties that are imported and growing in Nepal are not of high quality and have issue in uniformity. In addition to this seeds of currently growing hybrids are not easily accessible.

Therefore, we aimed to evaluate contrasting marigold genotypes for commercially valuable traits (vegetative growth, floral quality and yield attributes) at different locations of the Kathmandu Valley with similar agro-climatic condition, Nepal in the main cropping

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season of the year 2019. The main objective of this study was to identify the best genotype with desirable traits such as more numbers of flowers per plant, uniformity of flower in terms of size, color, texture and long shelf life (longevity after harvest).

II. Materials and Methods

This research was conducted at the three locations (Bhaktapur, Lalitpur and Kathmandu districts) of the Kathmandu Valley, Nepal (Fig., 1) during summer season, 2019. The experimental sites were situated between 27°42'14.40" N latitude and 85°18'32.40" E longitude with an elevation of 1400 masl. The experimental sites have mild and warm climate condition with less rainfall in winter season and high rainfall in summer season. The average annual rainfall amount to 1400 mm with an average winter temperature of around 11°C and average summer temperature of around 28°C.

Composite soil samples were taken from the pot mixture of soil, ash and oilcake that was prepared for planting marigold from all three locations. Pot mixture was made by mixing soil, ash and oilcake at the ratio of 2:1:0.03 (i.e., 100 kg of 2:1 mixture of soil and ash mixed with 1 kg of oilcake). Soil analysis was carried out in the laboratory of the Karma Group of Companies at Sitapila, Kathmandu to determine soil pH and soil EC. At Kathmandu, Lalitpur and Bhaktapur the pot mixture had pH 6.8 and 0.85 $mScm^{-1}$ EC, pH 7.0 and 1.29 $mScm^{-1}$ EC and pH 7.1 and 1.70 $mScm^{-1}$ EC respectively.

The experiment was laid out on Randomized Complete Block Design (RCBD) during August - November, 2019. The experimental material consisted of eleven F1 hybrids of marigold collected from different sources. The details of the eleven genotypes and their sources are presented in the Table 1. The experiment was conducted with 3 replications having 33 total numbers of plots. Each plot had 4 pots of dimension 10 inches upper diameter, 5 inches lower dimeter and 9 inches height. In total, 132 pots were used in the experiment in each location. The randomization of treatment (genotypes) was done by creating random numbers in the MS Excel sheet using [RAND()] command.

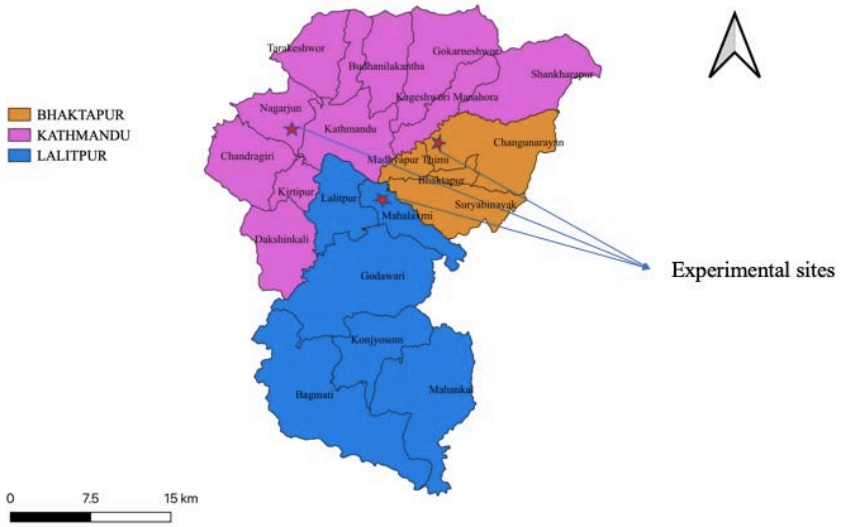


Fig. 1: Administrative map showing different locations of the field experiments in Bhaktapur, Kathmandu and Lalitpur districts of the Kathmandu Valley, Nepal

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Table 1: Description of the marigold genotypes and their source used in the study as treatments

Treatment	Variety	Flower Color	Flower shape	Petals	Company
T-1	Sun Orange	Orange	Flat	Flat	Ameriseed International Co., Ltd.
T-2	Sun Gold	Gold	Flat	Semi-tube	Ameriseed International Co., Ltd.
T-3	Sun Yellow	Yellow	Flat	Semi-tube	Ameriseed International Co., Ltd.
T-4	M-45 Orange	Orange	Flat	Flat	Karma International Seeds
T-5	M-45 Gold	Gold	Flat	Semi-tube	Karma International Seeds
T-6	M-45 Yellow	Yellow	Flat	Semi-tube	Karma International Seeds
T-7	SO1 Orange	Orange	Round	tube	Karma International Seeds
T-8	SO1 Gold	Gold	Round	tube	Karma International Seeds
T-9	SO1 Yellow	Yellow	Round	tube	Karma International Seeds
T-10	K-Yellow	Yellow	Flat	Flat	Karma International Seeds
T-11	FO9 Orange	Orange	Flat	Flat	Karma International Seeds

Seeds were sown on tray of 128 holes on the 2nd August, 2019. Seedlings at the two pairs of true leaf stage were transplanted on prepared pots on the 20th August, 2019. A light irrigation was provided just after transplanting for better anchorage of marigold seedlings. Pots with dead plants (shocked) were re-transplanted within a week after transplanting. All the intercultural operations like weeding and hoeing were carried out when necessary. Optimum irrigation was provided on daily basis through water pipe. Weekly spray schedule was followed as per package of practice of Karma Groups of Companies which included spray of plant nutrients (primary, macro and micro), fungicides and insecticides.

Three randomly selected pots from each plot were observed for commercially valuable traits such as plant height (cm), plant spread (cm), number of primary branches, stem diameter (cm), number of nodes, internodal length (cm), days to first flower bud formation, days to color formation on flower, days to complete bloom, number of flowers per plant, flower diameter (cm), flower depth (cm), flower weight (g) and pedicel length (cm).

All observed and measured data were encoded in Microsoft excel (MAC version 16.16.15) for data curation and management. Few parameters were estimated in the Microsoft excel using simple calculation methods. R-program (version 3.5.2) was used for statistical data analysis. Statistical tools such as One-way ANOVA was used to check significant differences between treatments and Least Significance Difference (LSD) at 0.05 significant level ($\alpha 0.05$) was used to compare differences between treatment means.

III. Result

Plant height and plant spread influenced significantly ($p \leq 0.01$) due to the varieties at all locations and mean of all locations. The combined analysis showed that plant height of M-45 Orange was maximum (50.48 cm) and was significantly different ($p \leq 0.01$) than other varieties except FO9 Orange (49.44 cm). Similar case was observed on plant spread too, where FO9 Orange (39.46 cm) and M-45 Orange (38.12 cm) were observed with highest plant spread and were significantly different ($p \leq 0.01$) than other varieties. The minimum height and spread were observed in the variety SO1 Gold (29.92 cm and 25.61 cm respectively) which was statistically not different from the varieties SO1 Orange and SO1 Yellow. Number of primary branches and number of nodes per plant also differed significantly ($p \leq 0.01$) because of ma rigold varieties at all locations. Numbers of primary branches were highest in all varieties (mean – 16.74) at the location Lalitpur. Among varieties M-45 Yellow was observed with highest number of primary branches (16.18) and nodes (10.10), however these varieties were statistically not different with other varieties. The minimum numbers of primary branches were observed in the variety SO1 Gold (10.40) and minimum numbers of nodes were observed on the variety SO1 Yellow (6.59) and both were statistically similar to other varieties.

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Table 2: Mean plant height and plant spread of marigold varieties at different location of Kathmandu valley

	Plant Height (cm)				Plant Spread (cm)			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	40.55^{d}	40.33^{c}	40.88^{bc}	40.59^{bc}	34.11^{cd}	32.55^{b}	31.83^{cde}	32.83^{b}
Sun Gold	37.16^{e}	37.00^{d}	38.72^{cd}	37.62^{c}	31.05^{e}	26.55^{d}	34.16^{b}	30.59^{bcd}
Sun Yellow	43.50^{c}	43.77^{ab}	39.44^{bcd}	42.24^{b}	37.11^{b}	29.22^{c}	33.91^{bc}	33.41^{b}
M-45 Orange	57.33^{a}	42.33^{abc}	51.77^{a}	50.48^{a}	40.44^{a}	33.22^{ab}	40.72^{a}	38.12^{a}
M-45 Gold	36.88^{e}	42.11^{bc}	37.44^{d}	38.81^{c}	33.05^{de}	28.38^{c}	31.94^{bcde}	31.12^{bc}
M-45 Yellow	44.03^{c}	44.22^{a}	40.94^{b}	43.06^{b}	35.16^{bc}	32.11^{b}	32.94^{bcd}	33.40^{b}
SO1 Orange	29.67^{f}	33.11^{e}	31.55^{e}	31.44^{d}	25.02^{g}	25.05^{e}	32.55^{bcd}	27.54^{def}
SO1 Gold	29.44^{f}	28.11^{g}	32.22^{e}	29.92^{d}	24.05^{g}	22.61^{f}	30.16^{e}	25.61^{f}
SO1 Yellow	30.38^{f}	31.00^{f}	28.66^{f}	30.01^{d}	25.83^{g}	23.38^{f}	31.16^{de}	26.79^{ef}
K-Yellow	29.47^{f}	33.33^{e}	33.00^{e}	31.93^{d}	28.94^{f}	25.38^{de}	33.11^{bcd}	29.14^{cde}
FO9 Orange	54.00^{b}	42.00^{bc}	52.33^{a}	49.44^{a}	41.33^{a}	34.33^{a}	42.72^{a}	39.46^{a}
Mean	39.31	37.93	38.82	38.69	32.38	28.44	34.11	31.64
LSD	2.28***	2.02***	2.18***	3.01***	2.03***	1.29***	2.32***	3.16***
SEM	0.78	0.69	0.74	1.86	0.69	0.44	0.79	1.95
CV	3.4	3.14	3.31	8.32	3.69	2.68	4	10.67

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively*

Table 3: Mean number of primary branches and nodes of different varieties at different location of Nepal

	Number of primary branches				Number of nodes			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	13.77^{ab}	13.77^{a}	18.11^{b}	14.33^{abc}	9.11^{bc}	7.77^{cd}	10.77^{a}	9.22^{ab}
Sun Gold	11.33^{de}	13.66^{a}	18.77^{b}	14.14^{abcd}	8.77^{cd}	8.22^{bc}	11.11^{a}	9.37^{ab}
Sun Yellow	14.00^{ab}	12.33^{ab}	20.33^{a}	16.03^{ab}	9.22^{bc}	9.55^{a}	10.11^{ab}	9.62^{ab}
M-45Orange	14.33^{a}	11.77^{bc}	16.66^{c}	13.97^{abcd}	10.70^{a}	7.55^{cde}	8.22^{cd}	8.85^{b}
M-45 Gold	12.11^{cd}	11.55^{bc}	16.66^{c}	13.51^{bcde}	9.55^{bc}	7.88^{bcd}	9.88^{abc}	9.11^{ab}
M-45 Yellow	14.88^{a}	11.11^{bcd}	20.00^{a}	16.18^{a}	10.00^{ab}	8.88^{ab}	11.44^{a}	10.10^{a}
SO1 Orange	10.44^{ef}	10.92^{bcd}	14.00^{d}	11.74^{def}	7.55^{e}	6.88^{def}	7.88^{d}	7.44^{d}
SO1 Gold	9.77^{fg}	10.77^{cd}	14.55^{d}	11.14^{ef}	6.22^{f}	6.44^{fg}	7.77^{d}	6.81^{d}
SO1 Yellow	8.66^{g}	10.66^{cd}	12.66^{e}	10.40^{f}	6.11^{f}	5.77^{g}	7.88^{d}	6.59^{d}
K-Yellow	11.55^{cde}	9.88^{de}	14.33^{d}	12.18^{cdef}	7.77^{de}	6.66^{efg}	8.55^{bcd}	7.66^{cd}
FO9 Orange	12.77^{bc}	9.11^{e}	18.03^{b}	14.12^{abcd}	9.22^{bc}	7.88^{bcd}	9.00^{bcd}	8.70^{bc}
Mean	12.15	11.42	16.74	13.44	8.58	7.6	9.33	8.5
LSD	1.39***	1.49***	1.07***	2.57***	1.17***	1.04***	1.78***	1.51***
SEM	0.47	0.5	0.36	1.59	0.39	0.36	0.6	0.71
CV	6.72	7.64	3.74	20.46	8	8.11	11.18	14.45

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

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All observed phenological parameters (days to flower bud formation and days to flower blooming) were found significantly different ($p \leq 0.01$) in terms of varieties. Moreover, there was a significantly different ($p \leq 0.01$) relation among varieties in combined mean of all locations. The combined analysis showed that (Table 4) variety FO9 Orange (25.48 days) took the shortest duration for the formation of flower bud and was statistically similar to the varieties SO1 Yellow, SO1 Gold, SO1 Orange and Sun Yellow. Variety M-45 Gold (28.96 days) took the longest duration for the formation of flower bud but was not significantly different than the varieties Sun Orange, Sun Gold, Sun Yellow, M-45 Orange, M-45 Yellow and K-Yellow. Looking at the mean values, marigold took shortest duration for flowering at Bhaktapur location (44.81 days) and longest at Kathmandu (49.76 days).

