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SUMARIO / SUMMARY / RESUMO

- Editorial 5
- Análisis del estado actual de las dimensiones de responsabilidad social universitaria en los centros de atención tutorial de una universidad pública en Colombia.....7
  Analysis of the current state of the dimensions of university social responsibility in the tutorial support centers of a public university in Colombia
  Gian Pool Brand Rojas. Medio ambiente (Colomia).
- Representaciones sociales de actores claves sobre el cambio climático y sus efectos en la producción agrícola en la localidad de pergamino, Buenos Aires 27
  Social Representations of Key Actors on Climate Change and Its Impact on Agricultural Production in Pergamino, Buenos Aires
  Marcela Agustina Ferrer. Universidad Europea del Atlántico, Australia
- Movilidad urbana y plataformas logísticas en las ciudades intermedias de américa: una revisión sistemática de la literatura científica 45
  Urban mobility and logistics platforms in the intermediate cities of the Americas: a systematic review of the scientific literature
  Victor Marcial Alegre Ortiz y Valeria Stefany Vitela Ramos. Universidad Privada Del Norte(Perú).
- Obtención de harina a partir de desechos de café para consumo humano 67
  Obtaining flour from coffee waste for human consumption
  Farah Silvana Marta Alabí Hernández y José Del Carmen Zavala Loría. Universidad Europea del Atlántico (España) y Universidad Internacional Iberoamericana (El Salvador).
- Reducción del costo energético y del impacto medioambiental en el proceso de añejado artificial del arroz a partir de energía solar térmica en la empresa rice molicas S.A.C.....93
  Reduction of the energy cost and environmental impact in the process of artificial aging of rice from solar thermal energy in the company Rice Molicas S.A.C.
  Urpi Castillo y Angie vilcherres Martínez, Medio ambiente (Perú)
- Diferencias de género en nivel educativo y ocupación; vulnerabilidad social y ambiental 109
  Gender differences in schooling and occupation; social and environmental vulnerability
  Leonela Ramírez Marfil. Docente (México).

Editorial

In the phase of the COVID 19 Pandemic; we had havoc worldwide, which evidently affected Within the framework of the Sustainable Development Goals (SDG) (17) also identified as the 2030 Agenda, there are 17 interconnected topics whose fundamental objective is to formulate a Plan to achieve a better and much more sustainable future; ranging from; End of poverty; Zero hunger; Health and well-being; Quality education; Gender equality; Clean water and sanitation; Affordable and non-polluting energy; Decent work and economic growth; Industry, innovation and infrastructure; Reduction of inequalities; Sustainable cities and communities; Responsible production and consumption; Climate action; Life below water; Life on land; Peace, justice and strong institutions; and Partnerships to achieve the goals. In the journal Environmental Sciences and Practices (ESAP) we address six articles, which, from the perspective of the SDGs, capture different approaches to the real problems of our societies, such as social responsibility, climate change, agricultural production, urban mobility, the use of by-products to combat hunger, affordable and non-polluting energy consumption, as well as gender equity.

The first article aims to analyze the current state of the dimensions of University Social Responsibility (USR), from the perspective of the administrative staff of the Tutorial Care Centers (CAT) of the University of Tolima, in Colombia. Five dimensions of study are considered (university extension, research, teaching, organizational management and environmental management). Additionally, the reliability test is presented, through Cronbach's alpha coefficient, with a score of 0.957 for the entire instrument used. As a result of this research project, progress in the implementation of USR actions was evidenced. Most indicators have positive aspects (73.52%) regarding the MSW activities carried out in the Higher Education Institution (HEI); in this same sense, it is not being taken into account in an integral manner or is not being fully complied with (26.47%) identifying an opportunity for improvement; in the same sense, university extension and environmental management are the dimensions with the most deficiencies in the subject in question.

In the second article, the way in which climate change is a reality that affects all inhabitants, everywhere in the world is identified. The generation of risk management, adaptation and mitigation policies are essential to face the changes that are coming in the future. A case study of the Argentine Republic and that is not exempt from its impact, as a country that produces raw materials with a great dependence on the agricultural/livestock production sector, it is very susceptible to suffer the consequences that occur at the climatic level and its effects on agricultural production in the area. This leads to understanding the social representations of the members of society and leading to the creation of policies for the protection and management of the natural environment, scientific and technical criteria, and above all social participation.

In the third article, logistics for the mobility sector is experiencing a development that involves the use of appropriate structures and larger transport units, and which represents an indirect impact on the environment due to fuel consumption in particular and the supply chain associated with this sector. The centralization of commercial operations in Latin American metropolises generates traffic congestion, creating delays and extra costs in the logistics chain. The trend in the development of logistics platforms in intermediate cities in America in the last 10 years seeks to generate sustainable development, by decentralizing operations, it would be possible to address the usual problems of urban areas as well as noise and air pollution in metropolises.

The fourth article.- From the perspective of the use of by-products, to food sufficiency, the case study on the drying of the coffee fruit is carried out as one of the previous activities to obtain the coffee bean that is then used in different preparations. In this work, two alternative drying processes are proposed, and it is evaluated if the amount of by-product obtained is significantly affected to then make a flour; by obtaining the material that surrounds the coffee seed, carrying out two drying processes which were: 1) Obtaining the pulp, with a manual pulper to then dry it in the sun and 2) Coffee dried in the sun to then pass it through a thresher. Each experiment found that there is a statistical difference between the two processes. s of drying since 2.66 pounds more are obtained than the process in which the coffee is first dried and then the pulp is obtained by threshing, which represents the use of a by-product for higher purposes.

The fifth article.- The Reduction of energy cost and environmental impact in the artificial aging process of rice from solar thermal energy is presented; During the last 20 years, Peruvian rice production has increased by 2.8% annually, thus increasing the number of rice mills and their energy consumption, generated mostly by fossil fuels. Studies have shown that the artificial aging and polishing processes

require more electricity. Therefore, the objective of this study was to demonstrate the monetary savings in electricity consumption and the reduction of environmental impact in the artificial aging of rice by developing a proposal based on solar thermal energy in the case study; This study contributes to the dissemination of the use of environmental resources using predictive models and shows that it is possible to design new, more efficient processes that reduce the carbon footprint.

In our sixth article, we address the issue of women's labor participation as being lower than men's participation, which is related to the level of education, having as its root the norms, roles and gender discrimination, which generates social, economic and environmental differences. In this sense, the objective of the present study was to analyze the gender differences in educational level and occupation and their possible social and environmental vulnerability in the city of Delicias, Chihuahua, Mexico. The results obtained serve as a basis for the implementation of social programs aimed at minimizing gender differences and reducing their vulnerability, and also contribute to understanding the importance of gender equity; in this sense, the Organization for Economic Cooperation and Development (OECD) identified that women surpass men in education, but they continue to earn less and have fewer opportunities; In OECD countries, the percentage of women with university studies is higher than that of men. For example, in 2017, 50% of women aged 25 to 34 had university studies, while 38% of men had the same studies. The vision of how to build societies to achieve a better and much more sustainable future implies an analysis of the realities and problems under a multifactorial approach without a doubt, but the optics of the objectives for sustainable development (ODS) (17), turns out to be a tool oriented to the identification of opportunities, considering a matrix arrangement where most likely more than one SDG coincide, given the complexity of our societies, whether in Colombia, Argentina, Peru or Mexico.

Dr. Miguel Ángel López Flores
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Analysis of the current state of the dimensions of university social responsibility in the tutorial support centers of a public university in colombia

Análisis del estado actual de las dimensiones de responsabilidad social universitaria en los centros de atención tutorial de una universidad pública en Colombia

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ABSTRACT

This project of quantitative-descriptive research has as its objective the analysis of the current state of the categories of University Social Responsibility (USR), from the perspective of the administrative staff of the Centros de Atención Tutorial (CAT) within the Universidad del Tolima in Colombia. The research method used for data collection is the questionnaire on Social Responsibility that takes into account five study categories (university extension, research, teaching, organizational management and environmental management). Additionally, the reliability test is evaluated using Cronbach's alpha coefficient, with a score of 0.957 for the entirety of the questionnaire. As a result of this research project, it was shown that the Universidad del Tolima has made significant progress in the implementation of USR actions. Most of the indicators have positive aspects (73.52%) about the USR activities that are carried out in the Higher Education Institution (HEI); on the contrary, the rest corresponds to aspects that the university is not taking into account comprehensively or is not fully complying with (26.47%) and that must be improved. Analyzing by category, it was identified that research, teaching and organizational management are the categories with the most compliance indicators in regards to USR. On the other hand, university extension and environmental management are the categories with the most deficiencies in the topic in question.

Palabras clave:
responsabilidad social universitaria, extensión universitaria, investigación, docencia, gestión organizacional y ambiental.

RESUMEN

El presente proyecto de investigación de corte cuantitativo-descriptivo tiene como objetivo el análisis del estado actual de las dimensiones de Responsabilidad Social Universitaria (RSU), desde la perspectiva del personal administrativo de los Centros de Atención Tutorial (CAT) con los que cuenta la Universidad del Tolima, en Colombia. El instrumento de investigación utilizado para la recolección de los datos es el cuestionario sobre Responsabilidad Social que tiene en cuenta cinco dimensiones de estudio (extensión universitaria, investigación, docencia, gestión organizacional y gestión ambiental). Adicionalmente, se presenta la prueba de fiabilidad, a través del coeficiente alfa de Cronbach, con una puntuación de 0.957 para la totalidad del cuestionario. Como resultado

	de este proyecto de investigación se evidenció que la Universidad del Tolima ha avanzado significativamente en la implementación de acciones de RSU. La mayoría de indicadores cuentan con aspectos positivos (73,52%) sobre las actividades de RSU que se llevan a cabo en la Institución de Educación Superior (IES); por el contrario, lo demás corresponde a aspectos que la universidad no está teniendo en cuenta de manera integral o no está cumpliendo a cabalidad (26,47%) y, que, debe mejorar. Analizando por dimensión, se identificó que la investigación, la docencia y la gestión organizacional son las dimensiones que más indicadores de cumplimento en cuanto a la RSU se están teniendo en cuenta. En sentido opuesto, la extensión universitaria y la gestión ambiental son las dimensiones con más carencias en el tema en mención.

Introduction

Social Responsibility is a topic that has been gaining relevance in recent years, as organizations seek to achieve their objectives and respond to the needs of different stakeholders. Thus, the university scenario is no exception; universities see the need to engage with all the actors that are part of it, either internally or externally (students, teachers, graduates, administrative staff, community, among others).

The University currently aims to propitiate academic processes adjusted to the needs and demands that each territory has, generating an impact on society; that is why it must assume social responsibility within its formative processes with the objective of energizing cultural, social and economic development in a region (Medina, Franco, Torres, Velázquez, Valencia, & Valencia, 2017). However, USR should not only be part of the formative processes; as stated by Forero (2019), it should be part of the administrative dependence of universities. In this way, a team of professionals must be in charge of the execution of programs, projects or activities in which the interested parties or stakeholders show optimal results in their management.

Now, regarding the Colombian context, few studies have been conducted on the subject of USR and, in general, actions are carried out that are delimited to the field of social projection or university extension, but do not take into account all the dimensions covered by the concept of USR (Forero, 2019). However, the effort that some universities in Colombia have made in the area of USR is recognized, for example, the part of educational inclusion through distance education programs (Pacheco, Rojas, Hoyos, Niebles and Hernández, 2020).

Taking into account the object of study of this research, as is the case of the University of Tolima in terms of USR, it has been evidenced that the HEI does not fully comply with the standards of a socially responsible organization, given that, in a research conducted by Uribe (2015a), in which the perception of the community near the University of Tolima on USR was analyzed, it was found that the University is not socially responsible, given the large percentage of disagreement in the answers given by the neighboring community in the applied instrument. In this research, it was concluded that the University should give priority to the creation of a social responsibility policy that meets the needs of the community.

Similarly, in a research conducted from the perception of the suppliers of the University of Tolima, from a proposal of an RSU model, it was evidenced that, suppliers do not acquire Social Responsibility habits as part of the interaction with the University, but, they carry them out because it is required by the legal framework, when wanting to carry out contracts with the higher education institution (Uribe et al., 2016).

In the same way, regarding the students of the Universidad del Tolima, a research was conducted reviewing the axis of professional and citizen training within the framework of social responsibility; it was found that, the IES does not present an adequate organization in the training of citizens that reflect a commitment to the development of society (Uribe, 2015b).

Another point is, a study conducted with the objective of looking at the impact that the RSU of the University of Tolima has had on the stakeholder graduates; it was concluded that, the greatest impact that the University of Tolima has had with this interest group is the application of citizenship competencies in the field of participation in social projects, the comprehensive training provided and the university-graduates contact; this has been reflected in the personal, professional and labor level (Uribe and Orjuela, 2017).

Additionally, in a study that sought to evaluate the aspects of academic responsibility and social coexistence, within the framework of RSU, in the population of undergraduate students attached to the University of Tolima, it was found that, students do demonstrate socially responsible behaviors for the variables evaluated, and it is the duty of the University, to continue to promote in their curricula aspects on ethical and social values, responding to the

needs of society, according to the environment in which they are immersed (Olivella et al., 2017).

Under these premises, it is important to analyze the current state of the USR dimensions in the CATs of the University of Tolima in Colombia. Specifically, the purpose is to measure the level of perception that the administrative staff has about the USR actions of the different CATs that the University of Tolima has; to describe the positive aspects and the aspects to be improved that the university has for each of the USR dimensions evaluated; to determine the improvement actions that respond to the needs considered by the CATs under the perspective of the administrative staff, for the dimensions of extension, research, teaching, organizational management and environmental management.

Method

The research was based on a quantitative approach. In this order of ideas, the scope was descriptive and cross-sectional. Likewise, the study was based on a non-experimental design.

Now, the study population corresponds to the administrative personnel (CAT coordinator, administrative assistant, monitor, university professional) of the different CATs of the Universidad del Tolima throughout Colombia.

A non-probabilistic study was carried out to select the sample. Thus, the sample corresponds to 30 people who are part of the administrative staff of the different CATs. It should be noted that the criteria for participation were based on people who hold administrative positions and who agreed to participate voluntarily in the research.

As for the variables, the independent variable in the study was the USR. On the contrary, the dependent variables were the dimensions of USR, in this case, university extension, research, teaching, organizational management and environmental management, are part of this type of variables.

On the other hand, the measurement instrument consisted of a validated questionnaire that assessed the 5 dimensions of USR proposed by Baca (2015). In the study developed by this author, the instrument was applied to administrative personnel, professors and students of a private university in Lima-Peru. It should be noted that the items of the instrument were adapted according to the group to be applied. In the present study, this questionnaire did not require translation. Thus, it consisted of closed questions with a Likert-type scale with a score from 1 to 5, distributed as follows: never (1); almost never (2); sometimes (3); almost always (4); always (5).

Similarly, the instrument consists of 39 items distributed in 5 dimensions (university extension, research, teaching, organizational management and environmental management) and, in turn, in 17 sub-dimensions (relationship with social actors, social accessibility of the university, education for development, production and social relevance of knowledge, interdisciplinarity, democratization of knowledge, linkage between research and training, ethical oversight of science, promotion of initiative and criticism, pedagogical structure with SR content in the university, environmental education, pay equity, ethical principles, responsible internal communication, staff training, responsible marketing and, finally, environmental management).

On the other hand, as for the statistical analysis, the quantitative data obtained after the application of the instrument were processed through the statistical software or program called SPSS.

After coding the data, Cronbach's alpha was obtained as the first statistical analysis, in order to determine the internal consistency of each of the categories or dimensions analyzed. In this case, the reliability test is presented through Cronbach's alpha coefficient, with a score of 0.957 for the entire questionnaire applied. Secondly, frequency tables and bar graphs were

generated in order to perform the respective analysis of the results according to each of the variables evaluated.

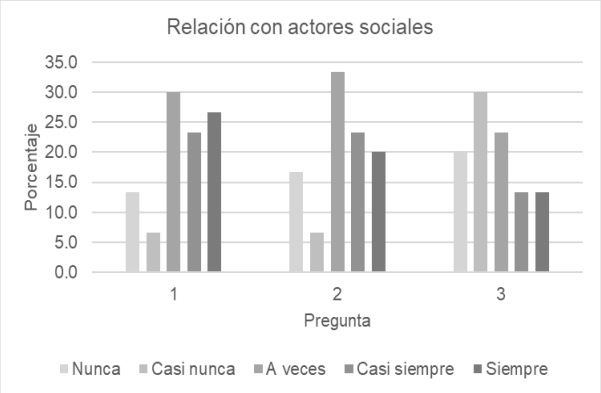
Results

Dimension 1. University Extension

Figure 1 shows the results obtained on the relationship between the University of Tolima and the different social actors.

Figure 1

Relationship of the University with social actors



According to the results obtained, in general, a neutral position is perceived in the three questions, however, it is evident that the University maintains agreements with key actors in social development, such as the State, Non-Governmental Organizations, International Organizations and companies (50%). Otherwise, the University has a tendency not to actively participate in the discussion of community problems with key actors (50%).

On the other hand, Table 1 shows the results obtained on the accessibility that the University has with the different social actors.

Table 1

Social accessibility of the University

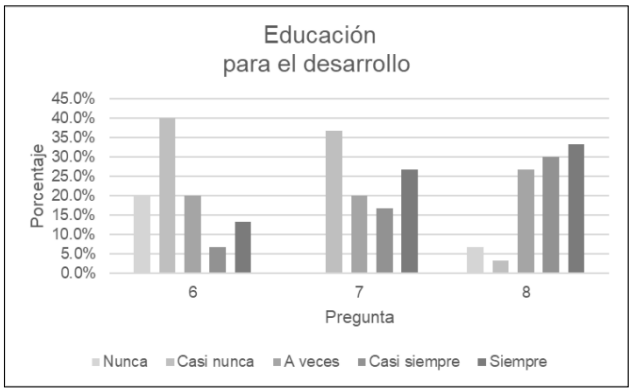
Ask / **Reply**	**4**	**5**
Never	0%	20.0 %
Almost never	10.0 %	26.7 %
Sometimes	33.3 %	26.7 %
Almost always	26.7 %	13.3 %
Always	30.0 %	13.3 %

It can be observed that the University provides its students with opportunities to interact with diverse social sectors (56.7%), however, there is no explicit policy to attend underrepresented or marginalized groups, such as the indigenous population, racial minorities, people with physical or mental disabilities, parents over 45 years of age, people with HIV, ex-convicts, among others (46.7%).

On the other hand, the set of pedagogical and institutional actions carried out by the University to promote development, as part of its social projection, were taken into account. Figure 2 shows the results for this subdimension.

Figure 2

Education for development



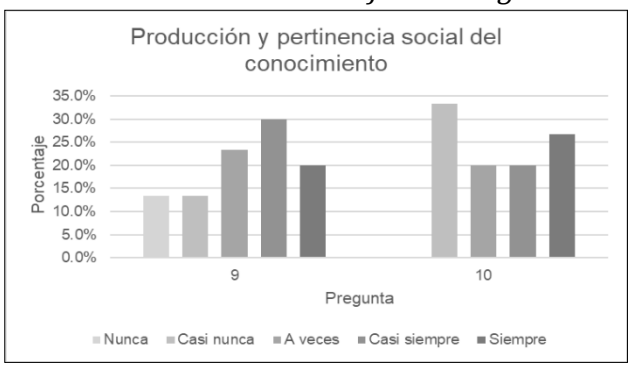
Taking into account the results obtained, it is perceived that the University does not study proposals to solve the country's social problems (60%). Similarly, the University does not promote student volunteering (56.7%). In contrast, HEI promotes environmental and social concern and sensitivity (63.3%).

Dimension 2. Research

Here, the production and social relevance of the University's knowledge was taken into account, that is, the alliances and strategies that the IES has to promote the lines of research according to the needs of the surrounding society. In this regard, Figure 3 shows the results achieved.

Figure 3

Production and social relevance of knowledge



According to the results obtained, it can be perceived that the University has lines of research oriented to the solution of social development problems (50%) and, in addition, it establishes alliances and synergies with other actors, such as the government, businesses and communities to develop lines of research appropriate to social requirements (46.7%).

Another point is the interdisciplinary nature of the University in the research aspect, where people from different specialties also take part. Thus, Table 2 shows the results.

Table 2

Interdisciplinary

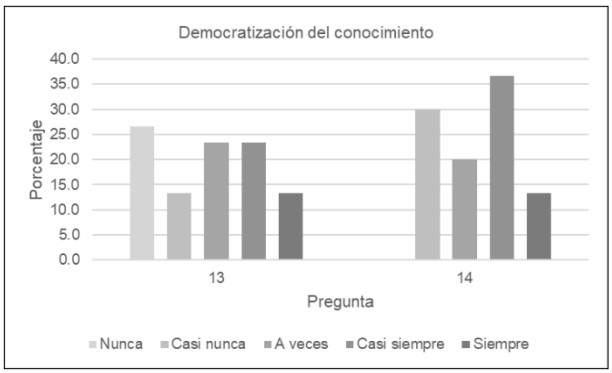
Ask / Reply	11	12
Never	13.3. %	13.3 %
Almost never	13.3%	13.3 %
Sometimes	23.3%	23.3 %
Almost always	30.0%	36.7 %
Always	20.0%	13.3 %

Considering the results, the University of Tolima investigates complex problems in an interdisciplinary manner (50%). Likewise, people from different specialties participate in the IES in community support projects (50%).

The mechanisms for the dissemination of knowledge to society and the organization of academic events that are easily accessible to the community were also taken into account. Therefore, Figure 4 shows the results achieved.

Figure 4

Democratization of knowledge



It can be observed that the highest percentages indicate that the University does not have specific means of disseminating and transferring knowledge to society (40%). Similarly, it can be seen that the Institution organizes academic events accessible to the community (50%).

Next, we inquired about the relationship between research and student training, in terms of projects, necessary resources and counseling required by the students. Table 3 shows the results obtained after applying the scale.

Table 3

Linking research and training

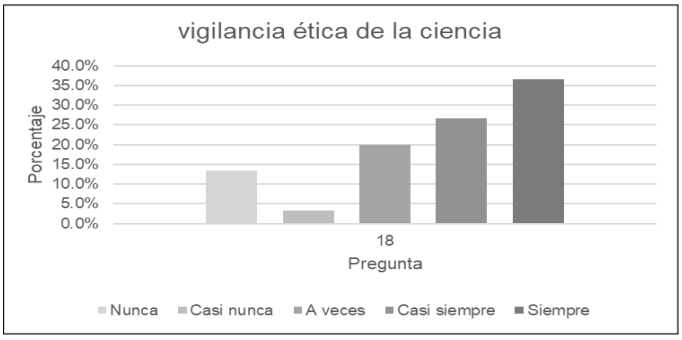
Ask / Reply	15	16	17
Never	0%	6.7%	13.3%
Almost never	13.3%	16.7%	13.3%
Sometimes	10.0%	33.3%	26.7%
Almost always	43.3%	16.7%	13.3%
Always	33.3%	26.7%	33.3%

The results obtained show that the highest percentages correspond to the incorporation of students in research projects (76.7%). Similarly, it is observed that the University requires students to conduct research with social impact (46.7%). It is also perceived that researchers have the time and resources to attend and advise students who wish to do so (43.3%).

Another aspect that was taken into account were the different ethical considerations required for the realization of research projects, theses or monographs. To illustrate this, Figure 5 shows the results.

Figure 5

Ethical oversight of science



It can be perceived that the University demands ethical considerations for the realization of research, whether projects, theses or monographs (63.4%).

Dimension 3. Teaching

Initially, the capacity of teachers to promote initiative and critical thinking in students was taken into account. Figure 6 shows the results obtained.

Figure 6

Promotion of initiative and criticism

It can be seen that sometimes teachers stimulate students' capacity for entrepreneurship and initiatives (53.3%). Likewise, teachers sometimes promote open discussion of topics that generate conflict in society or that are very controversial (40.0%). On the other hand, teachers do promote freedom of thought and criticism in their students (53.3%).

In other matters, the courses that have among their contents topics on ethics, social responsibility and development were discussed. Table 4 shows the results obtained.

Table 4

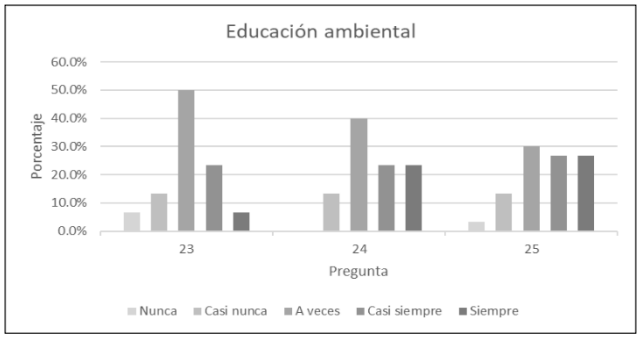
Pedagogical structure with SR contents in the university

Ask	
Reply	**22**
Never	23.3. %
Almost never	10.0%
Sometimes	20.0%
Almost always	23.3%
Always	23.3%

It can be seen that the University of Tolima has courses dedicated to ethics, social responsibility and development (46.6%).

On the other hand, the pedagogical actions carried out in environmental education at the University were taken into account. Figure 7 shows the results obtained.

Figure 7



Environmental education

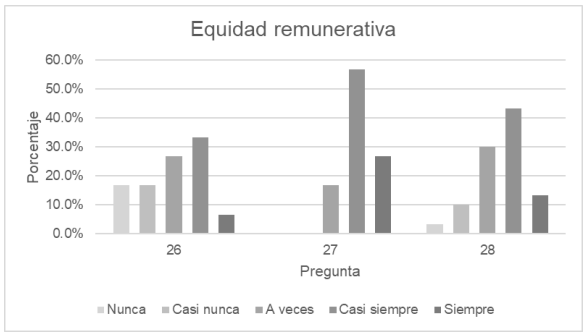
It can be observed that the university sometimes develops environmental education actions for the entire faculty (50%). In addition, it includes the discussion of social responsibility issues in training courses (46.6.%) and tries to practice the "4 SRs" among all its members: Reuse, Recycle, Reduce, Respect (53.4%).

Dimension 4. Organizational management

In this aspect, the organizational structure of the university was taken into account for the prevention/correction of corrupt practices. For this reason, Figure 8 shows the results obtained after the application of the scale.

Figure 8

Remuneration equity



It is evident that the procedures for the remuneration of teachers/administrators are transparent and respectful of labor rights (83.4%). Also, the university considers technical and not friendship aspects in the promotion of its administrative staff/faculty (56.6%). In addition, the HEI has an organizational structure to prevent/correct abuses of power by its members, fraud, bribery and other corrupt practices (40%).

The application of ethical principles within the university was also taken into account. Table 5 shows the results obtained.

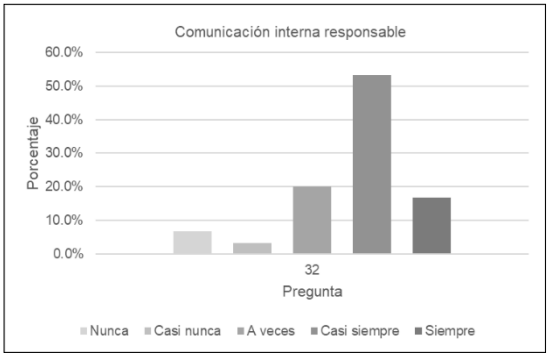
Table 5
Ethical principles

Ask / Reply	29	30	31
Never	3.3%	6.7%	6.7%
Almost never	0%	3.3.%	3.3%
Sometimes	10.0%	30.0 %	13.3 %
Almost always	23.3%	36.7 %	53.3 %
Always	63.3%	23.3 %	23.3 %

According to the results, the highest percentage refers to the prohibition of the use of illegal practices, such as corruption, extortion and bribery (86.6%). In addition, another high percentage shows that the university contemplates in its policies programs that promote the values and ethical principles of the organization (76.6%). The institution also develops procedures for dealing with complaints and resolving conflicts related to non-compliance with the code of ethics (60%).

Next, the policies and mechanisms for responsible internal communication were taken into account. Thus, Figure 9 shows the results obtained after applying the scale.

Figure 9
Responsible internal communication



According to the results obtained, it is evident that the university has formal policies and mechanisms to hear and address the concerns, suggestions and criticisms of the administrative staff (70%).

At the same time, emphasis was placed on activities for the development and continuous training of the administrative personnel of the Universidad del Tolima. In view of the above, Table 6 shows the results obtained.

Table 6
Training of administrative personnel

Ask	33
Reply	
Never	6.7%
Almost never	10.0 %
Sometimes	23.3 %
Almost always	43.3 %
Always	16.7 %

It can be seen that the HEI has development and training activities for the continuous improvement of its administrative personnel (60%).

Dimension 5. Environmental Management

In this dimension, reference was made to the different campaigns and strategic partnerships to promote social and environmental responsibility. The results can be seen in Figure 10.

Figure 10

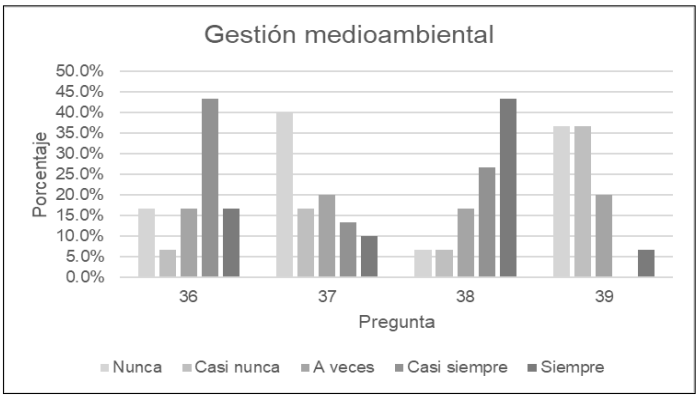
Responsible marketing

The highest percentage shows that the university develops strategic partnerships (with suppliers, companies, other universities, civil society organizations or public and international entities) to promote campaigns on social and environmental responsibility (60%). Similarly, the institution does not use its marketing campaigns to promote social and environmental responsibility issues (50%).

Finally, the university's efforts to care for natural resources and reduce the generation of solid waste were taken into account. In addition, the environmental issue was taken into account in the institution's strategic and organizational planning. Thus, Figure 11 shows the results after the application of the scale.

Figure 11

Environmental management



Considering the results obtained, it can be seen that the University does not publish an annual balance sheet on environmental performance (73.4%). In addition, the HEI does not treat the environmental issue as a cross-cutting theme in its organizational structure and include it in strategic planning (70%). However, the University of Tolima has programs to reduce the consumption of energy, water, toxic products and raw materials (60%), although it does not have an office or personnel responsible for environmental issues (56.7%).

Discussion and Conclusions

About University Extension

From an integral perspective, university extension can enrich educational processes, thus constituting a potential for research (Cano and Castro, 2016). According to this dimension, it was perceived that the University of Tolima maintains agreements with key actors in social development, such as the state, non-governmental organizations, international organizations and companies. Otherwise, the University has a tendency not to actively participate in the discussion of community problems with key players. At this point, the University of Tolima must become involved with dialogue and participation in the social problems of the environment.

With regard to the university's social accessibility, it was found that the IES provides its students with opportunities to interact with various social sectors (56.7%); however, there is no explicit policy to serve underrepresented or marginalized groups, such as the indigenous population, racial minorities, people with physical or mental disabilities, parents over 45 years of age, people with HIV, ex-convicts, among others. In view of the above, it is necessary for the University of Tolima to create a policy that integrates each of the minorities as part of its university extension process in order to ensure educational inclusion.

