Sociodemographic, cultural, environmental and agroecological characterization in order to adopt urban agriculture in the municipality of Tuluá, Colombia.

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Abstract:- Some communities have moved from the countryside to the city for different reasons, sometimes they have managed to settle in slums and some people go to agricultural production inside the city for their support, by means of a knowledge they bring from the countryside, seeking a place offering them useful resources to produce food, in this sense, urban agriculture as an alternative livelihood and occupation, has a symbolic value, since it is a survival strategy for families [3]. For this reason, this study was carried out within the macro project *"Implementación del proyecto educativo comunitario salud alimentaria y productiva en el desarrollo sustentable de la invasión de la carrilera, corregimiento Campoalegre del municipio de Tuluá"* (translated: "Implementation of the community educational project, food and productive health in the sustainable development of the invasion community La Carrilera, Campoalegre district of the municipality of Tuluá"), of the Health, Care and Society research groups; *GIUR* and Agricultural Production, which supported the characterization of the sociodemographic, cultural, environmental and agroecological components in the community of "La Carrilera" that aimed to evaluate and to identify the problems and needs of the study population, through the implementation of surveys, measurement of the biological quality of water based on the methodology used by *IDEAM*, Roldán and Shannon-Weaver, and the characterization of organic solid waste where the method defined by Marmolejo was implemented, resulting in the identification of the different social groups that make up the community, the occupation of women, the economic income of families, among others. In addition, the high levels of water pollution were manifested with a diversity index of 0.83, indicating the low diversity in the tributary of the community, also the BMWP index presented that the quality of the waters is critical and doubtful, and finally obtained an organic waste production of 60.1% identifying that mainly fruit and vegetable waste is produced. Subsequently, from the diagnosis obtained, some intervention strategies were determined for the conservation of the water resource and sustainable management practices for the use and transformation of organic waste in the study population, which allows adopting urban agriculture and contributing to sustainable development of the sector in the municipality of Tuluá, Valle del Cauca.

Keywords: Biological quality, communities, sustainable development, strategies, organic waste.

1. Introduction

In recent years, urban agriculture has been standing out in the different cities of the world as a strategy to be implemented to contribute to the development of some places seeking feasible solutions to problems of food crisis and social problems as a consequence of the changes caused quickly over time, caused by numerous variables such as the alteration of public order, natural disasters, economic losses, among others, that imminently affect cities [28].

Currently, there are numerous cities that are developing programs to promote urban agriculture. In order to become these programs truly transformative, they should integrate multiple dimensions such as health (food security), employment and social insertion (social economy), education (training and research), landscape, environment [13].

According to Morán, he mentions that "the city must be considered from a systemic perspective, which addresses the cycles of urban metabolism, the territorial context and the cultural and identity processes of the societies that inhabit them" [13], therefore, meeting the needs that arise from the different processes carried out in the communities that make up the urban area, mainly in low-income

communities, it is considerably important to be able to maintain stability within the system.

Based on the above, the need arose to help the community of "La Carrilera" invasion established in the city of Tuluá Valle del Cauca, which shows high poverty rates, where some social and food problems are evidenced as a result of the diverse needs and scarce opportunities that the population presents [20].

For this reason, urban agriculture became known as one of the development strategies that has been established worldwide in different cities, carried out in most cases as the most appropriate activity to contribute to the progress of populations [30]. Besides, this type of agriculture is related to other concepts such as alternative agriculture, which is defined as a way of life that respects the environment, by protecting natural resources and the human being in all its context, freeing it almost entirely from dependencies of the external environment and turning it into an element of social transformation [21].

Likewise, urban agriculture contributes significantly to cultural development, allowing the exchange of knowledge, experiences and the conservation of identity, environmental development, raising awareness about the use of natural resources, economic development, producing some food and allowing the income of the families to be used for other basic needs, and to the health contributing in the nutrition [19]. For his part, Nault believes that urban agriculture favors contact with the community and stimulates dialogue between neighbors, thus developing and strengthening community ties [14]. In this sense, it was possible to highlight urban agriculture as a fundamental tool to bring an impact on a social, cultural, environmental, economic level and achieve sustainable development, especially in low-income communities as in the invasion community "La Carrilera" in the municipality of Tuluá.

In Colombia, on the other hand, urban agriculture has been developed in cities such as Bogotá and Medellín to be promoted as a government project. The Mayor's Office of Bogotá in 2004, began the "*Bogotá sin hambre*" ("Bogota without hunger") program, being a public policy plan of the government of Mayor Luis Eduardo Garzón through which, through the Botanical Garden of Bogotá (JBB for its acronym in Spanish *Jardín Botánico de Bogotá*), are promoted as a final objective the practices of urban agriculture in this city. Similarly, in Medellín, the MANÁ (Food and Nutrition Improvement Program) program was carried out, which has contributed to the development of family gardens in urban areas. Currently, it has more than 7500 orchards in 90 municipalities and has become the flagship project to guarantee food sovereignty and security in the region [9].

Taking into account the foregoing, the importance of having carried out this work is highlighted by trying to raise awareness of urban agriculture for the development of the study community which lacks the resources and opportunities to lead a decent quality of life, being a critical situation that requires the collaboration of institutions or entities of the state contributing with the development and execution of strategies for the sustainable development of the community.

2. Methodology

A. Localization

The study was carried out in the community of "La Carrilera" invasion established in the city of Tuluá in the department of Valle del Cauca, Colombia, located geographically with the coordinates 4° 05' 05'' north latitude and 76° 11' 55'' Western length, has a height of 966 meters above sea level, with an average temperature between 26 - 28°C, relative humidity (RH) 78% and annual average rainfall of 900 mm. The community is made up of displaced people and people with limited resources who have different needs, being a population vulnerable to social, cultural, environmental problems, among others [20].