Variety SO1 Yellow (44.03 days) took the shortest duration for flowering and was not statistically different than varieties FO9 Orange, K-Yellow, SO1 Gold and M-45 Orange. Variety Sun Yellow (51.06 days) took the longest duration for flowering by not being significantly different from varieties Sun Orange, Sun Gold, M-45 Gold and M-45 Yellow.

Table 4: Mean days to flower bud formation and days to flowering of marigold varieties at different location of Nepal

	Days to flower bud formation				Days to flowering			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	30.88^{b}	26.66^{ab}	28.66^{a}	28.74^{ab}	47.44^{bc}	50.88^{cd}	49.44^{bc}	49.25^{ab}
Sun Gold	29.11^{cd}	25.66^{bc}	27.55^{ab}	27.44^{abc}	47.88^{b}	50.33^{d}	49.22^{bc}	49.14^{ab}
Sun Yellow	32.22^{a}	24.66^{cd}	28.27^{ab}	28.38^{ab}	52.44^{a}	50.33^{d}	50.40^{a}	51.06^{a}
M-45Orange	23.77^{e}	27.66^{a}	25.88^{c}	25.77^{c}	37.44^{f}	54.33^{a}	46.22^{e}	46.00^{cde}
M-45 Gold	30.44^{b}	27.66^{a}	28.77^{a}	28.96^{a}	43.88^{de}	52.77^{ab}	48.55^{cd}	48.40^{abc}
M-45 Yellow	30.66^{b}	26.77^{ab}	28.77^{a}	28.74^{ab}	48.11^{b}	52.22^{bc}	49.66^{ab}	50.00^{ab}
SO1 Orange	30.00^{bc}	24.22^{cde}	27.55^{ab}	27.26^{abc}	45.11^{de}	50.00^{d}	47.77^{d}	47.62^{bcd}
SO1 Gold	30.33^{bc}	23.18^{de}	27.00^{bc}	26.84^{bc}	$45.55c^{d}$	45.11^{ef}	45.53^{e}	45.40^{cde}
SO1 Yellow	28.00^{d}	23.00^{e}	25.88^{c}	25.62^{c}	43.44^{e}	44.44^{f}	44.22^{f}	44.03^{e}
K-Yellow	28.66^{d}	27.00^{ab}	28.00^{ab}	27.88^{ab}	43.44^{e}	46.37^{e}	44.55^{f}	44.79^{de}
FO9 Orange	23.11^{e}	27.33^{a}	26.00^{c}	25.48^{c}	38.11^{f}	50.55^{d}	44.44^{f}	44.37^{e}
Mean	28.83	25.81	27.49	27.38	44.81	49.76	47.28	47.28
LSD	1.28***	1.56***	1.31***	2.09**	1.96***	1.56***	0.96***	3.10***
SEM	0.43	0.53	0.45	1.28	0.67	0.53	0.32	1.91
CV	2.61	3.55	2.81	8.15	2.57	1.84	1.19	7.01

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

Number of flowers per plant was found significantly different ($p \leq 0.01$) in marigold varieties at all locations. Highest numbers of flowers were observed at the location Kathmandu (26.4) and lowest numbers of flowers were observed at the location Bhaktapur (15.62). The combined analysis showed that (Table 5) minimum numbers of flowers were found at the variety SO1 Yellow (11.17) and was significantly different than other varieties except SO1 Gold (13.89). More number of flowers were found on the variety M-45 Orange (27.62) but was statistically similar to the varieties M-45 Yellow (27.18), Sun Yellow (26.51), Sun Orange (24.48) and FO9 Orange (25.18).

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Table 5: Mean number of flowers per plant of marigold varieties at different location of Nepal

	Number of flowers/plant			
Variety	1	2	3	Combined
Sun Orange	14.33^{c}	34.11^{a}	25.00^{bc}	24.48^{a}
Sun Gold	14.11^{c}	23.44^{cd}	18.00^{de}	18.51^{bc}
Sun Yellow	22.00^{ab}	30.88^{b}	26.66^{ab}	26.51^{a}
M-45Orange	22.77^{ab}	31.66^{ab}	28.44^{a}	27.62^{a}
M-45 Gold	14.11^{c}	25.85^{c}	19.33^{d}	19.76^{b}
M-45 Yellow	23.66^{a}	30.77^{b}	27.11^{ab}	27.18^{a}
SO1 Orange	9.88^{d}	22.00^{d}	15.77^{ef}	15.88^{bc}
SO1 Gold	8.44^{de}	18.77^{e}	14.44^{f}	13.89^{cd}
SO1 Yellow	7.55^{e}	14.40^{f}	11.55^{g}	11.17^{d}
K-Yellow	13.44^{c}	23.77^{cd}	18.33^{d}	18.51^{bc}
FO9 Orange	21.44^{b}	30.77^{b}	23.33^{c}	25.18^{a}
Mean	15.62	26.04	20.73	20.80
LSD	1.86***	3.14***	2.43***	4.67***
SEM	0.64	1.07	0.82	2.88
CV	7.01	7.09	6.89	23.98

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

Flower diameter varied significantly ($p \leq 0.01$) due to the varieties at all locations. But combined analysis of the varieties mean showed that non-significant relation of flower diameter with varieties. Flower diameter of the variety M-45 Orange was highest at all locations (8.74 cm at Bhaktapur, 6.07 cm at Kathmandu and 9.18 cm at Lalitpur) however it is not significantly different with many other varieties. Variety SO1 Gold was found with minimum floral diameter (6.54 cm, 4.98cm and 7.96 cm) and is not statistically different with other varieties. Flower depth was significantly different ($p \leq 0.05$) according to varieties only at the location Bhaktapur and Lalitpur. Depth of the variety M-45 Orange was maximum (5.58 cm) and depth of SO1 Gold was minimum (4.81 cm) at the location Bhaktapur. Likewise, depth of SO1 Orange was highest (5.56 cm) and SO1 Gold was lowest (5.13 cm) at the location Lalitpur.

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Table 6: Mean flower diameter and flower depth of marigold varieties at different location of Nepal

	Flower diameter (cm)				Flower depth (cm)			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	8.35^{abc}	5.45^{ab}	8.92^{ab}	7.57	5.38^{abc}	3.60	5.38^{abc}	4.79
Sun Gold	8.16^{abc}	5.67^{ab}	8.90^{abcd}	7.57	4.97^{cd}	3.78	5.16^{bc}	4.64
Sun Yellow	8.09^{abc}	5.28^{ab}	8.40^{cde}	7.25	5.38^{abc}	3.77	5.24^{bc}	4.80
M-45Orange	8.74^{a}	6.07^{a}	9.18^{a}	8.00	5.58^{a}	4.03	5.54^{a}	5.05
M-45 Gold	8.41^{ab}	5.73^{ab}	8.92^{abc}	7.69	5.17^{abcd}	3.90	5.31^{abc}	4.79
M-45 Yellow	8.07^{abc}	4.92^{b}	8.38^{de}	7.12	5.03^{bcd}	3.46	5.30^{abc}	4.60
SO1 Orange	7.22^{de}	6.03^{a}	9.11^{a}	7.45	5.26^{abcd}	4.20	5.56^{a}	5.01
SO1 Gold	6.54^{e}	4.98^{b}	7.96^{e}	6.49	4.81^{d}	3.64	5.13^{c}	4.52
SO1 Yellow	7.63^{cd}	5.55^{ab}	8.45^{bcde}	7.21	4.98^{cd}	3.55	5.18^{bc}	4.57
K-Yellow	7.78^{bcd}	4.90^{b}	8.31^{e}	7.00	5.46^{ab}	3.57	5.4^{abc}	4.81
FO9 Orange	8.42^{ab}	6.03^{a}	9.07^{a}	7.84	5.62^{a}	3.87	5.42^{ab}	4.97
Mean	7.95	5.51	8.69	7.38	5.25	3.77	5.33	4.78
LSD	0.77***	0.91***	0.53***	1.44	0.46*	0.47	0.27*	0.75
SEM	0.26	0.31	0.18	0.89	0.16	0.16	0.09	0.47
CV	5.68	9.68	3.55	20.81	5.17	7.38	3.01	16.93

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

Flower weight and pedicel length were significantly different ($p \leq 0.01$) according to the varieties at all location. These parameters were also strongly influenced ($p \leq 0.01$) by the mean of varieties. According to the combined analysis (Table 7) variety M-45 Orange produced the heaviest flower (21.05 g) and was statistically similar to the varieties M-45 Gold (20.44 g) and Sun Gold (19.13 g). Minimum weight of flower was found on the variety SO1 Gold (14.64 g) by being statistically similar to the varieties K-Yellow (15.05 g) and Sun Yellow (16.07 g). Likewise, longest pedicel length was observed on the variety M-45 Orange (5.63 cm) which was significantly different than other varieties except FO9 Orange (5.41 cm). Shortest pedicel length was observed on the variety SO1 Gold (3.39 cm) and was significantly different ($p \leq 0.01$) than varieties M-45 Orange, FO9 Orange and Sun Orange (4.26 cm).