However, with regard to education for development, it was perceived that the university does not study proposals to solve the country's social problems (60%). In the same way, the university does not promote student volunteering; regarding this aspect, the university should promote student volunteering through motivational models that make students be attracted and get involved in the different programs (Saz, Gil and Gil, 2021).

Undoubtedly, it is a positive aspect that the university is concerned about social and environmental problems; breaking down this idea, from the environmental point of view, society must recognize that attacking the environment brings as a consequence the survival of the species. On the other hand, from the social point of view, transgressing the coexistence patterns causes a decline in the environment

social, thus generating, the detriment of values and quality of life (Severiche, Gómez and Jaimes, 2016).

About the Research

In this dimension, it was positively perceived that the Universidad del Tolima has lines of research oriented to the solution of social development problems and, in addition, establishes alliances and synergies with other actors, such as the government, businesses and communities to develop lines of research appropriate to social requirements.

On the other hand, taking into account the interdisciplinary nature of the Universidad del Tolima in the research aspect, it was evidenced that the IES investigates complex problems in an interdisciplinary manner and people from different specialties also participate in projects to support the community. Emphasizing this aspect, interdisciplinarity in research is important, since current problems are changing, highly complex and, in turn, multidimensional; hence the need for new research schemes, since disciplinary research would not be able to understand all the aspects involved; this would generate limitations and fragmentation of knowledge (Portugal, 2021).

However, with regard to the democratization of knowledge, the results indicated that the university does not have specific means of disseminating and transferring knowledge to society; however, it was noted that the institution organizes academic events accessible to the community. Accordingly, it is necessary for the university to establish specific means for the dissemination and transfer of knowledge to the community. Regarding the last aspect, similarly, a study was conducted in a Peruvian university on a proposal for measuring USR and it was found that, the university also carries out academic events that are freely accessible to the community; this Higher Education Institution periodically holds an event called "Catedra Peru"; this event is accessible not only in person, but also, from via internet (Baca et al., 2017).

Regarding the link between research and training, it was shown that the university incorporates students in research projects (76.7%). It is convenient that the HEI encourages and opens spaces for research through funding of internal projects, in addition to granting research students discounts on their academic tuition; also provide incentives to teachers for their research training, publications, among others (Guerra, 2017); this series of measures can further strengthen the research field at the university. Similarly, it was observed that the university requires students to conduct research with social impact. Likewise, it was perceived that researchers have the time and resources to attend and advise students who wish to do so.

Based on the ethical oversight of science, the university requires ethical considerations for the conduct of research, whether projects, theses or monographs. In this regard, in a bibliographic documentary research of contents on "ethics in scientific research and its inclusion in teaching practice", the author expressed that promoting ethics in research is transcendental to respect copyrights and thus avoid plagiarism in writings, generating respect and value to the ideas presented by other authors (Rosales, 2022).

About Teaching

In promoting initiative and criticism, teachers sometimes stimulate students' capacity for entrepreneurship and initiative. Certainly, in higher education, students can develop entrepreneurial skills through the development of content in classrooms that strengthen their skills in this area, addressing reasoning, analysis and problem solving (Aldana, Tafur, Gil and Mejía, 2019); it is essential that the University of Tolima works hard to promote entrepreneurship skills and the capacity for initiatives in students by teachers. Now, following in this order of ideas, teachers should encourage open discussion of issues that generate conflict in society or that are very controversial and promote freedom of thought and criticism in their students; it happens that sometimes it is difficult for students to develop critical thinking because teachers do not have sufficient clarity in the concept; the truth is that, if in the future it is achieved that students develop this skill, society will have reflective, critical beings, capable

of making decisions not only in the personal sphere, but also in situations that lead to a benefit for their community and their country (Espinola and Santos, 2022).

Regarding the pedagogical structure with Social Responsibility contents, the University of Tolima has courses dedicated to ethics, Social Responsibility and development. In relation to this, Marín (2018) thinks that universities should include in the curriculum the contents that have not yet been taken into account for the development of Social Responsibility and, likewise, formulate the teaching-learning strategies and their form of evaluation. In addition, this author considers that the contents oriented to Social Responsibility should be included in several courses throughout the curriculum and not only in one; he also assumes that the disciplinary professors are the ones who should teach these courses with Social Responsibility contents, since these are the ones that require more training in ethics and values in the students.

In reference to the environmental education subdimension, the university sometimes develops environmental education actions for the entire faculty. It also includes the discussion of social responsibility issues in training courses and tries to practice the "4 SRs" among all its members: Reuse, Recycle, Reduce, Respect.

In addition, it is important that the University of Tolima fully includes the topic of social responsibility within its curricular and extracurricular spaces throughout the university career in all academic programs.

About Organizational Management

With regard to pay equity at the University of Tolima, the procedures for the remuneration of teachers/administrative staff are transparent and respectful of labor rights. With respect to the above, it is gratifying that universities fully comply with labor rights in terms of the remuneration of their collaborators; making an analogy, in a study carried out by Baca et al. (2017) found that the human resources area has established a policy that is strictly enforced on the labor rights of teachers; all teachers obtain their benefits by law, depending on the modality of their hiring. Continuing in the same vein, the university considers technical and not friendship aspects in the promotion of its administrative/faculty staff and, in addition, the HEI has an organizational structure to prevent/correct abuses of power by its members, fraud, bribery and other corrupt practices.

Now, referring to ethical principles, the University of Tolima prohibits the use of illegal practices such as corruption, extortion and bribery (86.6%). In the same sense, it was evidenced that the university contemplates in its policies programs that promote the values and ethical principles of the organization. The institution also develops procedures for dealing with complaints and resolving conflicts related to non-compliance with the code of ethics.

Regarding responsible internal communication, the university has formal policies and mechanisms to hear and address the concerns, suggestions and criticisms of administrative personnel. In this regard, for example, in the study by Baca et al. (2017), it was concluded that, the human resources unit of Universidad San Martín de Porres, gives administrative and teaching staff an evaluation form annually, in which recommendations regarding internal communication are received; these recommendations are taken into account for the next working year.

With respect to personnel training, the Universidad del Tolima has development and training activities for the continuous improvement of its administrative personnel. As stated by Bravo, Montilla and Durán (2021), it is important to develop a training plan that takes into account a variety of contents, such as the legal and juridical aspects that concern the university, as well as human relations and the use of technological tools; likewise, the plan should focus on the development of activities related to the work environment and attitudinal considerations of the personnel. Evidently, all the aforementioned actions cooperate not only with work

performance, but also with the growth of interpersonal relationships of the administrative unit's collaborators.

About Environmental Management

In this dimension, in terms of responsible marketing, the University of Tolima develops strategic partnerships with suppliers, companies, other universities, civil society organizations or public and international entities to promote campaigns on social and environmental responsibility. According to the above, it is important for universities to create new strategies to manage the field of environmental protection, involving not only the educational community, but also society in general (Bernal and Díaz, 2020). Continuing in the order of ideas, it was found that the HEI does not use its marketing campaigns to promote issues of social and environmental responsibility. At this point, it is definitely important for the University of Tolima to use its marketing campaigns as another tool to promote social and environmental responsibility issues and to be able to carry out strategic partnerships with different stakeholders. For example, the University of Cundinamarca, within its model of University Social Responsibility, has as one of its goals in terms of organizational management "to develop campaigns to disseminate the issues, projects and strategies of SR work involving both internal and external audiences through institutional media (website, radio station, screens) and social networks" (Pinillos, 2021, p. 171).

On the other hand, regarding the subdimension of environmental management, the university does not publish an annual balance sheet on environmental performance; however, the IES, within the public accountability hearing that is held annually, does address within the axes of the Development Plan, the social and environmental commitment (Universidad del Tolima, 2022). Another finding of the study is that the HEI does not treat the environmental issue as a cross-cutting theme in its organizational structure and include it in strategic planning. However, the Universidad del Tolima has programs to reduce the consumption of energy, water, toxic products and raw materials, although it does not have an office or personnel responsible for environmental issues. On occasions, universities do not have an office or staff in charge of environmental issues, and end up leaving these functions to other departments; for example, in the study by Baca et al. (2017), it was found that the Institute for Quality at Universidad San Martín de Porres is the agency in charge of this environmental function. It is of utmost importance that the University of Tolima invariably includes environmental issues within its strategic planning and organizational structure and, in addition, creates a unit and hires personnel specifically in charge of environmental issues.

Therefore, it can be concluded that the University of Tolima has made significant progress in the implementation of USR actions. The majority of indicators (73.52%) have positive aspects on the USR activities carried out at the IES; on the contrary, the rest correspond to aspects that the University is not taking into account in a comprehensive manner or is not fully complying with (26.47%) and that should be improved. Analyzing by dimension, it has been identified that research, teaching and organizational management are the dimensions that are taking into account the most indicators of compliance in terms of USR. On the other hand, university extension and environmental management are the dimensions with the most deficiencies in this area.

In terms of research, the positive aspects that the University of Tolima has are: to have lines of research oriented to the solution of social problems and to create new lines according to the current needs of society; to consider in an ethical manner the realization of research projects; to investigate social problems in a complex manner; to organize academic events in which the community is included; to incorporate and advise students who wish to participate in research projects. However, one aspect to improve in this dimension is that the university must establish specific means for the dissemination of knowledge.

In terms of teaching, the positive aspects that IES has are: to have courses dedicated to ethics, social responsibility and development; to include the discussion of social responsibility issues in the training courses and to try to practice among all its members the "4 RE" (Reuse, Recycle, Reduce, Respect). However, a positive aspect, but one that the university should reinforce, is that it should develop more actions for teachers to stimulate entrepreneurship and initiative in students and promote open discussion of issues that generate conflict in society or that are very controversial, promoting freedom of thought and criticism. In turn, the university should develop more environmental education actions that include all faculties.

In terms of organizational management, it is important to note that the University of Tolima has only positive aspects in its management, since the procedures for the remuneration of teachers/administrative staff are transparent and respectful of labor rights, in addition, it considers technical aspects and not friendship in the promotion of its administrative/teaching staff and also has an organizational structure to prevent/correct abuses of power of its members, fraud, bribery and other corrupt practices.

In terms of university outreach, the university's positive aspects are: maintaining agreements with key players in social development; providing its students with opportunities to interact with various social sectors; promoting environmental and social concern and sensitivity. However, the university must improve by actively participating in the discussion of community problems with key actors; creating an explicit policy to address underrepresented or marginalized groups; studying proposals to solve the country's social problems; promoting student volunteerism.

In terms of environmental management, the positive aspects taken into account by the university are: developing strategic partnerships to promote campaigns on social and environmental responsibility; having programs to reduce the consumption of energy, water, toxic products and raw materials. However, the aspects in which the university should improve are: using marketing campaigns to promote social and environmental responsibility issues; publishing an annual balance sheet on environmental performance; treating the environmental issue as a cross-cutting theme in its organizational structure and including it in strategic planning; and creating an office responsible for environmental issues with personnel with expertise in the subject.

On the other hand, it is essential to mention the limitations of the study. In this case, other internal stakeholders (undergraduate and graduate teachers and students) and external stakeholders (customers, suppliers, community, among others) have not been included. In addition, another limitation refers to sample access, since a more significant sample of administrative personnel was not included due to logistical inconveniences.

In closing, for future research, there is a need to replicate the study for teachers and undergraduate and graduate students of the University of Tolima, both in the CATs and in the main campus located in Ibagué-Tolima, in order to have a more accurate generalization of the research. It is also appropriate to apply the research instrument to the administrative staff of the main campus of the IES and thus be able to perform a comparative analysis according to the perceptions obtained in the results of this study. It is also relevant to apply the study in other universities, whether public or private. Last but not least, it is recommended that the university implement possible actions for improvement in the area of RSU.

References

Aldana-Rivera, E.D., Tafur-Castillo, J., Gil, I. y Mejía, C. (2019). Práctica pedagógica de emprendimiento en docentes de educación superior en Institución Educativa

Universitaria de Barranquilla. *Archivos Venezolanos de Farmacología y Terapéutica, 38*(2), 9-18.

Baca-Neglia, H.Z., Rondán-Cataluña, F.J. y García-del Junco, J. (2017). Propuesta de medición de la responsabilidad social universitaria. *Espacios, 38*(43), 1-37.

Bernal, B. y Díaz, P. (2020). Análisis de la Responsabilidad Social Universitaria: un estudio comparativo en Latinoamérica. *Revista Activos, 18*(2), 111-128.

Bravo-Gómez, V.C., Montilla-Pacheco, A.J. y Durán-Vasco, M.E. (2021). Estrategia de capacitación formativa para personal administrativo. Caso, Universidad Laica Eloy Alfaro. *Revista Ciencias Sociales y Económicas -UTEQ, 5*(1), 132-155.

Cano-Menoni, A. y Castro-Vilaboa, D. (2016). La extensión universitaria en la transformación de la educación superior. El caso de Uruguay. *Andamios, 13*(31), 313-337.

Espinola-Calderón, J.L. y Santos-Meza, E.A. (2022). Importancia del pensamiento crítico en la labor docente. *Ciencia Latina Revista Científica Multidisciplinar, 6*(3), 2877-2894. 10.37811/cl_rcm.v6i3.2425

Forero-Jiménez, M.Y. (2019). Modelo de responsabilidad social universitaria: una propuesta para las instituciones colombianas. *Revista de Investigación, Desarrollo e Innovación, 9*(2), 249-260.10.19053/20278306.v9.n2.2019.9160

Guerra-Molina, R.A. (2017). ¿Formación para la investigación o investigación formativa? La investigación y la formación como pilar común de desarrollo. *Boletín virtual, 6*(1), 84-89.

Marín-Donato, K. (2018). *Ideas y expectativas en relación a la Responsabilidad Social de estudiantes de primer año de carreras de la salud. Un estudio de caso* [Tesis doctoral, Universitat de Barcelona]. http://diposit.ub.edu/dspace/bitstream/2445/123319/1/KMD_TESIS.pdf

Medina-Peña, R., Franco-Gómez, M.C., Torres-Barreiro, L., Velázquez-Rodríguez, K., Valencia-Vera, M.A. y Valencia-Vera, A.L. (2017). La responsabilidad social universitaria en la actual sociedad del conocimiento. Un acercamiento necesario. *Revista de Ciencias Médicas de Cienfuegos, 15*(6), 786-791.

Olivella-Fernández, M., Bastidas-Sánchez, C.V. y Quimbayo, J.H. (2017). Valoración de comportamientos socialmente responsables en estudiantes universitarios de pregrado de la Universidad del Tolima, Colombia. *Revista Salud Historia Sanidad, 12*(1), 171- 184.

Pacheco, C.M., Rojas, C.P., Hoyos, L., Niebles, W.A. y Hernández, H.G. (2020). Responsabilidad social universitaria en el contexto de la educación superior en Colombia. *Revista Espacios, 41*(35), 141-151

Pinillos-Castillo, W.R. (Coord.) (2021). *Modelo de Responsabilidad Social en la Universidad de Cundinamarca. Una propuesta de articulación de las estrategias de RSU al Modelo de Operación Digital*. Editorial de la Universidad de Cundinamarca.

Portugal-Portugal, G. *El reto de la investigación interdisciplinar en educación superior: análisis de trabajo interdisciplinar en artículos científicos* [Tesis de maestría, Universidad Autónoma del Estado de Morelos]. http://riaa.uaem.mx/xmlui/bitstream/handle/20.500.12055/1853/GEMAPO01T.pdf?s e quence=1&isAllowed=y

Rosales-Cevallos, M.M. (2022). La ética en la investigación científica universitaria y su inclusión en la práctica docente. *Ciencia Latina Revista Científica Multidisciplinar, 5*(6), 15039-15058. 10.37811/cl_rcm.v5i6.1454

Saz-Gil, I., Gil-LaCruz, A. y Gil-LaCruz, M. (2021). El voluntariado universitario en el marco de la Responsabilidad Social Universitaria. Estudio de un Campus, Universidad de Zaragoza. *Revista de la Educación Superior 197*(50), 41-58. 10.36857/resu.2021.197.1578

Severiche-Sierra, C., Gómez-Bustamante, E. y Jaimes-Morales, J. (2016). La educación ambiental como base cultural y estrategia para el desarrollo sostenible. *Telos, 18*(2),266-281.

Universidad del Tolima. (2022, 17 de marzo). *UT realizó su Audiencia Pública de Rendición de cuentas vigencia 2021*. http://medios.ut.edu.co/2022/03/17/ut-realizo-su-audiencia-publica-de-rendicion-de-cuentas-vigencia-2021/

Uribe-Macías, M.E. (2015a). Responsabilidad social en la Universidad del Tolima: una mirada desde la comunidad vecina. *Cuadernos de Administración, 31*(54), 89-98.

Uribe-Macías, M.E. (2015b). Responsabilidad social: Eje formación profesional, óptica del estudiante de la Universidad del Tolima. *Revista FACCEA, 5*(1), 77-83.

Uribe-Macías, M.E., Orjuela-Ramírez, D.F. (2017). Stakeholder Egresados y la Responsabilidad Social de la Universidad del Tolima. *Desarrollo Gerencial, 9*(2), 120- 139.

Uribe-Macías, M.E., Orjuela-Ramírez, D.F. y Moreno-Barragán, X. (2016). La responsabilidad social de la universidad del Tolima frente al stakeholder "proveedores". *Dimensión Empresarial, 14*(2), 115-126. 10.15665/rde.v14i2.458

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Social Representations of Key Actors on Climate Change and Its Impact on Agricultural Production in Pergamino, Buenos Aires

Representaciones sociales de actores claves sobre el cambio climático y sus efectos en la producción agrícola en la localidad de pergamino, Buenos Aires

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ABSTRACT

Climate change is a global reality affecting populations worldwide. Developing comprehensive policies for risk management, adaptation, and mitigation is essential to address the challenges posed by an evolving climate. Argentina is particularly vulnerable to these challenges due to its reliance on agricultural and livestock production and its role as a major producer of raw materials. The country's dependence on these sectors makes it highly susceptible to the impacts of climate variability. This article examines the social representations of key stakeholders in Pergamino, Buenos Aires, regarding climate change and its effects on local agricultural production. It explores their perceptions, attitudes, and opinions about climate change and its implications, aiming to identify potential strategies for management, adaptation, and mitigation. The study involved 21 surveys with local stakeholders, addressing their views on climate change, local government performance in addressing the issue, agricultural yields, production dynamics, and related concerns. Understanding social representations within the community is critical for designing policies that effectively protect and manage the natural environment. Such policies must incorporate not only scientific and technical evidence but also the voices of citizens to ensure inclusivity and relevance.

Palabras clave:
cambio climático, representaciones sociales, adaptación y mitigación al cambio climático, alternativas productivas.

RESUMEN

El cambio climático es una realidad que aqueja a todos los habitantes, en todas partes del mundo. La generación de políticas de gestión del riesgo, de adaptación y de mitigación son fundamentales para hacer frente a los cambios que se avecinan en el futuro.
La República Argentina no está exenta de dichos cambios, y como país productor de materias primas con una gran dependencia del sector productivo agrícola/ganadero es muy susceptible a sufrir las consecuencias que se presentan a nivel climático.
El siguiente artículo está orientado a estudiar las representaciones sociales de actores claves de la localidad de Pergamino -Buenos Aires-, sobre el cambio climático y sus efectos en la producción agrícola de la zona, es decir, las visiones, percepciones y opiniones de ciertos

	miembros de la sociedad en relación al cambio climático y sus implicancias, con el fin de vislumbrar posibles formas de gestión y acciones de adaptación y mitigación. Para dicho fin, se realizaron 21 encuestas a actores locales y se les consultó sus opiniones en relación al cambio climático, la gestión del gobierno local en la temática, los rendimientos y la producción, entre otros. Conocer las representaciones sociales de los miembros de la sociedad, es fundamental para dar lugar a la creación de políticas de protección y de gestión del medio natural, atendiendo no solamente a los criterios científicos y técnicos, sino también incorporando las voces de los ciudadanos.

Introduction

Climate change, understood as those changes in climate that modify the atmospheric composition and are the result -either directly or indirectly- of human actions (United Nations Framework Convention on Climate Change [UNFCCC], 1992), has become one of the greatest problems afflicting humanity today.

While the Earth's surface climate has remained relatively constant for thousands of years, unprecedented changes have occurred in recent decades, especially since 1950 as a result of human actions. These changes include ocean warming, rising sea levels, decreasing volumes of snow and ice, loss of biodiversity, increase in extreme weather events, among others (Intergovernmental Panel on Climate Change [IPCC], (2014).

The Argentine Republic is not exempt from these changes and will have to face the complexity of the situation through mitigation and adaptation policies and actions.

Bearing in mind that Argentina is largely sustained by agricultural/livestock activity, climatic influences are aspects that may seriously affect the country's productive and economic reality.

In the Third National Communication, the Secretariat of Environment and Sustainable Development [SAyDS, for its acronym] (2015) projects a temperature increase of between 0.5 and 1°C in practically all areas of the country in the near future, with little variation in the level of precipitation. This would lead to increased water stress that would impact natural ecosystems as well as production. On the other hand, the Pampas region (the most important in terms of soybean and corn productivity) would be favored by the expected increase in temperature and rainfall during the summer period, which would favor these crops. However, such a situation could mean an intensification and expansion in the exploitation of such activities, bringing as a result a deterioration of soil and water quality, a loss of biodiversity, the potential increase in social conflicts over land tenure and in general an increase to climate vulnerability (SAyDs, 2015, and Esperbent, 2017).

This article focuses on understanding the dynamics between social representations or visions of climate change and its relationship with agricultural production in the town of Pergamino, Buenos Aires.

In the words of Navarro, social representations are understood as those "(...) forms of thoughts shared by a given social group or set, which allow understanding its social and physical reality, in order to intervene accordingly or simply perpetuate this same social reality" (Navarro, 2013, p. 105).

Given that the study area represents one of the most important production poles in the country, interference with the climate would seriously affect producers and production in general. Since the subject of the article focuses on a particular reality and is limited to a very specific spatial context, no research has been found so far that has addressed the same problem for the region under study. The aim is to open the scientific dialogue to future research and possible adaptation and mitigation solutions through improvements in production and land management that will help reduce risks and the vulnerability of producers.

The research presented here aims to identify the social representations of climate change of key actors in the town of Pergamino, for the evaluation of adaptation and mitigation alternatives in relation to the agricultural sector. In addition, it is also proposed to learn about the role of the government in relation to climate change in the area; to present the perceptions of local producers on the effects of climate change on yields and

local productivity; to evaluate how the effects of climate change have been perceived by citizens; as well as to analyze potential areas of action for improving risk management.

It also highlights the adaptation and mitigation strategies that are being implemented or that are planned for the future, in order to determine the productive alternatives for dealing with possible climatic interference. Thus, this work will contribute to the search for viable alternatives to adapt to a world that is changing at the climatological level with a production model that may be seriously affected, and help in the construction of projects that contemplate these visions of reality, laying the groundwork for the changes that are coming at the global level in relation to climate change.

Method

The contribution of information was carried out not only from theory but also from the interpretation of the data obtained through the actors themselves who live day by day with a situation that has not yet found a solution.

3.1. Research Design

The research proposed here is *non-experimental*, since the variables were not manipulated for the purposes of the study. The final purpose of this work was not to interfere with the concepts, variables and data obtained, but rather to observe them in order to understand them.

The spatio-temporal framework used in this study is *transversal*: the reality of the object of study was observed at a specific time -last quarter of 2021 to first half of 2022-.

In addition, it was proposed as an *exploratory* study because it deals with a subject that, although of great importance and of growing interest, has not been investigated in detail in the north of the province of Buenos Aires, so the aim was to generate a first approximation to the current situation in that area.

In turn, this is also a *descriptive* study, given that what was pursued was the description and observation of the opinions of the informants in relation to climate change in the area, what their views on the subject are, what degree of importance they consider to be given to the subject, among other aspects, so that their points of view were simply described.

3.2. Population and Sample

A *non-probabilistic sampling* was carried out: the aim is not to generalize the results, but rather to learn and interpret the opinions of the informants in this particular scenario.

The population taken as the object of study refers to members of the town of Pergamino who have some degree of participation in productive activities and/or knowledge of them. This decision was based on theoretical relevance. According to Meo and Navarro (2009), the latter refers to the fact that the cases selected are representative according to the theoretical or empirical criteria of the research itself.

In this case, 3 agronomists, 3 members of INTA (Instituto Nacional de Tecnología Agropecuaria), 3 members of AIANBA (Asociación de Ingenieros Agrónomos del Norte de Buenos Aires), 3 members of UNNOBA (Universidad Nacional del Noroeste de Buenos Aires), 3 producers in the area, 3 members of environmental organizations, 3 municipal officials were consulted and 21 surveys were carried out.

The informants were divided into three groups: municipal officials (Group 1); producers and specialists in the subject (Group 2); and members of environmental associations (Group 3). In this way it was possible to obtain the opinion on the subject from the point of view of the local government, from a more technical/productive point of view, and from a more social consideration.

3.3. Variables

Theoretical variable: 1- Climate change
Operational variables: - Comparative climate information. - Mitigation practices and actions - Adaptation practices and actions. -Alternative production.
Theoretical variable: 2- Social representations
Operational variables: - Opinion and degree of knowledge about climate change. - Perception of climate change as a problem. - Beliefs about climate change.

3.4. Measuring instruments and techniques

The survey technique was used, and a self-administered questionnaire was used as a data collection instrument.

This study is a mixed research, where a qualitative approach is presented with data collection elements that are more typical of quantitative research. For this reason, qualitative surveys were conducted. These, analyze the diversity of the members of a given population, unlike the statistical survey that seeks to analyze the frequency of the characteristics of the members of a population (Jansen, 2012).

The application of the surveys was carried out via e-mail, by sending a link to access the questionnaire in *Google Forms*. It was carried out between May and June 2022. Three questionnaires were created in response to the three groups mentioned above.

3.6. Statistical Analysis

As a result of the application of the questionnaires through the *Google Forms* tool, the same program automatically generates graphs (bar and pie charts), some of which were incorporated into the data analysis section to complement the results obtained. This section also mentions FASHION as a measure of central tendency. The latter allows us to identify which value is the most repeated in a particular question, revealing which values obtained the most mentions, which allows us to observe the points in common that the participants have in their vision of certain areas.

As symbolic constructs, social representations are continuously created and recreated by the dynamics of social interactions. Their flexible nature makes them prone to be modified according to the context in which they are immersed. In this way, it can be said that the theory of social representations does not provide explanations that can be generalized to other social groups, but it can serve as a support for the generation of new comparative or similar studies, giving rise to a possible dialogue for the generation of new studies.

Results

Section: General Knowledge About Climate Change.

All informants - groups 1, 2 and 3 - agree that they have knowledge about climate change, although in different proportions (some of them indicating that *they know a lot* about the subject, others that they *know*). The most relevant information media in all cases were the Internet, academic articles, lectures and social networks. Consequently, those consulted agree that climate change is the result of human actions reflected in changes in weather patterns, and that, although these changes occur naturally, they have accelerated recently due to anthropogenic actions, especially greenhouse gas emissions, especially carbon dioxide. In this sense, extreme climatic phenomena such as increases in rainfall, high temperatures, floods and droughts are occurring more frequently.

Section: Climate Change in Argentina.

All members of the first group (municipal officials) agree that climate change is a problem in our country, but that it is nevertheless given little/very little priority, while gender issues are the ones that the respondents consider to be the most important in recent times.

As for the sectors that have the greatest impact on climate change in Argentina, all those surveyed in this group agreed that transportation has the greatest impact due to CO_2emissions, followed by livestock farming, which generates methane gas, deforestation, which does not allow trees to absorb these harmful gases, and agriculture, which emits nitrous oxides due to the application of fertilizers. On the other hand, all also agreed that natural cycles would have no impact on climate change and that all inhabitants are affected by it.

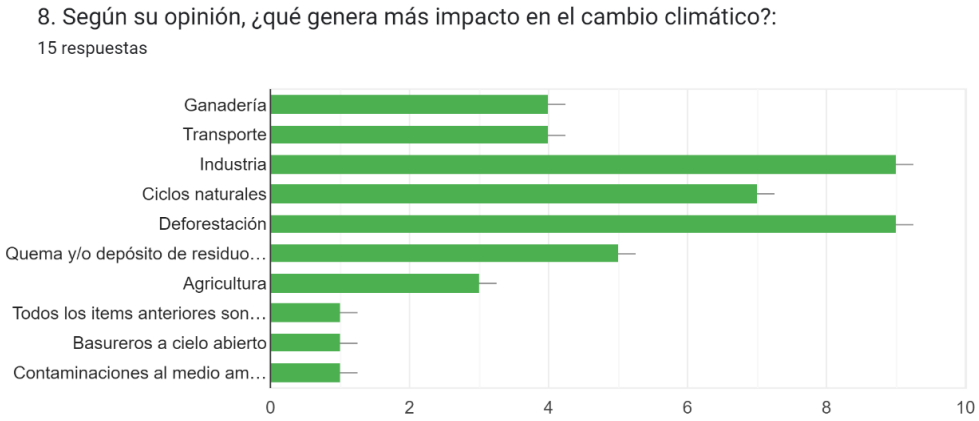
In relation to the respondents of the second group (technicians/specialists), there was a slight disparity in opinions, with 80% of those consulted considering that climate change does represent a problem in our country, while the remaining 20% believe that it is not.

As for the country's political, economic and social priorities, there were very different answers. Issues such as insecurity and the economy and inflation received very diverse responses, with the climate change issue being considered as one that is not given much importance (the largest number of responses refer to *very little* and *low priority*).

On the other hand, the central tendency measure MODA, in this case is made up of the values industry and deforestation, which obtained more mentions since they are presented as the sectors that generate more impact on the environment in our country, both with 9 mentions each, followed by natural cycles as responsible for climate change with a total of 7 mentions, as shown in Figure 1 below.

Figure 1

What generates generates more impact on climate change?



Note: Prepared by the authors based on the Google Forms tool (2022).

From the perspective of the vast majority of respondents in group 2 (86.7%), all inhabitants will be affected by climate change, and the impact it will have on low-income communities was also highlighted.

In the case of the third group (members of environmental associations), all agree on the fact that climate change is a problem that affects our country. However, while two of them considered that no priority is given to this issue, the remaining respondent considered that the issue is given considerable importance.

In relation to the sectors that generate the greatest impact on climate change, respondents mentioned livestock, transportation, industry and agriculture and deforestation as the activities that generate the most emissions, while waste burning and natural cycles were considered by only one of them. On the other hand, although two of the respondents considered that all inhabitants are affected by climate change, one of them pointed out that it is the poorest inhabitants and those living in coastal areas who would be most affected.

Section: The Role of the State in the Fight Against Climate Change

This particular section was consulted to the members of group 1. Respondents were asked if they considered that the municipal, provincial and national governments were carrying out actions to combat climate change. Although one of the members of group 1 considered that such actions were not being carried out, two of them pointed out that benefits and proposals to reduce the carbon footprint are being implemented at the provincial and municipal levels, as well as actions such as the replacement of public lighting with LED lights, waste separation and training, but that these are actions that alone and individually would not generate great changes. Regarding the role of the Municipality of Pergamino in the fight against climate change, two of the respondents considered that these actions are being carried out, while one of them does not know if this is happening. Among the actions taken by the municipality are the separation of waste, control in the application of phytosanitary products to reduce the number of applications and the amount of product applied, forestation of public spaces and home composting.