B. Ethnographic and cartographic diagnosis in the invasion community "La Carrilera"

The diagnosis of the community was made in order to identify problems and needs within the sociodemographic, cultural, environmental and agroecological components. In order to carry out this process, the recognition of the land was carried out through ethnographic observation in which, through some tours made in the place of study, it became possible to demonstrate the activities carried out by the people of the community in their daily lives, in addition, dialogues were built among the inhabitants to acquire confidence and information about their needs and problems in the population.

Then a socialization of the project was carried out, in which the objectives and activities to be developed in the educational project were exposed to the inhabitants of the study population. Subsequently, the characterization was carried out through surveys conducted to members of the community for the diagnosis of the current condition, in this way the information was collected and the sociodemographic, cultural, environmental and agroecological characteristics of the community "La Carrilera". Additionally, a social mapping was carried out in the communal sector with some of the inhabitants of the invasion community "La Carrilera", which, through the creation of maps of resources and needs, helped to identify the most relevant factors.

On the other hand, a field journal was used that allowed describing the most relevant facts in the activities, interventions and difficulties presented during community practices in the sector. In addition, a qualitative and quantitative study model was worked, allowing the identification of sociodemographic, cultural, environmental and agroecological factors. Then, databases were prepared for the tabulation of the information collected through the surveys carried out and the social cartography, which was carried out in the Microsoft Office Word and Excel programs [20], finally an analysis of the results against the problems and needs found in the invasion community "La Carrilera".

C. Determination of strategies for the conservation of water resources in the invasion community "La Carrilera"

The formulation of strategies for the conservation of the water resource was carried out through the measurement of the biological quality of the water of the Tuluá River and the study of the problems and needs of the invasion community "La Carrilera". In this sense, the measurement and determination of the biological quality of the water used by the community for its consumption and agricultural activities, was carried out through the identification of aquatic macroinvertebrates, used as bioindicators of water quality.

In this way, the recognition of the sampling site was the starting point, through the identification and selection of three points corresponding to the sample of an arm of the Tuluá River which crosses the entire invasion community "La carrilera". For its recognition, a map of the place was made and some aspects were described as weather conditions, coordinates, flow, and predominant vegetation, among others.

Then, the samples of the aquatic macroinvertebrates were collected using a manual net, consisting of a 900 cm2 frame that holds a nylon net and a metal handle. The frame was placed on the bottom of the stream in order to perform a scan, the macroinvertebrate organisms being trapped in the nylon, the scanning is done at least 3 times at each of the sampling points to form a single representative sample. The collected individuals were deposited in a plastic container and 95% alcohol was added for conservation, finally the samples were taken to the integrated laboratories of the UCEVA for later identification [16].

The identification and classification of aquatic macroinvertebrates was continuously carried out based on the descriptions and keys presented in the *IDEAM* aquatic macroinvertebrates manual and the guide for the study of aquatic macroinvertebrates of the Department of Antioquia. This identification started with the separation of the collected macroinvertebrates, in which the samples were passed through a 2mm sieve, to extract the macroinvertebrates from other materials such as sand, earth, lama, leaves, among others. It was necessary to soak the samples in water for 15 minutes to hydrate the organisms and prevent them from floating, then each portion of the sample was washed and placed on a white tray where a small amount of water was added to facilitate separation [16].

Likewise, the classification was carried out by means of the microscope, in which the collected species were observed taking into account some specific characteristics of the head and tail that facilitate identification, in this way, it was possible to classify taxonomically up to the family level and in some cases where even gener was possible, then the found families were counted.

Subsequently, the biological indices were determined to be used in this study in the measurement of water quality, which were the Shannon-Weaver diversity index and the modified BMWP (Biological Monitoring Working Party) index for Colombia, these indices helped assess the response of the macroinvertebrate community to water pollution in the

Tuluá River. The following is the method used to obtain the value of the indexes mentioned [9]:

Diversity Index (Shannon-Weaver). It was obtained from the following formula:

(Ec.1)

$$H' = -\sum_{i=1}^{S} (pi * Log_2 pi)$$

Source: Pinilla G., 1998

pi = ni/N = number of individuals of the species.
i = total number of individuals in the entire community.

The result determined the degree of contamination of water ranging from 0 to 5, indicating highly contaminated, moderately contaminated and very clean waters respectively.

BMWP Index (Biological Monitoring Working Party). In order to obtain this index, the taxonomic level in aquatic macroinvertebrates was taken into account and according to the ecological scores assigned to the families for their characteristics as a bioindicator (See TABLE I), a total sum of scores was made with which it was determined its value, classifying it according to its degree of contamination (Class I, II, III, IV, V) and subsequently assigned a color according to its classification level (See TABLE II).

Table 1. Points assigned to the different families of aquatic macroinvertebrates for the obtaining of the bmwp/col (modified of roldán, 2003 in álvarez, 2006).