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Table 7: Mean flower weight and pedicel length of marigold varieties at different location of Nepal

	Flower weight (g)				Pedicel length (cm)			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	16.14^{c}	20.07^{ab}	18.81^{d}	18.34^{bcd}	4.27^{c}	3.18^{cd}	5.32^{bc}	4.26^{b}
Sun Gold	16.70^{bc}	19.01^{bc}	21.68^{ab}	19.13^{abc}	3.51^{e}	3.90^{bc}	3.83^{e}	3.74^{bc}
Sun Yellow	13.78^{def}	14.69^{g}	19.74^{bcd}	16.07^{ef}	4.23^{cd}	3.67^{cd}	4.37^{de}	4.09^{bc}
M-45Orange	19.02^{a}	21.17^{a}	22.95^{a}	21.05^{a}	6.24^{a}	4.71^{a}	5.95^{ab}	5.63^{a}
M-45 Gold	19.06^{a}	20.66^{a}	21.60^{ab}	20.44^{ab}	3.60^{de}	3.62^{cd}	4.72^{cd}	3.98^{bc}
M-45 Yellow	14.79^{cde}	16.28^{f}	18.87^{d}	16.65^{def}	3.64^{cde}	3.76^{bcd}	5.16^{bcd}	4.19^{b}
SO1 Orange	13.67^{def}	16.40^{ef}	21.44^{abc}	17.17^{cde}	3.30^{e}	3.16^{d}	5.36^{bc}	3.94^{bc}
SO1 Gold	12.15^{f}	15.68^{fg}	16.08^{e}	14.64^{f}	3.02^{e}	3.42^{cd}	3.73^{e}	3.39^{c}
SO1 Yellow	15.43^{cd}	18.56^{cd}	20.77^{abcd}	18.25^{cd}	3.08^{e}	3.62^{cd}	4.45^{de}	3.72^{bc}
K-Yellow	13.01^{ef}	16.28^{f}	15.86^{e}	15.05^{ef}	3.47^{e}	3.64^{cd}	3.81^{e}	3.64^{bc}
FO9 Orange	18.31^{ab}	17.60d^{e}	19.07^{cd}	18.33^{bcd}	5.42^{b}	4.45^{ab}	6.37^{a}	5.41^{a}
Mean	15.64	17.86	19.72	17.74	3.98	3.74	4.82	4.19
LSD	1.91***	1.21***	2.45***	2.14***	0.67***	0.73**	0.8***	0.73***
SEM	0.65	0.41	0.83	1.32	0.23	0.25	0.27	0.45
CV	7.19	4.01	7.32	12.92	9.94	11.45	9.74	18.62

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

IV. Discussion

Phenological traits (days to achieve reproductive stage in our study) such as days to formation of flower bud and days to flower bloom determines the precocity of genotypes. This is also an important character to determine the earliness or lateness of the variety. All eleven varieties took more than 20 days for flower bud formation from the transplanting day. These eleven varieties showed varying phenological traits depending up on genotype and location. Similar kind of variation among varieties and location were also revealed by Kurakula *et al.* (2018), Imandi and Reddy (2017), *Kalaimani et al.* (2017) and Umesh *et al.,* (2018). This might be due to environmental variations in different location and genotypic variations among the varieties.

Morphological parameters such as plant height and plant spread explains canopy structure of the plant and is also known as plant architecture. Number of primary branches explains canopy structure, and number of nodes explains plant height character. These parameters are important to characterize plant type.

Parameters such as plant height, plant spread, number of primary branches, and number of nodes are related to the plant vigor and bushiness of plant. Pot culture of marigold for ornamental purpose, bushy structure with medium plant height that covers the vase is preferred by customers. Variation on observed morphological traits was due to genotype and environment. Similar variation on morphological traits especially on vegetative parts were also reported by the Mahantesh *et al.* (2018), Umesh *et al.* (2018), Mansour *et al.* (2015), Palei *et al.* (2014), Choudhary *et al.* (2014), Gupta *et al.* (2014) and Rolaniya *et al.* (2017).

Number of flowers per plant has significant role in determining suitability of variety for planting. Variation in number of flowers per plant due to genotype and location were also observed by Kumar et al. (2019), Sharma et al. (2017), Kurakula et al. (2018), Khanal (2014), *Kalaimani et al.* (2017) and Umesh *et al.* (2018).

Floral traits such as flower diameter, flower depth, flower weight and pedicel length determines the shape, size and attractiveness of flower. Our observation on variation of these floral traits due to genotype, location and interaction between genotype and location was in line with the findings of Kurakula *et al.* (2018), Choudhary *et al.* (2014), Lohar *et al.* (2018), Hemlata and Singh (2017), Gupta *et al.* (2014), Mahantesh *et al.* (2018) and Umesh *et al.* (2018).

V. Conclusion

This study showed that varieties M-45 Orange and FO9 Orange are not suitable for pot cultivation as these varieties were taller and had longer pedicel length than required. These types of varieties were susceptible to lodging and pedicel breakage. In contrast, varieties SO-1 Gold, SO-1 Orange, SO-1 Yellow and K- Yellow were short (dwarf) and less spreading due to these characters, such type of plants do not look bushy and

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do not cover the pot and therefore looks not attractive. In addition, these varieties had less number of flowers in general. Varieties M-45 Gold and M-45 Yellow are promising among Gold and Yellow series. These varieties had good plant spread, higher number of primary branches and nodes. Duration to flowering was less (short duration) in these varieties. These varieties had higher number of flowers per plant, higher flower diameter, heavier flower weight and less pedicel length. Among orange series, Sun Orange is recommended because of its medium size (plant height) more number of flowers and other suitable floral traits.

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Evaluación De La Diversidad Agrícola En Agroecosistemas Del Municipio Esmeralda

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Abstract- The work took place between September 2019 and June 2020, with the aim of evaluating agricultural biodiversity on farms in the Esmeralda municipality, quantifying the comprehensive status of agroecosystems, since there is no estimate of the existing situation in this problem. in the locality. The sampled area was 0.24 hectares per farm, subdividing the fields into six transects, 80 x 5 m each. A taxonomic record was made with plant agrobiodiversity, where greater diversity of families and species was observed in the herbaceous category, with 60.71% of tree species cultivated for human consumption and only 27.08% in herbaceous. Alpha and Beta indices were determined for the comparative studies, where diversity values located between low and medium were generally obtained, mean dominance and equity indices of one species over another. The farms were dissimilar or different floristically in herbaceous and moderately different floristically in tree species, while the Agricultural Diversity Index evidenced the application of unsustainable management practices in the agroecosystem, due to insufficient application of agroecological principles and management aimed at profit making rather than caring for the environment.

GJSFR-D Classification: *FOR Code: 340201*



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Evaluación De La Diversidad Agrícola En Agroecosistemas Del Municipio Esmeralda

José Luis Céspedes Cansino [α], Concepción de la Torre Rodríguez [σ] & Osmany Amé Rodríguez Ulloa [ρ]

Resumen- El trabajo tuvo lugar entre septiembre de 2019 y junio de 2020, con el objetivo de evaluar la biodiversidad agrícola en fincas del municipio Esmeralda, cuantificando el estado integral de los agroecosistemas, dado que no se cuenta con una estimación de la situación existente en esta problemática en la localidad. El área muestreada fue de 0,24 hectáreas por finca, subdividiendo los campos en seis transectos, de 80 x 5 m cada uno. Se confeccionó un registro taxonómico con la agrobiodiversidad vegetal, donde se observó mayor diversidad de familias y especies en la categoría de las herbáceas, con un 60,71 % de especies arbóreas cultivadas para la alimentación humana y solo el 27,08 % en herbáceas. Se determinaron índices Alfa y Beta para los estudios comparativos, donde se obtuvieron valores de diversidad ubicados entre bajo y medios generalmente, índices de dominancia y equidad medios de una especie sobre otra. Las fincas, resultaron disímiles o diferentes florísticamente en herbáceas y medianamente diferentes florísticamente en especies arbóreas, mientras que el Índice de Diversidad Agrícola evidenció la aplicación de prácticas de manejo insostenible en el agroecosistema, por la insuficiente aplicación de principios agroecológicos y una gestión encaminada a fines de obtención de ganancias más que al cuidado del medio. Se concluyó que los sistemas productivos son poco diversos y medianamente parecidos florísticamente por lo que son insostenibles por la aplicación de prácticas productivas inadecuadas, los modelos de gestión aplicados muestran una tendencia hacia fines de mercado y de acumulación de capital.

Abstract- The work took place between September 2019 and June 2020, with the aim of evaluating agricultural biodiversity on farms in the Esmeralda municipality, quantifying the comprehensive status of agroecosystems, since there is no estimate of the existing situation in this problem. in the locality. The sampled area was 0.24 hectares per farm, subdividing the fields into six transects, 80 x 5 m each. A taxonomic record was made with plant agrobiodiversity, where greater diversity of families and species was observed in the herbaceous category, with 60.71% of tree species cultivated for human consumption and only 27.08% in herbaceous. Alpha and Beta indices were determined for the comparative studies, where diversity values located between low and medium were generally obtained, mean dominance and equity indices of one species over another. The farms were dissimilar or different floristically in herbaceous and moderately different floristically in tree species, while the Agricultural Diversity Index evidenced the application of unsustainable management practices in the agroecosystem, due to insufficient application of agroecological principles and management aimed at profit making rather than caring for the environment. It was concluded that the productive systems are little diverse and moderately similar floristically so they are unsustainable due to the application of inadequate productive practices, the applied management models show a trend towards market ends and capital accumulation.

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I. Introducción

Uno de los temas fundamentales en nuestros días es, sin duda, la conservación de la biodiversidad. Es un tema que ha adquirido relevancia en diferentes ámbitos de la actividad humana, pero quienes suelen referirse a él en reuniones, congresos, conferencias, publicaciones especializadas y periódicos, no hablan de lo mismo e involucran distintos aspectos de la biodiversidad. En la actualidad se define a la biodiversidad como toda variación de la base hereditaria en todos los niveles de organización, desde los genes en una población local o especie, hasta las especies que componen toda o una parte de una comunidad local, y finalmente en las mismas comunidades que componen la parte viviente de los múltiples ecosistemas del mundo (Hoban, Campbell, da Silva, Ekblom, Funk, Garner, y Hunter, 2021).

De este modo, la diversidad biológica, según el sentido que hoy se le asigna al vocablo, distingue el conjunto de formas y funciones del mundo viviente. Corresponde en los hechos a una realidad conocida después de un largo tiempo: a cada nivel de organización de la vida, del material genético, de las comunidades de especies, de las células del organismo, es la diversificación del mundo viviente (Ims, Ehrich, Forbes, Huntley, Walker, y Wookey, 2013). En otros términos, la diversidad biológica es la propiedad que tienen los seres vivos de ser distintos, es decir diferentes. Es una propiedad fundamental de todos los sistemas vivientes en todos los niveles de jerarquía biológica; de las moléculas a los ecosistemas (Council, 2013).

La biodiversidad es un vocablo que surgió en un coloquio científico celebrado en 1986. Se impuso rápidamente al tomarse conciencia del acelerado proceso de extinción de las especies (Carboneras, Genovesi, Vilà, Blackburn, Carrete, Clavero y Wynde, 2018). Para Lévêque, la biodiversidad es una versión moderna de las ciencias de la evolución, que hace la síntesis entre las adquisiciones recientes de la biología

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molecular y la ecología. El ensamble de variedades de genes, de asociaciones poblacionales, y de ecosistemas (paisajes, regiones, biosfera) constituye la expresión y el fundamento de la continuidad de la vida sobre el planeta (Léveque, 1997).

En la práctica la biodiversidad se asocia comúnmente con el número de organismos diferentes o especies en una región determinada. No obstante, esta medida también conocida como riqueza no es completa, pues la biodiversidad incluye varios niveles de organización biológica que son medibles: el de paisaje, el de ecosistemas y comunidades, el de especies y poblaciones y el genético (Lean y Maclaurin, 2016).

Este concepto abarca, por tanto, todos los tipos y niveles de variación biológica. Las referencias y menciones del concepto biodiversidad a partir del final de los años 80, han tenido un crecimiento exponencial. Pero no todas remiten a los mismos aspectos ni dimensiones. Puede apreciarse que incluso difieren dependiendo del contexto en el que se encuentran inmersas; en el ámbito científico este comportamiento depende de la disciplina y el área de trabajo del investigador. Más aún, se ha observado el empleo de diferentes definiciones en la negociación de convenios y acuerdos internacionales, así como en la toma de decisiones en distintos ámbitos. Lo mismo sucede al referirse a la biodiversidad en términos de importancia y valor económico y sus repercusiones sociales (Forero-Medina, Valenzuela y Saavedra-Rodríguez, 2021).