Finally, all agree on the importance of implementing measures to combat climate change as soon as possible, particularly the following aspects:

-Improved industrial waste management.

-Increased awareness of the problem among citizens.

-The development of a greenhouse gas inventory so that mitigation actions are more focused on the emission problem and require more immediate action.
-Tree planting as an important mitigation measure.
-Carbon footprint measurements and the granting of benefits for those who improve their carbon footprint.

Section: Effects of Climate Change on Production in the Region

The following section was incorporated in the questionnaire of group 2 since it was focused on technicians and agronomists in the area. In relation to the effects of climate change on production, 80% of those surveyed considered that changes in production are occurring due to this problem, while the remaining 20% indicated that agricultural production in the area is not being affected.

Within this last 20%, it was indicated that the drop in yields would not be a determining aspect for the moment given that the quality of the soil in the area is very good and the changes in weather patterns remain relatively stable, as well as because it is understood that these are cycles in the climate and that so far the area has been able to adapt to them, also highlighting that short-term actions cannot be carried out against the climate.

On the other hand, respondents who indicated that there have been changes in agricultural production due to climate change, mainly stated that regional production is affected mainly by extreme events such as temperature increases, floods and periods of drought; the increase in pests and diseases; and in terms of yields.

In relation to this last aspect, respondents were asked specifically whether crop yields have been affected by climate change in the last decade, to which 73.3% said yes, while the remaining 26.7% said that there had been no changes in this aspect. When consultedó when asked about the effects on yields, the response of extreme weather events once again stood out in terms of the number of mentions, being the most repeated throughout the survey. These aspects have a direct effect on the yields that affect crops, since they are lost either due to excess or lack of water.

Respondents were asked if they consider that productive alternatives can be carried out, where the central tendency measure MODA for this question indicates that the vast majority (80%) consider that productive alternatives do exist, among which the following stand out: conservationist practices, regenerative agriculture, greater importance to agroecological production, forestation, crop adaptation through genetic improvements, climate predictions, that lead to the management of planting dates, the incorporation of sustainable management actions that involve reducing the use of inputs and phytosanitary products, the use of green fertilizers, the combination with trees in livestock areas, and a greater supply of adapted machinery managed by the national and provincial governments.

Section: Effects of Climate Change on the Community.

The following section was incorporated only for the case of the third group. This decision was based on the fact that, being the same members of the association *Asamblea por la vida, la salud y el ambiente Pergamino*, it was considered that the participants could offer their opinion from a more socially-oriented point of view.

In this sense, all respondents agreed on the fact that climate change affects the local inhabitants, especially in terms of floods that affect both the inhabitants (through damages and material losses) and the farmers in the area who see their production lost, and must adjust their crops to the rainfall patterns. In order to address this situation, all

respondents agreed that agroecology and changes in the production model are essential to carry out such actions in the fight against climate change. The role of individual citizens was also highlighted, as well as the role of the State, which is present, committed and responsible for the cause.

Section: Climate Change in the Region - Pergamino

All members of group 1 agreed that they have noticed changes in the climate in the region in recent times, such as unusual temperatures at different times of the year, abnormal rainfall cycles, higher average temperatures, and less water availability in the soil.

These changes are viewed very negatively by all members of the group, particularly highlighting that they may contribute to the appearance of diseases, such as the increase in cases of dengue fever due to the presence of the *aedes aegypti* mosquito, which previously did not reach the area.

In terms of the elements that are most affected by climate change, livestock and agriculture stand out. Regarding the latter, they pointed out that it is affected by climate change, especially in crop cycles, generating stress on crops and even producing desertification in some areas.

When group 2 was asked if they had perceived changes in the climate of the region in the last decade, 86.6% said yes, while the remaining 13.3% said they had not perceived any changes. The former unanimously pointed out the presence of extreme weather events -especially in terms of increased temperatures, rainfall and droughts-. A response was highlighted that also mentions the presence of pests and diseases in the area's crops that did not exist before. The same percentages mentioned above were highlighted in terms of the perception of these changes, where most of those consulted consider that the changes in the climate of the area are perceived as negative, while the rest indicated that they would be positive.

Within the percentage of respondents who stated that these changes are perceived as negative, the presence of extreme events is repeatedly mentioned. Such unpredictability in the weather has an impact on agricultural production, which becomes more unstable and insecure. But there were also responses that included the social sphere. Such is the case of those who expressed opinions such as:

-Disruptions in the normal development of human activities.

-They affect agricultural productivity and people's well-being.

-We are moving away from equilibrium.

-Risk to life and lowers the human standard of living.

Agriculture, followed by flora and fauna, and then livestock are the elements that respondents said are most affected by these changes in climate.

With respect to group three, the responses of two of the respondents stand out, who mentioned having noticed changes in the region, especially - and coinciding with what was mentioned by the participants in groups 1 and 2 - in terms of changes in temperature and rainfall patterns, as well as in the occurrence of extreme phenomena, while the remaining respondent did not perceive too many changes in the area, given that the ten-year parameter is not sufficient to observe significant changes. However, all respondents in this group agreed that flora and fauna are the elements that will be most affected by the effects of climate change, with more disparate opinions in relation to agriculture and livestock, where in the first case, two of the respondents considered that agriculture would be very affected, while the remaining respondent indicated that it would be little affected, and in the case of livestock, the opposite was true: two of the

respondents indicated that it would be little affected, while one considered that it would be very affected by the effects of climate change.

Section: Climate Change Management

All members of group 1 indicated that they had heard about climate change mitigation and adaptation, although two of them do not know if such practices are being carried out by the Municipality of Pergamino, while the remaining respondent indicated that some are being carried out, although they did not specify which ones. For their part, all agree that the implementation of adaptation and mitigation strategies are important (one respondent) and very important (two respondents).

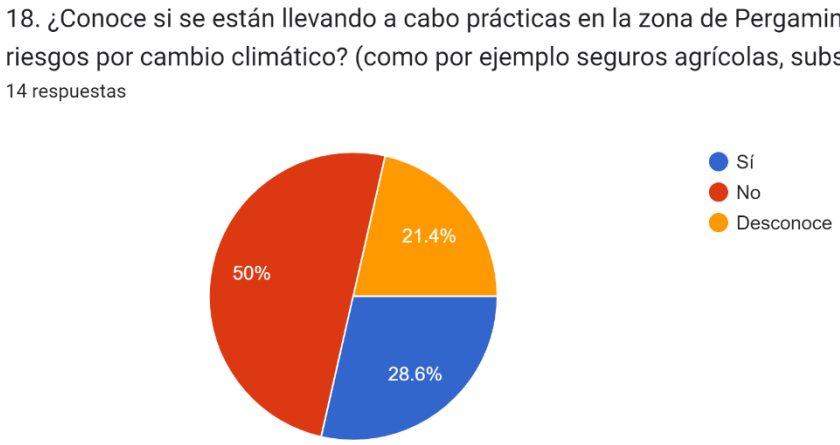
They unanimously emphasized that deforestation and forest control plans are very important, as well as agroecology, crop rotation, improvement of pastures and grazing systems, reliable weather forecasts to adjust crop dates and adaptation of germplasm banks to future climatic conditions.

In relation to group 2, the responses were more varied when asked if they had heard of climate change mitigation and adaptation, where 66.7% (10 respondents) mentioned having heard of it, 26.7% (4 respondents) said no, and the remaining 6.7% (1 respondent) said they did not know about it. However, regarding the existence of adaptation and mitigation strategies, all respondents expressed the importance of the role of such actions in the fight against climate change.

When respondents in the second group were asked if they knew whether risk management actions were being carried out in the area, the following responses were recorded, as shown below.

Figure 2

Risk management actions in the area



Note: Prepared by the authors based on the Google Forms tool (2022).

The MODA in the previous figure indicates that half of the respondents mentioned that risk management actions are not being carried out in the area, which could be seen as something negative, given that it is understood that from the political level this type of actions that are so necessary are not being carried out, especially in an area highly dependent on the agricultural sector such as the town of Pergamino. On the other hand,

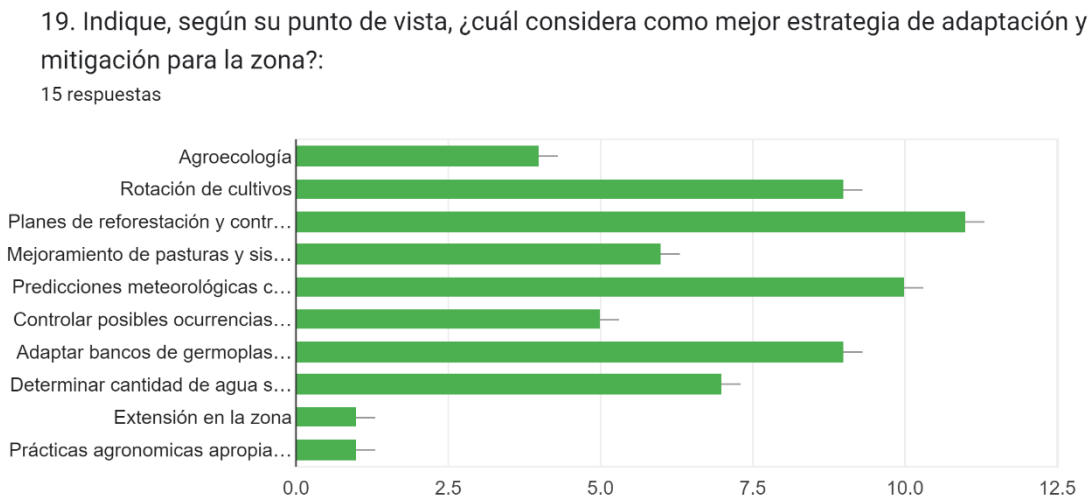
28.6% indicated that such actions are being carried out, while the rest of the respondents said they had no knowledge of the matter.

Agricultural insurance was the most frequently mentioned when asked which ones they knew about, as well as the existence of subsidies provided by the State to small agroecological producers.

When asked what they consider to be the best adaptation and mitigation strategies in the area, the following were highlighted, as shown in Figure 3.

Figure 3

Improved adaptation and mitigation strategies



Note: Prepared by the authors based on the Google Forms tool (2022).

As can be seen, reforestation and forest control plans obtained the most mentions (11 mentions), followed by reliable weather forecasts to adjust cropping dates (10 mentions), and crop rotation and adaptation of germplasm banks to future climatic conditions (9 mentions). For their part, some respondents added their own opinions, such as:

-Carbon sequestration strategies (soil and biomass) and reduction of GHG emissions (fertilization management, rice fields, livestock herds).

-Non-formal education with money from the municipality, the university and agricultural research entities, mediated by other educational institutions.

-Reduction of CO_2, methane and nitrous oxide in the atmosphere to limit global thermal increase.

-Carry out sustainability practices.

In the case of the third group, as in group 1, all respondents reported having heard about mitigation and adaptation practices, which they consider *important* (two cases) and *very important* (one case). However, despite the importance of this, one of the respondents did not know if such practices are being carried out in the locality, while the other two mentioned that no mitigation and adaptation actions are being carried out in the area.

Regarding the adaptation and mitigation strategies that respondents considered most appropriate, all members of group 3 agreed on agroecology and reforestation and

forest control plans, while crop rotation, improvement of pastures and pastoral systems and adaptation of germplasm banks to future climate conditions were mentioned.

The information gathered through the surveys suggests that the respondents are aware of climate change (to varying degrees, some more, others perhaps a little less) and the vast majority agree that the effects of climate change are being felt in the area, through extreme phenomena such as heavy rains or floods, droughts, increased temperatures, among others, which is affecting agricultural production. However, it is emphasized that there are mitigation and adaptation actions that should be carried out in the fight against climate change that should be given greater importance in order to defend local production.

Discussion

The results obtained from the surveys show that the respondents are aware of climate change, its repercussions on the environment and on production, the role that anthropic actions play in this problem and, in general, the perception that climate change will affect regional production.

The role of the government in environmental matters is fundamental since it is through this institution that tools such as regulations, decrees, laws, among others, can be created in the fight against climate change. Consequently, it was pointed out in the responses that the actions carried out by the municipality so far would not be sufficient to address this problem. These are actions that would not have a great impact, such as the change in public lighting, waste separation, public trees, among others, which, although they contribute in their own way to the issue, would not be enough to attack the root of the problem.

The way in which the subject matter is understood and approached is also of great importance. Taking up again what Celis et al. (2005) said, it would be interesting to look beyond the mere conception of the occurrence of isolated extreme phenomena that do not occur regularly, to understand that the recurrence of such phenomena is more common than is believed, and it is becoming more and more common for such phenomena that are believed to be "extreme" to occur. By recognizing the habitual nature of these problems, preventive rather than reactive policies are generated, so that management is more holistic and the aim is to attack the problem not only from the point of view of the effects but also by placing emphasis on the causes.

As pointed out by González Gaudiano (2012), it is very common to blame nature for consequences that in reality derive from erroneous and/or inefficient policies, but which in reality have a more social than natural character due to institutional disorder, lack of regulations and concrete actions, which increases social confusion and distrust on the part of citizens, causing a reduction in the urgency to act and to implement mitigation and adaptation actions.

This is a challenge that must be faced urgently, and for which governments must rise to the occasion through the generation of environmental management policies, preventive actions and adaptation and mitigation actions that require national and international cooperation to face this struggle in which all individuals, societies and nations must be part of the same team to confront the common enemy: climate change.

On the other hand, as indicated by Chávez-Caiza and Burbano-Rodríguez (2021), it is understood that climate change has become a latent threat to the productive sector. In the local reality, where production is focused on soybean monoculture, and where there

is a high dependence on the technological package required (use of phytosanitary products), the capacity to mitigate the effects of climate change is reduced.

Through some of the responses collected, it can be seen that the social representation of climate has been changing over time, and that there have been variations that did not exist as frequently in the past as they do today.

If the climate of the area is changing, it is understood that alternatives must be implemented, whether in production, management, mitigation and adaptation actions to face such changes. In terms of potential areas of action for improvement in risk management, several areas were highlighted that were repeated throughout the responses. Among these, reforestation and agroecology were the two most prominent potential areas of action.

It is also necessary to focus on the genetic improvement of crops in order to make them more resilient and thus better able to adapt and mitigate climate change.

In addition, it was noted that the deforestation of native areas to make way for agriculture and/or livestock (changes in land use) is one of the main problems in terms of climate change. In this way, a symbiotic situation is generated in which agriculture in the area is affected by climate variability, but at the same time, the production system itself exerts pressure on natural resources, emitting around 37% of GHGs at the national level (SAyDS, 2015).

The importance of the change in conventional production systems was also highlighted. Current forms of consumption are making the use of natural resources more intensive and are therefore generating pressure on the natural environment that cannot meet the requirements of a world that is home to more than 7 billion people.

Risk management requires long-term policies for the reduction of vulnerability conditions through mitigation, adaptation and prevention actions, as well as short term strategies to respond to disaster events such as floods, etc. This requires the involvement of state and non-state actors, social organizations and citizens to give rise to the emergence of new ideas and proposals for intervention on the subject. This idea of knowledge articulation is central to risk management, strengthening the link between the different actors based on the recognition of the problem, the place each one occupies in it and the capacity for intervention they can carry out (Bartolomé et al. 2005) (Bartolomé et al, 2005).

Pardo Buendía (2011) argues that the complexity of climate change requires a change in public and private policies from corrective and legislative ones to preventive, precautionary policies that combine regulatory, scientific-technological instruments and economic incentives, as well as more comprehensive policies that emphasize social participation in environmental management, incorporating the voices of citizens in the resolution of these problems.

In this way, the social representations that the members of society have in relation to climate change would be of great importance, because they would contribute to the knowledge of the perceptions of the actors, of how they understand the problem, what they believe are the best paths to follow in the face of this situation and what they consider to be the most appropriate forms of management in the face of a problem that grows every day and affects the population. Citizen participation is required in the fight against climate change, because it is through this social cohesion that society's constantly changing and modifying problems can be addressed.

Thus, the social dimension of climate change is considered necessary and complementary to the sciences that have been studying climate and its modifications in recent times. In this way, the knowledge provided by these sciences would be further

enriched if the information on how the population understands and interprets climate change and its implications on their lives were also incorporated into the policies for responding to these changes.

Adherence to mitigation and adaptation programs and actions to reduce the vulnerability of the population will also be determined as long as citizens recognize climate change as a real factor that affects their lives on a daily basis. For this reason, it is necessary to bring together the voices of concerned citizens, technologists, scientists, environmentalists, and members of society as a whole, when it comes to taking sides in risk management and natural resource management.

Climate change is the product of a society that is, at the same time, changing, advancing, but in its growth and in its path it is destroying and creating devastation in the natural environment, just as a climatic event creates devastation in the area it touches.

In short, climate change is a social fact since its causes are due to human action and it is precisely societies and their citizens who suffer its consequences through environmental change. But it is also a social fact because its solution depends on radical changes in society.

Conclusions

The following conclusions were drawn from the information gathered:

Climate change is a real issue to which science has devoted thousands of proven studies. It has been determined that changes in the climate are being seen in recent times, which are occurring rapidly and are a consequence of human actions.

There are effects on local production in the study area (for the vast majority of respondents) that can already be seen in the drop in yields due to extreme weather events, pests, and that are very likely to continue to be seen in the future.

The members consulted have clear ideas about the way forward, where changes in conventional production models for agroecological models, forestation, genetic improvement and the creation of laws are fundamental.

It can be said that the social representations or perceptions of the actors consulted on the problem are that there is a problem and that its consequences can be seen in day-to-day life, that these consequences can worsen but that there are ways and means to follow that can mitigate the effects of climate change in the area, which are those already mentioned.

In terms of risk management, governments must understand the dangers caused by climatic interference and begin to focus their actions not only in a reactive manner -once an incident has already occurred- but also, and above all, in a preventive manner. Long-term risk management requires joint actions by local and national governments and international alliances, with the participation of social actors, contributing their views and knowledge on the subject. In other words, a joint, holistic effort is required that reaches all areas.

Although this is an exploratory and descriptive study, which is intended as a first approach to the problems in the area, it should be noted that the voices of the people who participated are very important and knowing their opinions can be very useful in the creation and/or revision of policies, laws, decrees, which can lead to a more pleasant use of the natural resource.

For future research, it would be very useful to have a broader scope through the participation of more stakeholders in the study, providing more opinions and further enriching the subject matter. It would be very interesting to extend the concern of the

research to the school environment, and to consult teachers and students about their views in relation to climate change, in order to understand what is being taught today to the youngest, and how they understand the problem that is raised here.

References

Bartolomé, M., Kisilevsky, G. y Rodríguez, C. (2005). Gestión local del riesgo: Pergamino, una experiencia participativa hacia la gestión del riesgo Ambiental. VII Seminario Nacional de la Red de Centros Académicos para el Estudio de Gobiernos Locales. http://municipios.unq.edu.ar/modules/mislibros/archivos/bartolomkisilevkyrodriguez2005.pdf

Celis A., Caputo G., Bartolomé M., Kisilevsky G., Herzer H., y Rodríguez C. (2005). Primeros pasos hacia una política local que gestione el riesgo de inundación.https://www.ingentaconnect.com/content/iieal/meda/2005/00000062/F0020001/art00010

Chávez-Caiza, J. P., y Burbano-Rodríguez, R. T. (2021). Cambio climático y sistemas de producción agroecológico, orgánico y convencional en los cantones Cayambe y Pedro Moncayo. Letras Verdes - Revista Latinoamericana de Estudios Socioambientales (29), 149-166. https://revistas.flacsoandes.edu.ec/letrasverdes/article/view/4751/376.

Convención Marco de las Naciones Unidas sobre el Cambio Climático (CMNUCC). (1992) https://unfccc.int/resource/docs/convkp/convsp.pdf

Esperbent, C. (2017). El cambio del clima deja su huella en la agricultura. Revista de Investigaciones Agropecuarias (RIA). http://ria.inta.gob.ar/contenido/el-cambio-del-clima-deja-su-huella-en-la-agricultura

González Gaudiano, É. J. (2012). La representación social del cambio climático. Una revisión internacional. Revista Mexicana de Investigación Educativa, 17(55), 1035-1062. https://www.redalyc.org/articulo.oa?id=14024273003

Grupo Intergubernamental de Expertos sobre el Cambio Climático (IPCC). (2014). Cambio climático 2014. Informe de síntesis. Resumen para responsables de políticas. https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM_es.pdf

Jansen, H. (2012). La lógica de la investigación por encuesta cualitativa y su posición en el campo de los métodos de investigación social. Paradigmas, 5(1), 39-72. https://dialnet.unirioja.es/servlet/articulo?codigo=4531575

Meo A., y Navarro A. (2009). La voz de los otros. El uso de la entrevista en la investigación social. Capítulo 5: La entrevista: el antes, el durante y el después. Oicom System. http://metodo3.sociales.uba.ar/wp-content/uploads/sites/169/2014/10/La-voz-de-los-otros.-Capu00EDtulo-5.pdf

Navarro, O. (2013). Representación social del medio ambiente y de la contaminación del aire: efecto de imbricación de dos objetos. Revista CES Psicología, 6(I), 104-121. http://www.scielo.org.co/scielo.php?pid=S2011-30802013000100007&script=sci_abstract&tlng=es

Pardo Buendía, M. (2007). El impacto social del Cambio Climático. Panorama Social, (5), 22-35. https://portal.uc3m.es/portal/page/portal/grupos_investigacion/sociologia_cambio_climatico/Sociology_of_Climate_Change_and_Sustainable_Development/El%20impacto%20social%20del%20Cambio%20Clim%E1tico.pdf

Secretaría de Ambiente y Desarrollo Sustentable de la Nación. (SAyDS). (2015). Tercera Comunicación Nacional de la República Argentina a la Convención Marco de las Naciones Unidas sobre el Cambio Climático.
https://unfccc.int/resource/docs/natc/argnc3s.pdf

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(2024) Environmental Sciences & Practices, 2(2) 43-62.

URBAN MOBILITY AND LOGISTICS PLATFORMS IN THE INTERMEDIATE CITIES OF THE AMERICAS: A SYSTEMATIC REVIEW OF THE SCIENTIFIC LITERATURE

Movilidad urbana y plataformas logísticas en las ciudades intermedias de américa: una revisión sistemática de la literatura científica

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urban mobility, logistics platforms, intermediate cities, urban logistics, sustainable development.

ABSTRACT

Logistics are experiencing a growth in its development, which demands the use of adequate structures and larger transport units, which also represents an indirect impact on the environment due to fuel consumption and the use of packaging. Introduction: To identify trends in urban mobility and logistics platforms in the intermediate cities of the Americas in the years 2011-2021. Methodology: The synthetic method and the PRISMA method were used to compile, interpret and select the scientific articles that were used for the construction of the systematic review. The research sample is composed of scientific articles published in Latin America between 2011 and 2021 that meet the inclusion criteria of scientific rigour of the research. Results: Due to the centralisation of commercial operations in Latin American metropolises, vehicle congestion is generated, creating delays and cost overruns in the logistics chain; this congestion generates greater demand for the use of vehicles and therefore a greater spectrum of pollution produced by fuels. Discussion: The trend of developing logistics platforms in the intermediate cities of the Americas in the last 10 years seeks to generate sustainable development because decentralising operations could address the daily problems of urban areas, such as noise, pollution and costs generated in a metropolis.

Palabras clave:
movilidad urbana, plataformas logísticas, ciudades intermedias, logística urbana, desarrollo sostenible.

RESUMEN

La logística está experimentando un crecimiento en su desarrollo por lo que demanda el uso de estructuras adecuadas y mayores unidades de transporte, lo que además representa un impacto indirecto en el medioambiente por el consumo de combustibles y el uso de empaques. Introducción: Conocer las tendencias de movilidad urbana y plataformas logísticas en las ciudades intermedias de América en los años 2011-2021. Metodología: Se empleó el método sintético y el método PRISMA para realizar la recopilación, interpretación y selección de los artículos científicos que fueron utilizados para la construcción de la revisión sistemática, la muestra de la investigación está compuesta por artículos científicos publicados en América Latina entre los años 2011 y 2021 que

	cumplan con los criterios de inclusión de rigor científico de la investigación. Resultados: Por la centralización de las operaciones comerciales en las metrópolis de América Latina se genera el congestionamiento vehicular creando demora y sobrecostes en la cadena logística, este congestionamiento genera la mayor demanda de uso de vehículos y por ende un mayor espectro de contaminación producida por los combustibles. Discusión: La tendencia del desarrollo de plataformas logísticas en las ciudades intermedias de América en los últimos 10 años busca generar desarrollo sostenible porque al descentralizar las operaciones se podría hacer frente a los problemas cotidianos de las zonas urbanas, como el ruido, la contaminación y los costes generados en una metrópoli.

Introduction

Urban mobility is the concept given to the human practice of moving from a point of origin to a destination for the purpose of carrying out daily activities and under this concept coexists transportation complementing human movement. As a reference, in the early 1980s, industries began to occupy spaces far from the urban sprawl, which accelerated the construction of urban expressways; however, most transportation did not evolve at the same pace as this progress. In these urban expressways there are no preferential lanes for public transportation and this is mixed with private transportation evidencing the uncivic use of the roads by breaking traffic rules and ignoring regulatory tools when activities such as improper overtaking, lane invasion and violation of established speed limits are carried out, generating vehicular congestion and loss of time (Obregón and Betanzo, 2015).

Fernández (2018) explains that a logistics platform is the set of facilities, material resources, human resources and information and management systems that allow the operation of each of them in an integral manner in the same space to be able to generate or assist international trade operations, logistics platforms seek to fulfill the objective of being strategic, useful and transcendental locations for logistics activities of an international nature and that at the same time have an impact on the generation of territorial commercial planning.

Fernandez (2018) determines the types of logistics platforms that exist are as follows:

- Logistics Distribution Platform (PLADIS).
- Border Support Logistics Platform (PLF).
- Cluster Support Logistics Platform (PLC).
- Port Logistics Activities Zone (ZAL).
- Dry Ports (Bonded Warehouses).
- Agrocentro Logístico (AGROLOG).

Llop et al. (2019) explain that the term intermediate city is used to refer to urban systems differentiated from the metropolitan dimension, thus transcending the scope of spatial, demographic size and the analysis of external factors such as political, economic, sociocultural, technological, ecological and legal study.

An intermediate city, beyond its demographic relevance, has the capacity to articulate and cohere the urban system and the urban-rural connection links; derived from its scale, it has the capacity to outline and achieve the implementation of value-added strategies such as the use of fewer resources than large cities to position itself in a regional, national and international commercial scenario; derived from the impact of globalization, an intermediate city is considered a demolishing element of the *status quo* because of its controversy with the hierarchies of the traditional urban system by opening new operational horizons of territorial cooperation (Llop et al., 2019).

The combination of urban mobility and logistics platforms occurs in a transdisciplinary scenario that seeks to achieve the reduction of time and space losses in the commercial operation, with the aim of optimizing the product, the client, the place and the time needed to develop an international commercial operation. From an international business perspective, a logistics platform encompasses concepts such as physical distribution, warehousing, transportation, management indicators and information systems that are important aspects for an optimal global logistics process (Salazar, 2012).

The justification for this research lies in the need to expand knowledge on the holistic and transdisciplinary concept of urban mobility and its incidence on the establishment of logistics platforms in the intermediate cities of the Americas, due to the great impact they can create on international business by becoming an active and strategic territorial node with respect to commercial activities. Many of the intermediate cities in the Americas are not economic generators at scale, but they are concentrators of key services such as health,

education and commerce for the rural populations in their *hinterland*. The importance of the study of intermediate cities lies in the fact that they are the step prior to migration to a metropolis.

Based on the above, the following question arises for the development of the systematic review of the literature: what are the trends in urban mobility for the development of logistics platforms in the intermediate cities of the Americas in the last 10 years? Following this question, the objective of the systematic review is to know the trends in urban mobility for the development of logistics platforms in intermediate cities in the Americas in the last 10 years based on the study of scientific articles.

Method

Design

The present research is a systematic review of the scientific literature in which we seek to develop an understanding, in synthesis, of the theoretical evidence found in repositories on trends in urban mobility and logistics platforms in intermediate cities in the Americas. In this type of research, a review of a large volume of quantitative and qualitative scientific articles is carried out, which provides different theoretical perspectives on the research topic.

Participants

The scientific articles to develop the systematic literature review were searched and obtained through relevant research repositories such as Scielo, Dialnet, Researchgate and Redalyc. The search for scientific information in a systematic review of the literature is one of the fundamental stages for the development of the research because it is necessary to know the content, the documentary typology, the tools and the results obtained in order to be able to analyze the study.

Data Analysis

For the search of the scientific articles in these scientific repositories, keywords related to the research topic such as urban mobility, logistics platforms and intermediate cities will be used, however, technical words related to the research will also be used, it is also necessary to use the keywords in other languages in order to have access to more information from America in general.

Due to the transdisciplinary nature of this systematic review, we will search for key words in Spanish, English, French and Portuguese because we will be working with the American continent and probably due to the Spanish terminology, we will not be able to find scientific articles developed in countries such as the United States, Canada or Brazil because of the language difference. Initially, the information will not be discriminated by time period; all the information found will be compiled.

Table 1

Keywords in Spanish and other languages for the search of studies

Keyword	English	French	Portuguese
Urban Mobility	Urban mobility	Urban mobility	Urban mobility
Logistics Platforms	Logistics Platforms	Logistical forms	Logistics platforms
Urban Logistics	Urban Logistics	Urban logistics	Urban Logistics
Intermediate Cities	Intermediate Cities	Intermediate villages	Intermediary cities
Logistics Planning	Logistics Planning	Logistics planning	Logistics Planning

Note. The grouping of the keywords in Spanish and their respective translations is presented (Prepared by the authors, 2021).

The process of classification of the scientific articles obtained for the development of the systematic review of the literature will follow the worked database that groups all the researches by their generic criteria in order to subsequently carry out an evaluation for the inclusion of the scientific articles following the parameters defined in the inclusion and exclusion criteria. In this third stage we will classify the research articles by country.

Table 2

Inclusion and exclusion criteria for scientific articles

Inclusion criteria	Exclusion criteria
▪ Scientific articles hosted in the following repositories: Scielo, Dialnet, Redalyc, Researchgate and Elsevier. ▪ Scientific articles in the 2011 - 2021 time period. ▪ Scientific articles with correlational information between urban mobility and logistics platforms in intermediate cities. ▪ Scientific articles that have developed their research in the continental context of the Americas.	▪ Scientific articles or information scattered in other web hosts. ▪ Old scientific articles published before 2011. ▪ Discrimination by type of document, for example, theses and opinion articles. ▪ Scientific articles whose research context is other geographical areas outside the Americas.

Note. This table groups the criteria under which the information for the systematic review of the literature will be discriminated (Own elaboration, 2021).

Instrument

In order to develop an adequate selection of relevant articles for the optimal development of the systematic literature review, a documentary evaluation matrix has been designed in which the scientific articles will be evaluated in a scrupulous and scientific manner according to the criteria of inclusion, exclusion, reliability, documentary typology, context developed, time period established for the review, traceability and transferability of the research.