Families				Points
Anomalopsychidae, Atriplectididae, Blephariceridae,	Ptilodactylidae, Chordodidae, Gripopterygidae	Lampyridae, Odontoceridae, Perlidae	Polymitarcyidae, Polythoridae, Psephenidae	10
Coryphoridae, Ephemeridae, Euthyplociidae,	Gomphidae, Hydrobiosidae, Leptophlebiidae	Limnephilidae, Oligoneuriidae, Philopotamidae	Platystictidae, Polycentropodidae, Xiphocentronidae	9
Atyidae, Calamoceratidae, Hebridae, Helicopsychidae,	Hydroptilidae, Leptoceridae, Limnephilidae, Lymnaeidae,	Palaemonidae, Planorbidae (Cuando es dominante Biomphalaria)	Pseudothelpusidae, Saldidae, Sialidae,	8
Hydraenidae,	Naucoridae		Sphaeriidae	
Ancylidae, Baetidae, Calopterygidae, Coenagrionidae,	Dicteriadidae, Dixidae, Glossosomatidae, Hyalellidae	Hydrobiidae, Hydropsychidae, Leptohyphidae, Lestidae	Pyralidae, Simuliidae, Veliidae	7
Aeshnidae, Ampullariidae, Caenidae, Corydalidae,	Dryopidae, Dugesiidae, Elmidae, Hyriidae	Limnichidae, Lutrochidae, Megapodagrionidae	Mycetopodidae, Pleidae, Staphylinidae	6
Ceratopogonidae, Corixidae, Gelastocoridae,	Glossiphoniidae, Gyrinidae, Libellulidae	Mesoveliidae, Nepidae, Notonectidae	Tabanidae, Thiaridae	5
Belostomatidae, Chrysomelidae, Curculionidae, Ephydridae,	Haliplidae, Hydridae, Muscidae	Scirtidae, Empididae, Dolichopodidae	Hydrometridae, Noteridae, Sciomyzidae	4
Chaoboridae, Cyclobdellidae,	Hydrophilidae (larva)	Physidae, Stratiomyidae	Tipulidae	3
Chironomidae (when it is not the dominant family, if it dominates it is 1)		Culicidae, Psychodidae	Syrphidae	2
Tubificidae				1

Source: Arango M, *et al*., 2008

Table 2. Water classification and its ecological meaning in accordance with the bmwp col index (modified by roldán, 2003 in álvarez, 2006).

Class Quality Value of the BMWP Meaning Color
I Good> 150 Very clean waters Blue
Strongly polluted waters, critical situation Red
Source: Arango M, et al. (2008), Adapted by Hidalgo V., 2018

Class	Quality	BMWP value	Meaning	Color
I	Good	> 150	Very clean water	Blue
		101-120	Nom-polluted water	
II	Acceptable	61-100	Slightly polluted: pollution effects are evidenced	Green

III	Doubtful	36-60	Moderately polluted water	Yellow
IV	Critical	16-35	Very polluted water	Orange
V	Very critical	<15	Strongly polluted water, critical situation	Red

Source: Arango M, et al. (2008), Adapted by Hidalgo V., 2018

Finally, the study of the surveys in the community was carried out, considering the information obtained in the diagnosis for the identification of the problems and needs, and through a bibliographic review of some authors who have worked on the topic of water conservation, they determined the strategies of conservation of the water resource to be implemented later in the community.

D. Determination of sustainable management practices based on urban agriculture in the invasion community "La Carrilera"

In order to determine some sustainable management practices from urban agriculture, with which the organic waste generated by the study community can be used, it was necessary to carry out the characterization of organic solid waste for the identification of these residues.

This characterization started with the recognition of the study area, where some visits and tours were carried out to identify the need to develop this study, in this way, the problems of pollution in the community became evident. The sample size was then established, which was determined from the total number of homes that are approximately 158 houses. In addition, taking into account the decision-making process and the participation of the community itself, in order to carry out this activity, it was decided to carry out 10% of the total number of residences, obtaining a representative sample of 16 dwellings for this study [9].

Once the sample size was defined, the selection of the houses was continued randomly to carry out the characterization. Each of the selected homes was trained to provide guidance on the management of solid waste and aspects such as: presentation to the owners of the selected homes, communicating about the type of information to be collected, the work to be performed with the collected waste, record the name of the responsible person, the number of the dwelling and the number of inhabitants per selected dwelling [11].

Then, a test test was carried out with the selected homes for 5 continuous days, in which they were told through brochures how to perform the separation of solid waste and the owners were given 3 bags of different color every day (black, green, red) based on the colors of the bags determined in the classification of the different types of solid waste defined by the Colombian Technical Standard *NTC-GTC 24*. From the collected samples weighed the organic waste to estimate the amount generated in the 5 day trial [9].

Based on the previous procedure, experimental sampling was carried out, which consisted of carrying out the collection of solid waste in previously selected and trained homes for 14 consecutive days, trying to carry out this activity every day at the same time. Subsequently, the collected samples were taken to the integrated laboratories of the UCEVA, for the identification of organic waste, where a daily weighing of the waste was carried out using a scale and then the samples were divided into two parts to observe and make a description of the organic material found [9].

Subsequently, databases were prepared for the tabulation of the information collected and based on the data collected, the per capita generation of organic waste was determined using the total waste collected per day and daily weighed, all the bags collected during the days that the experimental sampling lasted, taking into account that the first day was not considered for the analysis. Then, the number of people per home determined the total number of people who participated in the sampling and the total weight of the bags was divided by the total number of people, thus obtaining the average daily per capita generation of the sampled homes (gr/hab/day), [11].

$$Generation\ per\ capita\ daily\ of\ waste\ (gpc) = \frac{total\ weight\ of\ waste\ (Wt)}{Total\ number\ of\ people\ (Nt)} \quad \text{(Ec.2)}$$

After that, a projection of the total daily organic waste produced in the study community was made, multiplying the generation per capita of organic waste (gpc) by the average number of inhabitants found in the sampling dwellings, after obtaining the result, it

was multiplied by the total number of homes that make up the community [9].

$$Total\ daily\ waste\ generation\ = \quad (Ec.3)$$

$$(gpc * average\ inhabitants)(Total\ of\ dwellings)(Kg/day)$$

Finally, by means of the diagnosis made in the invasion community "La Carrilera", the information for the identification of the problems and needs was taken into account, in the same way, the bibliographic review of some sources such as articles, technical manuals, books, among others, prepared by authors with experience in the subject of sustainable management practices to be implemented in the communities, in this way, some management practices were proposed based on the concept of urban agriculture, in order to use organic solid waste generated by the community.

This work was carried out as part of the macro research project "*Implementación del proyecto educativo comunitario salud alimentaria y productiva en el desarrollo sustentable de la invasión de la carrilera, corregimiento Campoalegre del municipio de Tuluá*", carrying out in the first phase the diagnosis and strategy approach. This project will last five years and will consist of five phases to develop the implementation in the later phases of the project.