Sin embargo, un término muy relacionado con el de biodiversidad es el de agrobiodiversidad el cual se refiere a un concepto reciente que emergió en un contexto interdisciplinario que envuelve diversas áreas del conocimiento (agronomía, antropología, ecología, botánica, genética, biología de la conservación, etcétera) y que refleja las dinámicas y complejas relaciones entre las sociedades humanas, las plantas cultivadas y los ambientes en que conviven, repercutiendo sobre las políticas de conservación de los ecosistemas cultivados, de promoción de la seguridad alimentaria de las poblaciones humanas, de inclusión social y de desarrollo local sostenible (Stupino, 2019).

De manera práctica, es esencialmente el producto de la intervención del hombre sobre los ecosistemas y de su creatividad en la interacción con el ambiente natural, en los cuales constituyen componentes clave de la agrobiodiversidad, los procesos culturales, los conocimientos, prácticas e innovaciones agrícolas desarrolladas y compartidas por los agricultores (Santilli, 2009).

En tal sentido es importante señalar que las actividades humanas están degradando este capital, de tal manera y a tasas tales que ponen en peligro el valor de la biodiversidad para el bienestar y el desarrollo y supervivencia de nuestra propia especie. Comprender el valor de la biodiversidad para las personas, las comunidades y las empresas es el primer paso hacia un compromiso adecuado y significativo con el fin de desarrollar acciones de conservación de la naturaleza (UNEP, 2001).

Los ecosistemas de nuestro planeta producen una riqueza de alimentos nutritivos. La biodiversidad es la raíz de esta abundancia: la variedad de cultivos y alimentos con los que las civilizaciones humanas han crecido y dependen es posible debido a la enorme variedad de vida sobre la Tierra. Si la población del planeta se va a alimentar en el siglo XXI y más allá, la humanidad necesita preservar la biodiversidad que nos garantiza nuestros complejos y diversos estilos de vida (Nicholls, Altieri, y Vázquez, 2015).

La comunidad internacional es cada vez más consciente de la relación entre la diversidad biológica y el desarrollo sostenible. Cada vez son más quienes se dan cuenta de que la riqueza de la vida de este planeta, sus ecosistemas y sus repercusiones constituyen la base de nuestro patrimonio, nuestra salud y nuestro bienestar común. Esta tendencia positiva se debe ampliar como parte de nuestros esfuerzos en la lucha contra las pruebas inquietantes de la pérdida de la diversidad biológica, que repercute mayoritariamente en los pobres y, en última instancia, afecta a todas las sociedades y economías Secretaría del (Convenio sobre la Diversidad Biológica, 2014).

En tal sentido la agrobiodiversidad enfrenta grandes desafíos que van desde los procesos de transferencia tecnológica que se originan en los sectores modernos o desarrollados y se dirigen a los tradicionales o subdesarrollados de la agricultura campesina o familiar no siempre han tenido los resultados esperados. Esto ha producido una brecha entre la tecnología disponible y la que realmente utilizan los agricultores, debido al condicionamiento que múltiples factores han impuesto respecto a la adopción, provocando entre otros problemas, la simplificación de la biodiversidad (Forero-Camacho, Rojas-Carvajal y Argüelles-Cárdenas, 2013; Rodríguez-Espinosa, Ramírez- Gómez, y Restrepo-Betancur, 2016; Garrido-Rubiano, Martínez- Medrano, Martínez-Bautista, Granados-Carvajal y Rendón-Medel, 2017).

Es necesario salvaguardar y hacer uso de la biodiversidad, es decir, la variedad de vida en nuestro planeta para superar los desafíos globales a los que nos enfrentamos. La biodiversidad es parte integral de la salud de los ecosistemas, es esencial para el aumento sostenible de la producción de alimentos y necesaria para crear medios de subsistencia resilientes. Sin embargo, el alarmante ritmo de pérdida de biodiversidad actual amenaza con consecuencias devastadoras para la humanidad si no hacemos algo al respecto. Los cambios en el clima pueden revertirse con el tiempo, pero no hay marcha atrás una vez que una especie se extingue (Rivera-Ramírez, Ríos-De la Cruz, Bravo-Avilez, Bernal-Ramírez, Velázquez-

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Cárdenas, de Santiago-Gómez, Lozada-Pérez y Rendón-Aguilar, 2021).

El impacto de una población mundial en aumento está afectando los recursos naturales necesarios para la vida humana. Los cultivos, la ganadería, la silvicultura, la pesca y la acuicultura insostenibles, así como otros sistemas productivos insostenibles como la industria y la minería y los procesos de urbanización, tienen consecuencias incalculables sobre la riqueza de nuestra biodiversidad y sobre la salud de nuestros ecosistemas. Los recursos naturales son cada vez más escasos, el clima se ve afectado, los conflictos aumentan, y las personas huyen de sus países natales en busca de una vida mejor (dos Santos, Grisolia, Cares y Garrafa, 2020).

Por otra parte, la totalidad de nuestros cultivos domésticos se derivan de especies silvestres que han sido modificadas a través de la domesticación, mejoramiento selectivo e hibridación. La mayor parte de los centros mundiales de biodiversidad contienen poblaciones de variedades madres variables y adaptables, además de parientes silvestres y malezas relacionadas con plantas cultivadas. Muchos sistemas agrícolas manejados en forma tradicional en el Tercer Mundo constituyen repositorios *in situ* de diversidad vegetal nativa. Hoy día existe una gran preocupación por la erosión genética en áreas donde los pequeños agricultores son empujados por la modernización agrícola a adoptar variedades a expensas de las tradicionales (Vargas, 2015).

Esta situación resulta más preocupante si se tiene en cuenta que la domesticación y selección agrícola se ha llevado a cabo sobre una pequeña parte de los miles de especies vegetales y animales que nuestros antepasados solían cazar, pescar y recoger. Esto condujo a un mejor rendimiento y adaptación de las especies a unas condiciones específicas, lo que nos permite alimentar a una población creciente. Sin embargo, también dio lugar a una pérdida de diversidad. Hoy en día, solo tres cultivos básicos (arroz, maíz y trigo) y tres especies animales (vacas, cerdos y pollos) juntas proporcionan la mayoría de la ingesta de energía alimentaria del mundo, todo lo cual se debe fundamentalmente a la intensificación de la producción y un mayor uso de insumos externos que han reducido la gama de variedades utilizadas en la producción de cultivos (Marqués, Huillca y Segura, 2020).

En Cuba, los estudios de escenarios productivos agroecológicos integrales no son abundantes, aun cuando existen muchos agroecosistemas que erigen su proyección hacia una agricultura integral. Las experiencias exitosas y sobresalientes, se enmarcan a predios de pequeños productores o cooperativas excepcionales dentro del movimiento de agricultura urbana (Llanes, Caballero y Perera, 2014).

II. Materiales Y Métodos

a) Localización y tiempo para la realización el trabajo

El trabajo tuvo lugar en la etapa comprendida entre septiembre de 2019 y mayo 2020. En cinco fincas del municipio Esmeralda, pertenecientes cuatro de ellas a la ANAP y una a la Empresa Agropecuaria Esmeralda. Las fincas se ubican geográficamente de la siguiente forma:

Finca La Lima perteneciente a la CCS 26 de Julio, se encuentra en los 21^{0}84´ 59´´ de Latitud Norte y 78^{0}10´ 53´´ de Longitud Oeste, se dedica fundamentalmente a la producción cultivos varios y cría de caballos. El dueño de la finca es Vicente Esquivel Rodríguez, de procedencia campesina, la misma fue adquirida en 1925.

Finca El Prado pertenece a la CCS Jorge Fernández Bello, se ubica en los 21^{0}86´ 51´´ de Latitud Norte y 78^0 12´ 59´´ de Longitud Oeste. Su dueño Aroldo Hernández, de procedencia campesina, se adquiere desde 1910, cuya actividad fundamental es los cultivos varios, además incluye la ganadería donde practica desde hace siete años la inseminación artificial. Finca La Maravilla perteneciente a la CCS Macario Guevara, su dueño Diosbaldo Campo se ubica en los 21^0 79´ 06´´ de Latitud Norte y los 78^{0}10´ 51´´ de Longitud Oeste, la misma fue fundada en el 2011.

Finca La Patrona perteneciente a la CCS Lázaro Peña, su dueña Neri Fariña, ubicada en los 21^0 78´ 05´´ de Latitud Norte y 78^0 10´ 44 ´´ de Longitud Oeste. La misma fue comprada hace 8 años y se empezó a trabajar pues no la trabajaban, su actividad fundamental son cultivos varios.

Unidad Empresarial de Base (UEB), perteneciente a la Empresa Agropecuaria Esmeralda, perteneciente al Programa de Agricultura Urbana, Suburbana y Familiar. Su administrador es Raúl Céspedes, ubicada en los 21^0 84´ 35´´ de Latitud Norte y 78^0 11´ 20 ´´ de Longitud Oeste. Fundada en el 2013.

b) Clima y suelos predominantes en los agro-ecosistemas

Los suelos predominantes en las fincas según clasificación de los suelos de Cuba de 2015:
En la finca El Prado es suelo Pardo con Carbonato Típico, caracterizado por perfil ABC formado bajo proceso de sialitización, con textura que va desde franco a arcillosa. Tiene un horizonte B Siálico que caracteriza al grupo de suelo. Tiene una capacidad de intercambio catiónico mayor de 30 cmol kg^{-1}, con contenido de hierro libre menor del 3 %.

La finca La Maravilla, con un suelo tipo Fersialítico Pardo Rojizo, caracterizado por perfil ABC, con presencia del horizonte fersiálico y características de color pardo rojizo. Cuando se forma sobre roca carbonatada presentan diferente grado de lavado.

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Finca La Lima Fersialítico Pardo Rojizo Típico con características similares al anterior.

Finca La Patrona, con presencia de suelos del tipo Pardo con Carbonato, con características similares a la finca el Prado.

UBPC 2, presenta un suelo del tipo Vertisol, caracterizado por formarse por sedimentos arcillosos ricos en esmectitas con un espesor considerable (igual o mayor a 60 cm), con alta plasticidad, con color oscuro, presencia de grietas.

El clima se caracteriza en la zona por una insolación media diaria de alrededor de ocho horas y un régimen térmico muy cálido con noches confortables con temperaturas con temperaturas promedios de 15-19,9 ^{0}C, para las mínimas y entre 25 y 29,9 ^{0}C, para las máximas, en la época analizada y con marcada oscilación térmica 15-19,9 las mínimas y 30 y 34,9, para determinadas áreas del municipio.

Las precipitaciones 1200 y 1400 mm en el año, ocurriendo entre el 72 y 82 % de estas en la época lluviosa (mayo-octubre), con desbalance entre los ingresos y egresos dado que los valores de evaporación se ubican entre los 2000 y 2200 mm anuales.

c) Metodología aplicada en el trabajo

El método utilizado se generó y desarrolló según la metodología empleada por Moreno (2000) adaptándose a las condiciones del lugar, fundamentándose en lo siguiente:

Para el muestreo de arvenses se inspeccionan los campos de los sistemas productivos registrando las especies presentes en un área de 0,24 hectáreas. Para ello se subdividen los campos en 6 transectos, de 80 por 5 m, cada uno de ellos dividido por 16 parcelas de 5 x 5 m. En total se obtienen 64 parcelas de 5 x 5 m, donde se determinan la presencia de las diferentes especies de plantas. La ubicación de los transectos es al azar, evitando la intercepción de los mismos. La distancia entre transectos es de 20 m como máximo. Para demarcar los transectos se utilizó una cuerda de 80 m de longitud, marcada cada 5 m. Para dimensionar el tamaño de cada parcela de 5 x 5 m, se miden 2,5 m a cada lado de la cuerda. Para el conteo de especies de plantas cultivadas se determinó conociendo el porciento de población del cultivo y el marco de siembra o plantación utilizado (conocer el número de plantas que debía haber y conocido el porciento de población estimar el número real de plantas y en el caso de las especies arbóreas se contabilizan el 100 % de las plantas existentes dentro de las áreas del sistema productivo.