Table 3
Matrix for the evaluation of scientific articles

No.	do you have urban mobility data? (0-1)	do you have data on logistics platforms? (0-1)	do you have intermediate cities in the Americas as a context? (0-1)	did it take place between 2011 and 2021? (0-1)	were urban mobility and logistics platforms studied? (0-1)	TOTAL
1	1	1	0	1	1	4
2	1	1	1	1	1	5
3	1	1	0	0	1	3
4	1	1	1	1	1	5
5	1	1	0	1	1	4
6	1	1	0	1	1	4
7	1	1	0	1	1	4
8	1	1	1	1	1	5
9	1	1	1	1	1	5
10	1	1	1	1	1	5
11	1	1	1	1	1	5
12	1	1	0	1	1	4
13	1	1	1	1	1	5
14	1	0	0	1	0	2
15	1	0	1	1	0	3
16	1	1	1	1	1	5
17	1	1	0	1	1	4
18	1	1	0	1	1	4
19	1	1	1	1	1	5
20	1	1	1	1	1	5
21	1	1	0	1	1	4
22	1	1	0	1	1	4
23	1	1	1	1	1	5
24	1	0	1	1	0	3
25	1	1	0	1	1	4
26	1	1	1	1	1	5
27	0	0	0	1	0	1
28	1	1	1	1	1	5
29	1	1	1	1	1	5
30	1	1	1	1	1	5
31	1	0	1	1	0	3
32	1	1	1	1	1	5
33	1	1	1	1	1	5
34	1	1	1	1	1	5
35	1	1	1	1	1	5
36	1	1	1	1	1	5
37	1	1	1	1	1	5

38	1	1	0	1	1	4
39	1	1	1	1	1	5
40	1	1	0	1	1	4

Note. This table includes an evaluation for analyzing the scientific articles collected; the criterion for them to be included in the systematic review of the literature is to obtain the maximum 5 points (Prepared by the authors, 2021).

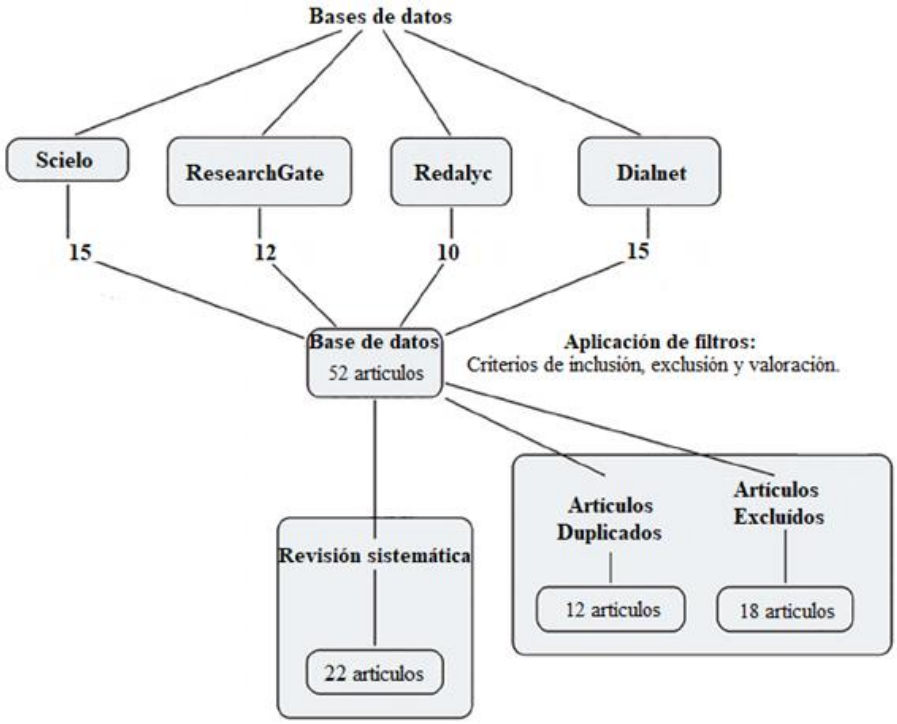
The matrix presented in Table 3 responds to the critical appraisal with which the research articles that will be analyzed in the systematic literature review will be selected. Forty scientific articles were collected from the Dialnet, Scielo, Redalyc and Researchgate repositories, searching through keywords such as urban logistics, urban mobility, logistics platforms and their translations into English, Portuguese and French. After applying the assessment criteria, 22 scientific articles were selected for the systematic review of the literature.

Results

For the selection of the scientific articles used in the systematic review of the literature, the following flow chart was used to obtain the 22 articles included in the systematic review.

Figure 1

Flowchart of item identification, selection and inclusion



Note. Figure 1 shows the flow chart used by the authors for the development of the systematic literature review (Own elaboration, 2021).

In Table 3, an evaluation was made of the scientific articles collected to choose those that will be addressed in the systematic review. Thus, after having made an assessment of the characteristics of the study approach through the research variables, the context, the year and the correlation of the variables, it was decided that the systematic review will be conducted on the basis of the following articles with the following characteristics:

Table 4

Articles included in the systematic review

Item number	Title of Scientific Article	Repository	Language	Year
1	Urban mobility of the population in the city of Encarnación, Paraguay. Urban development and environmental management	Scielo	Spanish	2021
2	Sustainable Urban Mobility and Logistics: Huancayo Case	ResearchGate	Spanish	2016
3	Analysis of urban mobility in a medium-sized Mexican city, case study: Santiago de Querétaro	Scielo	Spanish	2015
4	Analysis and proposal of sustainable urban mobility: Accessibility to the cultural heritage of the city of Guanajuato	ResearchGate	English	2020
5	Analysis of accessibility from collection and delivery points: Towards the sustainability of the e-commerce delivery	Scielo	English	2019
6	Are Brazilian cities ready to develop an efficient urban freight mobility plan?	Scielo	English	2018
7	Logistic behaviors in the last mile distribution of food products in Villavicencio, Colombia	Scielo	Spanish	2014
8	Challenges for freight mobility in high congestion areas	Dialnet	Spanish	2016
9	Distribution in Large Urban Centers: Mobility Disabilities Generating Complex Logistics	ResearchGate	English	2018
10	The capital of daily urban mobility: mobility on the outskirts of Metropolitan Lima	Scielo	Spanish	2020
11	Logistical factors affecting the increased competitiveness of SMEs: a literature review	Dialnet	Spanish	2016
12	Urban mobility: Dimensions and challenges	Scielo	Spanish	2018
13	Logistics models applied to Urban Distribution of	Scielo	Spanish	2017

	Goods.			
14	Business Logistics In Production, Commercialization And Service Companies In Portoviejo	Dialnet	Spanish	2014
15	Urban logistics and territorial planning: A political approach	Redalyc	Portuguese	2016
16	Urban mobility: A Paulistano challenge	Scielo	Portuguese	2013
17	Logistics management model for small and medium-sized enterprises in Mexico	ResearchGate	Spanish	2015
18	Strategic Approaches to Urban Logistics: University-State-Business Relationship Perspective	ResearchGate	Spanish	2013
19	Logistic Platforms: an approach to typologies and characteristics through a systematic review	Scielo	Portuguese	2014
20	Public policies in urban logistics. Collective construction of guidelines for logistics in Bogota-Colombia	Scielo	Spanish	2018
21	Current logistics and supply chain challenges	Scielo	Spanish	2021
22	Urban transport and mobility, towards a sustainable and competitive urban dynamic	Redalyc	Spanish	2014

Note. Table 4 shows the articles that will be taken into account for the systematic review of the literature, as well as their repositories, languages and year of publication (Prepared by the authors, 2021).

The characteristics presented in Table 4 of the 22 scientific articles chosen for the development of the systematic review allow the clear identification of studies that address the study of urban mobility and logistics platforms. With this information, data triangulation was carried out to identify the objectives set, the results found and the conclusions developed that allow the identification of urban mobility trends in the intermediate cities of the Americas in the last 10 years with the purpose of being able to elaborate the discussion and conclusions of the systematic review.

Table 5

Main findings of the selected scientific articles

Title and author	Findings
Title: Movilidad urbana de la población en la ciudad de Encarnación Paraguay.	**Objective:** study the factors that influence the flow of vehicular movement in terms of accessibility to the downtown area. **Results:** the

Desarrollo urbano y gestión ambiental **Author:** Fernández, A. (2021).	needs of the population are not being met in the neighborhoods under study, and that greater displacements are required to satisfy them. **Conclusion:** the factors that influence mobility are predominantly location and dependence on services in other areas, in addition to taking measures to favor sustainable urban mobility by promoting the use of clean technologies and improving the management of the transportation system.
Title: Movilidad y Logística Urbana Sostenible: Caso Huancayo **Author:** Regalado, G. (2016).	**Objective:** achieve economic and business feasibility through the adoption of sustainable urban logistics solutions. **Results:** Mobility Logistics is a technological tool applied basically to the movement of people, although its operability also favors the distribution of goods. **Conclusion:** the problems that urban logistics seeks to solve are congestion caused by public and private transport, pollution levels due to congestion and heavy traffic, distribution of goods in unsuitable urban environments such as historic centers, and the use of traffic lanes for loading and unloading in the absence of adequate bays.
Title: Análisis de la movilidad urbana de una ciudad media mexicana, caso de estudio: Santiago de Querétaro **Authors:** Obregón, S. and Betanzo, E. (2015).	**Objective:** analyze current commuting patterns in the Querétaro Conurbation Zone (ZCQ) based on an origin-destination survey. **Results:** the patterns, motives and preferences in the existing means of transportation were found; in this respect, income is a significant factor in the choice of means of transportation. **Conclusion:** the correlation between urban spatial structure and transportation is reflected in travel time and travel distance. A major deterrent for car users is the travel time by public transport.
Title: Analysis and proposal of sustainable urban mobility: Accessibility to the cultural heritage of the city of Guanajuato **Authors:** Colmenero, F. and Cruz, A. (2020).	**Objective:** analyze the restructuring of public transportation in the city of Guanajuato. **Results:** the Urban Sustainability Index (ISU) should be carried out to understand as a degree reached by the city to maintain the balance of all systems present in urban life. **Conclusion:** urban mobility allows the improvement and development of infrastructure with a set of economically profitable actions, and proposes that short and medium-term actions contribute to a long-term vision and strategy.

Title: Analysis of accessibility from collection and delivery points: Towards the sustainability of the e-commerce delivery **Authors:** Kelli, L., Magalhães, R., Muzzi, L., Caliari, I. and Leite, C. (2019).	**Objective:** analyze the accessibility of pick-up and delivery points located in commercial establishments (drugstores, gas stations, post offices, supermarkets and malls) considered most attractive by e-consumers to receive this delivery solution. **Results:** there are differences in accessibility levels between collection and delivery points, highlighting the important associations between economic activities, land use patterns and transportation for planning sustainable cities. **Conclusion:** Pick-up and delivery points is an alternative to reduce externalities and cost overruns for companies with recurring home delivery failures, moreover, a large number of home deliveries means more freight traffic and therefore more pollution and congestion.
Title: Are Brazilian cities ready to develop an efficient urban freight mobility plan? **Authors:** Dias, J., Sobanski, G., Ramos, J., Kelli, L. and Vidal, J. (2018).	**Objective:** determine whether Brazilian cities are ready to design an urban mobility plan for the distribution of goods. **Results:** "restrictions" are the solutions most adopted by Brazilian authorities, including the representative sample of cities in the state of São Paulo with more than 250,000 inhabitants. **Conclusions:** Brazilian cities are not prepared to develop an efficient urban transportation plan, as public managers seem to be unaware of the urban logistics demands within their cities or have neglected aspects related to urban freight transportation.
Title: Comportamientos logísticos en la distribución de última milla de productos alimenticios en Villavicencio, Colombia **Authors:** Adarme, W., Arango, M. and Cárdenas, I. (2014).	**Objective:** the main trends and behavior of household purchases, specifically in the purchase of food, through the use of primary sources of information and statistical tools. **Results:** At the strategic level, the need was identified to design facilities such as logistics platforms and urban consolidation centers and tactical/operational facilities such as vehicle restrictions, parking and coordination mechanisms. **Conclusion:** there are trends related to the place of purchase with respect to the type of products purchased, the vehicle used to make the purchase and its frequency.
Title: Desafíos para la movilidad de carga en zonas de alta congestión **Authors:** Merchán, D. and Blanco, E. (2016).	**Objective:** analyze the challenges of freight mobility, with a particular focus on high-density and congested areas. **Results:** There is a gap in urban planning with respect to freight transportation and a methodology, based on

	metrics and data visualization tools, is introduced to support decision-making processes at the public policy level. **Conclusion:** it is essential to ensure the articulation of the needs and challenges of the urban logistics system in the city's comprehensive mobility plans, as one of the pillars of the transportation system, such as Santiago de Chile or Mexico City.
Title: Distribution in Large Urban Centers: Mobility Disabilities Generating Complex Logistics **Authors:** Alves, K. and Silveira, R. (2018).	**Objective:** analyze how the literature has addressed the impact of deficiencies in urban mobility on logistics capabilities. **Results:** The deficiencies in urban mobility have led to the dispersion of economic activities throughout the environment, which implies an increase in the fleet of small vehicles. **Conclusion:** these urban mobility challenges are the result of the lack of planning in large Brazilian cities and insufficient resources.
Title: El capital de la movilidad urbana cotidiana: motilidad en la periferia de Lima Metropolitana **Author:** Regalado, G. (2020)	**Objective:** study the social practices of travel and their direct relationship with the motility capital held by an individual, which allows him to exercise his itinerant *habitus*. **Results:** the population of the area, on a daily basis, basically moves around in search of economic sustenance; they develop informal commerce in inadequate urban spaces, but conveniently located next to formal businesses, and focus on the sale of basic necessities and second-hand products, especially clothing. **Conclusion:** adequate conditions of accessibility to the immediate urban environment and to urban mobility networks, as well as the presence of skills or competencies in a better state of development, would grant a greater capacity for action and would provide a state of appropriation with greater autonomy that would allow for movements with total freedom, convenience, safety, comfort and speed.
Title: Factores logísticos que inciden en el aumento de la competitividad de las PyMES: una revisión de literatura **Authors:** Bailón, T., Romero, R., Alvarado, A., Romero, J. and Guerrero, J. (2015).	**Objective:** identify the Logistics Management Models and their factors that contribute to the increased competitiveness of SMEs. **Results:** Within the conceptualization of urban mobility, we can understand that it refers to the movements made by people regardless of the type of transportation, as well as urban logistics as the location of warehouses, surveillance systems and market control, policies and

	efficient storage to achieve an efficient distribution. **Conclusion:** The use of the SCOR (Supply Chain Council of North America) model is recommended as a reference for the logistics models used by SMEs.
Title: La movilidad urbana: Dimensiones y desafíos **Author:** Cruz, F. (2018).	**Objective:** present, from a theoretical and applied perspective, urban mobility, taking into account metropolitan development, sustainability and management. **Results:** the clear need to strengthen a Metropolitan Mobility and Transportation Information System was highlighted and explains the need to understand the effects of information and communication technologies. **Conclusion:** it is essential to articulate local transportation in peripheral areas with metropolitan systems and encourage the generation of local labor markets that help reduce the number of long trips for work purposes.
Title: Modelos logísticos aplicados en la Distribución Urbana de Mercancías. **Authors:** Arango, M., Gómez, C., & Serna, C. (2017).	**Objective:** Classify the logistics models that have been developed to solve the problems of integration, coordination, sustainability and mobility that arise in the urban distribution of goods (DUM). **Results:** Due to population growth and increased traffic congestion in large cities, the search for improvement and optimization of processes in the distribution systems of goods and services in urban areas has increased in recent years. **Conclusion:** The problems of urban distribution of goods can be divided into four categories: integration, coordination, mobility and sustainability. The first two have a direct impact on the main stakeholders and solutions are sought to improve their performance, while the other two have an impact on the community at large.
Title: Logística Empresarial En Empresas De Producción, Comercialización Y De Servicios En Portoviejo **Author:** Verduga, A. (2014).	**Objective:** know the organizational culture, the processes of logistics for companies and the wireless technology they implement in terms of operations, and their strategies to achieve effectiveness in logistics processes. **Results:** the supply chain must be understood as a network of links that cannot be separated into production criteria and then distributed to the final consumer. **Conclusion:** urban mobility and logistics platforms impact the growth of global and regional channels, accelerated technological

	innovation, integrated logistics and organizational speed.
Title: Logística urbana e planejamento territorial: Uma abordagem política **Authors:** De Oliveira, F. and Rodrigues, W. (2016).	**Objective:** analyze the concept of urban logistics from a geographic and business perspective, understanding its performance and limitations. **Results:** the complexity and high competitiveness of distribution services that cause serious problems of accessibility to the city space and its urban activities (work, leisure, shopping, etc.), noise pollution, accidents, stress, among others. **Conclusion:** the situation of urban logistics in Brazilian cities is far from the concept of Supply Chain Management or even from the requirements of a City Logistics, urban centers are focused on solving problems that hinder the operation of public and private transportation of people.
Title: Mobilidade urbana: Um desafio paulistano **Author:** Wilem, J. (2013).	**Objective:** describe urban mobility and its relationship with the distribution of goods in Sao Paulo. **Results:** The breadth of the urban mobility issue, as well as the complexity of the issues involved, define the problem as crucial within city planning. **Conclusion:** In the absence of adequate urban mobility planning and the establishment of logistics platforms, in the last ten years there has been an increase of 872 vehicles per day, the growth of this vehicle fleet is parallel to the increase in traffic jams in the city, the second most important indicator being the presence of 234,803 trucks in Sao Paulo.
Title: Modelo de gestión logística para pequeñas y medianas empresas en México **Authors:** Cano, P., Orue, F., Martínez, J., Mayett, Y. & López, G. (2015).	**Objective:** describe a logistics management model for small and medium-sized companies in Mexico. **Results:** Logistics activities are the driving force for new investments in infrastructure, so integrated logistics platforms are a way of linking supply and demand at the corporate and national levels. **Conclusion:** Taking this model as a reference could allow managers of small and medium-sized companies in Mexico to improve the logistics performance of the supply chain, as well as to improve their competitiveness and face the challenges of urban mobility that they may face.
Title: Planteamientos Estratégicos para la Logística Urbana: Perspectiva de la	**Objective:** describe the results obtained in the forum Impact of research on urban logistics: perspective of the University-State-Business

Relación Universidad-Estado-Empresa. **Authors:** Suero, F., Orozco, E. & Meza, K. (2013).	relationship. **Results:** we suggest the main and most used strategies that have been effective in recent years, and some that could be effective in the future, such as: Crossdocking, synchronization, creation of distribution centers, ICT, vehicle routing, among others in intermediate cities. **Conclusion:** the problems present in urban logistics are not linked to a universal solution, but require a set of closely related strategies to address the issues.
Title: Plataformas Logísticas: uma abordagem sobre as tipologias e características através de uma revisão sistemática. **Authors:** Silva, R., Pereira, E., Dos Santos, L. & Lima, O. (2014).	**Objective:** analyze the main typologies and characteristics of logistics platforms in Brazilian cities. **Results:** the use of logistics platforms emerges as an alternative in the face of contemporary challenges, where a logistics redesign is necessary to meet the demands and the transposition of current restrictions imposed on the distribution of products in urban centers. **Conclusion:** Organizations are faced with the need to adapt quickly to changes, whether these are related to their supply channels or even their distribution networks.
Title: Políticas públicas en logística urbana. Construcción colectiva de lineamientos para la logística de Bogotá-Colombia. **Authors:** Rojas, L., Castrellón, J., & Adarme, W. (2018).	**Objective:** present the methodology used to define the guidelines for the Bogotá D.C. district urban logistics system. **Results:** the coordination of the flow of products, information, energy, money, not only within the city, but also in the surrounding region, generated by regional, national and international trade, whose impacts are directly reflected in the productivity, economic development and mobility of the city. **Conclusion:** public policies towards the promotion of specialized logistics services must contemplate integral solutions around the mobility of products and people, habitability and sustainability.
Title: Retos actuales de la logística y la cadena de suministro **Authors:** Sánchez, Y., Pérez, J., Sangroni, N., Cruz, C., & Medina, Y. (2021).	**Objective:** analyze the challenges of logistics and the supply chain post Covid-19. **Results:** Supply chains in recent decades have been characterized by massive globalization, worldwide sourcing and the configuration of increasingly complex supply networks. This has given companies competitive advantages by reducing manufacturing costs by benefiting from the resources, skills and talents that each part of the world has to offer (supply, manufacturing,

	design), but it has also created a global interdependence that poses many challenges for the future. **Conclusion:** logistics as a management activity of operations with resources, their organization and optimization in terms of customer welfare has taken a leading role at this stage, which requires innovative solutions in this area to maintain the high level of service provided and perceived to customers.
Title: Transporte urbano y movilidad, hacia una dinámica urbana sustentable y competitiva. **Authors:** Jiménez, J., De Hoyos, J. & Álvarez, A. (2014).	**Objective:** study the relationships between urban transport, as an object of study, and land uses, as the system of spaces adapted for urban activities. **Results:** the relationship schemes between activities and individuals have undergone quantitative and qualitative changes in which telecommunications and information technology modify spatial relationships and imprint a new dynamic on the functioning of the city. **Conclusion:** globalization has imposed new logics for the occupation of space in cities; the search for better schemes to revitalize depressed areas in order to maintain urban spaces in competitive and profitable conditions has led the State to relax regulations on land use and thus encourage the renovation of productive spaces.

Note. Table 5 presents the main findings made by the authors of the 22 scientific articles of the systematic review of the literature (Own elaboration, 2021).

Discussion and Conclusions

Discussion

Fernández (2021) details that urban mobility is defined as the movement of people in order to obtain a good or service. In addition, it defines that the factors with the greatest influence on urban mobility are location and service dependence. In his research, the author observed that people in the intermediate city of Encarnación in Paraguay, South America, make longer trips and frequently use vehicles, which in addition to causing vehicle congestion also contributes to environmental pollution.

In this scientific article we understand the importance of the environmental impact generated in urban mobility from congestion and vehicular traffic, it also places us in a rational scenario to understand that people develop longer trips according to the obligation of their needs, then, it is understood deductively that the use of the vehicle fleet in society is proportionally direct to the distance of the trips made.

Regalado (2016) in his scientific article addresses the study of mobility and sustainable urban logistics in the intermediate city of Huancayo, Peru, in South America, for which he highlights that, Businesses should seek economic feasibility through the adoption of sustainable urban logistics solutions. Therefore, by applying this idea to human movement and the distribution of goods, we seek to alleviate the problem faced by the logistics chain, which is the congestion of private and public transportation.

It is understood in this scientific article that the commercial logistics chain of the companies sees its operational capacity diminished when faced with traffic and congestion of public and private transport, so we could infer that the author recommends that the transport and distribution of goods should enjoy exclusive urban sections for transit, parking, loading and unloading of their products.

Obregón and Betanzo (2015) developed their research in the intermediate city of Santiago de Querétaro, Mexico, where they found that it is congested with vehicular traffic due to the constant mobilization of people who choose to use their cars rather than public transportation, identifying that, the demand driven by the private vehicle makes necessary a greater road capacity, which affects the sustainability of cities in terms of mobility and environmental quality.

As in the previous scientific article, the authors identified that one of the factors that prevent intermediate cities from enjoying balanced and satisfactory urban mobility is vehicular congestion caused by private transportation -in this case- but it can be assumed that public transportation also has an impact on the congestion of vehicular traffic routes. We can understand that congestion and vehicular traffic are factors that directly attack, theoretically, the concept of efficient urban mobility and, practically, the distribution of goods, which is an important activity within the framework of logistics operations.

Dias et al. (2018) in their research on the ability to implement a mobility and urban logistics plan in Brazilian cities in South America, define that, the application of restrictions on vehicular traffic routes are the measures most adopted by the authorities in Brazilian cities, however, defines that Brazilian cities are not prepared for the implementation of a mobility and urban logistics plan because the competent authorities of these decisions are unaware of the demands of urban logistics in their cities.

From this research we can understand that, despite the fact that Brazil is one of the most influential countries in the South American region, it has not been able to implement an adequate urban mobility and logistics management because it is unaware of the capacities that should be taken advantage of in the intermediate cities it possesses, which allows us to highlight the importance that a good urban mobility and logistics planning is accompanied by the real identification of the potentials and needs of the intermediate cities.

Rojas et al. (2018) identified that, the creation of public policies for the city's freight logistics was a complicated challenge that required the participation and analysis of all stakeholders, which involved the management of a large amount of data. The results from the perspective of various stakeholders show that logistics is crucial for the planning and sustainable development of urban areas, which have traditionally been governed by passenger transport plans without including or harmonizing freight transport.

This scientific article shows that the creation of a logistics platform not only seeks to improve land use planning, but also to generate added value to the supply chain, and could improve the quality of life of the people living in the vicinity of the logistics platform, which would provide them with a wide range of goods and services without having to travel to a metropolis to purchase them.

Silva et al. (2014) explain in their research that logistics platforms are an alternative for the current challenges of the logistics chain in which a logistics redesign is needed to be able to achieve the satisfaction of the demand and the overcoming of some restrictions, a logistics platform is able to respond dynamically and efficiently to the different levels of the supply chain, highlights the importance of the creation of logistics platforms as means that allow the improvement of the quality of life of its hinterland.

This scientific article presents certain similarities with the previous scientific article by highlighting that a logistics platform becomes a dynamic tool that allows companies to exploit

their resources to the maximum in the optimization of the logistics chain and that people within a close radius of access to the logistics platform can enjoy quality goods and services.

Jiménez, De Hoyos and Álvarez (2014) in their scientific article establish that, through an adequate study and reformulation of the urban mobility system in cities, it is possible to take advantage of the new logics of occupation of cities imposed by the advance of globalization, this purpose seeks to achieve that, depressed urban areas can become strategic nodes before the adequate exploitation of spaces.

These scopes have shown that the concept used to describe depressed urban areas is used to refer to rural areas, specifically, agrarian areas, technologically backward, subjected to a constant loss of resources, which have been drained by other more developed, industrialized and urban areas in their geography.

Conclusions

It was learned that urban mobility in the intermediate cities of the Americas in the last 10 years has been applied mostly as restrictions on vehicular traffic lanes that limit public and private transportation with the purpose of favoring agile displacement as has been seen in the cases explained in Santiago de Querétaro, La Serena and Sao Paulo; it was learned that one of the aggravating factors in the lack of an adequate urban mobility index is the congestion and vehicular traffic that prevents adequate transit to meet the needs of people who are involved in a moderately long trip to obtain goods or services.

It was learned that the concept of logistics platform does not only include a strictly functional dimension of the business area, in fact, its variety of dimensions makes it dynamic, adopting different forms depending on the configuration of these dimensions such as its functionality with respect to land use planning and the improvement of goods and services that it can make available to its hinterland through the reduction of negative externalities to promote an attractive investment mechanism.

The trend in the intermediate cities of the Americas in the last 10 years has been to seek the development of logistics platforms that serve as a specialized area with the necessary infrastructure and services to achieve trade efficiency and generate added value, with the purpose of reducing the high cost and pollution of the last mile, which is a process of the logistics chain; the main objective of the application of urban mobility and logistics platforms is sustainable development, therefore, research has been developed in intermediate cities because they could address the daily problems of metropolises, such as noise, pollution and costs generated.

References

Apellido, A. A., Apellido, B. B, y Apellido, C. C. (Fecha). Título del artículo. *Nombre de la revista*, *volumen*(número), pp-pp. Adarme, W., Arango, M. y Cárdenas, I. (2014). Comportamientos logísticos en la distribución de última milla de productos alimenticios en Villavicencio, Colombia. *Revista EIA*, *11*(21), pp. 145–166. https://doi.org/10.24050/reia.v11i21.627

Arango, M., Gómez, C. y Serna, C. (2017). Modelos logísticos aplicados en la Distribución Urbana de Mercancías. *Revista EIA, 14*(28), pp. 57-76. Retrieved from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S1794-12372017000200057

Cano, P., Orue, F., Martínez, J., Mayett, Y. y López, G. (2015). Modelo de gestión logística para pequeñas y medianas empresas en México. *Contaduría y Administración, 60*(601), pp. 181–203. Retrieved from https://www.redalyc.org/pdf/395/39533059008.pdf

Cruz, F. (2018). La movilidad urbana: Dimensiones y desafíos. *Eure, 44*(133), pp. 277–281. https://doi.org/10.4067/s0250-71612018000300277

De Oliveira, F. y Rodrigues, W. (2016). Logística urbana e planejamento territorial: Uma abordagem política. *Revista Geográfica de América Central, 1*(56), pp. 39–54. Retrieved from https://www.redalyc.org/pdf/4517/451746028002.pdf

Dias, J., Sobanski, G., Azevedo, J., De Oliveira, L. y Vidal, J. (2018). Are Brazilian cities ready to develop an efficient urban freight mobility plan? *Urbe, 10*(3), pp. 587–599. https://doi.org/10.1590/2175-3369.010.003.AO07

Fernández, A. (2021). Movilidad urbana de la población en la ciudad de Encarnación Paraguay. Desarrollo urbano y gestión ambiental. *Revista de Arquitectura, 23*(1), pp. 34–42. https://doi.org/10.14718/revarq.2021.2286

Fernández-Villacañas, M. (2018). Las plataformas logísticas 4.0 y la mejora del comercio global: Creando ventaja competitiva logística y desarrollo sostenible. https://doi.org/10.13140/RG.2.2.14709.29923

Fonseca, F. y Ramírez, A. (2020). Analysis and proposal of sustainable urban mobility: Accessibility to the cultural heritage of the city of Guanajuato; *Gto. Vitruvio, 5*(1), pp. 17–35. https://doi.org/10.4995/vitruvio-ijats.2020.13254

Freitas, K. y Martins, R. (2018). Distribution in Large Urban Centers: Mobility Disabilities Generating Complex Logistics. *Revista de Administração de Roraima - RARR, 8*(1), p. 171. https://doi.org/10.18227/2237-8057rarr.v8i1.4734

Idalí, T., García, B., López, R. e Iniesta, A. (2016). Factores logísticos que inciden en el aumento de la competitividad de las PyMES: una revisión de literatura. *Cultura Científica y Tecnológica, 12*(56), pp. 216-225. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=7132236

Jiménez, J., De Hoyos, J. y Álvarez, A. (2014). Transporte urbano y movilidad, hacia una dinámica urbana sustentable y competitiva. *Quivera, 16*, pp. 39–53. Retrieved from https://www.redalyc.org/pdf/401/40132130003.pdf

Llop, J., Iglesias, B., Vargas, R. y Blanc, F. (2019). Las ciudades intermedias: concepto y dimensiones. *Ciudades, 22*, pp. 23–43. https://doi.org/10.24197/ciudades.22.2019.23-43

Merchán, D., & Blanco, E. (2016). Desafíos para la movilidad de carga en zonas de alta congestión. *Economía Industrial*, (400), pp. 13–19. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=5687068

Obregón, S. y Betanzo, E. (2015). Análisis de la movilidad urbana de una ciudad media mexicana, caso de estudio: Santiago de Querétaro. *Economía Sociedad y Territorio, 15*(47), 61–98. Retrieved from https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-84212015000100004

Oliveira, L., Oliverira, R., Magalhaes, L., Tavares, C., Ian, P., y Nascimento, C. (2019). Analysis of accessibility from collection and delivery points: Towards the sustainability of the e-commerce delivery. *Urbe, 11*. https://doi.org/10.1590/2175-3369.011.e20190048

Regalado, G. (2016). Movilidad y Logística Urbana Sostenible: Caso Huancayo. *Conferencia del Foro Movilidad Urbana*. Retrieved from https://www.researchgate.net/publication/311965854_MOVILIDAD_Y_LOGISTICA_URBANA_CASO_HUANCAYO

Regalado, G. (2020). El capital de la movilidad urbana cotidiana: motilidad en la periferia de Lima Metropolitana. *Revista de Arquitectura (Bogotá), 22*(1), pp. 67–81. Retrieved from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S1657-03082020000100067

Rojas, L., Castrellón, J. y Adarme, W. (2018). Políticas públicas en logística urbana. Construcción colectiva de lineamientos para la logística de Bogotá-Colombia. *Ingeniería, Investigación y Tecnología, 19*(2), pp. 159–169. https://doi.org/http://dx.doi.org/10.22201/fi.25940732e.2018.19n2.014

Salazar, I. (2012). *Ciudad logística y plataformas logísticas urbanas*. [Tesis de Pregrado, Pontificia Universidad Javeriana]. Retrieved from https://repository.javeriana.edu.co/bitstream/handle/10554/18239/SalazarAranzazuIrene2012.pdf?sequence=3&isAllowed=y

Sánchez, Y., Pérez, J., Sangroni, N., Cruz, C. y Medina, Y. (2021). Retos actuales de la logística y la cadena de suministro. *Ingeniería Industrial, 42*(1), pp. 1-12. Retrieved from http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1815-59362021000100169

Silva, R., Pereira, E., Dos Santos, L. y Lima, O. (2014). Plataformas Logísticas: uma abordagem sobre as tipologias e características através de uma revisão sistemática. *Journal of Transport Literature, 8*(1), pp. 210–234. https://doi.org/10.1590/s2238-10312014000100010

Suero, F., Orozco, E. & Meza, K. (2013). Planteamientos Estratégicos para la Logística Urbana: Perspectiva de la Relación Universidad-Estado-Empresa. *Ingeniare*, (15), pp. 133-141. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=5980479

Verduga, A. (2014). Logística Empresarial En Empresas De Producción, Comercialización Y De Servicios En Portoviejo Logistics Business Enterprises in Production, Marketing and Services in Portoviejo. *ECA Sinergía, 5*, pp. 1–8. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=6197595

Wilheim, J. (2013). Mobilidade urbana: Um desafio paulistano. *Estudos Avancados, 27*(79), pp. 7–26. https://doi.org/10.1590/S0103-40142013000300000

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OBTAINING FLOUR FROM COFFEE WASTE FOR HUMAN CONSUMPTION
Obtención de harina a partir de desechos de café para consumo humano

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ABSTRACT

The drying of the coffee fruit is carried out as one of the previous activities to obtain the coffee bean, which is later used in different drinks. In this study, two alternative drying processes have been applied, and it has been evaluated if the amount of by-product obtained is significantly affected in order to elaborate a flour. The methodology consisted in obtaining the material that surrounds the coffee seed and drying through two different drying processes, which were: 1) Obtaining the pulp, with a manual pulper and then drying it in the sun and 2) Coffee dried directly by the sun and then pass it through a thresher.
Each experiment consisted of pulping 14 print runs of 115 pounds each; (leaving out 140 pounds of coffee that were delivered, but not taken into account in the statistical analysis, due to the difficulty of going down to the farms and taking measurements (statistically missing values); the data was recorded and tabulated to perform a t test comparison between independent samples. The research found that there is a statistical difference between the two drying processes since 2.66 pounds more are obtained than the process in which the coffee is first dried and then the pulp is obtained by threshing.