3. Results

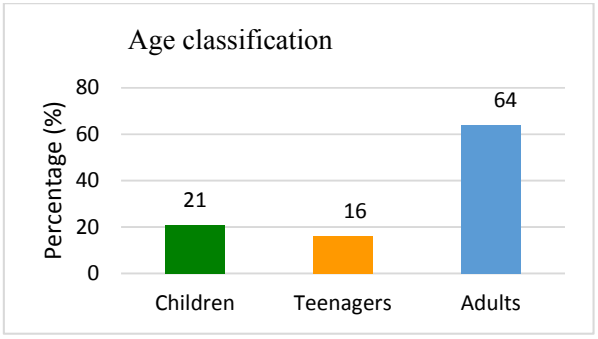
A. Ethnographic and cartographic diagnosis in the invasion community "La Carrilera"

Based on the surveys and social cartography carried out in the invasion community "La Carrilera", a diagnosis was made of the current condition of the study population, managing to identify some relevant aspects such as those described below:

1) Sociodemographic and cultural components.

It was determined that the study community is mainly made up of adults with 63.8% while children and teenagers are 20.5% and 15.6% respectively (see Fig. 1). According to some studies conducted previously by the UCEVA, the population is mostly made up of children, teenagers and female head of household [20].

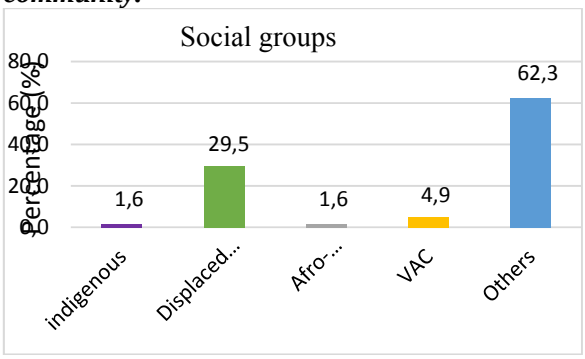
Fig. 1 Age classification of the inhabitants of "La Carrilera".



Source: Hidalgo V., 2018 (translated)

Likewise, it was inquired which were the social groups that are currently in the community of "La Carrilera", finding that 3.2% are represented jointly by indigenous and afro-descendants, while 29.5% are made up of displaced persons in the same way, 4.9% are inhabitants victims of the armed conflict (VAC) and finally 62.3% correspond to people who did not identify with any of the aforementioned groups (see Fig. 2).

Fig. 2 Social groups that are in the "La carrilera" community.

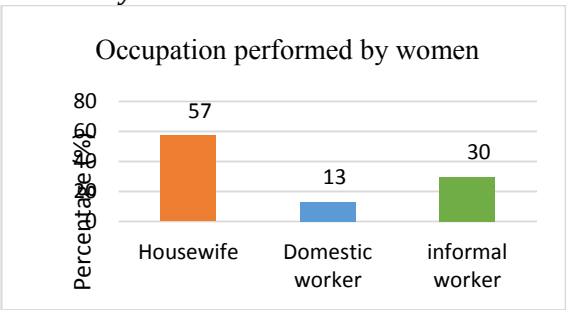


Source: Hidalgo V., 2018 (translated)

Taking into account the importance of the participation of women in different social and cultural activities, it was inquired about the occupation of women in their daily lives, finding that 57.4% of them are housewives and 13.1 % are domestic workers, however, a significant percentage of 29.5% perform other types of work, for example, motorcycle taxi riders, coal merchants, traders, farmers, among others (see Fig. 3). Likewise, it was determined that the role of women in the study community is very important for decision-making, demonstrating that women lead their population representation by having a

community leader and a president of the community action board.

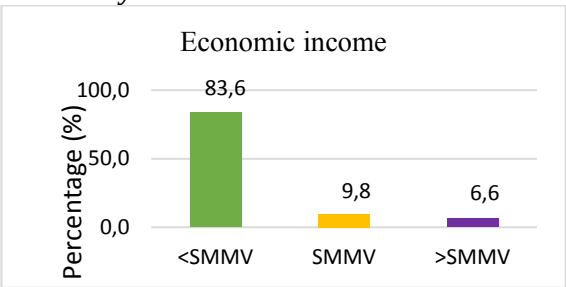
Fig. 3 Occupation performed by women in the community "La Carrilera".



Source: Hidalgo V., 2018 (translated)

Similarly, the economic income of the families of the community was considered and it was determined that 83.6% live on less than a minimum wage (<SMMV), while 9.8% receive the minimum wage (SMMV) and 6.6% of the families have a monthly support higher than the minimum wage (>SMMV) for various income they have (see Fig. 4).

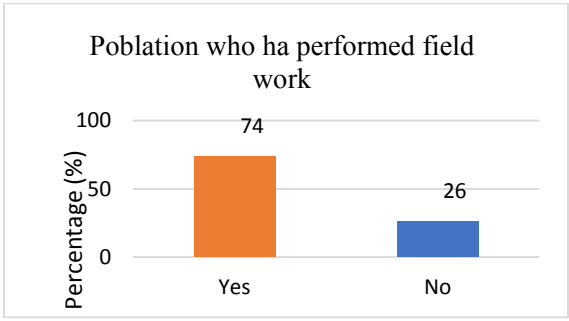
Fig. 4 Economic income of the families of the community "La carrilera".



Source: Hidalgo V., 2018 (translated)

On the other hand, people who have performed in field work were identified and it was found that 73.8% of the population surveyed did work in field activities at some time, however, 26.2% indicated that they have not performed a similar work with respect to field (see Fig. 5).