Cada transecto de 80 x 5 m subdividido en 16

Para el estudio de la biodiversidad se utiliza la medición mediante el empleo de índices Alfa y Beta, empleando de cada uno de ellos los que se relacionan a continuación.

Métodos Alfa para medir la diversidad

Índice de diversidad de Margalef

$$D_{Mg} = S\text{-}1/\ln N$$

donde:

S = número de especies

N = número total de individuos

Interpretación

Valores entre 0 y 1,35 diversidad baja.

1,36 y 3,5 diversidad media.

Mayor de 3,5 diversidad alta.

Índice de dominancia de Simpson

$$\lambda = \Sigma\, p_i^2$$

donde:

pi = abundancia proporcional de la especie *i*, es decir, el número de individuos de la especie i dividido entre el número total de individuos de la muestra (pi= ni/N).

Entonces para determinar la diversidad que influye en la equidad o uniformidad del agroecosistema y es por demás contrario a la dominancia, se calcula mediante la operación 1- λ, realizando el siguiente análisis a dicho resultado:

Interpretación

Cuando el valor está entre:

0 – 0,33 Diversidad baja y alta dominancia.

0,34 – 0,66 Diversidad media.

> 0,66 Diversidad alta y baja dominancia.

Índice de equidad

Índice de Shannon-Wiener

$$H' = -\Sigma pi \times \ln pi$$

Interpretación

Valores entre 0 y 1,35 diversidad baja.

1,36 y 3,5 diversidad media.

Mayor de 3,5 diversidad alta.

Índice de uniformidad o Equitabilidad de Pielou.

$$E = H'/\ln S$$

H´: Corresponde a los valores de diversidad obtenidos.

S: Número de especies recolectadas.

Tabla 1: Interpretación de los valores del índice de uniformidad de Pielou

Valores	Significación	
0 – 0,33	Heterogéneo en abundancia	Diversidad baja
0,34 – 0,66	Ligeramente heterogéneo en abundancia	Diversidad media
> 0,66	Homogéneo en abundancia	Diversidad alta

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Índices de diversidad beta
Coeficiente de similitud de Jaccard

$$I_J = c/\ a+b-c$$

Donde:
a = número de especies presentes en el sitio A
b = número de especies presentes en el sitio B
c = número de especies presentes en ambos sitios A y B

Tabla 2: Interpretación de los valores del coeficiente de similitud de Jaccard

Rango	Explicación	Significación
0 a 0,33	No parecidos	Disímiles o diferentes florísticamente
0,34 a 0,66	Medianamente parecidos	Medianamente disímiles florísticamente
0,67 a 1	Muy parecidos	Similares florísticamente

Índices para evaluar la Agrobiodiversidad.

Para el cálculo de los índices se tuvo la metodología elaborada por Leyva y Lores (2018), para lo cual se tuvo en cuenta la integración de los diferentes grupos y componentes de la agrobiodiversidad que representa el índice de diversidad del agroecosistema y cuya expresión matemática es la siguiente:

$$IDA = \frac{S_1IFER + S_2IFE + S_3IAVA + S_4ICOM}{St}$$

Dónde: IFER es el Índice de biodiversidad para la alimentación humana; IFE: el índice de biodiversidad para la alimentación animal; IAVA: el índice de biodiversidad para mejorar las propiedades físicas, químicas y biológicas de los suelos e ICOM: que es el índice de biodiversidad complementaria; *St*: representa al número de componentes de cada grupo de la biodiversidad agraria, teniendo en cuenta que cada grupo tiene un número específico de componentes. Los índices en cada caso quedan como sigue:

$$IFER = \frac{Vi\ (I)+Vi(II)+Vi(III)+Vi(IV)+Vi(V)\ +\ Vi(VI)}{18}$$

$$IFE = \frac{Vi\ (VII)\ +\ Vi(VIII)}{6}$$

$$IAVA = \frac{Vi\ (IX)\ +\ Vi(X)}{6}$$

$$ICOM = \frac{Vi(XI)\ +\ Vi(XII)\ +\ Vi(XIII)\ +\ Vi(XIV)}{12}$$

$$\text{Entonces: } IDA = \frac{IFER\ +\ IFE\ +\ IAVA\ +\ ICOM}{4}$$

Se asumió que los valores de *IDA* por debajo de 0,66 no se consideran sostenibles, siendo el valor 1,0 el máximo valor posible a obtener, algo que, además, resulta sumamente difícil lograr.

Cada grupo posee especies diferentes, las cuales se agrupan en 14 componentes o grupos específicos que responden a las necesidades directas e indirectas del agroecosistema.

III. Resultados Y Discusión

a) Resultados del inventario de la agrodiversidad en agroecosistemas del municipio Esmeralda

Como resultado del estudio de la agrodiversidad en cinco sistemas productivos del municipio Esmeralda, se comprobó que el agroecosistema que mostró la mayor diversidad, tanto para la categoría de herbáceas y arbustivas (15 familias y 21 especies), como para las arbóreas (13 familias y 21 especies), corresponde a La Maravilla, mientras que la de resultados más desfavorables es la que se nombra La Patrona con nueve familias y 15 especies en la herbácea-arbustivas, mientras que en la categoría de arbórea se registraron 10 familias y 17 especies. El resto de los agroecosistemas estudiados mantuvieron una tendencia de 11 familias y entre 19 y 20 especies para las herbácea-arbustivas, mientras que para las arbóreas estuvo entre las 11 y 13 familias y entre 18 y 21 especies (Tabla 4).

Tabla 3: Comportamiento de la composición botánica en el período por agroecosistemas

Agroecosistemas	I	II	III	IV
El Prado	11	13	19	18
La Maravilla	15	13	21	21
La Lima	11	11	19	18
UBPC 2	11	12	20	20
La Patrona	9	10	15	17

I. Familias herbáceos-arbustivas II. Familias arbóreas III. Especies herbáceas-arbustivas IV. Especies arbóreas

Al comparar estos resultados con los aportados por Vargas *et al*., (2016) y Vargas *et al*., (2017), para agroecosistemas de la Agricultura Suburbana en Santiago de Cuba y los obtenidos por Céspedes, Jiménez y Estévez (2017) y Céspedes, Rodríguez y de la Torre (2018), resultan muy inferiores en el número de familias y especies para las categorías de herbácea-arbustivas y arbóreas, en igual periodo poco lluvioso, con suelos un tanto desiguales dado el municipio, además, de un comportamiento diferente en las variables climáticas y su influencia en la biodiversidad de los agroecosistemas, al estar este ubicado en la parte norte de la provincia y hacia la costa, donde la incidencia de la temperatura, la velocidad de los

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vientos, y la radiación solar son diferentes que hacia el interior de la provincia.

b) Especies registradas y su papel dentro de los agroecosistemas

La relación de las familias y especies registradas en cada agroecosistemas aparecen en los anexos (Tabla 5-14), utilizando la ubicación taxonómica en familias y especies descrita por Greuter y Rodríguez (2016).

Es posible apreciar que 13 de las 48 especies herbácea-arbustiva registradas pueden ser empleadas para la alimentación humana, lo cual representa un 27,08 %, mientras que para las especies arbóreas 17 de las 28 registradas se consideran plantas alimenticias para el ser humano (60,71 %). Estos resultados son comparables a los aportados por Céspedes, Jiménez y Estévez (2017) y los obtenidos por Céspedes, Rodríguez y de la Torre (2018), para la categoría de plantas arbóreas, pero superiores en la categoría de herbáceas y arbustivas, lo cual permite considerar que en los agroecosistemas de Esmeralda se cultivan un mayor número de especies herbáceas para la alimentación humana, como promedio, que las establecidas en sistemas productivos del municipio de Minas y Camagüey (Figura 1), algo que se considera está relacionado con la cultura productiva de los actores.

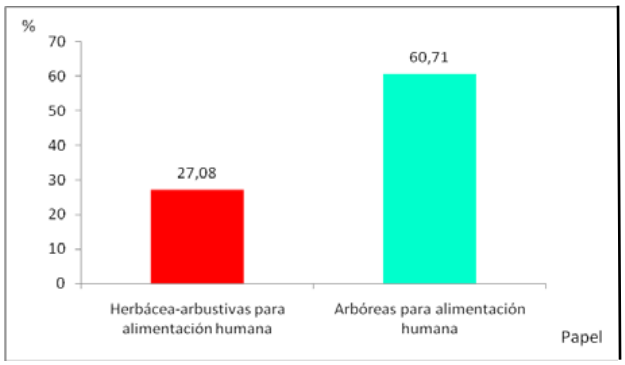


Figura 1: Porciento por categorías de especies registradas en agroecosistemas de Esmeralda

Uno de los servicios importantes que se ve afectado en los agroecosistemas estudiados es la polinización, por escaso número de especies, ecosistemas más biodiversos son más saludables y les brindan un hábitat a las especies nativas. Las abejas melíferas no nativas y otras especies exóticas tienen una influencia significativa en los sistemas de polinización en los agroecosistemas, lo cual se ve seriamente afectada por el cambio mismo de los sistemas naturales a sistemas de producción, donde el hombre modifica y destruye los hábitats afectando las poblaciones de polinizadores de tres maneras, destruye las fuentes de alimento, destruye los sitios para anidar o para ovipositar y destruye los sitios de descanso o apareamiento, según lo planteado por Pfiffner y Balmer (2011), esta constituye una meta no alcanzada en los sistemas productivos estudiados.

El control de plagas es otro de los servicios del agroecosistemas que se ve afectado, dado a que existen evidencias que indican que a medida que se intensifican los sistemas de producción agrícola se produce un cambio en la estructura del paisaje, lo cual tiende a la pérdida de su biodiversidad y a su desestabilización, implicando brotes de plagas de una frecuencia y un alcance mayor, aspecto advertido por Rahmanian., Gómez,, Bannò, y Meybeck (2016), algo que solo se logra impedir cuando los productores establecen agroecosistemas de una alta estabilidad por su alta biodiversidad de especies vegetales, manteniendo así, relaciones cercanas a las existente en el medio natural, propósito por alcanzar en los agricultores de Esmeralda, reflejado en los datos obtenidos durante los muestreos realizados.

De las especies de plantas existentes en los agroecosistemas estudiados es importante señalar que ocho de las correspondientes a la categoría de herbácea-arbustivas; *Merremia umbellata* (tres agroecosistemas), *Cynodon dactylon* (cuatro agroecosistemas), *Dichrostachys cinerea* (tres agroecosistemas), *Momordica charantia* (un agroecosistema), *Sida acuta* (dos agroecosistemas) *y Bromelia pinguin* (un agroecosistema), están incluidas dentro de las 100 especies más nocivas del listado de especies invasoras y potencialmente invasoras en la República de Cuba, mientras que en esa misma categoría pero para los árboles registrados en los agroecosistemas, se contabilizaron cuatro especies; *Cordia obliqua* (un agroecosistema), *Psidium guajava* (cinco agroecosistemas), *Leucaena leucocephala* (cuatro agroecosistema) y *Albizia procera* (dos agroecosistema), corroborado por los resultados obtenidos por Oviedo *et al*. (2012).

Este es un aspecto a tener muy en cuenta por los productores dado que representa uno de los factores que contribuye a la pérdida de la biodiversidad por su elevada capacidad de dispersión y

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desplazamiento de otras especies, algo que pueden hacerlas incontrolables por parte del agricultor, afectando áreas productivas y con potencial para la producción de alimentos.