Palabras clave:
Pulpa, despulpado manual, trillado, harina, secado.

RESUMEN

El secado del fruto del cafeto se realiza como una de las actividades previas para obtener el grano de café que luego se utiliza en diferentes preparaciones. En este trabajo se han utilizado dos procesos alternativos de secado, y evaluado si la cantidad de subproducto obtenida se ve significativamente afectada para luego elaborar una harina. La metodología utilizada consistió en obtener el material que envuelve a la semilla del café y hacer el secado utilizando dos procesos de secado los cuales fueron: 1) Obtención de la pulpa, con una despulpadora manual para luego secarla al sol y 2) Café secado al sol para luego pasarla por una trilladora. Cada experimento consistió en el despulpado de 14 tirajes de 115 libras cada uno; (dejando por fuera 140 libras de café que fueron entregados, pero no tomados en cuenta en el análisis estadístico, por dificultad de bajar a las fincas y tomar mediciones (valores perdidos

	estadísticamente) los datos fueron registrados y tabulados para realizar una prueba *t* de comparación entre muestras independientes. La investigación encontró que existe diferencia estadística entre los dos procesos de secado ya que se obtienen 2.66 libras más que el proceso en que primero se seca el café y luego se obtiene la pulpa por trillado.

Introduction

It includes the presentation of the paper and the analysis of the literature on the subject, with special emphasis on previous research that justifies the study and that will then be contrasted in the discussion of the results.

All text is in 12-point Cambria font, single-spaced and with no spacing between paragraphs.

The present investigation attempts to compare the impact that two different drying methods have on the amount of pulp obtained after its separation from the coffee bean.

The yield of this process is important when considering the pulp, not as a disposable by-product, but as an input to extend the coffee production chain. In this case, by becoming raw material for the production of a flour suitable for human consumption.

Academic research and initiatives aimed at taking advantage of the by-product in question have been varied in the recent past; since, as has been demonstrated, achieving its objective implies reducing harmful impacts on ecosystems and generating income for economic actors who potentially perceive this activity as a source of profits.

The coffee bush is a shrub whose seed is ground and roasted to obtain a powder that serves as the base for the popular beverage known as coffee. Both the cultivation, harvesting and processing involved in the production chain have become a central activity for many companies and families, to the point that the economy of several countries is influenced by the commercial transactions that revolve around coffee. In view of the above, it is necessary to identify opportunities for improvement in all processing activities (Pérez et al., 2022), and to try to extend the production chain in order to minimize losses and waste.

There are several characteristics to take into account in the cultivation of coffee

Depending on the altitude at which it is grown, it can be classified as follows

- Lowland coffee between 400 and 800 meters above sea level (m.a.s.l.); Huizúcar coffee in the Department of La Libertad, like the one used for this research, is cultivated at 640 meters above sea level (m.a.s.l.).
- Average coffee from 800 to 1200 m.a.s.l.; coffee from the municipality of Jayaque in the Department of La Libertad, like the one used for this research, is cultivated at 998 m.a.s.l.
- High altitude coffee is grown from 1200 to 1600 meters above sea level

There are coffee plantations exposed directly to the sun that develop fruits with low weight and, therefore, low relative yields in comparison to those obtained in plantations under the shade of other trees that protect the coffee plants from the elements manifested in direct solar radiation, strong winds, copious rainfall, and high temperatures. On the other hand, producing under shade improves the landscape and biodiversity characteristic of complementary crops, among others:

- Agroforestry systems, which due to the diversity of woody species capture high levels of carbon in the plant biomass, helping to reduce negative environmental impacts caused by pollution and inadequate exploitation of natural resources; thus, coffee cultivation contributes to the sustainability of ecosystems (Valdés et al., 2023).
- Transient shading such as those formed by leguminous species, which are associated with nitrogen-fixing bacteria (Pérez et al., 2021), are good alternatives to conserve moisture and prevent soil degradation.

- Fruit plantations that are usually associated with coffee trees. Production systems are dominated by avocado (Persea americana), citrus (Citrus spp.), coconut (Cocos nucifera), chontaduro (Bactris gasipaes), guaba (Isonga edulis), papaya (Carica papaya) and pineapple (Ananas comosus). (Vargas et al., 2018)

Coffee fruit is classified as non-climacteric, as it does not ripen after being harvested (Martínez et al., 2017)

Once harvested, it is dried, roasted and ground to produce coffee powder.

As regards drying, two alternative processes are generally applied: one using mechanical dryers and the other using solar heat. The artisanal method consists of spreading the grain to be exposed to the sun using soil, cement patios, or plastic film (Medina et al., 2016)

After drying, as mentioned above, the grain is roasted and milled, a process that, once completed, yields an average of 60% of the grain. The 40% surplus is constituted by pulp: organic waste that being understood as a by-product is generally not taken advantage of, and whose management entails environmental impacts (Serna et al., 2018).

The environmental impact of coffee pulping is negative if it is not carried out responsibly. Their careless disposal could affect the edaphic microflora, where acidophilic fungi are the main metabolizers of organic matter (Cervantes et al., 2023).

However, a counterproposal to the simple action of discarding the pulp is to take advantage of its properties to expand the value chain by industrializing it as a raw material for various agroindustrial products. The pulp contains about 86% water, 43.58% of the dry fruit weight, 1.3% caffeine and is rich in carbohydrates, proteins, pectins, bioactive compounds such as polyphenols (Torres et al., 2019).

Various background information on how to use pulp and reduce waste can be found. In 2013, research was conducted on processes for obtaining honey and flour from coffee pulp (Ramírez & Jaramillo, 2013). The researchers set out to take advantage of coffee co-products in the development of raw materials that can be incorporated into the development of other products containing polyphenols, vitamins, proteins, and minerals suitable for human or animal consumption and that can be incorporated into medicines, cosmetics, and ethanol, among others. This was achieved by concentrating and conserving the mucilage to produce honey, and from the pulp they manufactured coffee pulp flour.

This last effort coincides with this research, as it aims to reduce environmental pollution (Ramírez Vélez, 2013) by reducing industrial waste, expanding the boundaries of the production process, and making the most of the coffee plant product whose pulp has bioactive compounds with functional characteristics, which allows its use as a raw material. (Serna et al., 2018)

In this sense, it is intended that the by-products of the coffee process are taken advantage of and can contribute to various social and economic sectors, to the national economy, to the generation of employment, and to the development of new products that contribute to consolidate food security.

Among the products that can be developed is a pulp flour, which is the proposal of this work, and which finds as preceding activities the comparison of two drying-pulping methods.

Drying is a process by which the coffee bean is dehydrated to prevent deterioration and thus preserve its quality during storage (Zactiti et al., 2004; Ventura-Cruz et al., 2019).

During 2019, research was conducted on the Effectiveness of a Coffee Drying Process using solar dryers with continuous air flow system and driven by photovoltaic energy (Prada et al., 2019); this in order to reduce drying time to obtain an average of 12% humidity. What was interesting about this research was that grain moisture was gradually reduced over five days and the usefulness of solar dryers was demonstrated (Prada et al., 2019).

With this background, the methodology used here is developed, followed by an analysis of the drying-pulping processes and their outstanding results.

Method

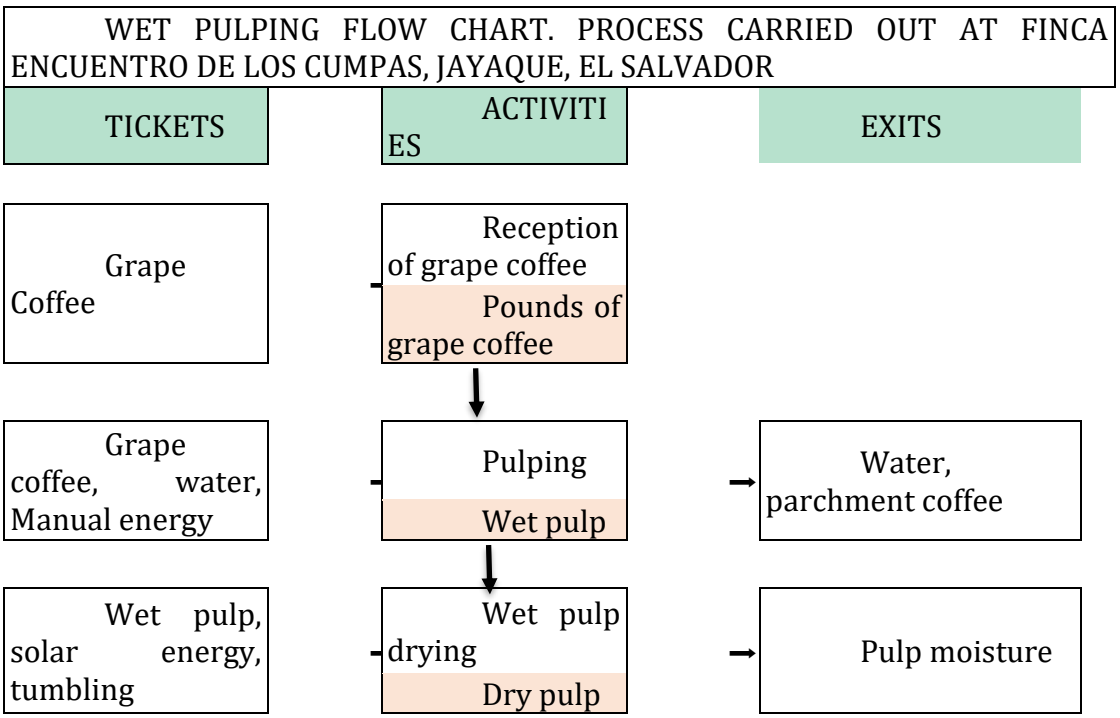
This study was carried out in collaboration with two farms located in the department of La Libertad, El Salvador, where the two drying processes were carried out independently and then compared to determine which one provided the best pulp yield.

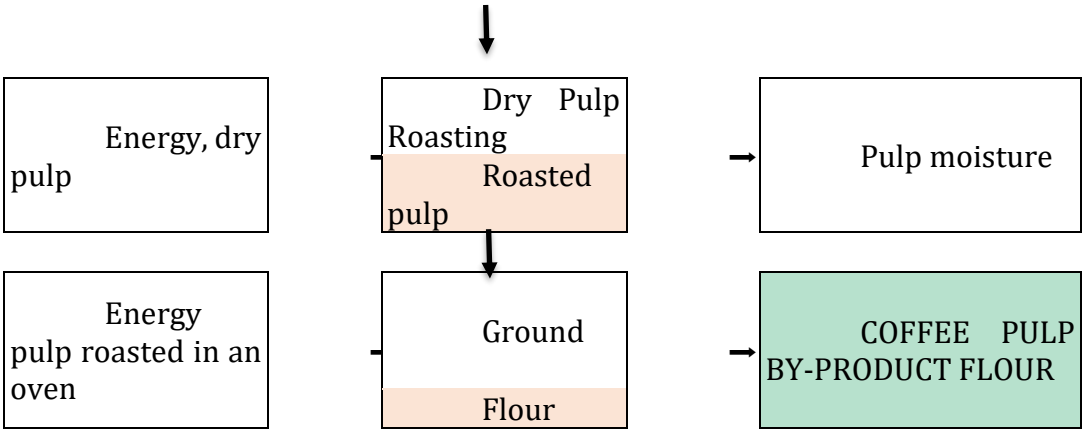
Encuentro de los Cumpas Farm

The farm is located in the municipality of Jayaque, department of La Libertad, at 998 meters above sea level. Where a manual pulper "IDEAL ANTIOQUEÑA" is used to separate the husk of the coffee grapes (pulp) and extract the almonds that are used for the traditional beverage. This equipment is supplied with coffee grapes and water through a hopper, and by manually turning the handle, pressure is exerted that suctions the grain and separates the kernel from the by-product as the inputs pass through the gear. For this research, the by-product (pulp) was collected in sacks and handled to ensure its safety, since it is later used as raw material for a flour suitable for human consumption. The following flow chart is derived from the applied process (Figure 1)

Figure 1

Diagram of the wet pulping process. It is used to separate or remove the shell from the coffee fruit and extract the kernel





Each activity is described with its inputs and outputs. Own elaboration.

The above figure coincides with the sequence shown below:

A total of 1750 pounds of coffee grapes were received, separating it into 15 observations, of which 14 of 115 pounds each were taken, leaving out a lot of 140 pounds; With the wet pulping machine, the grape coffee was processed to separate the bean from its coating.

The pulp is dried in the sun with constant turning for 15 days, generating the dried by-product;

This pulp was transported for medium dark roasting;

Passage through industrial mill;

Flour production.

Figure 2 shows each of the stages of the process, from the cutting of the coffee until the flour is obtained.

Figure 2

From the cutting of the coffee plant and the use of a mechanical pulper to the production of coffee pulp flour

ELABORATION OF FLOUR FROM COFFEE PULP BY-PRODUCT AT EL ENCUENTRO DE LOS CUMPAS JAYAQUE FARM

COFFEE SHORT

In El Salvador, this operation begins in October and usually lasts until May and June of the following year.

At the Encuentro de los Cumpas farm, the maturity of the coffee fruit is determined by the changes in color from green to yellow to crimson red, and by a change in the consistency of the pulp from hard to soft.

At this last stage, the fruit is cut by hand by knowledgeable people who visually determine the right point to remove the fruit from the bush.

OBTAINING GRAPE COFFEE

Grape coffee is understood to be the fruit cut from the coffee bush during harvesting on the farm.

The fruits are harvested in containers, and then transferred to sacks to facilitate transport and handling.

On the farm, the coffee that is harvested is pulped the same day, as they consider that careless piling accelerates fermentation processes that would damage the fruit.

MECHANICAL PULPING

Pulping is carried out by means of a machine that separates the coffee bean (product) from the pulp (by-product); the latter being the input for this research.

This operation consists of extracting the pulp or epicarp from the grain with a machine called a pulper, as described below:

Washing and immersing the grains in water to remove the grains that have little weight (immaturity or damage index).

The grains are fed into the machine, which sucks the grains by means of rollers that will exert mechanical pressure as the pulper cylinder is manually rotated.

Water is added to the hopper, which, by soaking the contents, contributes to the conduction of pulp and coffee.

Finally, whole coffee beans are obtained separated from the pulp. The latter is used as an input in this research, as opposed to the disposable by-product treatment it is generally given.

SUN DRYING OF WET PULP

For the development of this research, we proceeded as follows:

Washing of the pulp, for which a 200 ppm chlorine solution is prepared, obtained from a commercial chlorine at a concentration of 6%, diluting 5 ml per gallon of water.

Rinsing the pulp to remove any residual chlorine

Drained to dry it for the necessary time to lose humidity and taking advantage of the sun as a natural resource.

The parameter that is observed is the color change, which goes from crimson red on day one, and changing to brown (coffee) on day 21.

After a few days, a manual test is carried out to check if the pulp pulverizes easily.

STOVE ROASTING

Oven roasting is a unitary operation that serves:

To finish extracting moisture until a medium dark roast is achieved, which are the characteristics desired for the pulp.

To eliminate biological risks by destroying microorganisms, complying with the time-temperature binomial where baking exceeds 70º C where pathogens are destroyed, being maintained at 250º C for 2 hours.

Ground

Unit operation used to reduce the size of the dry pulp until it is pulverized. This is a fine milling process to obtain flour characterized by its easy mixing with any other type of edible sifted material to make cookies, bread, pasta, among others.

Flour production	Powder resulting from the grinding of dry pulp that can be used for human and/or animal consumption

La Sierra de León Farm

Finca La Sierra de León is located in the municipality of Huizúcar, department of La Libertad, at 640 meters above sea level in El Salvador. In this environment, the drying of the coffee grapes in patios was experimented in order to later be threshed. The process followed the sequence described below:

-1750 pounds of coffee grapes were received, separating it into 15 observations, of which 14 of 115 pounds were taken, leaving out 140 pounds (lost value);

-The grape coffee was dried, for 21 days, directly in the sun until it was transformed into cherry coffee;

-After 21 days, the coffee beans were threshed to separate them from the pulp (by-product) using a threshing machine.

-The pulp obtained by threshing was collected immediately and carefully deposited in clean sacks. Since it is the input for the process being considered, it was handled as raw material: keeping it safe so that the flour does not involve any physical, chemical or biological risk.

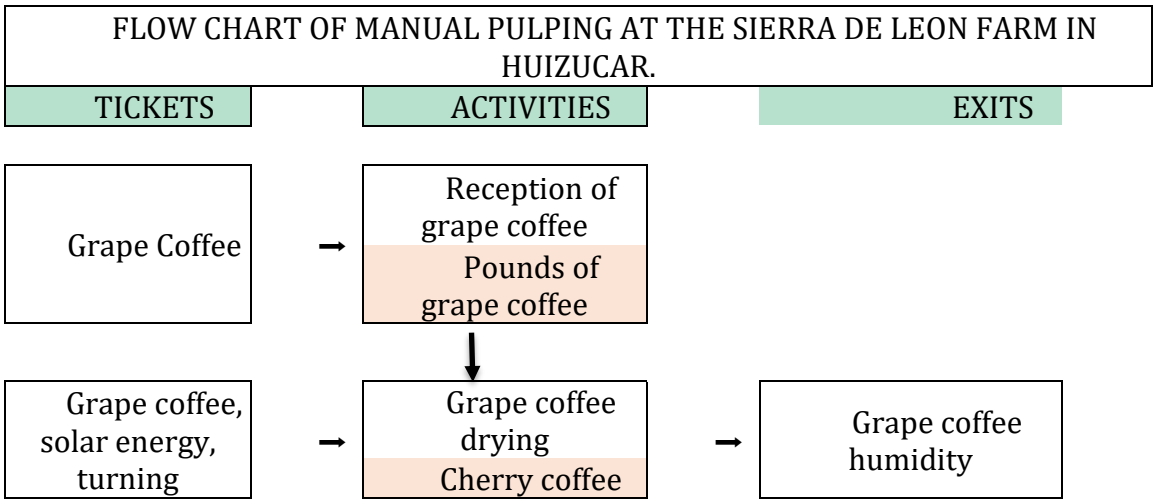
-The bags were transported to the roasting station where the pulp was exposed to heat until a medium dark finish was achieved, which, in addition to facilitating the grinding stage, maintains the caffeine with greater sweetness than a completely dark roast. Temperature is used as a contributor to safety.

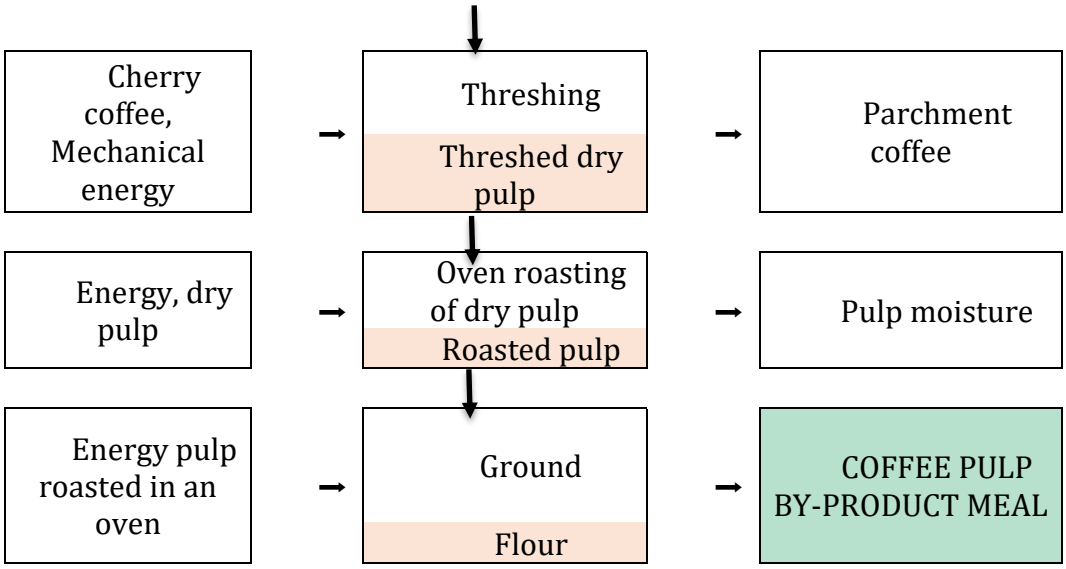
-The roasted pulp was passed through an industrial mill to obtain flour.

Figure 3 shows the flow diagram for pulping by threshing machine.

Figure 3

Flow chart for pulping with threshing machine





Each activity is described with its inputs and outputs. Own elaboration.

In order to facilitate the understanding of the process, Figure 4 is included; in which each of the stages of the process from the cutting of the coffee to the obtaining of the flour are observed.

Figure 4

Processing of flour by-product of coffee drying using a threshing machine

PREPARATION OF FLOUR FROM COFFEE PULP BY-PRODUCT AT THE SIERRA DE LEÓN FARM LOCATED IN HUIZÚCAR

COFFEE SHORT

The coffee is harvested manually, selecting the ripe fruit and leaving the rest for 15 to 30 days;

- The ripe fruits are cut with care not to damage the plant or the delayed harvest;
- The cutting task on this farm is carried out by people trained in the selection of the grain suitable for the subsequent stages.

COFFEE DRYING TO CHERRY

In this method the drying is done directly on the cement; the grain is spread in layers whose thickness is calculated between 3.50 and 3.55 centimeters, stirring constantly from 3 to 5 times per day.

During the night or periods when there is no sun, the deployment is covered with plastic sheeting.

Drying lasts from 10 to 21 days, and 3 aspects are taken into account for testing:

- When a sample is kicked it peels off the shell easily. (pulp is released);
- When bitten, it feels hard;
- The color change on day one is red and yellow grains, until they turn into a dark brown.

The coffee is collected in sacks that are neatly stowed to be transported to the threshing machine

THRESHOLDING

Threshing is the operation in which, after drying, the grain is separated from the dry pulp known as husk.

The final objective of the process is to obtain the grain. This research extends its purpose to processing the by-product (pulp) obtained from threshing.

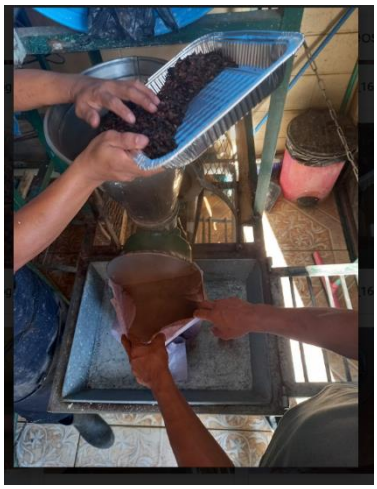
SUBPRODUCT

The by-product is treated as agricultural waste; despite being rich in bioactive compounds such as polyphenols, alkaloids, proteins, chlorogenic acids, dietary fiber, carbohydrates, and antioxidants.

STOVE ROASTING

Stove roasting is carried out until the application of heat allows the pulp to reach a dark brown color.

Ground



The desired finish was achieved in the oven at a temperature of 250º C, for a period of 2 hours.

The grinding operation was carried out in an industrial electric mill.

Finally, it was possible to obtain a flour suitable for human consumption and usable in combination with another food sift.

The flours obtained from the two processes discussed above were exposed to moisture tests on a dry basis in triplicate, using the moisture analyzer programmed with standard drying profile at a temperature of 120°C and in the automatic drying determination mode (mass change per 1 mg/d for 60 s).

The intervening factors were the raw materials and the appropriate equipment to measure humidity; according to detail:

- Experiment 1 samples. Wet pulping process.
- Experiment 2 samples. Process used: Dry pulping during threshing.
- RADWAG® moisture analyzer of the MAC 50/WH series. Laboratory equipment for measuring the relative humidity of samples of different materials.

Procedure

The samples of the different stages of the processes used were arranged in triplicate; they were stored at room temperature in plastic bags to be transported to the point where they would be analyzed.

The moisture content of the samples was determined in triplicate using the RADWAG Analyzer. The equipment was programmed with standard drying profile at 120º C and in automatic determination mode.

Subsequently, the data were recorded in order to obtain their averages.

Results (14 points)

The database generated for the two experiments to collect data were as follows: Table 1 shows a consolidated summary of the results obtained considering the two drying methods.

Table 3

Comparison between the two drying methods used

Place of coffee production	Meeting of the Cumpas	The Sierra de León
Pounds of initial coffee	1610 lbs	1610 lbs
Meters above sea level at which the coffee was harvested.	998 meters above sea level.	640 m.a.s.l.
Pulping method	With machine after cutting	Separated after drying and threshing
Obtaining by-product (pounds of pulp)	685 lbs. wet pulp obtained with pulper	310 pounds of threshing
Dry pounds	350 lbs	310 lbs
% dry by-product	20%	17.71%

Oven-roasted by-product	260 lbs	220 lbs
Flour production	150 lbs	110 lbs

Each of the raw materials in the different activities of the process were characterized according to the milestone to which they correspond, in order to justify drying as a method of conservation and stabilization, since the pulp, being dry, avoids the proliferation of microorganisms, molds and yeasts that would be present in an aqueous environment. The humidity results are presented below.