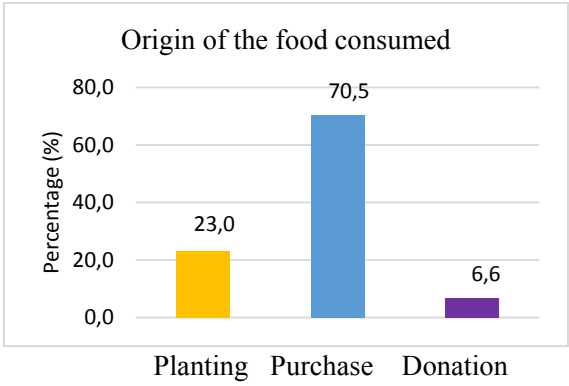
Fig. 5 Population that has performed field work in the community "La carrilera".



Source: Hidalgo V., 2018 (translated)

Likewise, it was determined that a large part of the study population accesses food mainly through the purchase corresponding to 70.5% of the inhabitants, others instead access food through planting, representing 23% of the population and 6.6% state that they depend mainly on the donation made by third parties (see Fig. 6).

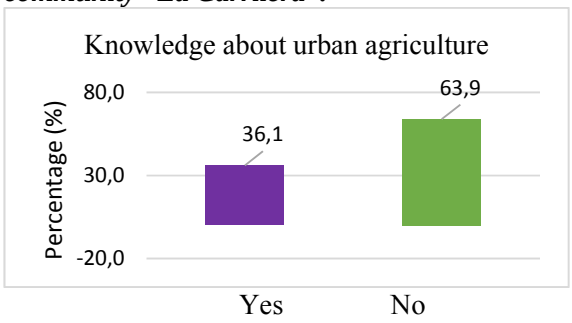
Fig. 6 Origin of the food consumed by the community "La Carrilera".



Source: Hidalgo V., 2018 (translated)

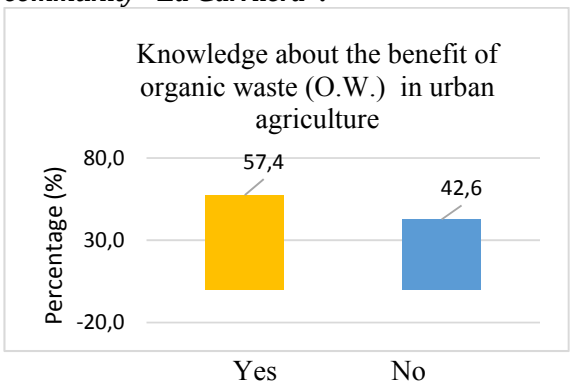
2) Environmental and agroecological components.
On the other hand, it was inquired with the community if they know or have heard about urban agriculture or community gardens, where 36.1% said they knew about this practice, while 63.9% of the remaining population still do not know the topic (see Fig. 7). As a whole, it was asked if they know the benefits of using organic waste in urban agriculture and it was obtained that 57.4% say they know their benefits, on the contrary, 42.6% state that they are unaware of the advantages of use organic waste in urban agriculture (see Fig. 8).

Fig. 7 Knowledge about urban agriculture in the community "La Carrilera".



Source: Hidalgo V., 2018 (translated)

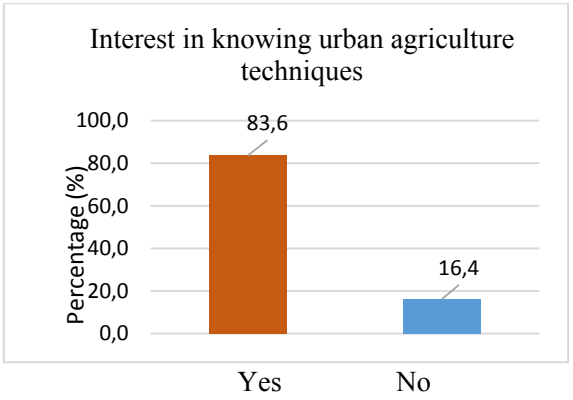
Fig. 8 Knowledge about the benefit of organic waste (O.W.) in urban agriculture by inhabitants of the community "La Carrilera".



Source: Hidalgo V., 2018 (translated)

Additionally, it was consulted if the community is willing to learn and in fact to learn about urban agriculture techniques, in this way, a large part of the population expressed interest in learning from this activity representing 83.6% of the respondents, however, a 16.4% indicated they had no interest in urban agriculture, because it is unknown or even because food has not been cultivated at some point (see Fig. 9).

Fig. 9 Interest of the invasion community "La carrilera" in knowing urban agriculture techniques.



Source: Hidalgo V., 2018 (translated)

On the other hand, the solid waste that is most produced in the homes of "La Carrilera" was studied, finding that 54.1% corresponds to plastics or PET containers, followed by paper and cardboard with 49.2 %, and organic waste representing 21.3%, as well as some homes indicate that mostly glass and metal corresponding to 3.3% and 1.6% are produced respectively (see Fig. 10).

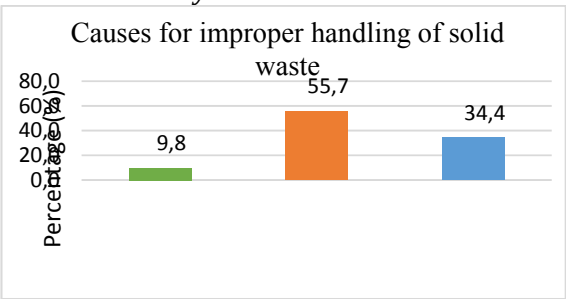
Fig. 10 Solid waste generated in greater quantity in the invasion community "La Carrilera".

Paper and cardboard, plastics/PET containers, glass, metal, polysterene and organic waste.

Source: Hidalgo V., 2018 (translated)

In the same way, the community expressed that the inadequate management of solid waste is generally due to the lack of knowledge of the population in its reuse processes, representing 55.7% of the families that coincide with this description, however, 9,8% state that it is due to the lack of training on the different uses and benefits, and finally 34.4% affirm that it is due to lack of interest in the recycling issue (see Fig. 11).