En relación con las familias registradas es preciso señalar que el conocimiento de sus funciones dentro del agroecosistema es de suma importancia dado que muchas de ellas juegan un papel primordial en la cría, desarrollo y dispersión de especies beneficiosas como biorreguladores naturales del medio, como tales se pueden citar: Apiaceae, Asteraceae y Fabaceae, las cuales han sido señaladas como especialmente importantes porque pueden proporcionar alimento, sitios de apareamiento, refugio e hibernación para estos organismos benéficos según lo planteado por Paleologos, Cicchino y Sarandón, (2008) y se pudo apreciar la presencia de al menos dos de ellas (Asteraceae y Fabaceae) en cuatro de los agroecosistemas estudiados representadas por entre dos y ocho especies en Fabaceae, entre dos y cinco en Asteraceae, algo favorable para los agroecosistemas, pero desconocida su utilidad por los productores.

Otras familias también estuvieron muy representadas en los agroecosistemas por ejemplo dentro de las herbácea-arbustivas, además de las señaladas anteriormente aparecen; Poaceae (tres a cuatro especies) y presente en todos los agroecosistemas, Amaranthaceae (presente en tres de los sistemas estudiados y dos especies) y Euphorbiaceae (tres agroecosistemas y de dos a tres especies).

Dentro de las arbóreas las familias más representativas incluye a Anacardiaceae, Annonaceae, Arecaceae y Rutaceae, presentes en todos los agroecosistemas y de una a tres especies, además, Fabaceae (de tres a cinco especies en cuatro de las fincas estudiadas), es necesario agregar la importancia que tiene la presencia de familias botánicas como las fabáceas por el papel que desempeñan como mejoradoras de las propiedades físicas y biológicas del suelo, otro de los servicios prestados por estas plantas al agroecosistema, además de los ya planteados. Se registraron seis especies de frutales presentes en todos los agroecosistemas estudiados, *Mangifera indica* L. (mango), *Persea americana* Mill (aguacate), *Psidium guajava* L. (guayaba), *Citrus aurantium* var. *sinensis* L. (naranja dulce), *Citrus limon* (L.) Osbeck. (limón criollo) y *Roystonea regia* (Kunth) O. F. Cook. (palma real), especies todas que juegan un papel importante por sus aportes a la alimentación humana e incluso los animales (palma real).

Estos resultados son similares a los aportados por Vargas *et al*., (2016) y Vargas *et al*., (2017) y los reportados por Céspedes, Jiménez y Estévez (2017) en agroecosistemas del municipio de Minas y los obtenidos por Céspedes, Rodríguez y de la Torre (2018), en agroecosistemas del municipio Camagüey, tanto para las familias más comunes, así como las especies más representadas por agroecosistema, en herbácea-arbustivas y arbóreas.

c) Especies animales, su papel dentro de los agroecosistemas

En los agroecosistemas estudiados se registraron un total de 417 aves, 360 cerdos, equinos 56, caprino 10 y en el caso de los ovinos 135, su distribución por agroecosistema, aparece en la Figura 2.

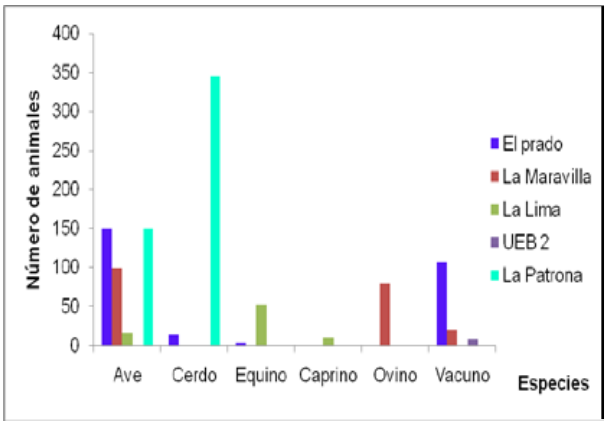


Figura 2: Relación de especies animales por agroecosistema

Como principales propósitos de la crianza de las diferentes especies están:

- El consumo familiar
- Ventas al Estado

La actividad económica que implica la comercialización de los recursos animales agrícolas, ha significado la obtención de altos dividendos desde el punto de vista monetario para el propietario y su familia, sin embargo, se adolece de una estrategia racial como vía para lograr mejores resultados productivos y la

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sostenibilidad en este importante renglón, dado que solo se dispone de una o dos razas introducidas por su alto potencial productivo, en el caso de los cerdos, buscando un fin comercial que signifique jugosos ingresos a la familia. Para el caso de los ovinos y caprinos, se desarrollan animales que por tradición se han criado en la zona y se busca solo un aporte para el consumo familiar, aunque no se desprecia el factor de comercialización y obtención de ingresos para la familia. En el caso de la crianza de bovinos, ésta tiene un doble fin; producción de leche y ventas al Estado, actividades que no cumplen con las expectativas de los productores dado que el promedio de litros de leche por vaca es bajo (4 l) y el peso al momento de las ventas está por debajo de indicadores aceptables, todo esto como resultado de que no se explotan otras variantes para el logro de un mayor aporte al Estado y mayores ingresos a la familia, como es el caso de la ceba de toro, el mejoramiento racial que proporcione una mayor producción de leche por vaca y animales mejor adaptados a las condiciones de los ecosistemas locales, constituyendo una asignatura pendiente en los productores dueños de los agroecosistemas estudiados, con todo lo negativo que implica estas prácticas de manejo inapropiadas, agregándose a esto el no contar con una enumeración y la caracterización fenotípica de la biodiversidad pecuaria de que disponen, como primeros pasos esenciales en la planificación de programas de manejo sostenible de los Recursos Genéticos de Animales (RGA), en fincas, en contraposición con lo planteado por Grisa y Sabourin (2019).

d) Resultados de los índices de diversidad biológica aplicados

i. *Índice de diversidad de Margalef*

Los resultados del cálculo del índice para cada agroecosistema se comportan de la siguiente forma:

Los valores para las especies herbácea-arbustivas se ubicaron entre 1,21 (diversidad baja) en el agroecosistema que representa la finca La Patrona propiedad de Neri Fariñas, mientras que el valor más elevado corresponde a la finca La Maravilla, perteneciente a Macario Guevara con un valor de 2,03 (diversidad media). En el resto de los agroecosistemas predominan los valores de diversidad medio, con la excepción de la finca El Prado, propiedad de Jorge Fernández, con índice de 1,28, representando una diversidad baja (Tabla 15).

Tabla 15: Índice de diversidad de Margalef por finca

Fincas estudiadas	Herbáceas-Arbustivas	Arbóreas
El Prado	1,28	2,41
La Maravilla	2,03	2,06
La Lima	1,95	3,47
UEB 2	1,56	4,04
La Patrona	1,21	2,89

Un análisis a priori de estos resultados permite entender los problemas que presenta la biodiversidad en agroecosistemas del municipio de Esmeralda y los inconvenientes que trae este elemento a partir de la limitación de servicios ecosistémicos y a la comunidad, pues mundialmente se reconoce que la diversidad fitogenética es esencial para satisfacer las necesidades alimenticias a corto plazo y alcanzar la sostenibilidad a largo plazo según lo planteado por Rahmanian, Gómez, Bannò y Meybeck (2016).

Al comparar estos valores reportados en la investigación para fincas del municipio Esmeralda, resultan similares a los reportados por Leiva y Lores (2012), en agroecosistemas del municipio San José de las Lajas provincia Mayabeque en lo que se registraron valores de diversidad media, pero resultan inferiores a los obtenidos por Céspedes, Jiménez y Estévez (2017) en agroecosistemas del municipio de Minas y los obtenidos por Céspedes, Rodríguez y de la Torre (2018), en agroecosistemas del municipio Camagüey, para la categoría de herbácea-arbustivas, mientras que son superiores a los obtenidos por los autores anteriormente citados para la categoría de arbóreas.

e) Resultados de la aplicación del índice de dominancia y diversidad de Simpson

Los resultados del índice de dominancia y diversidad de Simpson, muestra que para las especies herbácea-arbustivas, los agroecosistemas La Lima y la UEB 2, mostraron valores de dominancia bajos y de diversidad altos, La Maravilla y La Patrona evidenciaron valores de diversidad y dominancia medios, mientras que La finca El prado fue la única que reflejó valor de dominancia alto y diversidad bajo, todo esto en la categoría de herbácea-arbustiva. Para la categoría de arbóreas las fincas; La Lima, UEB 2 y La Patrona, aportaron valores de diversidad alto y baja dominancia, sin embargo, la finca El Prado reflejó altos índices de dominancia y bajos de diversidad, siendo el valor de diversidad de la finca La Maravilla significativamente bajo en relación con el resto.

De este análisis se puede apuntar que la dominancia de especies en los agroecosistemas constituye una limitante pues el establecimiento de sistemas biodiversos promueve una variedad de servicios ecológicos en los agroecosistemas que, de no existir, pueden ocasionar costos significativos tanto de índole económico, pero sobre todo, desde el punto de vista ecológico, de igual forma la biodiversidad agrícola

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es el indicador de mayor importancia para la sostenibilidad general de los agroecosistemas; ella refleja en su relación directa o indirecta, los cambios que ocurren a favor o en contra de la sostenibilidad, su riqueza natural actual y futura, es seguridad económica, para la alimentación, de producción, de negociación y seguridad alimentaria para las generaciones presentes y futuras, por lo que el éxito está en lograr un adecuado equilibrio entre las especies que se establecen por la actividad del hombre en cada finca, con el propósito de satisfacer sus necesidades de alimentación, para los animales y la garantía del aporte a las necesidades de otros individuos a través del proceso de comercialización de los productos, además, su uso como maderas para muebles, construcción de viviendas, como combustible, como medicinal, para el mejoramiento de los suelos, entre otras funciones no menos importantes, todo lo cual se ve afectado, sobre todo en aquellos agroecosistemas que su diversidad resultó ser baja, dominando solo un grupo limitado de especies, lo cual significa la simplificación de la biodiversidad del sistema productivo (Tabla 16).

Tabla 16: Valores del índice de dominancia de Simpson por fincas

Fincas estudiadas	Herbáceas-Arbustivas λ	Arbóreas Dominancia λ
El Prado	0,73	0,74
La Maravilla	0,38	0,97
La Lima	0,26	0,14
UEB 2	0,25	0,11
La Patrona	0,47	0,24

Al comparar estos resultados con los obtenidos por Leyva y Lores (2012), quienes en su investigación en el municipio San José de las Lajas de la Provincia Mayabeque, obtuvieron valores de diversidad altos, mientras que los obtenidos en esta investigación, en la categoría de herbácea-arbustivas, los rangos están entre bajo a medios marcando la falta de correspondencia entre ambos autores, no siendo así en el caso de la categoría de arbóreas, donde son similares los resultados en ambas investigaciones al predominar la diversidad alta.

Si lo comparamos con los valores obtenidos por Vargas *et al*., (2016) y Vargas *et al*., (2017) en agroecosistemas de la provincia Santiago de Cuba y los reportados por Céspedes, Jiménez y Estévez (2017) en agroecosistemas del municipio de Minas y Céspedes, Rodríguez y de la Torre (2018), en agroecosistemas del municipio Camagüey, en los cuales predominan los bajos índices de dominancia y altos de diversidad tanto para especies herbácea-arbustivas y arbóreas, son inferiores los índices reportados en esta investigación para las primeras dado que como se planteó, en las fincas de Esmeralda predominan los valores entre bajos y medios de diversidad y similares para las arbóreas, donde predominan los valores de diversidad altos. Estos resultados son comparables dado que se tuvo en cuenta que se llevaron a cabo en época poco lluviosa todos, una de las razones que explica los menores índices de diversidad se debe según Candó *et al*. (2015) a que las semillas de muchas especies consideradas arvenses tienen un largo período de latencia las cuales se mantienen viables hasta que encuentran las condiciones propicias para germinar, lo cual no han encontrado aún por la época en que se realiza la investigación caracterizada por la baja ocurrencia de las lluvias.

f) Resultados del índice de Equidad de Shannon-Wiener

Al analizar los resultados ofrecidos por el cálculo de los valores del índice Shannon-Wiener, es posible apreciar que con la excepción de las fincas El prado (0,64) y La Patrona (0,98), que corresponden a valores de diversidad bajos, el resto se ubica en la categoría de medios para las herbácea-arbustivas. En el caso de las especies arbóreas, El Prado se mantiene en categoría de diversidad baja (0,85), siendo muy baja en la finca La maravilla (0,10), el resto se mantuvo en la categoría de media.