Humidity results of the jayaque experiment "finca el encuentro de los cumpas"

UVA COFFEE						AVERAGE	
	M1		M2		M3		UNIT
INITIAL WEIGHT	5,644	g	5,347	g	5,936	g	5,64233333	g
FINAL WEIGHT	1,765	g	1,983	g	2,011	g	1,91966667	g
TOTAL TIME	2:18 a.m.	h:min:sec	0:13 a.m.	h:min:sec	2:48 a.m.	h:min:sec	2:14:20 a.m.	h:min:sec
% HUMIDITY WET BASIS	68,728	%	62,913	%	66,121	%	65,92066667	%
% HUMIDITY DRY BASIS	21 9,773	%	16 9,64	%	19 5,176	%	194,863	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

WET LUNG						AVERAGE	
	M1		M2		M3		UNIT
INITIAL WEIGHT	5,904	g	5,001	g	2,604	g	4,503	g
FINAL WEIGHT	1,203	g	1,064	g	0,605	g	0,9573333	g
TOTAL TIME	1:03:36 a.m.	h:min:sec	12:57:49 a.m.	h:min:sec	1:06:03 a.m.	h:min:sec	1:02:29 a.m.	h:min:sec
% HUMIDITY WET BASIS	79,624	%	78,724	%	76,766	%	78,37133333	%
% HUMIDITY DRY BASIS	39 0,773	%	37 0,019	%	33 0,413	%	363,735	%

ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

BY-PRODUCT (PULP DRIED 12 DAYS) WITHOUT STOKER							AVERAGE	
	M1		M2		M3		UNIT	
INITIAL WEIGHT	2,583	g	2,887	g	2,618	g	2,696	g
FINAL WEIGHT	2,409	g	2,682	g	2,441	g	2,5106 66667	g
TOTAL TIME	12:21:25 a.m.	h:min:sec	12:22:05 a.m.	h:min:sec	12:21:20 a.m.	h:min:sec	12:21:37 a.m.	h:min:sec
% HUMIDITY WET BASIS	6,664	%	7,101	%	6,761	%	6,842	%
% HUMIDITY DRY BASIS	7,139	%	7,643	%	7,251	%	7,3443 33333	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

MEDIUM DARK ROASTED BY-PRODUCT							AVERAGE	
	M1		M2		M3		UNIT	
INITIAL WEIGHT	2,195	g	2,217	g	2,597	g	2,3363 33333	g
FINAL WEIGHT	2,169	g	2,186	g	2,562	g	2,3056 66667	g
TOTAL TIME	12:04:03 a.m.	h:min:sec	12:04:50 a.m.	h:min:sec	12:05:10 a.m.	h:min:sec	12:04:41 a.m.	h:min:sec
% HUMIDITY WET BASIS	1,185	%	1,354	%	1,31	%	1,283	%
% HUMIDITY DRY BASIS	1,198	%	1,372	%	1,327	%	1,299	%
ANALYSIS	120	°C	120	°C	120	°C	120	°C

TEMPERATURE									

BY-PRODUCT MEAL							AVERAGE	
	M1		M2		M3		UNIT	
INITIAL WEIGHT	5,073	g	5,061	g	5,194	G	5,1093333	g
FINAL WEIGHT	4,777	g	4,720	g	4,868	G	4,7883333	g
TOTAL TIME	12:20:56 a.m.	h:min:sec	12:19:54 a.m.	h:min:sec	12:21:03 a.m.	h:min:sec	12:20:38 a.m.	h:min:sec
% HUMIDITY WET BASIS	5,835	%	6,737	%	6,276	%	6,2866667	%
% HUMIDITY DRY BASIS	6,196	%	7,224	%	6,697	%	6,7056667	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

Humidity results of the huizucar experiment "finca de léon"

UVA COFFEE							AVERAGE	
	M1		M2		M3		UNIT	
INITIAL WEIGHT	6,310	g	6,300	g	6,109	g	6,2396667	g
FINAL WEIGHT	2,116	g	1,802	g	2,019	g	1,979	g
TOTAL TIME	2:18:23 a.m.	h:min:sec	2:20:16 a.m.	h:min:sec	2:19:54 a.m.	h:min:sec	2:19:31 a.m.	h:min:sec
% HUMIDITY WET BASIS	66,466	%	71,396	%	66,950	%	68,270667	%
% HUMIDITY DRY BASIS	198,204	%	249,611	%	202,575	%	216,79667	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

CHERRY COFFEE 10 DAYS							AVERAGE	
	M1		M2		M3		UNIT	
INITIAL WEIGHT	4,739	g	5,587	g	4,741	g	5,02233333	g
FINAL WEIGHT	4,477	g	5,325	g	4,479	g	4,76033333	g
TOTAL TIME	12:59:05 a.m.	h:min:sec	12:57:56 a.m.	h:min:sec	12:59:03 a.m.	h:min:sec	12:58:41 a.m.	h:min:sec
% HUMIDITY WET BASIS	5,509	%	4,689	%	5,526	%	5,24133333	%
% HUMIDITY DRY BASIS	5,829	%	4,920	%	5,849	%	5,53266667	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

BY-PRODUCT (THRESHED PULP) (WITHOUT STOVE)							AVERAGE	
	M1		M2		**M3**		UNIT	
INITIAL WEIGHT	3,018	g	3,045	g	2,875	g	2,97933333	g
FINAL WEIGHT	2,682	g	2,712	g	2,562	g	2,652	g
TOTAL TIME	12:23:15 a.m.	h:min:sec	12:21:50 a.m.	h:min:sec	12:21:00 a.m.	h:min:sec	12:22:02 a.m.	h:min:sec
% HUMIDITY WET BASIS	11,104	%	10,848	%	10,887	%	10,94633333	%
% HUMIDITY DRY BASIS	12,490	%	12,168	%	12,217	%	12,29166667	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

MEDIUM DARK ROASTED BY-PRODUCT							AVERAGE	
	M1		**M2**		M3		UNIT	
INITIAL WEIGHT	2,858	g	3,096	g	3,090	g	3,01466667	g

FINAL WEIGHT	2,799	g	3,030	g	3,025	g	2,95133333	g
TOTAL TIME	12:07 a.m.	h:min:sec	12:08 a.m.	h:min:sec	12:08 a.m.	h:min:sec	12:08:03 a.m.	h:min:sec
% HUMIDITY WET BASIS	1,996	%	2,132	%	2,072	%	2,06666667	%
% HUMIDITY DRY BASIS	2,036	%	2,178	%	2,115	%	2,10966667	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

	BY-PRODUCT MEAL						AVERAGE	
	M1		M2		M3		UNIT	
INITIAL WEIGHT	5,219	g	5,061	g	5,071	g	5,117	g
FINAL WEIGHT	4,874	g	4,718	g	4,733	g	4,775	g
TOTAL TIME	12:25:10 a.m.	h:min:sec	12:19:50 a.m.	h:min:sec	12:19:25 a.m.	h:min:sec	12:21:28 a.m.	h:min:sec
% HUMIDITY WET BASIS	6,6	%	6,7	%	6,6	%	6,6776	%
% HUMIDITY DRY BASIS	7,1	%	7,2	%	7,1	%	7,1553	%
ANALYSIS TEMPERATURE	120	°C	120	°C	120	°C	120	°C

After studying moisture throughout the process, the quantitative yields in pounds of the two alternative methods were examined. The data were recorded and tabulated in the SPSS® statistical program, version 22, and then a t-test was performed to compare means between independent samples.

Table 1

Experiment 1. Jayaque manual pulper and pulp dryer treatment

ACTIVITIES/COMMENTS	OBSERVATION 1	OBSERVATION 2	OBSERVATION 3	OBSERVATION 4	OBSERVATION 5	OBSERVATION 6	OBSERVATION 7	OBSERVATION 8	OBSERVATION 9	OBSERVATION 10	OBSERVATION 11	OBSERVATION 12	REMARK 13	REMARK 14	REMARK 15	TOTAL POUNDS
UVA COFFEE	115	115	115	115	115	115	115	115	115	115	115	115	115	115	1405	1750
WET PULP BY-PRODUCT	4,960	5,120	5,080	4,910	5,230	5,370	5,140	5,260	5,030	5,100	4,940	5,210	5,060	5,030	3,560	85,000
BY-PRODUCT SUN-DRIED PULP WITHOUT AN OVEN	22,972	23,054	23,034	22,947	23,110	23,182	23,064	23,126	23,008	23,044	22,962	23,102	23,023	23,008	7,366	350,000
BY-PRODUCT KILN DRIED PULP	11,065	11,126	11,111	11,046	11,168	11,221	11,133	11,179	11,092	11,118	11,058	11,160	11,103	11,092	10,329	160,001
FLOUR	9,845	9,880	9,872	9,834	9,904	9,935	9,885	9,911	9,861	9,876	9,841	9,900	9,867	9,861	1,728	150,000

Table 2

Experiment 2. Sun-dried and threshed to obtain pulp

ACTIVITIES/COMMENTS	OBSERVATION 1	OBSERVATION 2	OBSERVATION 3	OBSERVATION 4	OBSERVATION 5	OBSERVATION 6	OBSERVATION 7	OBSERVATION 8	OBSERVATION 9	OBSERVATION 10	OBSERVATION 11	OBSERVATION 12	OBSERVATION 13	OBSERVATION 14	REMARK 15	TOTAL POUNDS
UVA COFFEE	115	115	115	115	115	115	115	115	115	115	115	115	115	115	1405	1750
CHERRY COFFEE (SUNNY PATIOS) IN	42,810	42,620	42,760	42,670	42,800	42,820	42,730	42,670	42,690	42,650	42,710	42,790	42,680	42,770	1,830	650,000

BY-PRODUCT THRESHED PULP WITHOUT STALENESS	2 0,41 7	2 0,32 6	2 0,39 3	2 0,35 0	2 0,41 2	2 0,42 2	2 0,37 9	2 0,35 0	2 0,36 0	2 0,34 1	2 0,36 9	2 0,40 8	2 0,35 5	2 0,39 8	2 4,71 9	3 10,0 00
BY-PRODUCT KILN DRIED PULP	1 4,49 0	1 4,42 5	1 4,47 3	1 4,44 2	1 4,48 6	1 4,49 3	1 4,46 2	1 4,44 2	1 4,44 9	1 4,43 5	1 4,45 6	1 4,48 3	1 4,44 6	1 4,47 6	1 7,54 2	2 20,0 00 1
FLOUR	7 ,245	7 ,213	7 ,236	7 ,221	7 ,243	7 ,246	7 ,231	7 ,221	7 ,224	7 ,218	7 ,228	7 ,241	7 ,223	7 ,238	8 ,771	10,0 00

Table 4

Group Statistics

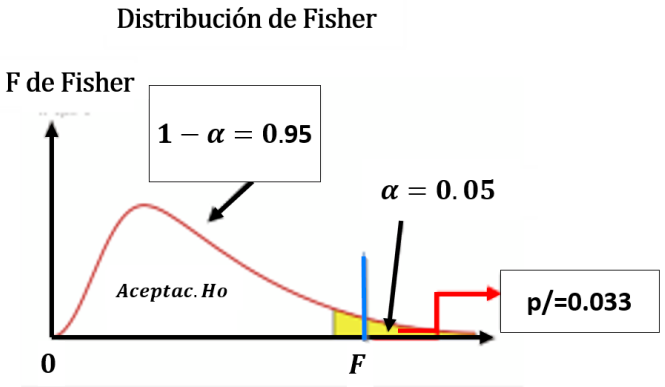
TREATMENT		N	MEDIA	STANDARD DEVIATION	AVERAGE OF STANDARD ERROR
Pulping	Initial pulping (wet)	14	23.0453	.06684	.01786
	Pulping at threshing (dry)	14	20.3772	.03117	.00833

The above table shows that, in pounds, a lower average by-product is obtained by the process in which the pulp is released dry during threshing. The standard deviations indicate that in both processes the observations tend to concentrate around the mean; that is, we have consistent performance in both pulping methods.

1. TEST OF EQUALITY OF VARIANTIES (Levene's test)

Levene's test is an integral part of the battery of results that SPSS produces when running a t-test for comparison of means. The purpose of the test is to determine whether the groups under study have equal variances. It is widely used because many statistical tests use the assumption that groups have equal variances. We start with the following hypothesis:

Ho: Variances of the 2 treatments are equal ($\sigma^2_1 = \sigma^2_2$)
H1: The variances of the two treatments are different. Treatment 1 is more variable than treatment 2 ($\sigma^2_1 > \sigma^2_2$)



As the p-value of the test: p = 0.033 < α = 0.05 , it is observed that it falls in the Rejection zone, therefore the differences observed between the Variances are significant; therefore the null hypothesis of equality in the variances is rejected, since at the given significance level (α = 0.05) the variability of Treatment 1 is greater than that of Treatment 2.

2. TEST OF EQUALITY OF MEANS (Student's t-test)

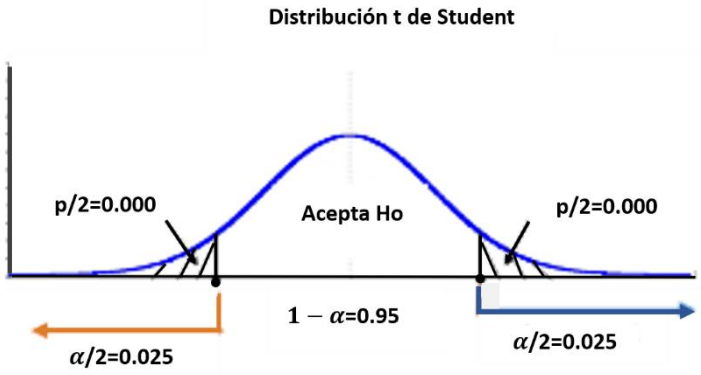
Hypothesis Statement

Ho: The means of the 2 treatments are equal ($\mu_1 = \mu_2$)
H1: Means of the two treatments are different ($\mu_1 \neq \mu_2$)

The data was recorded and processed with SPSS software version 22, obtaining the following results:

INDEPENDENT SAMPLES TEST.

		Levene's test for quality of variances		T-test for equality of means						
									95% confidence interval of the difference	
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia from stockings	Standard error difference	Inferior	Superior
Dried Pulp	The following are assumed variances Equal	5.067	.033	135.35	1 26	.000	2.66804	0.1971	2.62752	2.70855
	Equal variances are not assumed			135.35	18.398	.000	2.66804	0.1971	2.62669	2.70938



The row corresponding to non-equal variances is taken: As the p-value of the test: p = 0.000 < α = 0.05 , falls in the rejection zone, it indicates that the differences observed between the means are significant; that is, there is statistical evidence at the significance level α = 0.05, that the mean μ1 = 23.0453 is greater than μ2 = 20.3772; that is, the difference of 2.668 in favor of Treatment 1 is significant

From these results it can be established:

- Levene's test for equality of variances results in 0.033; therefore, since it is less than the significance value (alpha 0.05), the null hypothesis (Ho) of equality is not accepted, which implies that equal variances between treatments are not assumed.
- Since equal variances are not assumed, the bilateral significance test results in 0.00, which is less than the 0.05 granted to the alpha value; therefore, Ho (equality of means) is not accepted; and the alternative hypothesis (H1) is concluded: difference of means.
- That is, with a 95% confidence interval percentage, and significance at the 0.05 level, the average yield in pounds is different when comparing the result of one drying process versus the other.
- The sun-dried pulp by-product without an oven was on average 2.66 pounds greater for each 115 pound block of coffee subjected to this process with respect to the same amount subjected to the threshed pulp by-product procedure without an oven.

Discussion and Conclusions

The results of this research show that it is technically feasible to produce flour from the pulp of coffee harvested in El Salvador, at different heights, and regardless of the pulping method; although the dry method yields lower pounds. Previous work demonstrated the usefulness of the pulp in the manufacture of honey and a flour of similar characteristics.

Either wet or dry pulping would not require additional investment beyond what is already in place. Eliminating moisture through drying prevents deterioration of the pulp, maintaining its shelf quality as a raw material for a longer period of time than if it is left wet, as it tends to ferment and decompose at an accelerated rate. This has been verified by researchers such as Zactiti in 2004 and Ventura-Cruz in 2019.

Efforts to maintain pulp safety and quality could translate into alternatives to generate economic flows for producers and contribute to food security.

Prada and its associated researchers, in 2019 addressed the effectiveness of solar dryers with continuous airflow system applied to coffee drying, which undoubtedly accelerates the process. However, the traditional way has also shown favorable results. It will be a matter of available technology and market conditions that will tip the balance in favor of one of the two visions.

The awareness of sustainable production needs to be extended to the creation of consumption alternatives that contribute to natural resources and the environment. Torres' research corroborates that the use of coffee pulp reduces environmental impact and highlights the nutritional benefits it contains.

As a result of the work carried out, it was possible to establish the feasibility of making flour from coffee pulp, which is traditionally treated as a by-product that is discarded, and which entails environmental impacts, transportation and disposal costs. Taking advantage of coffee pulp implies an opportunity to expand the production chain, generate profits and food alternatives.

Regarding the amount of pulp obtained, it was found that, with a manual pulper and subsequent sun drying, a higher yield is obtained than with the process in which the coffee is first dried and then the pulp is obtained by threshing. In the case of the present study, 2.66 pounds more sun-dried pulp was obtained per 115-pound block than that obtained by stoving and threshing. The difference in performance is statistically significant.

From the application of the pulping methods, it was observed that the appearance of the flour is independent, i.e., applying one or the other method does not change the appearance and consistency of the flour

References

Garza Lau, Rubén, Maldonado Torres, Ranferi, Álvarez Sánchez, María Edna, & Buendía Espinoza, Julio César. (2020). Aporte nutrimental de especies arbóreas fijadoras de nitrógeno en sistemas agroforestales con café. Revista mexicana de ciencias agrícolas, 11(4), 801-814. Epub 13 de septiembre de 2021.https://doi.org/10.29312/remexca.v11i4.2465

Guevara-Sánchez, Maricely, Bernales del Águila, Carlos Ivan, Saavedra-Ramírez, Jorge, & Owaki-López, Johnny Jakson. (2019). Efecto de la altitud en la calidad del café (Coffea arabica L.): comparación entre secado mecánico y tradicional. Scientia Agropecuaria, 10(4), 505-510. https://dx.doi.org/10.17268/sci.agropecu.2019.04.07

Martínez-González, Mónica Elizabeth, Balois-Morales, Rosendo, Alia-Tejacal, Irán, Cortes-Cruz, Moises Alberto, Palomino-Hermosillo, Yolotzin Apatzingan, & López-Gúzman, Graciela Guadalupe. (2017). Poscosecha de frutos: maduración y cambios bioquímicos. Revista mexicana de ciencias agrícolas, 8(spe19), 4075-4087. https://doi.org/10.29312/remexca.v0i19.674

Medina-Meléndez, José Alfredo, Ruiz-Nájera, Ramiro Eleazar, Gómez-Castañeda, Julio César, Sánchez-Yáñez, Juan Manuel, Gómez-Alfaro, Gabriela, & Pinto-Molina, Omar. (2016). Estudio del sistema de producción de café (Coffea arabica L.) en la región Frailesca, Chiapas. CienciaUAT, 10(2), 33-43. Recuperado en 04 de marzo de 2023, de http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-78582016000100033&lng=es&tlng=es.

Pérez-González, Jairo Roberto, Cárdenas-Cortés, Xiomy Carolina, Ocampo-Arias, Daniela, & Ceballos, Yony Fernando. (2022). Oportunidades de mejora para los procesos de recepción, fabricación y despacho de máquinas despulpadoras de café. Ingeniería, 27(3), e203. Epub November 11, 2022.https://doi.org/10.14483/23448393.18314

Prad, Á., Vela, C. P., Bardález, G., & Saavedra, J. (2019). Efectividad de un Proceso de Secado de Café usando Secadores Solares con Sistema de Flujo de Aire Continuo Impulsado por Energía Fotovoltaica, en la Región San Martín, Perú. Información tecnológica, 30, 85-92.

Ramírez Vélez. (2013). Proceso para la obtención de miel y/o harina de café a partir de la pulpa o cascara y el mucilago del grano de café (Patent N.o A23F 5/02 (2006.01) A23N 12/00 (2006.01)). https://patents.google.com/patent/WO2013088203A1/es.

Serna-Jiménez, Johanna Andrea, Torres-Valenzuela, Laura Sofía, Martínez-Cortínez, Katherine, & Hernández-Sandoval, María Camila. (2018). Aprovechamiento de la pulpa de café como alternativa de valorización de subproductos. Revista ION, 31(1), 37-42. https://doi.org/10.18273/revion.v31n1-2018006

SIFRE, Maria, PERAIRE, Manu, SIMÓ, Delfina, SEGURA, Amparo, SIMÓ, Pepita y TOSCA, Pepita. (2019). La harina. http://bibliotecavirtualsenior.es/investigacion/la-harina/.

Torres-Valenzuela, Laura S., Martínez, Katherine G., Serna-Jimenez, Johanna A., & Hernández, María C.. (2019). Secado de Pulpa de Café: Condiciones de Proceso, Modelación Matemática y Efecto sobre Propiedades Fisicoquímicas. Información tecnológica, 30(2), 189-200. https://dx.doi.org/10.4067/S0718-07642019000200189

Valdés-Velarde, Eduardo, Vázquez-Domínguez, Laura Patrícia, Tinoco-Rueda, Juan Ángel, Sánchez-Hernández, Rufo, Salcedo-Pérez, Eduardo, & Lagunes-Fortiz, Erika. (2022). Servicio ecosistémico de carbono almacenado en cafetales bajo sombra en sistema agroforestal. Revista mexicana de ciencias agrícolas, 13(spe28), 287-297. Epub 13 de enero de 2023.https://doi.org/10.29312/remexca.v13i28.3283

Vargas-Tierras, Yadira Beatriz, Prado-Beltrán, Julia Karina, Nicolalde-Cruz, José Rogelio, Casanoves, Fernando, Virginio-Filho, Elias de Melo, & Viera-Arroyo, William Fernando.

(2018). Characterization and role of Amazonian fruit crops in family farms in the provinces of Sucumbíos and Orellana (Ecuador). Ciencia y Tecnología Agropecuaria, 19(3), 501-515. https://doi.org/10.21930/rcta.vol19_num3_art:812

Cervantes Beyra, Rafael, Castro-Lizazo, Iván, Mesa Pérez, María Aurora, Ocampo Ramírez, Arturo, Fernández Valdés, Daybelis, & Fernández Valdés, Dayvis. (2015). Efecto de la pulpa de Coffea arabica L. sobre la microflora de tres unidades de suelos. Revista de Protección Vegetal, 30(2), 115-122. Recuperado en 19 de marzo de 2023, de http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1010-27522015000200005&lng=es&tlng=es.

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(2024) Environmental Sciences & Practices, 2(2), 89-103.

REDUCTION OF THE ENERGY COST AND ENVIRONMENTAL IMPACT IN THE PROCESS OF ARTIFICIAL AGING OF RICE FROM SOLAR THERMAL ENERGY IN THE COMPANY RICE MOLICAS S.A.C.

Reducción del costo energético y del impacto medioambiental en el proceso de añejado artificial del arroz a partir de energía solar térmica en la empresa Rice Molicas S.A.C.

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ABSTRACT

During the last 20 years, Peruvian rice production has increased by 2.8% annually, increasing the number of rice mills and their energy consumption, generated mostly by fossil fuels. Studies have shown that artificial aging and polishing processes require more electricity. Therefore, the objective of this study was to demonstrate the monetary savings in electricity consumption and the reduction of environmental impact in the artificial aging of rice by developing a proposal based on solar thermal energy in the case of the company Rice Molicas S.A.C. First, the company's current situation was studied through its electricity consumption monetized in soles, and the carbon footprint based on a production batch calculated using a multimeter, the unit price per kWh and using the SEIN conversion factor. Then, the materials and equipment for the design of the proposal were determined, where the referenced articles were consulted and evaluated with the technical specification sheets. The proposal was then simulated in CHEMCAD software version 1.7.5. Finally, the design was validated with a physicist and the simulation with a metallurgical engineer. As a result, savings of 12.11 s/ton of electricity consumption and a reduction of 0.03651 tonCO2eq of the carbon footprint were obtained. This study contributes to the dissemination of the use of environmental resources, it should be noted that the proposal was not chosen for implementation or monetization, and it is possible to develop more efficient designs.

Palabras clave:
energía solar térmica, alternativas de energía, granos de arroz, añejado, energías renovables.

RESUMEN

Durante los últimos 20 años la producción peruana de arroz se ha incrementado un 2.8% anualmente, aumentando así la cantidad de molinos arroceros y su consumo energético, generado mayormente por combustibles fósiles. Estudios demostraron que los procesos de añejado artificial y pulido demandan más electricidad. Por esto, el objetivo de este estudio fue demostrar el ahorro monetario del consumo eléctrico y la disminución del impacto ambiental en el añejado artificial del arroz al desarrollar una propuesta basada en la energía solar térmica en el caso de la empresa Rice Molicas S.A.C. Primero, se estudió la situación actual

de la empresa mediante su consumo eléctrico monetizado en soles, y la huella de carbono en base a un lote de producción calculados mediante el uso de un multímetro, el precio unitario del kWh y utilizando el factor de conversión del SEIN. Luego, se determinó los materiales y equipos para el diseño de la propuesta donde se consultó con los artículos referenciados y fueron evaluados con las fichas de especificaciones técnicas. Después, se simuló la propuesta en el software CHEMCAD versión 1.7.5. Finalmente, se validó el diseño con un físico y la simulación con un ingeniero metalurgista. Como resultado, se obtuvo un ahorro de 12.11 s//ton del consumo eléctrico y una reducción de 0.03651 tonCO_2eq de la huella de carbono. Este estudio contribuye a la difusión del uso de recursos medioambientales, cabe resaltar que no se optó por la implementación ni la monetización de la propuesta, y es posible elaborar diseños más eficientes.

Introduction

In all countries, it is the responsibility of the authorities to ensure the protection of environmental components, including flora, fauna and natural resources, since they are the basis for the production of various goods that drive the national economy, generating jobs and the circulation of currency. In Peru, rice production has increased by an average of 2.8% per year over the last 20 years, leading to a substantial increase in the number of rice mills (Ministerio de Agricultura and Riego [Midagri], 2020) this has led to a substantial increase in the number of rice mills. Most of these mills consume electric power and fossil fuels to operate. This results in the emission of environmentally harmful gases that add to the pollution already existing from the planting of the rice. Although there are mechanisms, both preventive and controlling, and multiple legislative compendiums to prevent violations of the ecological system, they are often not complied with, either by omission or negligence.

According to Ferre (2010), the United Nations confirmed that rice is considered the second most produced cereal in the world. Within the agricultural sector, rice is responsible for 4.19% of Peru's greenhouse gas (GHG) emissions. The most energy-intensive processes in this industry are artificial aging and polishing or bleaching. Rice aging consists of causing irreversible changes in the physicochemical, sensory, cooking and textural properties that depend on time and temperature (Saikrishna et al., 2018). These changes are mostly beneficial, as they provide the added value desired or preferred by consumers.

Due to industrial improvements, aging has gone from being a natural process to an artificial one where the consumption of fossil fuels is higher. For this reason, many companies have opted for the use of clean energies such as solar thermal energy that seeks the concentration of heat generated by the sun to be transferred to some material as a fluid and to use it as heating for this process (Carbonell, 2021).

The question for this research will be the following: To what extent is a proposal for the use of solar thermal energy capable of reducing energy costs while reducing the negative environmental impact for the rice artificial aging process at Rice Molicas S.A.C.?

Likewise, the objective is to demonstrate the savings in electricity consumption costs and the reduction of the environmental impact in the artificial aging of rice by developing a proposal based on solar thermal energy.

Justification of the Study

Theoretical: According to Ekasilp and Soponronnarit (1995) the total electrical energy consumption in a mill is approximately 190 MJ (megajoules) per ton of paddy rice. However, the optimization of a cogeneration system can help reduce the excess steam generated during the rice production process, especially in the soaking and drying stages of the grains. These grains should reach a moisture content between 12% and 14% to avoid microbiological activity and minimize quality losses during storage, since there is a great risk when using natural drying methods due to sudden climatic changes (Salvatierra-Rojas et al., 2017). To calculate the percentage of moisture, Burbano (2005) the company states that currently it can be estimated by studying the thermal properties of the grains, one of them being the enthalpy or latent heat of vaporization. This property determines the amount of heat required to evaporate a certain volume of water in the product.

Methodology: There are different ways of using solar thermal energy, such as obtaining hot water using a thermosyphon, heating or hot air and generating electricity using a solar thermal system (Carbonell, 2021). Vijayaraju and Bakthavatsalam (2020) also comment that there are two ways to heat the air, one is by natural convection, where the air flow enters naturally through thermal conductors and the other is by forced convection where the air enters through a fan and is heated by a solar collector. On the other hand, Lovegrove and Dennis

(2006) they advise using a method of concentrating the radiation on an absorbing surface and, as a result, decreases thermal losses. This is by means of a linear Fresnel concentrator consisting of adapting linear absorbers and long mirror strips that are adjusted to direct solar radiation on an elevated surface. This method can take advantage of the mathematical properties of a parabola.

Environmental: According to Burbano (2005), there is a wide variety of agricultural products that can employ the use of solar thermal energy, but only those that generate a greater impact or have a national diversification will be analyzed. Because of this, Goyal et al. (2014) mention that the rice industry is considered one of the most energy consuming industries making the utilization of renewable energy a challenging task; however, such energy savings would lead to the reduction of fossil fuels and polluting electricity. Vijayaraju and Bakthavatsalam (2020) also found that each unit of rice processing accounts for between 5% and 10% of global methane emissions. Therefore, they recommend using a thermal system that utilizes renewable energies to be used for all energy requirements in the rice industry to maximize the heat from the system.

Based on the above, the objective of this research was to describe and validate a proposal for the use of solar thermal energy more convenient for the reduction of fossil fuels in the process of artificial aging of rice in the company Rice Molicas S.A.C.

Other Studies on Rice Aging

According to the systematic approach of Ekechukwu and Norton (1999) on the economic impact on the use of thermal energies in the rice drying process compared to the traditional method, cost savings are demonstrated for farmers in rural areas who do not have large capital by resorting to resources such as air or land. Also, a study in a rice mill located in the Tambo Valley, Arequipa, demonstrated an economic benefit for the owners and farmers in the area with the redesign of the processes and changes in the technology and energies used to improve the flexibility and efficiency of production (Najar & Alvarez, 2007).

Lee et al. (2014) used three drying methods from different heat sources: UV irradiation, autoclave sterilization and convection heating. All showed changes in the physicochemical properties of milling and cooking rice without showing a clear tendency to accelerate the aging process. However, Peinado et al. (2013) developed a proposal for a dehydrator with thermal energy that provided the desired results in less time than direct sun dehydration. Also, a proposal for aging using a microwave obtained results very similar to natural aged rice without using clean energy (Zhong et al., 2020).

Many people believe that the quality level of a product decreases when it undergoes artificial processes, however, Saikrishna et al. (2018) it has been demonstrated with various aging methods that, although it does not provide the same effect as naturally aged rice, the quality parameters are improved when artificially processed, and that is why the aging method should be carefully selected according to the desired attributes. On the other hand, Jebur et al. (2019) propose the design of aging systems that combine the natural and artificial methods in order to take advantage of solar thermal energy and thus reduce costs. In the same way, Karaca et al. (2019) showed the benefits using a PV/T system, which consists of a combination of a solar thermal and a photovoltaic system, for the long-term production and feeding of the population.

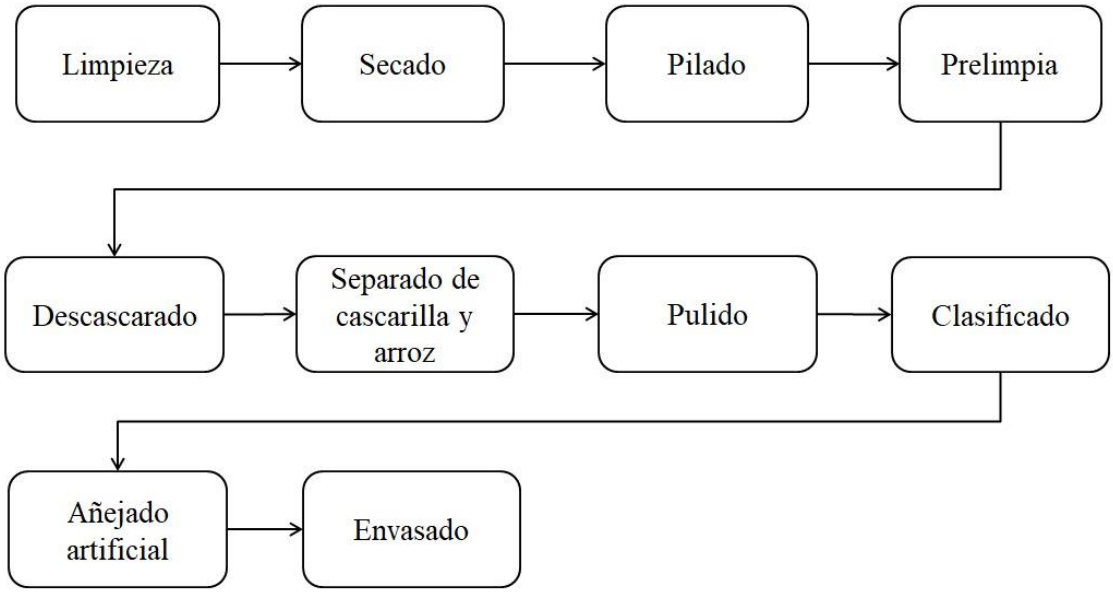
As for the final product, in order to ensure the required quality and properties of the rice, the researchers and Diao et al. (2019) and Mahakham et al. (2017) recommend the use of reducing agents and silver nanoparticles to improve the production of a good quality aged rice by evaluating the germination and metabolism of the seeds for this process.

Method

Rice Molicas S.A.C. has been operating for three years in the city of Lambayeque, located in northern Peru, and its main products are husked, selected and aged rice. The following is a block diagram detailing the rice production process in the company.

Figure 2. 1

Block diagram of the production process



The aging process has the highest energy consumption per ton of the company. The tool used to arrive at this statement was a survey of information during a visit to the company, which consisted of measuring with a DT830L multimeter a motor for each machine in operation to obtain its voltage and amperage.