Fig. 11 Causes for improper handling of solid waste in the community "La Carrilera".

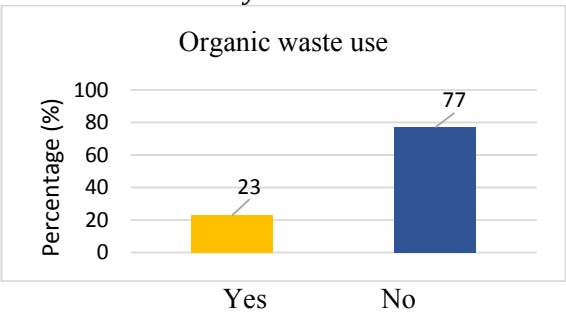


Lack o training, lack of knowledge, lack of interest.

Source: Hidalgo V., 2018 (translated)

On the other hand, a small part of the study population represented by 23% state that they use and benefit from organic solid waste, as some use it as animal feed and/or as a form of fertilizer for plants, while 77% of the inhabitants do not use this waste (see Fig. 12).

Fig. 12 Use of organic solid waste in the "La carrilera" community.



Source: Hidalgo V., 2018 (translated)

From the information studied, the consolidated of the evaluated variables was obtained, showing that the current situation of the invasion community "La Carrilera" is insufficient to provide decent living conditions to the population, as evidenced by many of the deficiencies they present additionally, serious environmental pollution problems are added. In this way, the sociodemographic component showed a value of 2.8, indicating that some social and economic factors need to be improved, and the cultural component with a value of 2.7 also demonstrates that education, participation and food security in the the community is not enough to have stability and finally the environmental and agroecological components are shown at a value of 2.3, indicating that it requires prompt intervention to contribute to the progress of the environmental situation and achieve an adequate management of natural resources (see Fig .13).

In this sense, the macro research project *"Implementación del proyecto educativo comunitario salud alimentaria y productiva en el desarrollo sustentable de la invasión de la carrilera, corregimiento Campoalegre del municipio de Tuluá"* that will last five years and will consist of five phases , in which it is intended to implement some of the strategies put into consideration in the development of this study in the first phase, where they will be executed in later phases of the project and thus achieve a positive impact on the study population.

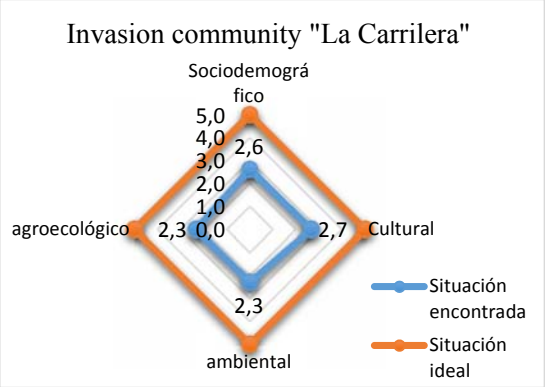
B. Determination of strategies for the conservation of water resources in the invasion community "La Carrilera"

According to the characterization made to the community's water resource, it was found that the water source is used for different activities such as irrigation, agricultural or livestock use and for housing, in addition, it does not present any type of treatment for its use and final disposition, in the same way, it is not protected or isolated for its conservation and the inhabitants can dispose of the tributary at any time, which is constantly in abundance.

On the other hand, by identifying the sampling site, different vegetative species such as red dandelion (*Emilia purpurea*), fern (*Pteridium aquilinum*), sugar cane (*Saccharum officinarum*), amaranth (*Amaranthus incomptus*), cane cane (*Arundo donax*), banana (*Musa x paradisiaca*), papyrus (*Cyperus papyrus*), guava (*Psidium guajava*), mango (*Mangifera indica*) and guadual (*Guadua angustifolia*), some of them of bioremediation interest which, when found adapted to the place, favor regulation and filtration of some water pollutants.

Similarly, as a result of the identification of aquatic macroinvertebrates, a list of the species found is presented, taxonomically identified to family and others to gender (see TABLE III).

Fig. 13 Consolidated of the sociodemographic, cultural, environmental and agroecological indicators in the invasion community "La carrilera".



Socio-demographic, agro-ecological, environmental, cultural. Blue, found situation; orange, ideal situation.
Source: Hidalgo V., 2018

Table 3 identification of the aquatic macroinvertebrates of the tuluá river in the invasion community "la carrilera".

Identification of aquatic macroinvertebrates			
Order	**Family**	**Gender**	**N° Individuals**
Ephemeroptera	*Baetidae*	*Baetodes* sp	3
Trichóptera	*Hydropsychidae*	*Smicridea*	2
	Glossosomatidae	*Mortoniella* sp	1
	Hydroptilidae		2
	Leptoceridae		1
	Hydrobiosidae	*Atopsyche*	1
Coleóptera	*Psephenidae*	*Psephenops*	4
	Staphylinidae		3
Díptera	*Dolichopodidae*	*Aphrosylus* sp	2
	Chironomidae		3
Basommatóphora	*Physidae*		9
Mesogastropoda	*Thiaridae*		24
		Σ	55

Source: Hidalgo V., 2018

The above table shows the 55 individuals that were studied, the species found in the greatest amount was *Thiaridae* with 24 individuals; these organisms live in slow-flowing waters and are equipped with rooted or submerged aquatic vegetation that favor the proliferation of this species [24].

On the other hand, in 2014 the composition and structure of aquatic macroinvertebrates was determined in the Tuluá River where 1174 individuals were found distributed in 3 Phyllum, 4 Classes, 12 Orders, 25 Families and 12 Genders with diversity values between medium and low [26]. In this work, 6 Orders and 12 families of aquatic macroinvertebrates were found in the tributary of the community.