Este índice es importante porque reconoce los valores de diversidad biológica de los agroecosistema aspecto elemental dado que como plantea Swift *et al.*, (2004), la diversidad específica (el número de especies o riqueza) pero, además, la diversidad funcional, estructural y fenológica, entre otras, constituyen un aspecto fundamental para el cumplimiento de las funciones ecológicas que aseguran la estabilidad y resiliencia del sistema. La pérdida de ciertos niveles de diversidad, puede alterar o disminuir significativamente estas funciones en los agroecosistemas, las que, entonces, deben ser suplidas mediante el empleo de insumos. La función más sensible al respecto, parece ser la regulación biótica (Tabla 17).

Tabla 17: Valores del Índice de Equidad de Shannon-Wiener para cada finca.

Fincas estudiadas	Herbáceas-Arbustivas H'	Arbóreas H'
El Prado	0,64	0,85
La Maravilla	1,63	0,10
La Lima	1,70	2,42
UBPC 2	1,62	2,61
La Patrona	0,98	1,88

Si comparamos estos resultados con los obtenidos por otros investigadores en condiciones similares de época y suelos diversos, son similares a los obtenidos por Leyva y Lores (2012), quienes en su investigación en el municipio San José de las Lajas de

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la Provincia Mayabeque obtuvieron valores del Índice de Equidad medios, tal como se aprecian en los resultados logrados en agroecosistemas de del municipio de Esmeralda, de igual forma se coincide en lo general, con los resultados logrados por Vargas *et al*., (2016) y Vargas *et al*., (2017) en agroecosistemas de la provincia Santiago de Cuba y los reportados por Céspedes, Jiménez y Estévez (2017) en agroecosistemas del municipio de Minas y Céspedes, Rodríguez y de la Torre (2018), en agroecosistemas del municipio Camagüey, en los cuales predominan los valores medios del Índice Equidad.

g) Resultados del índice de Uniformidad o Equidad de Pielou

Los resultados del cálculo de este índice muestran que predominan los valores que indican una ligera heterogeneidad en abundancia en tres agroecosistemas estudiados (La Maravilla, La Lima y La UEB 2), con el mayor valor reportado en la UEB 2 (0,60), para la categoría de herbácea-arbustivas, mientras que existen dos agroecosistemas (El Prado y La Patrona), ubicados en la categoría de heterogéneos en abundancia, registrando el valor más bajo la primera finca con 0,22.

El análisis de los resultados de los valores obtenidos para el cálculo del propio índice en las arbóreas, indican que las fincas La Lima y La Patrona, mostraron resultados que indican homogeneidad en abundancia, mientras que La UEB 2 se encuentra en el valor límite del rango que indica una ligera heterogeneidad en abundancia (0,66). Las fincas El Prado y La Maravilla se ubican en la categoría inferior que corresponde a heterogeneidad en abundancia, con el menor valor en la segunda con 0,03, el cual constituye un índice muy bajo.

Los resultados anteriormente explicados demuestran que la tendencia en la distribución de las plantas, tanto herbáceas como arbóreas, en los agroecosistemas en estudio, manifiestan una tendencia a una distribución poco uniforme en cuanto al número de ejemplares correspondiente a cada especie existente dentro de la finca, lo cual es un factor negativo al afectar los índices de equidad y el número de servicios que pueda prestar este a los productores y a la sociedad en su conjunto (Tabla 18).

Tabla 18: Índice de Uniformidad de Pielou

Fincas estudiadas	Herbáceas-Arbustivas E	Arbóreas E
El Prado	0,22	0,29
La Maravilla	0,54	0,03
La Lima	0,58	0,84
UBPC 2	0,60	0,66
La Patrona	0,33	0,84

Al comparar estos resultados con otros realizados en relación con el tema, se aprecia que son inferiores a los obtenidos por Leyva y Lores (2012), quienes en su investigación en el municipio San José de las Lajas de la Provincia Mayabeque obtuvieron valores del Índice de Uniformidad ubicado en la categoría superior (homogéneo en abundancia), mientras que en la actual investigación predominan los valores que ubican a los agroecosistemas estudiados, según los valores reportados del índice, entre heterogéneo en abundancia a ligeramente heterogéneo. También es comparable con los resultados aportados por Céspedes, Jiménez y Estévez (2017) en agroecosistemas del municipio de Minas, donde se reportaron valores de ligera heterogeneidad en abundancia para la categoría de herbácea-arbustivas, lo cual es similar a los aportados en la presente investigación, mientras que en la categoría de arbóreas predominan en el municipio de Minas los agroecosistemas homogéneos en abundancia, sin embargo, en el actual trabajo, predominan las fincas entre heterogéneos y ligeramente heterogéneos en abundancia. Al contrastar los resultados de esta investigación con los obtenidos por Céspedes, Rodríguez y de la Torre (2018), en agroecosistemas del municipio Camagüey, se aprecian valores superiores en esta al ubicar todas las fincas estudiadas, en la categoría de herbácea-arbustivas, como homogéneos en abundancia, mientras que para las arbóreas se ubican todas en la categoría de ligeramente heterogéneas en abundancia, resultados superiores a los logrados en el municipio Esmeralda, lo cual favorece el funcionamiento del agroecosistema, no manifestándose de igual forma en las fincas estudiadas como se ha venido expresando.

h) Determinación de los índices de Diversidad Beta

Para el estudio de la relación de especies de una comunidad con las de otra se emplearon los índices de Diversidad Beta o diversidad entre hábitats.

i) Coeficiente de similitud y disimilitud de Jaccard

Al analizar los resultados del cálculo de este índice se pudo comprobar lo siguiente:

De las diez comparaciones efectuadas entre dos agroecosistemas en cuanto a las especies de plantas presentes, para la categoría herbácea-arbustiva, que mayormente se trató de las especies arvenses que aparecen espontáneamente, seis de estas comparaciones resultaron en la clasificación de agroecosistemas disímiles o diferentes florísticamente, mientras que cuatro de estas resultaron medianamente disímiles florísticamente, tales son los casos de El Prado-La Maravilla, El Prado-La Lima, La Maravilla-La Lima y La Maravilla-UEB 2, ninguna de las comparaciones entre los agroecosistemas resultó en similares florísticamente.

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Este mismo análisis, pero en la categoría de plantas arbóreas, ofreció los siguientes resultados:

De las propias diez comparaciones realizadas entre los agroecosistemas, ocho resultaron medianamente disímiles florísticamente, mientras que dos se ubicaron en similares desde el punto de vista de las especies presentes en sus predios, tales son los casos de El prado-La Lima y La Lima-UEB 2, ninguna de las comparaciones arrojó agroecosistemas disímiles florísticamente.

El análisis de estos resultados, deben verse con ciertas reservas, por las limitantes propias que implica la existencia de agroecosistemas que desde el punto de vista florístico, sean similares o medianamente similares en las especies de plantas presentes en sus predios, dado que si se trata de especies cultivadas con fines de alimentación humana, la variedad de productos o alimentos que ofrece es prácticamente la misma en cada finca, algo negativo a los fines de una variedad que proporcione una alimentación equilibrada en nutrientes, además, los propios servicios ecológicos ofrecidos por el agroecosistema serían muy similares afectando la posibilidad del control de plagas, de la cría y desarrollo de especies de polinizadores, entre otros elementos negativos que afectarían la sostenibilidad de los agroecosistemas a nivel de la propia comunidad (Tabla 19).

Tabla 19: Valores del coeficiente de similitud de Jaccard

Dos comunidades comparadas	Coeficiente de similitud Herbáceas-Arbustivas	Coeficiente de similitud Árboles
El Prado-La Maravilla	0,38	0,48
El Prado-La Lima	0,36	0,67
El Prado-UBPC 2	0,22	0,63
El Prado-La Patrona	0,17	0,48
La Maravilla-La Lima	0,43	0,58
La Maravilla-UBPC 2	0,58	0,62
La Maravilla-La Patrona	0,20	0,61
La Lima-UBPC 2	0,30	0,74
La Lima-La Patrona	0,21	0,59
UBPC 2- La Patrona	0,09	0,63

Al comparar estos resultados con los ofrecidos por otros autores como Vargas *et al*., (2016) y Vargas *et al*., (2017) en agroecosistemas de la provincia Santiago de Cuba, en los cuales todas las comparaciones entre los agroecosistemas estudiados, se ubican en la categoría de disímiles florísticamente, en contraposición a los resultados logrados en agroecosistemas del municipio de Esmeralda provincia de Camaguey, donde predominan sobre todo en la categoría de arbóreas los agroecosistemas medianamente disímiles y similares, sin embargo son semejantes a los resultados para las especies herbácea-arbustivas, donde prevalecieron las categorías de disímiles florísticamente en las comparaciones efectuadas entre las fincas.

Es posible también, comparar los resultados obtenidos en los agroecosistemas del municipio Esmeralda, con los reportados por Céspedes, Jiménez y Estévez (2017) en agroecosistemas del municipio de Minas y Céspedes, Rodríguez y de la Torre (2018), en agroecosistemas del municipio Camagüey, en los cuales predominan los valores, resultados de la comparación entre agroecosistemas, tanto para especies herbácea-arbustivas y arbóreas, la categoría de fincas disímiles florísticamente, lo cual solo es similar a los resultados obtenidos en Agroecosistemas del municipio Esmeralda para las especies herbácea-arbustivas y difieren para las arbóreas.

j) Análisis de los índices de la agrobiodiversidad

i. *Diversidad de especies por el rol que desempeñan dentro de los agroecosistemas*

El análisis de las especies registradas en los diferentes grupos establecidos para el cálculo de los índices de la agrobiodiversidad, permitieron apreciar que los valores más elevados se encuentran en los designados como productores de alimento para el ser humano, manifestando entre 13 y 18 especies según el agroecosistema, con el menor valor en la finca La Lima (13) y el mayor valor en la UEB 2 (18). El número de especies arvenses por agroecosistemas y que pueden ser incorporadas al suelo durante su preparación, favoreciendo la fertilidad de éste por el incremento en el contenido de materia orgánica, a partir de su descomposición por los microorganismos del suelo, se ubican entre seis y 14 especies, con el valor más elevado en la finca La Lima (14), mientras que el inferior se registró en la finca La Patrona (6). Sin embargo, un elemento que aún sigue siendo negativo en el trabajo de las fincas es que no explotan la posibilidad de alimentar los suelos a partir del uso de los abonos verdes, lo cual sería un elemento esencial para mejorar las propiedades químicas, físicas y biológicas de los suelos y en tal sentido, su fertilidad, no obstante, se vienen explotando otras vías para mejorar la fertilidad del suelo, así por ejemplo; en la finca El Prado, usan la cachaza del central, el estiércol y la fabricación de compost, para aplicar al suelo como vías para el mejoramiento de su fertilidad y el incremento de su capacidad productiva. También se explota la variante del compost y la lombricultura, con una producción de humus de dos toneladas anuales en la finca La Maravilla, algo similar se viene haciendo en la finca La Lima, en la cual se práctica la tecnología del compost como vía para la producción de abono orgánico con el propósito de ser aplicado al suelo para mejorar su fertilidad, prácticas agrícolas que según Latifah, Ahmed

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y Majid (2017), ayudan a detener la degradación, restableciendo y aumentando la diversidad biológica.