Table 2. 1

Energy consumption per ton with motors

Process	No. of machines	No. of motors	Voltage (V)	Amperage (A)	Hours/ton	Consumption (kWh/ton)
Pre-clean	1	1	380	4.2	0.167	0.262
Shelling	1	2	380	4.15	0.25	0.798
Husk and rice separator.	1	2	380	4.15	0.167	0.532
Polishing	4	1	380	5.05	0.333	2.609
Classified	1	1	380	5.3	0.333	0.671
Artificial aging	1	4	380	3.75	0.125	0.713

Table 2. 2

Energy consumption per ton with resistors

Process	No. of resistors	Voltage (V)	Amperage (A)	Hours/ton	Consumption (kWh/ton)

Artificial aging	18	380	5.3	0.125	4.532

To obtain the consumption expressed in kWh for one hour of work on one ton of rice to be processed, the number of machines, the number of motors, the voltage, the amperage and the hours per ton were multiplied and divided by 1000 and, in the case of aging, the consumption of the resistors was added, resulting in a total consumption of 5,244 kWh. This is because the aging machine uses four motors and eighteen resistors when it is in operation compared to the other machines in the other processes that only have one or two motors and no resistors at the time of operation.

This case study is oriented to a technological improvement proposal with an experimental design and a descriptive scope. The instruments and techniques used to collect and analyze the information in this case study will be:

Table 2. 3

Table of research techniques and instruments

Techniques	Instruments
Process analysis	Block diagram
Field study	Multimeter and data logging
Improvement design	Flowchart
Operations	Simulation of processes

The case to be investigated is Rice Molicas S.A.C., a company dedicated to rice processing, starting with the storage of paddy rice and ending with the packaging of granulated rice ready for cooking. In order to obtain adequate information when using the techniques and instruments (See Table N°1), the object of study was dimensioned in 2 fields: environmental management, which will contain information about the negative energy impact on the environment, and the electrical energy used in the process, including energy costs and the duration of the process.

In turn, these variables are subdivided into indicators, which are distributed as follows:

Table 2. 4

Table of variables and indicators

Variables	Indicators	Instruments
Environmental impact	Carbon footprint reduction (TonCO_2eq).	CO_2 conversion factor in the SEIN.
	Aging energy savings (kWh).	Multimeter GOLD POWER DT830L.
Energy costs	Variation in energy consumption for aging (kWh/ton) and (S/ton).	Multimeter GOLD POWER DT830L.
Duration of the process	Difference in the time of use of the resistors (h/batch).	Flexzion D-113 stopwatch.

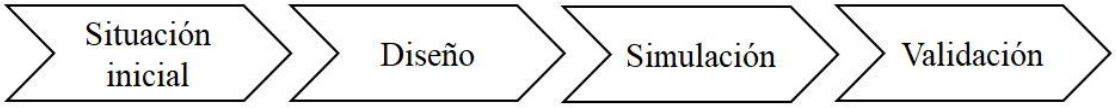
- Carbon footprint reduction: The electricity consumption of the process in MWh had to be found and multiplied with the factor of the National Interconnected Electrical System (SEIN) equal to 0.4521 tonCO2/MWh (see Annex 2) to obtain the value of tonCO_2eq.

- Aging energy savings: The current energy consumption of the company was taken in such a way that after the simulation of the improvement, a difference of values is made to demonstrate the negative impact compared to the environmental improvement.
- Variation in energy consumption during aging: It consisted of the difference between the current energy consumption with respect to the energy consumption with the implemented improvement. The energy consumption for one ton to be processed was obtained with the total consumption of the aging process multiplied by the thirty hours of work of the motors and the resistors, the result was expressed in kWh/ton. In the case of energy cost, this consisted of multiplying the aforementioned energy consumption by the tariff, which had a value of 0.15 S/kWh, expressed in S/ton.
- Difference in the time of use of the resistors: Measured by a stopwatch in units of hours for each batch entering the machine for processing.

The information obtained in this stage will be necessary to know the initial situation of the company and to propose an optimal improvement proposal to be validated by the general manager. In addition to the above, the multimeter is currently calibrated, the chronometer is new, so it does not need to be calibrated, and the SEIN conversion factor was obtained from the Ministry of Economy and Finance (MEF). In order to prepare this proposal, the following phases were followed in general:

Figure 2. 2

Methodology



A simulation of the proposal to be developed will be carried out in order to avoid resorting to economic losses for the company and to obtain data in advance of the real process, being validated by three specialists in the field. They will consist of a physicist with expertise in clean energy, a metallurgical engineer with experience in unit operations and processes, and the general manager of the organization.

Phase 1: Initial situation.

The artificial aging works from 28 to 30 hours per batch to be processed and goes through four manual changes of temperature increasing during the process starting at 40 °C. The first change occurs after the first 3 hours rising to 51 °C; the second change occurs after 3 hours rising to 62 °C; the third change is 2 hours after the second one and rises to 73 °C. Finally, the last change occurs 2 hours after the third and rises to 83 °C. The purpose of these changes is to give the rice the desired graininess.

To obtain the data for this phase, a personal communication was conducted with the company's general manager and the operator of the study machine during which they answered the following questions.

Table 2. 5

Personal conversation data

Questions	Responses
what is the amount of kW consumed by the aging machine?	Per motor it consumes 380 volts, about 4 amps, which is 0.15 kW. By resistance it consumes 380 volts, about 5 amperes, that would be 0.19 kW.
what is the temperature required in the artificial aging process for the rice to meet the necessary qualities? (°C)	It has four manual temperature changes starting at 40 °C. After the first 3 hours it rises to 51 °C; 3 hours later it changes to 62 °C; 2 hours later it rises to

	73 °C. After another 2 hours it rises to 83 °C.
Do you have any value on the recent unit cost of energy?	The rates we pay are attached to the ENSA invoice.
How long is the aging process? (days, hours)	Aging lasts 30 hours, after which the rice is left to cool for about 8 hours.
What is the processing capacity of the aging machine? (input bags/hour)	175 bags/hour.
What is the weight per bag of processed rice?	49kg/sack.
What is the percentage of moisture required in rice before and after the aging process?	Before: 12% - 13% Afterwards: 8% - 9%

Note: F. Castillo & T. Quesada (personal communication, September 8, 2021)

The data obtained are based on a batch that is equivalent to eight tons based on the methodology previously described.

Table 2. 6

Initial situation data.

Data	Value
Carbon footprint	0.07112 TonCO2eq
Aging energy	1258.56 kWh/lot
Aging energy consumption	157.32 kWh/ton 23.60 soles/ton
Time of use of the resistors	30 h/batch

Based on the data obtained after gathering information on the current state of the company, the initial value of the carbon footprint emitted was 0.07112 tons of carbon dioxide equivalent for one ton of processed rice; the energy consumption for the aging process was 1258.56 kWh for each batch of rice to be processed; the energy consumption for the original aging process was 157.32 kWh and 23.60 soles per ton of processed rice. Finally, the time of use of the resistors was 30 hours per processed batch of rice.

Phase 2: Design

Solar irradiation in Lambayeque averages 5.38 kWh/m2 per year, transforming into a total annual energy of 1.96 MWh/m2, making the city where the company is located have a high solar potential for the generation of electricity from solar energy (Gastelo-roque et al., 2018).

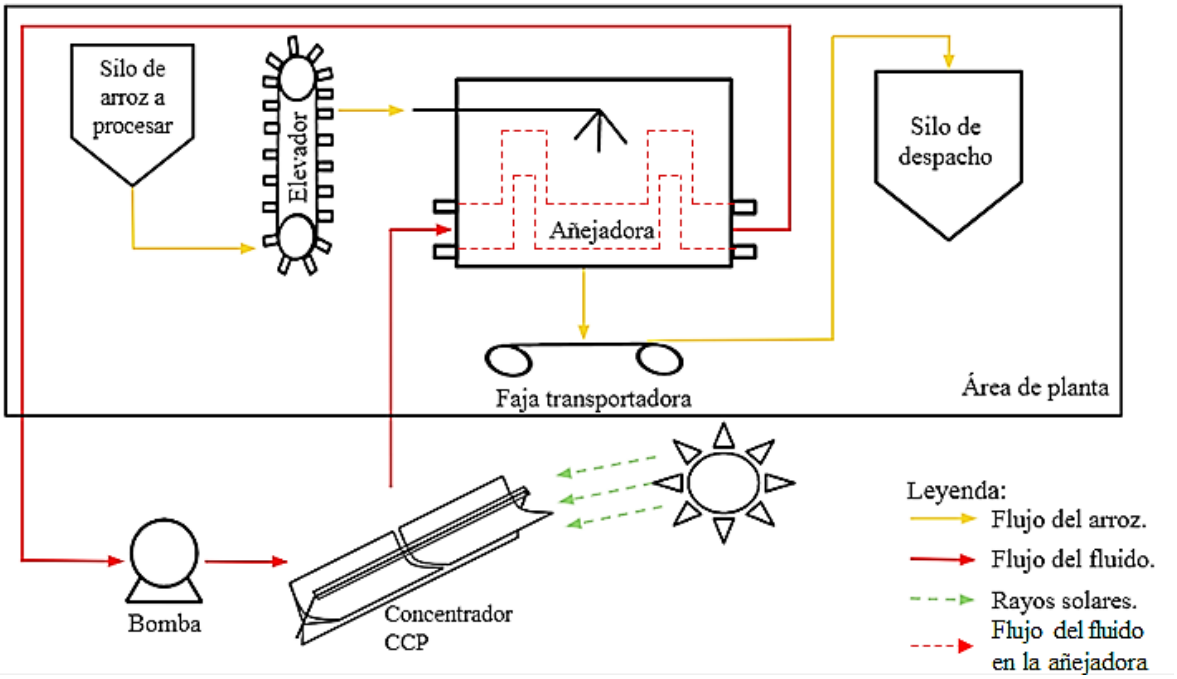
The design of the proposal consisted of a pump, two parabolic-cylindrical thermal concentrators (PCC), a steel pipe to transport the fluid from the concentrator outlet to the inlet of the aging machine. For the interior of the machine, a copper pipe was chosen as it is a better conductor of heat, in addition, a foam covering was added to the steel pipe except for the heat absorption area (CCP concentrator), this is to reduce heat losses.

Both the steel and copper tubes carry a thermal fluid that carries the heat absorbed by the sun. Once inside the aging machine, the fluid releases the absorbed heat by heating the air, which is mobilized by the fans located inside the machine.

The flowchart of the process with the added improvement was presented in this way:

Figure 2. 3

Flowchart with the improvement included



Equipment dimensions:

Steel absorber pipe with selective coating of 0.048m diameter and 40m long.

Glass tube with anti-reflective treatment of 0.058m diameter and 10m long.

Copper tube of 0.048m diameter and 10m long.

Solar thermal concentrator of approx. 20m^2.

Solar tracking system.

1HP centrifugal pump.

Thermal oil (Therminol 66)

Phase 3: Simulation.

The program used in this phase was CHEMCAD, which specializes in preparing chemical process simulations showing a close-to-reality view of the equipment used in the various production processes. The version used for the simulation was 7.1.5, to obtain it, first we went to the Chemstations page, selected this version and, finally, proceeded to download it. It should be noted that this design can be supported for any version of the software and it is recommended to create a separate folder before downloading the program. Likewise, the requirements used in this program were:

Pump: A mineral oil outlet pressure of 3.4 atm was required and for machine efficiency 80 % was set.

Heat exchanger #20: It was used as a replacement for the CCP concentrator, it was necessary to know the initial temperature of the mineral oil, which was 25 °C.

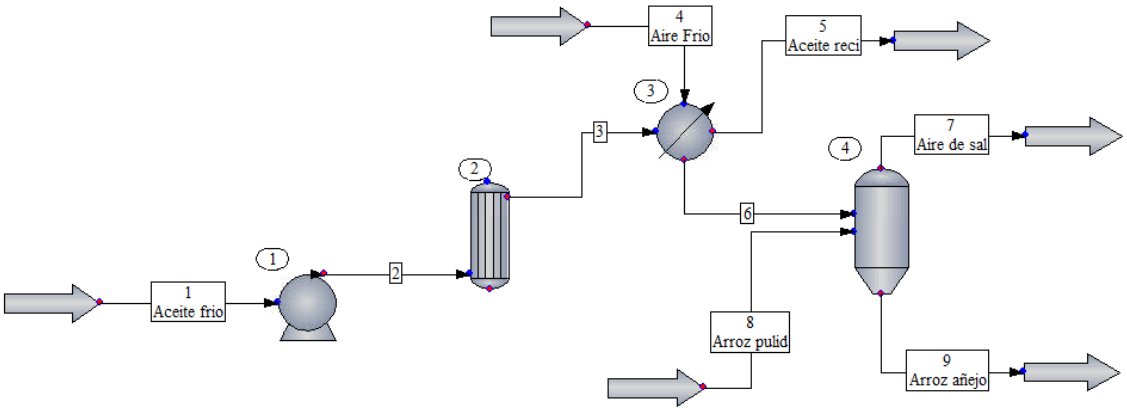
Heat exchanger #1: In this equipment, an air stream will be heated with the oil previously heated in heat exchanger # 20. The hot air will come into contact with the rice inside the aging machine.

Solids dryer: It represented the rice aging machine, the final temperature of the solid was 75 °C.

The graph that represented this simulation was as follows:

Figure 2. 4

Simulation diagram



In addition, the type of liquid and solid to be used had to be recorded in order to find the data of the components of each material that will enter the process and obtain the expected results. For mineral oil, its inlet temperature was set at 25 °C and a weight of 6000 kg/h. For rice, the same temperature and weight of 285.83 kg/h were used.

Results

Phase 4: Proposal validation

The design was validated by physicist Erich Saettone and the simulation has been validated by metallurgical engineer George Power. Likewise, the results obtained once the simulation was completed in the program were as follows:

Figure 3. 1

Results obtained from rice with the simulation

Stream No.	9
Stream Name	**Arroz añejo**
Temp C	**75**
Pres atm	**1**
Vapor Fraction	**0**
Enthalpy kW	**-566.001**
Total flow	**273.2747**
Total flow unit	**kg/h**
Comp unit	**kg/h**
Therminol 66	0
Air	0
Water	24.59472
Dextrose	225.81
Lysine	22.87

As a result, the enthalpy released by the system was 566 kW-h leaving the aged rice with a moisture content of 9% using an air inlet flow of 778 kg/h with a humidity of 5% at 141°C.

Figure 3. 2

Results obtained from the air with the simulation

Stream No.	7
Stream Name	**Aire de salida**
Temp C	**75.4765**
Pres atm	**1**
Vapor Fraction	**1**
Enthalpy kW	**-180.3625**
Total flow	**790.5652**
Total flow unit	**kg/h**
Comp unit	**kg/h**
Therminol 66	0
Air	739.1
Water	51.46527
Dextrose	0
Lysine	0

With respect to the air leaving the aging machine, the enthalpy is interpreted as the energy that was released once the process was completed, being 180.36 kW-h with a humidity of 6.5%. To obtain the data for the initial situation, the results obtained in the CHEMCAD program were used and the same steps were followed as in phase 1.

Table 3. 1

Data with modeled proposal

Data	Value
Carbon footprint	0.03464 tonCO2eq
Aging energy	606.02 kWh/lot
Aging energy consumption	75.75 kWh/ton 11.36 soles/ton
Time of use of the resistors	12 h/batch

With the simulated improvement, the new carbon footprint emitted was 0.03464 tons of carbon dioxide equivalent for one ton of processed rice, with regard to the energy consumption of aging the change was 606.02 kWh for each batch of rice to be processed, and for the energy consumption of aging the values of 75.75 kWh and 11.36 soles for each ton of processed rice were obtained. Finally, the time the resistors were used was 12 hours per batch processed.

Discussion and Conclusions

The results that were found with the implemented improvement were compared with the data found in the initial situation of the company, this variation is presented as follows:

Table 4. 1

Value of indicators

Indicator	Initial value (Vo)	Value final (Vf)	Δ (Vo - Vf)
Carbon footprint reduction.	0.07112	0.03464	0.03649 tonCO2eq

Aging energy savings.	1258.56	606.02	652.54 kWh/lot
Variation in energy consumption during aging.	157.32	75.75	81.57 kWh/ton
	23.6	11.36	12.24 soles/ton
Difference in the time of use of the resistors.	30	12	18 h/lot

According to the variation, the carbon footprint reduction indicator shows a reduction of 51.3%, while the indicators of aging energy savings and variation of aging energy consumption are 51.8%, finally, the indicator of difference in the time of use of the resistors was 60% compared to the initial situation. This demonstrates the high probability of a positive change through the use of CCP concentrators in the aging process of Rice Molicas S.A.C. without affecting the quality of the final product. For this reason Najar and Alvarez (2007) consider that this will allow the use of existing renewable resources with the scarce use of other types of non-renewable and more polluting resources, such as the natural gas currently used.

In the case of energy consumption, there are systems that can obtain up to 82% of their required energy, as is the case with Karaca et al. (2019). On the other hand, some authors such as Ekasilp and Soponronnarit (1995) found that the polishing process is the one with the highest energy consumption with 43%, while for our research this process reaches 27%. Likewise, in the simulation, there is a variation in the desired final moisture content as in the case of Vijayaraju and Bakthavatsalam (2020) whose objective is to have a range between 13% - 14%.

Table 4. 2

Identification of study limitations

Problems / limitations encountered	Did it affect the results?	Solutions used	Strengths
1. The improvement proposal could not be implemented.	Yes	The necessary data was collected using simulation software and validated with an expert.	Despite the fact that there was no implementation of the improvement in the company, the data obtained had to be analyzed with a low error rate.
2. Air capture is not used when heating the process.	No	-	-
3. The necessary project materials could not be afforded.	No	-	-
4. The project is tailored to a specific capacity.	Yes	The technical characteristics of the aging machine were used together with the size of the batch to be produced.	Working with a defined capacity of aged product facilitates the calculations to obtain the desired indicators in the research.
5. Consider the solar radiation intensity of the site to be implemented.	Yes	We consulted the NASA database to know the historical radiation of the Lambayeque site.	The site where the plant was located has high solar radiation, which is beneficial for the design of the improvement proposal.

In the second constraint, the proposed design, unlike other models such as the one described by Ekechukwu and Norton (1999)the second constraint is that the proposed design, unlike other models such as the one described by the company, applies a natural air circulation model since it focuses on the heating of the thermal oil, which heats the air trapped inside the aging machine. As for the third limitation, given the current circumstances in Peru, it was not possible to budget for the materials needed to implement the proposal, the opposite case being the research carried out by Placco et al. (2017).

The findings show the possibility of generating the heat quota required by the process using environmental resources to reduce the cost problem and the negative environmental impact generated by the aging process in the company by implementing solar thermal concentrators. This benefits the company and the environment, since the development of solar thermal energy is offered as an additional way to reduce the cost of electricity consumption, since the case study is one of the processes with the highest energy demand, which demonstrates the importance of opting for renewable and less polluting resources for the environment.

As for the conclusions, cost savings and a 51.3% reduction in environmental impact were calculated using the indicators when simulating the improvement proposal. Likewise, it was possible to demonstrate that the artificial aging process consumes more energy than other production processes in the company. As for the design, it was deduced that the choice of materials will vary according to the requirements of each type of aging machine and the preferences of the entrepreneurs. Thus, with the simulation and validation of the improvement proposal, it was concluded that it satisfies the aging requirements.

Although the benefits of the proposal were demonstrated, it could not be implemented and the materials could not be afforded because the company limited staffing due to the current pandemic situation. On the other hand, authors such as Ekechukwu and Norton (1999) used at the time of designing their proposals the air induction method as a thermal agent; however, the aging machine had internal fans, so this method was not necessary. In addition, the operation of the CCP concentrator will depend on the solar radiation in the area, as this is an important factor for the CCP concentrator. Bearing in mind that this approach can also be adapted to a specific industry and not necessarily to a case study leading to the heating of a system.

While the design of the proposal is not a fixed model, future research should explore the development of new, more practical and efficient designs that meet the same objective. It is essential to adhere to programs and processes for the use of renewable energy, because, with the objective of reducing the environmental impact generated, it is possible to promote long-term monetary savings for the company, being one of the applicable instruments the ecological planning, which implies the evaluation of alternatives for the use of natural elements, trying not to alter the ecosystem too much, and ensuring its conservation.

Finally, it is important to emphasize that it is necessary to constantly and periodically evaluate the environmental impact generated by the companies, and thus control and supervise the levels of generation of polluting agents. At the same time, it is of great relevance to point out the need to promote the speed in the sanctioning processes that are promoted by the competent authorities to the polluting companies that violate environmental regulations, considering that it implies a possible irreversible damage to society.

References

Adelaida Ferre. (2010). La paja del arroz amenaza el ecosistema - BBC News Mundo. *12 de Noviembre*. https://www.bbc.com/mundo/noticias/2010/11/101112_paja_arroz_ecosistema_af

Burbano, J. C. (2005). *Dialnet-DISPONIBILIDADTERMICASOLARYSUAPLICACIONENELSECADOD-4838419*. *27*, 127–132.

Diao, M., Guo, Y., Tian, W., Tu, K., Guan, L., & Wei, M. (2019). Restoring fresh texture in cooked aged rice with reducing agents. *Food Research International*, *121*(8), 84–90. https://doi.org/10.1016/j.foodres.2019.03.023

Ekechukwu, O. V, & Norton, B. (1999). Review of solar-energy drying systems II: an overview of solar drying technology. *Fuel and Energy Abstracts*, *40*(3), 216. https://doi.org/10.1016/s0140-6701(99)97881-5

Gastelo-roque, J. A., Morales-acevedo, A., & Tineo-soto, J. E. (2018). *Estimación de la radiación solar diaria y ángulos de inclinación óptimos para Estimación de la radiación solar diaria y ángulos de inclinación óptimos para Lambayeque (Perú) utilizando el modelo de Hargreaves-Samani . Estimation of the daily global sola*. *8*(September).

Goyal, S. K., Jogdand, S. V., & Agrawal, A. K. (2014). Energy use pattern in rice milling industries—a critical appraisal. *Journal of Food Science and Technology*, *51*(11), 2907–2916. https://doi.org/10.1007/s13197-012-0747-3

Jebur, H. A., Jabr, A. K., & Jassim, S. Y. (2019). Evaluation of thermal efficiency for solar energy storage of agricultural products: A review. *Plant Archives*, *19*(1), 17–24.

Karaca, G., Dolgun, E. C., Kosan, M., & Aktas, M. (2019). Photovoltaic-Thermal solar energy system design for dairy industry. *Journal of Energy Systems*, *3*(2), 86–95. https://doi.org/10.30521/jes.565174

Lee, Y., Mauromoustakos, A., & Wang, Y. J. (2014). Effects of heat treatments on the milling, physicochemical, and cooking properties of two long-grain rice cultivars during storage. *Cereal Chemistry*, *91*(1), 56–64. https://doi.org/10.1094/CCHEM-02-13-0029-R

Lovegrove, K., & Dennis, M. (2006). Solar thermal energy systems in Australia. *International Journal of Environmental Studies*, *63*(6), 791–802. https://doi.org/10.1080/00207230601047156

Mahakham, W., Sarmah, A. K., Maensiri, S., & Theerakulpisut, P. (2017). Nanopriming technology for enhancing germination and starch metabolism of aged rice seeds using phytosynthesized silver nanoparticles. *Scientific Reports*, *7*(1), 1–21. https://doi.org/10.1038/s41598-017-08669-5

Marcos Carbonell. (2021). *Instalación energía solar termica*. https://www.hogarsense.es/energia-solar/instalacion-energia-solar-termica

MINAGRI. (2020). *Perú: Produción, Importaciones Y Precios Del Arroz*. https://cdn.www.gob.pe/uploads/document/file/1230425/nota-informativa_arroz_02.pdf

Najar, C., & Alvarez, J. (2007). Mejoras en el proceso productivo y modernización mediante sustitución y tecnologías limpias en un molino de arroz. *Industrial Data*, *10*(1), 22–32. http://sisbib.unmsm.edu.pe/bibvirtualdata/publicaciones/indata/vol10_n1/a05.pdf

Peinado, M. J. L., Vidal, H. R., Grado, D. J. A., & Gándara, F. J. A. (2013). Deshidratación de alimentos utilizando energía solar térmica. *Culcyt*, *50*(2), 99–107.

Placco, C., Gea, M., Echazú, R., Fernández, C., & Saravia, L. (2017). *EVALUACION DE UN PROTOTIPO DE CONCENTRADOR SOLAR TÉRMICO DE REFLECTOR LINEAL FIJO*. *21*, 11–23.

Saikrishna, A., Dutta, S., Subramanian, V., Moses, J. A., & Anandharamakrishnan, C. (2018). Ageing of rice: A review. *Journal of Cereal Science*, *81*, 161–170. https://doi.org/10.1016/j.jcs.2018.04.009

Salvatierra-Rojas, A., Nagle, M., Gummert, M., de Bruin, T., & Müller, J. (2017). Development of an inflatable solar dryer for improved postharvest handling of paddy rice in humid climates. *International Journal of Agricultural and Biological Engineering*, *10*(3), 269–282. https://doi.org/10.3965/j.ijabe.20171003.2444

Vijayaraju, K., & Bakthavatsalam, A. K. (2020). Adoption of Integrated Solar System with Thermic fluid working medium for Parboiling Rice Mills in Tamilnadu. *IOP Conference Series: Earth and Environmental Science*, *573*(1). https://doi.org/10.1088/1755-1315/573/1/012049

Wannee Ekasilp, Somchart Soponronnarit, A. T. (1995). *Energy analysis in white rice and par-boiled rice mills for cogeneration in Thailand*. *17*(2), 83–92. http://www.rericjournal.ait.ac.th/index.php/reric/article/view/308

Zhong, Y., Xiang, X., Chen, T., Zou, P., Liu, Y., Ye, J., Luo, S., Wu, J., & Liu, C. (2020). Accelerated aging of rice by controlled microwave treatment. *Food Chemistry*, *323*(March), 126853. https://doi.org/10.1016/j.foodchem.2020.126853

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GENDER DIFFERENCES IN SCHOOLING AND OCCUPATION; SOCIAL AND ENVIRONMENTAL VULNERABILITY

Diferencias de género en nivel educativo y ocupación; vulnerabilidad social y ambiental

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ABSTRACT

Women's labor force participation worldwide is lower than men's, this is directly related to their education level, and it is caused by gender norms, roles and discrimination, which generates social, economic and environmental differences. In this regard, the objective of this study was to analyze gender differences in the schooling and working fields and its possible social and environmental vulnerability in the city of Delicias, Chihuahua, Mexico. 384 surveys were conducted in the forementioned city, with a minimum reliability of 95%, using stratified random sampling divided into levels of marginalization. A descriptive statistical analysis was carried out, showing differences in education and occupational levels by gender in Delicias city, affecting women with notorious disadvantages, increasing their vulnerability, the occupation with the highest percentage in women was housewife and in men it was an employee, affecting women with noticeable disadvantages, which increases their vulnerability. Obtained results represent a starting point for the implementation of social programs aimed at minimizing gender differences in order to reduce their vulnerability, they also contribute to the understanding of gender equity´s importance in society.

Palabras clave:
desventajas, escolaridad, roles de género, vulnerabilidad.

RESUMEN

En todo el mundo la participación laboral de la mujer es inferior a la participación del hombre, lo cual tiene relación con el nivel de estudios, teniendo como raíz las normas, roles y discriminación de género, lo que genera diferencias sociales, económicas y ambientales. En este sentido, el objetivo del presente estudio fue analizar las diferencias de género en nivel educativo y ocupación y su posible vulnerabilidad social y ambiental en ciudad Delicias, Chihuahua, México. Se realizaron 384 encuestas distribuidas en la ciudad, mediante un muestreo aleatorio estratificado dividido en niveles de marginación. Se efectuó un análisis estadístico descriptivo, los resultados mostraron que existen diferencias en nivel de educación y en ocupación por género en Delicias, la ocupación con mayor porcentaje en las mujeres fue ama de casa y en los hombres fue empleado, repercutiendo en las mujeres con desventajas notorias lo que incrementa su vulnerabilidad. Los resultados obtenidos sirven como base para la implementación de programas sociales orientados a minimizar las diferencias de género y reducir su vulnerabilidad, además contribuyen a comprender la importancia de la equidad de género.

Introduction

At present, despite the great efforts of national and international organizations, governmental programs and social groups, and the progress made in gender equality, there are still evident differences in the subject worldwide, but with greater emphasis on Latin America and other regions. Compared to race, age, and occupation, gender represents the strongest category for differentiation among people (Wood and Eagly, 2010). But in society it is not only a theoretical classification, but also entails differences in roles, rights and obligations, as well as opportunities, representing social and economic advantages or disadvantages. Therefore, the effort to minimize this inequality should not stop, for which it is important to generate information and data that serve as a basis for reducing gender disadvantages.

In terms of education, the difference in educational levels by gender has social repercussions, there is a relationship of educational level and pregnancy, due to the fact that it is among the main causes of teenage pregnancy, as well as income and ethnicity (Lechuga et al., 2018), also generally pregnancy is accompanied by school dropout. Regarding labor participation worldwide it is currently 49% for women, for men it is 75%, but in some places the difference is more than 50 percentage points (International Lobour Organization, 2018). In Mexico the figures are similar to global data, 78 out of every 100 men and 44 out of every 100 women participated in economic activities during 2018 (Instituto Nacional de las Mujeres, n.d.). The United Nations (UN, 2015) reports that, worldwide, women earn less than men, in most countries women on average earn between 60 and 75 percent of men's wages. According to the National Survey of Household Income and Expenditures (ENIGH) of the National Institute of Statistics and Geography (INEGI, 2020), there are 64.4 million women in Mexico, representing 51.5% of the total population, 60.6% of women between 3 and 29 years of age attend school and 44 out of every 100 women are affiliated with a health institution. An example of labor inequality is that only 34.7% of people over 25 years of age who work as public, private and social sector officials and managers are women.

On the other hand, the construction of social norms allows the emergence of authority figures that guide towards compliance with rules or sanctions (Betancur and Castro, 2016). Social norms are rules of action shared by people in a given society or groups; they define what is considered normal and acceptable behavior for people. There are also gender norms where gender is conceptualized as a social system that distributes resources, roles, power and rights according to whether a person or practice is perceived as masculine or feminine. They are learned in childhood, in the socialization process and then reinforced in the family and social context: at school, at work, in religion, in the media and other institutions. These norms are produced and reproduced through social interaction, when people conform to or question notions of masculinity and femininity. Most existing gender systems are deeply hierarchical, inequitable, privileging what is masculine over what is feminine, keeping this system intact. This can have multiple consequences such as affecting adolescent health, child marriage, intimate partner and violence (Cislaghi and Heise, 2020). The World Health Organization (WHO, 2016), mentions that the norms, roles and relationships assigned to each gender generate inequalities between men and women.

With respect to gender roles in Mexico, although they have been changing, until today women have been educated mainly for domestic work, unlike men who have been educated to be providers. In addition, women are located to a greater extent in the non-economically active population, performing domestic work that is not economically remunerated. Likewise, the female gender has greater responsibility for the care of infants and elderly people in their

households, and they are also responsible for preparing household food in 85-90% of cases (WHO, 2014), factors that have an impact on environmental vulnerability.

On the other hand, an important term for this study is marginalization, which was used in the methodology and is a multidimensional phenomenon produced by the economic model expressed in inequality of progress and exclusion of social groups, which generates vulnerability. The characteristics of marginalization are illiteracy or incomplete primary education, housing without drainage, without sanitation, housing without electricity, overcrowding and low income (CONAPO, 2010), there are different levels of marginalization according to these characteristics. The marginalization index is measured in AGEB (Basic Geostatistical Area), depending on the socioeconomic characteristics of each territory (CONEVAL, 2010).