1) Determination of biological indices.
According to the biological indeces studied for diversity (Shannon-Weaver) and BMWP, a value of 0.83 was obtained for the diversity index, indicating that the affluent of the community is highly contaminated. Likewise, in a study conducted in 2014, very low values of diversity were found from 0.1 to 2.6 at different sampling points in the Tuluá River when determining its ecological quality, indicating that low diversity is due to that few organisms are resistant or tolerant to water pollution conditions (see TABLE IV), [26].

Table 4. Diversity index (shannon-weaver) for the community of aquatic macroinvertebrates.

Shannon-Weaver diversity index				
Family	**N° Individuals**	**Pi**	**LogPi**	**PixLogPi**
Baetidae	3	0,05	-1,26	-0,07
Hydropsychidae	2	0,04	-1,44	-0,05
Glossosomatidae	1	0,02	-1,74	-0,03
Hydroptilidae	2	0,04	-1,44	-0,05
Leptoceridae	1	0,02	-1,74	-0,03
Hydrobiosidae	1	0,02	-1,74	-0,03
Psephenidae	4	0,07	-1,14	-0,08
Staphylinidae	3	0,05	-1,26	-0,07
Dolichopodidae	2	0,04	-1,44	-0,05
Chironomidae	3	0,05	-1,26	-0,07
Physidae	9	0,16	-0,79	-0,13
Thiaridae	24	0,44	-0,36	-0,16
Σ	55	Σ		-0,83
			H'	0,83

Source: Hidalgo V., 2018 (translated)

Likewise, in TABLE V the estimated values are presented by sampling point with the BMWP index, which indicated that the water of the Tuluá River in the community of the invasion "La Carrilera" presents high degrees of contamination, in the same way in which was manifested by the diversity index (Shannon-Weaver). These results resemble values determined by some previous studies carried out on the Tuluá River in the urban area, where it is indicated that the quality conditions of the aquatic environment of the Tuluá River in the lower part meet very polluted waters and very critical quality [26]. On the other hand, in 2017, it was also stated that the waters of the Tuluá River in the urban part continued to be classified as contaminated waters, due to uncontrolled discharges to the river, inhabitants of the street, waste in the river, etc. [16]; Similar reasons why pollution in the water resource of the study population is present today [9].

Table 5. Classification of the biological quality of the water of the tuluá river in the invasion community "la carrilera" according to the index bmwp col.

Sampling point	Class	Quality	BMWP value	Meaning	Color
1	IV	Critical	35	Highly polluted water	Orange
2	IV	Critical	27	Highly polluted water	Orange
3	III	Doubtful	57	Moderately polluted water	Yellow

Source: Hidalgo V., 2018 (translated)

Taking into account the results obtained in this measurement of the biological quality of the water of the Tuluá River in the invasion community "La Carrilera", some viable strategies for the conservation of the water resource were determined, which can be implemented and thus contribute to the reduction of environmental pollution.

2) Strategies for the conservation of water resources in the invasion community "La Carrilera".

To achieve the conservation of the water resource, some of the strategies that allow to intervene in the development of this process are considered, which are described below:

Strategy 1. Restoration of the place with native species.

To protect and conserve the water source, it is proposed to establish native species and some induced species that contribute not only to improving the conditions of ecological quality but also to animal and human food in the community of the invasion "La Carrilera". In this way, it is intended to restore the defragmented sites found in the place because of the inappropriate actions carried out by the community itself in the different agricultural, livestock, and other activities [9].

In this regard, it should be noted that ecological restoration is a long-term activity and therefore those who must guarantee the continuity of the projects are local populations with the support of local, municipal, departmental and national organizations [27]. In addition, it must be taken into account that the community must be considered as an integral unit, therefore, it is necessary to promote the participation of adults (women and men), youth, boys, girls and generate work processes among [27]:

- Peasant community: agricultural workers of different ages and genders.
- Indigenous communities.
- School community: teachers, parents and students.
- Local entities: community associations, NGOs, indigenous organizations, environmental organizations, state entities that participate in the regional conservation of resources.
- Ecological conservation and restoration researchers: biologists, ecologists, forest engineers, anthropologists, sociologists, geographers and social workers.

Strategy 2. Establishment of a river corridor for the micro basin of the Tuluá River.

One of the most viable options to restore some connectivity in many ecosystems and its conservation is through strips of vegetation protecting the rivers, these strips or river corridors serve as a filter or barrier to reduce water pollution, sediment transport or also as a natural barrier to land uses, among others [4]. In addition, the river corridor is a type of "biological corridor" which allows the enclosure and improvement of the habitat, which are important to allow levels of connectivity and supply of appropriate resources [18].

In the same way, the protective strips in the urban environment allow the "human habitat", specific non-residential activities of low impact where the use of the water source is involved: recreational, sports, cultural, pedestrian and cycling paths, etc., also they can drastically reduce the risks caused by floods, create small habitats for fauna and flora within the city, facilitate the flow of water with open pipes, control wastewater discharges, avoid spills of anthropic solid waste, among others [4].

Strategy 3. Homemade activated carbon filter.
Taking into account the needs of the study population, which does not have a potable water service, a strategy is proposed that improves water quality and also improves health conditions in the inhabitants of the community. In this sense, the homemade activated carbon filter serves as a primary treatment and plays a very important role in improving water quality in marginalized rural and urban areas. Filters can drastically reduce the number of viruses, bacteria, protozoa or eggs of nematodes harmful to health [2].

In this way, activated carbon is presented as a natural material that attracts, captures and breaks pollution molecules, normally retains non-polar substances such as mineral oil, aromatic polyhydrocarbons, chlorine and derivatives, halogenated substances such as I, Br, Cl, H, F, substances that generate bad odors and flavors in the water, yeasts, organic matter, microorganisms, herbicides, pesticides, among others, all without altering the original composition of the water, respecting the oligominerals and without generating waste. In addition, it should be taken into account that the effective life of the carbon in the filter will depend on the quality of the coal, as well as the characteristics of the water source; a homemade carbon filter that supplies 300 L/day must be renewed at least once a year [2].