Entre las complementarias utilizadas como cercas vivas y las especies maderables existen entre seis y ocho especies, con el valor más elevado en la UEB 2 (8) y el menor en la finca El Prado (6), entre las complementarias con uso medicinal, no existe una gran diversidad de especies, en El prado con tres y La Maravilla con cinco, es donde mayor número de éstas se vienen explotando, en el caso de las complementarias empleadas como ornamentales y flores, es más crítica la situación, con una sola especie registrada en la UEB 2. Es importante reconocer como una limitante de los agroecosistemas, el hecho de contar con muy escasas especies medicinales, incluso peor un, no contar prácticamente, con especies ornamentales y flores, pues las primeras ofrecen un servicio importante para el combate de algunas afecciones de salud que pueden aquejar a la propia comunidad y la segunda, forman parte de la espiritualidad del ser humano que entraña, un beneficio importante para el estado de ánimo y la propia motivación del productor hacia las actividades que a diario realiza, y mejora la estética y belleza del paisaje, aspecto a considerar como parte del incremento de la biodiversidad en los agroecosistemas, además, se agrega a este elemento el hecho de que muchas especies de plantas ornamentales y medicinales, pueden ser refugio y fuente de alimentos para insectos beneficiosos.

En general la riqueza vegetal se comportó con valores entre 32 y 45 especies, siendo superior en el agroecosistema representado por la finca La Maravilla (45) e inferior en la finca nombrada La Patrona (32) (Tabla 20).

Tabla 20: Diversidad de especies por su papel dentro del agroecosistema

Grupos	I	II	III	IV	V
Alimentación humana (vegetal)	17	15	13	18	16
Alimentación del suelo (arvenses)	11	12	14	11	6
Complementaria (cercas vivas y maderables)	6	7	7	8	6
Complementaria (medicinales)	3	5	0	2	0
Complementaria (flores y ornamentales)	0	0	0	1	0
Alimentación animal (pastos y forrajes)	5	0	5	5	4
Alimentación del suelo (abonos verdes)	0	0	0	0	0
Total de especies	42	45	39	44	32

Si se analizan los resultados anteriores, se debe señalar que la diversidad registrada en agroecosistemas del municipio Esmeralda, no se considera elevada, si se compara con las reportadas por Leyva y Lores (2012), en trabajo realizado durante tres años en 15 agroecosistemas en la comunidad Rural "Zaragoza" del Municipio San José de las Lajas, provincia Mayabeque, de igual forma sucede con los logrados por Vargas *et al*., (2016) y Vargas *et al*., (2017) en agroecosistemas de la provincia Santiago de Cuba, o los obtenidos por Céspedes, Jiménez y Estévez (2017) en agroecosistemas del municipio de Minas y Céspedes, Rodríguez y de la Torre (2018), en agroecosistemas del municipio Camagüey.

k) Diversidad de especies por grupos de cultivos dentro del agroecosistema

Del análisis de las especies por grupos de cultivos, según la función que desempeñan en el agroecosistema, permitió arribar a los resultados siguientes:

El grupo más abundante es el de los reguladores frutales, con el mayor número de especies registradas en las fincas La Maravilla y la UEB 2, ambas con 13, mientras que la menor cifra reconocida, se reportaron en las fincas El Prado y la Lima, ambas con 11 especies, en La Patrona se registraron 12 especies. Como se puede apreciar los frutales están presentes en todas las fincas, formando parte de la cultura que existe en el país de sembrar árboles frutales en los sistemas productivos, dado la aceptación que tiene el consumo de sus frutos por nuestra población, además, de que responde a la filosofía productiva de los actores, basado en la disponibilidad de mercado y la generación de ingresos para la familia.

Con relación al cultivo de los reguladores, constituidos en este caso por las hortalizas, se pudo apreciar que es una práctica muy limitada dentro de los agroecosistemas del municipio Esmeralda, pues donde mayor cantidad de especies se cultiva es en la UEB 2, con tres, mientras que en fincas como La Maravilla, La Lima y La Patrona, no existió su cultivo en la etapa en que se desarrolla la investigación, la cual se correspondía con la época óptima para el desarrollo de las principales hortalizas en Cuba, (octubre-marzo).

En relación con las especies formadores de origen vegetal, donde se ubican las leguminosas como el *Phaseolus vulgaris* (frijol), por su aporte en proteínas a la dieta del ser humano, se pudo apreciar que es un grupo muy deprimido en los agroecosistemas en estudio, pues solo dos de ellos cultivan una variedad del grano, tales son los casos de las fincas nombradas El Prado y La Patrona, lo cual debe verse como una limitante, ya no solo desde el punto de vista de la biodiversidad vegetal, que es la razón o el propósito de esta investigación, sino, por la restricción misma que le impone a la alimentación de la población, que es para

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quien producen, dado que este es un producto básico en la mesa de cada cubano.

En cuanto a los energéticos, donde se ubican la viandas, solo existe un agroecosistema donde no se cultiva ninguna especie, tal es el caso de la UEB 2, mientras que en las otras se cultivan solo las viandas tradicionales, *Musa acuminata* (plátano) y *Manihot esculenta* (yuca), que no dejan de ser quizás de las viandas más importantes y hasta cultivos estratégicos por su resistencia a condiciones adversas, pero podía explotarse otras variantes de cultivos de viandas, no menos importantes en la dieta del cubano.

Aunque en los países en desarrollo hay menos datos para respaldar la contribución de la diversidad en la dieta a la salud (Johns, 2003). En Kenia, sin embargo, la diversidad en la dieta se ha relacionado con un mejor crecimiento en niños de uno a tres años (Onyango *et al.,* 1998).

l) Valores de los diferentes índices de diversidad por su papel dentro del agroecosistema

El valor de cada índice para evaluar la biodiversidad en los agroecosistemas de acuerdo al papel que desempeñan cada uno de ellos, se comportaron de la siguiente forma:

El Índice de Diversidad para la Alimentación Humana, al comportarse por debajo de 0,66, valor estándar establecido que indica la existencia de sostenibilidad, se considera insostenible en todos los agroecosistemas, siendo superior en las fincas El Prado y La Patrona con 0,50.

En cuanto al Índice de Diversidad para la Alimentación Animal, solo muestran valores de sostenibilidad las fincas La Maravilla y La Lima, ambas con 0,67, el resto sus resultados indicaron insostenibilidad. De igual forma se comporta el Índice de Diversidad para el Mejoramiento de las Propiedades Físicas Químicas y Biológicas del Suelo, dado que todos los resultados están por debajo del valor estándar establecido, es preciso señalar que los valores más elevados se producen en tres fincas con igual índice (0,50), en este caso fueron; El Prado, La Maravilla y La UEB 2, donde se utilizó en alguna manera la materia orgánica y de manera limitada se trabajó alguna forma de producción de humus a partir de la lombricultura o el compost, incorporaban en ocasiones los restos de cosechas al suelo y las arvenses, sin embargo, todos aplicaron como modalidad de preparación de suelo labores tradicionales con arado de disco y gradas de disco, que invierten el prisma provocando un grupo de inconvenientes al suelo, reduciendo su capacidad productiva. En relación con el índice que tiene que ver con el desarrollo de especies que complementan los servicios que prestan los agroecosistemas, es donde tuvieron lugar los valores más bajos, indicando insostenibilidad en todos los agroecosistemas, lo cual indica que estas especies que no producen alimentos directos al ser humano, en su gran mayoría, y que no reportan ingresos directos a la familia, son obviadas por los actores (productores).

En general, el Índice de Diversidad Agrícola, que es el resultado del comportamiento individual de los índices anteriormente explicados, estuvo por debajo de los estándares establecidos para que se consideren sostenibles, en todos los agroecosistemas estudiados, mostrando el valor más elevado en la finca la Maravilla (0,46) y el más bajo en La Patrona (0,13).

Un análisis general de los resultados indican que; es insuficiente la labor realizada en las fincas para aumentar el reciclado de biomasa y optimizar la disponibilidad y el flujo balanceado de nutrientes, al no realizarse adecuadamente y de forma sistemática la incorporación de residuos de cosecha y especies arvenses presentes en los campos, como vía para favorecer las interacciones ecológicas y los sinergismos entre sus componentes biológicos, lo cual proveería los mecanismos condicionantes para que los sistemas subsidien la fertilidad de su propio suelo, la productividad y la protección de los cultivos.

Otro aspecto a señalar en los agroecosistemas estudiados es el uso insuficiente de la materia orgánica para asegurar las condiciones necesarias del suelo para el crecimiento de las plantas, elemento que tiene una repercusión directa en el incremento de la actividad biológica del suelo y de sus condiciones agroproductivas, lo cual incide de manera directa en su mejoramiento y conservación.

Es insuficientemente explotada la aplicación de prácticas que impliquen la disminución de pérdidas debidas a flujos de radiación solar, aire y agua mediante el manejo del microclima, cosecha de agua y el manejo de suelo a través del aumento en la cobertura, lo cual es una práctica por lo general nula en estos agroecosistemas.

En relación con la práctica encaminada a la diversificación específica y genética del agroecosistema en el tiempo y el espacio, los niveles logrados en este sentido son insuficientes, puesto que los campos de las fincas están dominados mayormente por especies frutales, o por uno o dos cultivos de plantas herbáceas para la alimentación humana, que tienen como primer fin el mercado y la acumulación incesante de capital, el cual es el último fin de la Agroecología, cuyo propósito más importante está en fomentar valores que privilegien el altruismo económico y la co-responsabilidad en el devenir de la sociedad.

Con relación a este tema es preciso plantear que los agroecosistemas en estudio realizan prácticas en su gestión productiva que siguen siendo limitadas para aumentar las interacciones biológicas y los sinergismos entre los componentes de la biodiversidad que promuevan los procesos y servicios ecológicos claves, lo cual está relacionado con la aplicación de aquellas actividades productivas que potencien las

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interacciones del sistema donde los productos de un componente sean utilizados en la producción de otro componente, por ejemplo: las malezas utilizadas como forraje para la alimentación de los animales, el estiércol utilizado como fertilizante, rastrojos y malezas dejadas para pastoreo animal o para incorporarse al suelo como vía para el reciclaje de nutrientes evacuados por las cosechas, la rotación de cultivos, según lo planteado por Contino-esquijerosa *et al*. (2018).

Tabla 22: Índices Agrobiodiversidad por fincas. Simbología

Agroecosistemas	IFER	IFE	IAVA	ICOM	IDA
El Prado	0,50	0,33	0,5	0,25	0,40
La Maravilla	0,33	0,67	0,5	0,33	0,46
La Lima	0,11	0,67	0,33	0,17	0,32
UBPC 2	0,33	0,33	0,5	0,42	0,40
La Patrona	0,50	0,50	0,17	0,25	0,13

Índice de biodiversidad para la: alimentación humana (IFER); alimentación animal (IFE); para mejorar las propiedades físicas, químicas y biológicas de los suelos (IAVA) e índice de biodiversidad complementaria (ICOM).

Estos resultados, son inferiores a los logrados por Leyva y Lores (2010), en 15 agroecosistemas en la comunidad Rural "Zaragoza" del Municipio San José de las Lajas, provincia Mayabeque, donde el Índice de Diversidad Agrícola aportó valores que según los estándares establecidos, indicaron sostenibilidad en las prácticas establecidas por los actores en los agroecosistemas, sin embargo, de forma general son similares a los reportados por Céspedes, Rodríguez y de la Torre (2018), en cuatro agroecosistemas del municipio Camagüey, donde los valores obtenidos indicaron agroecosistemas insostenibles, todos con valores del Índice de Diversidad Agrícola inferiores a 0,66.

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The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Associate membership can later be promoted to Fellow Membership. Associates are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Associate Members.

To the institution

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Career | Credibility | Reputation

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Associate	Fellow	Research Group	Basic
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Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



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7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



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- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
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Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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