In this sense, vulnerability is the absence of capacity of communities to cope with changes or during an emergency, it is determined by exposure to some phenomenon, being fragility and capacity to adapt or respond (Vera and Albarracín, 2017). The term vulnerability refers to the condition of being defenseless for a person, a group or a community, when someone does not have the resources to meet basic needs, such as food, housing, health services and drinking water, so it is closely linked to marginalization, therefore, citizens are at greater risk in any situation (Espinosa et al*.,* 2012). Thus, Zamudio *et al*. (2014) analyzed vulnerability according to gender, turning out to be different, the most important factors for women were violence, families and households, political participation, work, and being a rural or indigenous woman. For men, poverty, childhood and migration were significant. An example regarding gender differences was evidenced in a study on mood and emotions of students conducted in Chile, in which the lowest scores were obtained by women, which may be related to depression and could increase the risk of suicide. The authors conclude that including a gender perspective can contribute to the improvement of educational and health policies (González et al., 2016).

On the other hand, there are currently multiple environmental problems in the world, the most important of which is the climate emergency that increasingly affects the health and well-being of people (WHO, 2018), the mortality rate increases as temperatures deviate from the optimal temperature for the population. Such vulnerability increases with gender, for example, pregnant women are especially vulnerable to malaria, as malaria-transmitting mosquitoes are twice as attractive to them as non-pregnant women (WHO, 2016). An example of environmental vulnerability was what happened in Bangladesh in 1991, when cyclones claimed the lives of 140,000 people, 90% of whom were women (Aguilar, 2004). This is explained by the fact that there are more women than men who are confined to their homes, taking care of children, several of them lose their lives waiting for company to go to a safe place, in addition to the fact that they are generally less well nourished, and consequently have less physical capacity than men to cope with such circumstances. In addition, as a consequence of climate change on women, one can mention the increase in workload, causes insufficient food, increase in family violence, harassment and loss of privacy in shelters, among others (WHO, 2016).

In this regard, it is emphasized that women, especially those living in poverty, are more vulnerable to natural disasters, this is evidenced by a study conducted in 141 countries, which found that girls, boys and women die more than men as a result of natural hazards. If the socioeconomic status of women is high, the number of deaths of women and men is equal during and after natural disasters, but when the socioeconomic status of women is lower, they are more likely to die than men (Neumeyer and Plumper, 2007) men (Neumeyer and Plumper, 2007). Therefore, environmental vulnerability is different in women and men, due to a different social vulnerability in which the social exclusion of women and their lack of access to power increase their fragility and risks. Women were brought up to assume their own self as "being-for-others", which causes a double vulnerability during a disaster. Thus, when there is training

for both genders in a community, it increases their fitness and resilience competence, even after an extreme event (Oswald, 2016). Gender differences in occupation and educational attainment suggest greater social and environmental vulnerability of women (Neumeyer and Plumper, 2007; Jungehülsing, 2010; WHO, 2016; Oswald, 2016).

In view of the above, the hypothesis proposed is that gender has an effect on the level of education and therefore on occupation, having economic, social and personal effects, generating greater social and environmental vulnerability. Therefore, the objective of the study was to analyze gender differences in educational level and occupation and their possible social and environmental vulnerability in the city of Delicias, Chihuahua, Mexico. This generates information that serves as a tool to minimize gender differences and reduce their social and environmental vulnerability, in order to truly achieve gender equity.

Method

Study area

The municipality of Delicias is located in the south-central zone of the state of Chihuahua, in northern Mexico (Figure 1), between parallels 27°57' and 28°17' North Latitude; meridians 105°20' and 105°42' West Longitude (CONAGUA, 2008).

Figure 1
Location of the municipality of Delicias

Source: Matos (2015).

Procedure

For the data collection, a survey was designed to gather general information about the people, such as level of education and occupation. The survey was conducted directly in households in different neighborhoods, with stratified random sampling. Participation was voluntary and the objective of the study was notified, without taking personal data such as name, for personal protection. A survey was used because it is a standardized instrument that allows efficient data collection (Meneses and Rodriguez, 2011).

The minimum sample size was calculated using the formula for a finite population, with a minimum of 95% reliability, a maximum of 5% precision error, to ensure representativeness

of the population. To obtain the sample, the total population of the municipality of Delicias with 148,045 inhabitants was considered (COESPO, 2017), being the most recent figure at the time of the study, resulting in a minimum sample size of 384 people. The formula used was as follows:

$$n = \frac{N \; Z^{2}_{\alpha/2}(pq)}{d^{2}N + Z^{2}_{\alpha/2}(pq)}$$

where n= is the minimum representative sample size; N= is the population size; Z= is the value of the standard normal distribution for a given confidence level; pq= is the variance in the response, using for this study the maximum variance assumption (0.25), where p is the probability of success in the expected response and q the probability of failure (q=1-p) and d=is the maximum precision error of the sample.

For the sampling, the classification of marginalization was considered, which has five levels, the levels of higher marginalization (MA and A) were grouped because they are few AGEB and have little land area, leaving only four levels, MA-A with 3 AGEB, M with 17, B with 21 and MB with 31, giving a total of 72 AGEB representing 100%. Each level was divided by the total number of AGEB (72) and multiplied by 100 to obtain the corresponding percentage. The sample number (384) was divided into these percentages to avoid overestimation, obtaining a representative sample of each marginalization zone. Therefore, the number of surveys per level was MA-A 16, M 91, B 112 and MB 165, for a total of 384, which is represented in the following graph (Table 1).

Table 1

Number of surveys by level of marginalization

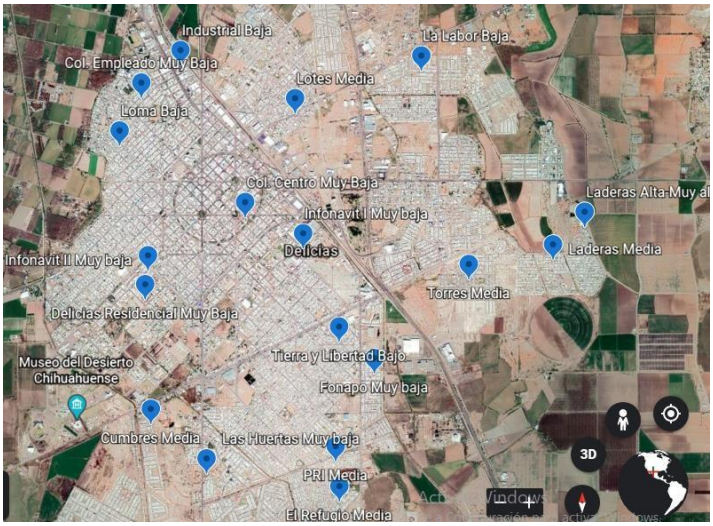
Level of marginalization	Number of AGEB	Number of surveys per level
MA-A	3	16
M	17	91
B	21	112
MB	31	165
Total	72	384

Sampling

A stratified random sampling was carried out, divided by degree of marginalization of the city's AGEBs, according to the CONAPO classification (2012), in order to analyze the information and compare by strata, which are given by an already established classification, the randomization consisted of neighborhoods and households. Data collection was conducted in the summer of 2019. The data were obtained from 17 neighborhoods distributed throughout the city, which were: Zone MA-A of marginalization; Colonia Laderas (farthest sector), Zone M; Laderas (entrance sector), Las Torres, PRI, El Refugio, Los Lotes and Cumbres, from Zone B; Loma de Pérez, Colonia Industrial, La Labor, Tierra y Libertad, from Zone MB; Fovissste I, Fovissste II, Ignacio C. Enríquez, Las Huertas, Colonia del Empleado, Delicias Residencial and Colonia Centro (Figure 2).

Figure 2

Location of neighborhoods surveyed in Ciudad Delicias



Source: *Google Earth (2020).*

Data analysis

Finally, descriptive statistics were used to analyze the results, which were measured based on 100% of the frequency presented in the survey, with the gender of the participants as the main variable. Descriptive statistics allows analyzing a set of data, from which conclusions are obtained (Salazar and Del Castillo, 2018). In such a way that the information derived from the research is synthesized through tables and graphs, providing timely information on the results (Rendón-Mácias et al., 2016).

Results

Age by gender

The participants were between 11 and 90 years of age, the minimum age by gender did not vary, the maximum age did, while the maximum age for men was 85 years, for women it was 90 years, in the average age there was a slight difference of one year, 34.58 years for men and 35.77 years for women.

Occupation

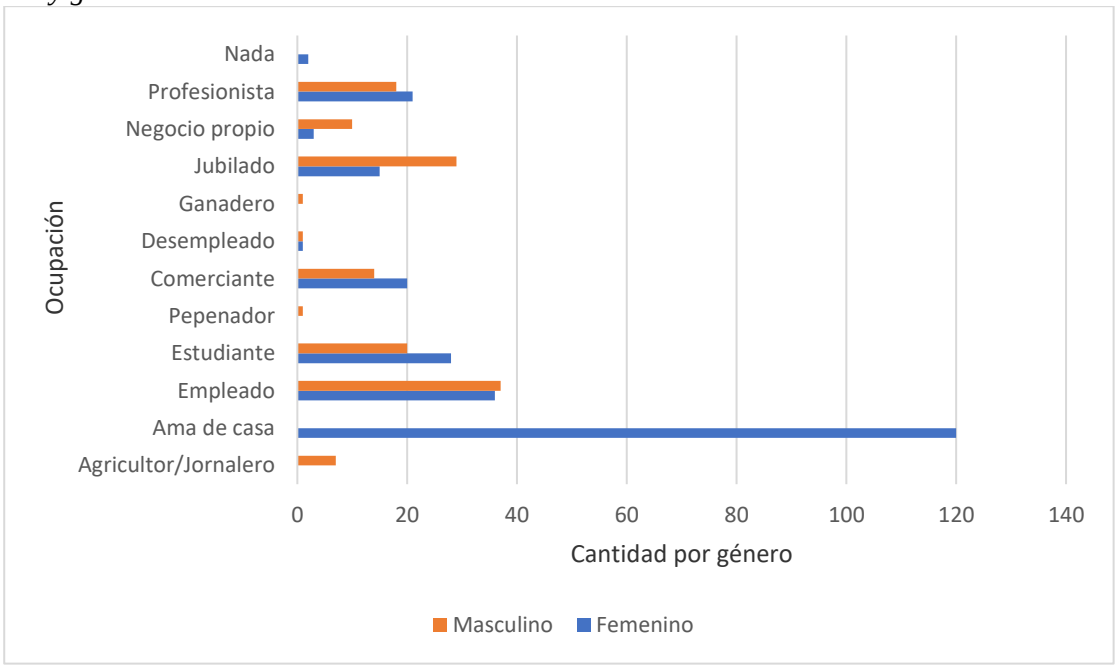
Of the respondents, 139 were male (36.19%) and 245 were female (63.81%). In terms of occupation, of the total respondents 31.25% were housewives, 19% employees, 12.5% students, 11.45% retired, 10.5% professionals, 8.85% merchants, 3.38% people with their own business and only 1.82% people engaged in farming or day laborers (Figure 3).

Source: Own elaboration.

Occupation by gender

Similarly, the occupations in the municipality were analyzed by gender to see if there are differences (Figure 4). Of the total number of women only 38.7% are in the economically active population, below that reported by Kaplan and Piras (2019) based on Inegi data, with a percentage of 43.5 at the national level for 2018. Among women, the main occupation was housewife with 48.97%, in second place, employee with 14.69% and in third place student with 11.42%. In the case of men it was different, in first place, they were employees with 26.61%, in second place, retirees with 20.86% and in third place, students with 14.38%. In contrast, the first place for women is for housewives and for men it is for employees. Therefore, there is a difference in the occupations according to gender, in addition, there was a greater variety of occupations among men, and in some cases they were exclusive to this gender, such as farmers, cattle ranchers and scavengers.

Figure 4
Occupation by gender



Source: *Own elaboration.*

In Mexico, women's labor participation is below men's contribution, and is also low in comparison with other countries, which causes significant economic impacts. Women's labor

participation was only 45% in 2019, compared to 77% for men, with a difference of 32% (UN, 2020). The results reported in the present article can be explained by data obtained by Kaplan and Piras (2019), who state that worldwide, female labor participation is lower than male labor participation. However, compared to other Latin American countries, labor force participation among women in Mexico is extremely low in Mexico is extremely low compared to other Latin American countries. Mexico is the country with the second largest gender gap in Latin America. The participation rate of women of reproductive age in Mexico is particularly low, and a result related to the low labor participation of women is the high percentage of young women with no education. This evidence suggests that low female participation reflects the constraints women face in matching their domestic responsibilities with employment, rather than preference. It also affects the perception of unequal opportunities and open discrimination in the Mexican labor market.

Occupation by marginalization zones

The occupations by gender at each level of marginalization were also analyzed. For women in all marginalization zones being a housewife predominated (Table 2), but with different percentages, having in the highest marginalization zone (60%) and in the lowest marginalization zone (40.9%), decreasing by almost 20 percentage points. Therefore, the lower the level of marginalization, the lower the percentage of housewives.

Table 2

Dominant occupation for females by marginalization zone

Marginalization zone	Occupation	Percentage
A-Very high	Housewife	60
Media	Housewife	53.3
Download	Housewife	57.7
Very low	Housewife	40.9

In the case of men, the dominant occupation varied according to the marginalization zone (Table 3), with day laborer/farmer in the first place in the A-Very high marginalization zone, employee in the Medium and Low zones, and retired in the Very low marginalization zone. There are more employment options as marginalization decreases, in contrast to the most marginalized zone where more than 60% of the occupations are related to farming. In addition, being part of formal jobs (employee/retiree) means having benefits, among other benefits, which reduces their vulnerability, since access to productive employment and decent work is essential to meet people's needs (Weller, 2012).

Table 3

Dominant occupation for the male gender by zone of marginalization

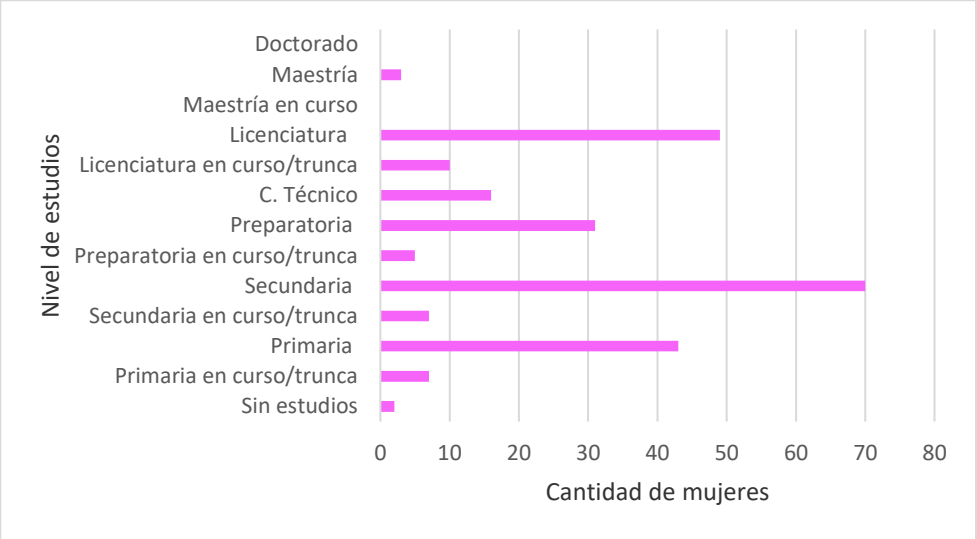
Marginalization zone	Male Occupation	Percentage
A-Very high	Farmer/Journalist	66.6
Media	Employee	35.29
Download	Employee	34.14
Very low	Retired	26.6

Studies

For this classification, there were several levels: no studies, elementary, middle school, high school, bachelor's, master's and doctorate, with two variants: complete or truncated/ongoing. With four uneducated people, two from the MA-A zone, one from the M zone and one from the B zone, only one person with a doctorate in the B zone and predominantly at the high school level for the Municipality. Regarding the level of studies by gender, among women, secondary school completion predominates with 28.57%, followed by bachelor's degree completion with 20%, followed by primary school completion with 17.55% (Figure 5). This has an effect on women's occupations (Kaplan and Piras,2019), representing that career aspirations cannot be high given that more than half (55.51%) of the female gender has less than high school level education.

Figure 5

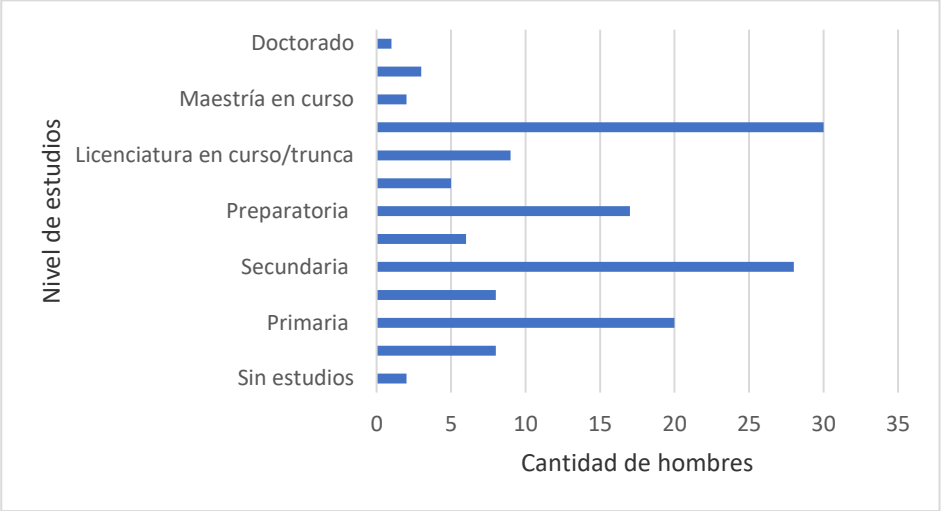
Educational level in women



On the other hand, the level of studies in men was different, with 21.58% of men having completed a bachelor's degree, 20.14% completed secondary school, and 14.38% completed elementary school (Figure 6).

Figure 6

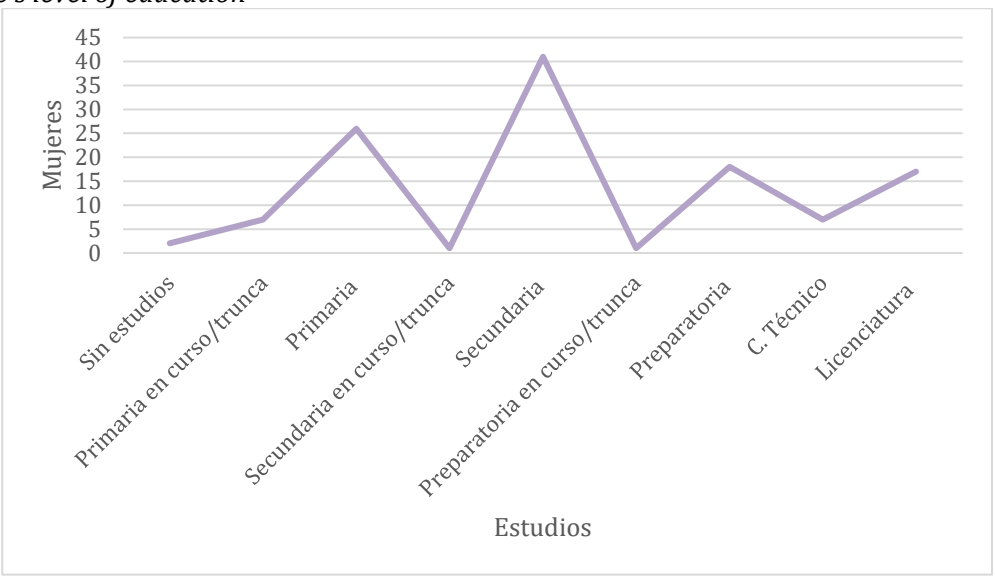
Level of education in men



Contrasting the first place of studies in men and women, for men it is completed bachelor's degree while for women it is completed high school, having a significant difference, this result is related to occupation (Hualde, 2015) since being a housewife predominated. Regarding the educational level of housewives, 34.45% only studied secondary school, 21.84% studied primary school, and only 15.12% completed high school (Figure 7).

Figure 7

Housewife's level of education



Education on a personal level means being able to socialize, acquire learning, develop potential and interact with the environment. At the social level, it translates into culture, social welfare and sustainable development (Lechuga et al., 2018). Having a lower level of education means that women face effects in the labor market, for example, less opportunity to obtain a good job, lower salaries, fewer benefits, less formality, and less possibility of acquiring goods, among others. In the personal sphere, dependence on their partner, depression, higher number of pregnancies, psychological, emotional and economic violence, occurring higher risk of violence in people who do not reach to study a degree (Gonzalez and Mora, 2014). In the social sphere, discrimination, backwardness, vulnerability, among other effects. Likewise, the importance that education suggests for economic growth and for people's income has been the

subject of several research studies increases education increases the productivity of the individual, he/she will have higher income and job opportunities (Gutierrez and Salgado, 2020). As a result of the difference in educational levels by gender there are social repercussions, for example, there is a relationship of educational level and pregnancy (Lechuga et al., 2018). In this way, the educational level has results in labor participation, globally it is currently 49% in women, for men it is 75%, (International Lobour Organization, 2018). Differences in educational level and labor occupation are important because they generate social exclusion, where social exclusion has a gender dimension that increases women's vulnerability (Lechuga et al., 2018). Therefore, gender has an effect on the level of education and, in turn, on occupation, generating economic, social, personal and environmental differences that represent a heightened vulnerability.

Discussion and Conclusions

In the present study, differences in occupation by gender were detected, while for women the first place was housewife, for men the first place was employee. Likewise, there are occupations with gender exclusivity, for example, in household matters (housewives) only women were registered, on the other hand, in the occupations of scavenger, farmer and cattle rancher only men were registered. In addition, the level of marginalization affects the occupation in both genders, in males it was found that when marginalization decreases there is a greater variety of jobs, in contrast to the female gender in which housewife predominated at all levels, however, decreasing its percentage as marginalization decreases, that is to say, it is directly proportional. Of the total number of women, only 38.7% are in the economically active population, a figure that is below the percentage reported at the national level (43.5).

Regarding the level of education by gender, for men a bachelor's degree prevailed, while for women it was secondary school completion, which has an effect on the occupation. Differences in educational level and employment are important because they generate social exclusion. Given gender roles, women have lower educational levels and therefore less job opportunities, lower incomes and less purchasing power, increasing their vulnerability.

The results indicate that there are gender differences in occupation and level of education, thus suggesting greater social and environmental vulnerability of women. As a result, this gender has greater exposure to risks, for example, climate change has different consequences by gender due to the different degree of vulnerability. Therefore, it is important to generate information to be able to implement projects and social programs focused on both raising awareness of the importance of gender equity and minimizing differences in order to reduce vulnerability and its effects.

References

Aguilar, L. (2004). Climate change and disaster mitigation Gland. International Union for Conservation of Nature. http://www genderandenvironment org/admin/admin_biblioteca/documentos/ Climate pdf

Betancur, A. & Castro, D. (2016). Significados de las normas sociales y las figuras de autoridad en personas adultas con experiencia de vida en calle. *Revista Psicoespacios,* 10(16), 67-88. Disponible en http://revistas.iue.edu.co/index.php/Psicoespacios/article/view/714/1012

Cislaghi, B. & Heise, L. (2020). Gender norms and social norms: differences, similarities and why they matter in prevention science. *Sociology of health illness.* 42(2), 407-422. doi: https://doi.org/10.1111/1467-9566.13008

Consejo Estatal de Población. (COESPO) (2017). Programa Estatal de Población 2017-2021. Gobierno del Estado de Chihuahua. Disponible en http://ceg.chihuahua.gob.mx/PED/EJE5/MedianoP/COESPO.PDF.

Comisión Nacional del Agua (CONAGUA). (2008). Estadísticas del Agua en México. Disponible en http://www.conagua.gob.mx/CONAGUA07/Publicaciones/Publicaciones/EAM_2008.pdf

Consejo Nacional de Población (CONAPO). (2010). Capítulo 1. Concepto y dimensiones de la marginación. Disponible en http://www.conapo.gob.mx/work/models/CONAPO/Resource/1755/1/images/01Capitulo.pdf

Consejo Nacional de Población (CONAPO). (2012). Índice de Marginación urbana 2010. Dirección General de Planeación en Población y Desarrollo. Disponible en http://www.conapo.gob.mx/es/CONAPO/Indice de marginacion urbana 2010.

Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL). (2010). Medición de la pobreza. https://www.coneval.org.mx/Medicion/IRS/Paginas/Rezago_social_AGEB_2010.aspx

Espinosa, S; Calzoncit, J.; Valdez, M. del R. & Castro, G. (2012). Los trabajadores sociales ¿Un grupo vulnerable*?* En Acevedo Jesús, Ma. De Los Ángeles Trijillo y María de la Luz López (1ª Ed.), *En La problemática de los grupos vulnerables: Visiones de la realidad* (10-34) Disponible en http://www.ts.ucr.ac.cr/binarios/libros/libros-000025.pdf

González, E.; Martínez, V; Molina, T.; George, M.; Sepúlveda, R.; Molina, R. e Hidalgo-R. C. (2016). Diferencias de género en la calidad de vida relacionada con la salud en adolescentes escolarizados chilenos. *Rev Med Chile*; *144*(3), 298-306

González, F. & Mora, B. (2014). Percepción sobre la violencia de género según el nivel educativo y el género. *Información psicológica*, *108*, 68-81. doi: dx.medra.org/10.14635/IPSIC.2014.108.6

Google Earth. (2020). Delicias, Chihuahua, México. https://earth.google.com/web/search/dELICIAS/@28.18622799,105.4633392,1182.68990945a,16392.25054998d,35y,0h,0t,0r/data=CnMaSRJDCiUweDg2ZWIxNWI5Y2IwMDFhOGQ6MHg4ZmQ4MDA1NzA3MmFhZjRlGZvsVRrnLzxAIbigCPNoXVrAKghkRUxJQ0lBUxgCIAEiJgokCUzkm08DODxAEbtnLmsjJjxAGcLBqKWmV1rAIXnahIutY1rA

Gutiérrez, M. & Salgado, T., M. (2020). La relación entre educación e ingresos: estimación de las diferencias salariales por nivel educativo alcanzado. DOI: 10.13140/RG.2.2.26464.30722

Hualde, A. (2015). Educación y empleo: un análisis de trayectorias ocupacionales en México. *Cuadernos del CENDES*, *32*(90), 63-86.

Instituto Nacional de Estadística y Geografía (INEGI) (2020). Estadísticas a propósito del día internacional de la mujer. Datos nacionales. Disponible en https://www.inegi.org.mx/contenidos/saladeprensa/aproposito/2020/mujer2020_Nal.pdf

Instituto Nacional de las Mujeres. s.f. Indicadores básicos. http://estadistica.inmujeres.gob.mx/formas/panorama_general.php?IDTema=6&pag=1

International Labour Organization. (2018). La brecha de género en el empleo: ¿qué frena a las mujeres? https://www.ilo.org/infostories/en-GB/Stories/Employment/barriers-women#footer

Jungehülsing, J. (2010). Relaciones de género y vulnerabilidad de mujeres frente al cambio climático. Heinrich Boll Stiftung México, Centroamérica y el Caribe. Cambio climático. Disponible en https://mx.boell.org/sites/default/files/tabasco11.pdf

Kaplan, D. & Piras, C. (2019). Brechas de género en el mercado laboral Mexicano: comparaciones internacionales y recomendaciones de política pública. *Revista de Economía Mexicana Anuario* UNAM. No. 4. Disponible en http://www.economia.unam.mx/assets/pdfs/econmex/04/04DavidKaplan-Claudia%20Piras.pdf

Lechuga, J.; Ramírez, G. & Guerrero, M. (2018). Educación y género. El largo trayecto de la mujer hacia la modernidad en México. *Journal of Economic Literature*, *15* (43), 110-139.

Matos, M. B. (2015). Mapa de Chihuahua. *Revista educativa* MapaInteractivo.net. Recuperado de https://www.mapainteractivo.net/fotos/mapa-de-chihuahua.html

Meneses, J. & Rodríguez, D. (2011). *El cuestionario y la entrevista.* Fundación para la Universitat Oberta de Catalunya. http://femrecerca.cat/meneses/publication/cuestionarioentrevista/cuestionario-entrevista.pdf

Neumeyer, E. & Plumper, T. (2007). The Gendered Nature of Natural Disasters: The Impact of Catastrophic Events on the Gender Gap in Life Expectancy, 1981–2002, *Annals of the Association of American Geographers, 97*(3): 551-556. Disponible en https://www.tandfonline.com/doi/full/10.1111/j.1467-8306.2007.00563.x

Rendón-Macías, M. E.; Villasís-Keeve, M. Á. & Miranda-Novales, M. G. (2016). Estadística descriptiva. *Revista Alergia México*, *63* (4), 397-407. Disponible en https://www.redalyc.org/pdf/4867/486755026009.pdf

Organización de las Naciones Unidas (ONU). (2015). Hechos y cifras: Empoderamiento económico. Disponible en https://www.unwomen.org/es/what-we-do/economic-empowerment/facts-and-figures#notes

Organización de las Naciones Unidas (ONU). (2020). La participación laboral de la mujer en México.Disponible en https://www.onu.org.mx/la-participacion-laboral-de-la-mujer-en-mexico/

Organización Mundial de la Salud y Fondo de las Naciones Unidas para la Infancia. (2014). Update: Progress on Sanitation and Drinking Water, 8-9. Disponible en http://whqlibdoc.who.int/publications/2010/9789241563956_eng_full_text.pdf?ua=1

Organización Mundial de la Salud (OMS). (2016). Género, cambio climático y salud. Disponible en https://apps.who.int/iris/bitstream/handle/10665/204178/9789243508184_spa.pdf;jsessionid=3D93ED105AFEF3D88522FE76E5C8CDA0?sequence=1

Organización Mundial de la Salud (OMS). (2018). Salud, medioambiente y cambio climático. Disponible en https://apps.who.int/gb/ebwha/pdf_files/EB144/B144_15-sp.pdf

Oswald, Ú. (2016). Perspectiva de género ante el cambio climático y la doble vulnerabilidad. *Revista Internacional de Ciencias Sociales y Humanidades*, 26 (2), 137-161.

Salazar, C. y Del Castillo, S. (2018). Fundamentos básicos de estadística. Quito: Sin editorial. 226 p. Disponible en http://www.dspace.uce.edu.ec/bitstream/25000/13720/3/Fundamentos%20B%C3%A1sicos%20de%20Estad%C3%ADstica-Libro.pdf

Vera, R. J. M. & Albarracín, A. P. C. (2017). Metodología para el análisis de vulnerabilidad ante amenazas de inundación, remoción en masa y flujos torrenciales en cuencas

hidrográficas. *Ciencia e Ingeniería Neogranadina,* 27(2),109-136. http://dx.doi.org/10.18359/rcin.2309

Weller, J. (2012). Vulnerabilidad, exclusión y calidad del empleo: una perspectiva latinoamericana. *Revista Internacional de Estadística y Geografía*, 3(2), 82-97.

Wood, W. & Eagly, A. (2010). Género. En ST Fiske, DT Gilbert y G. Lindzey (Eds.), *Manual de psicología social* (pp. 629–667). John Wiley & Sons, Inc. https://doi.org/10.1002/9780470561119.socpsy001017

Zamudio, F; Ayala, M.& Arana, R. (2014). Mujeres y hombres. Desigualdades de género en el contexto mexicano. *Estudios Soc*iales, *22*(44), 251-279. Disponible en http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0188-45572014000200010