C. Determination of sustainable management practices based on urban agriculture in the invasion community "La Carrilera"
Considering the process of characterization of organic solid waste, 222 Kg of organic waste was obtained during the 14 days of sampling, as a daily indicator it showed an average generation of 17.1 Kg to total approximately one year in 6.2 Ton, of in the same way, a total projection of the 158 homes in the community was made, obtaining a daily production of 169 Kg, a monthly production of 5.1 Ton and an annual production of 60.7 Ton of organic waste generation. In addition, the daily percapic generation of organic waste on average was 222.1 gr per inhabitant and the average per family was 1.06 Kg, on the other hand, the average number of inhabitants per dwelling was determined, which for this sample was 4.8 [9].

These results are similar to the values obtained in Salento Quindío in 2012, where a community made up of 117 homes was characterized, the sampling performed generated 485 Kg of solid waste during a month, allowing to establish as a daily indicator an average of 16 generation, 1 Kg in sampled homes [23].

On the other hand, when carrying out a total weighing of the solid waste samples, it was possible to calculate that 39.9% correspond to inorganic solid waste, which was mostly made up of paper, cardboard, plastic, icopor, glass, among others; in some cases these wastes are recycled and sold, others are disposed of in the drought that crosses the entire community or burned, which leads to critical problems of environmental pollution, while 60.1% of the remaining solid waste is organic [9].].

Besides, when identifying the organic waste, what was found mainly were vegetable remains in a proportion of 19%, followed by fruits with 18%, in the same way, tubers and animal derived residues are presented in the 18%, 12% was also obtained in remains of cereals and also wastes of pruning and legumes with 8% and 7% respectively (see Fig. 14), [9].

Fig. 14 Characterization of organic solid waste generated by the invasion community "La carrilera".

Animal derived residues (18%), pruning (8%), root vegetables (18%), cereals (12%), fruits (18%), legumes (7%), vegetables (19%)
Source: Hidalgo V., 2018

From the previous results and taking into account that organic waste is mostly made up of all types of waste material produced by the processing, handling, processing of food or any other plant or animal origin, it should be noted that these can be used and used in transformation processes, by performing practices such as composting, vermiculture, among others; with which you can obtain economic benefits that contribute to improving living conditions [9].

1) Management practices for the use, transformation and final disposal of organic solid waste.
To achieve an adequate management of biotransformation, some viable strategies are proposed to support the process of use and minimization of organic waste:

Strategy 1. Vermicomposting.
It is a technique that consists of the use of worms to obtain compost from organic matter residues, which can be developed in small spaces, ideal for application in urban gardens [7]. This method is complementary to composting to reduce household organic solid waste, some of the reasons that are found to be carried out are described below [12]:

- Promotes ecology by reducing pollution problems generated by organic solid waste.
- Transforms organic waste into products or co-products of great benefit to man.
- Earthworms produce a high quality humus, with a very stable crumb structure, allowing greater advantages over other types of organic fertilizers, such as the richness of enzymes and microorganisms that stimulate plant growth and restore the earth-vegetable's balance.
- The nutrients in the worm compost are in available form for plants; its content with respect to certain elements in particular varies depending on the food consumed by the earthworm.
- With the vermicompost obtained, the plants of the urban garden can be paid in a very economical way.
- The protein content present in earthworms allows them to be used as a supplement in human and animal nutrition.

Strategy 2. Composting with the use of black soldier flies (*Hermetia illucens*).
By using black welded flies, composting can be performed more efficiently, because unlike the Californian earthworm, they can feed on any type of organic waste such as (vegetables, citrus, grains, meat, dairy products, fats, vegetable oils and manure), in addition, due to its characteristics, it gives some benefits to the composting process [29]:

- They manage to digest food faster: Larvae can digest more than 15 kg per day of food waste per square meter.
- They help prevent flies: The larva eats larvae and fly eggs that transmit diseases to animals and humans.
- They eat any type of food and are a source of food for many animals: they feed on all types of waste and are an ideal protein food for birds, pigs and fish.
- They do not have any type of parasite.
- More resistant than other worms to various substances such as ammonia, alcohol and toxic substances in food.
- Due to their high activity and movement in the larval state, they keep the medium aerated and prevent anaerobic pathogens.
- They do not eat live plants or vegetables.
- They can withstand minimum temperatures of 0 ° C and maximum temperatures of 45 ° C.

Strategy 3. Liquid biofertilizer based on fruits and vegetables.
Taking into account that the majority of organic waste generated in the study community corresponds to fruit and vegetable waste, it is proposed to produce a product obtained from the fermentation process, which is basically used as a foliar fertilizer. Beneficial microorganisms such as mycorrhizae, rhizobium, azotobacter, among others, are used to make the product; they help with the breakdown of organic waste and convert them into nutrients available to plants [9]. Some of the reasons for preparing this type of organic fertilizer are described below [25]:

- Organic household materials are used.
- Its handling is simple and its elaboration is easy to understand.
- It can be exchanged or sold to get other products of interest.
- It does not pollute the earth and do not influence people's health.
- It increases the quality and quantity of plants and fruits of the garden.

The above proposals are intended to be applied on a small scale, such as community organic solid waste

transformers, which can be developed in five phases [22]:

- Use of the material: collection, selection and cutting of the material.
- Transformation of organic solid waste: biological composting processing.
- Compost production: harvest or collection of compost already processed.
- Use of fertilizer in productive processes: benefiting the community gardens.
- Marketing of the product obtained.

In this way, it is intended that when considering the above strategies and being carried out in the study community, urban agriculture can be projected as an alternative for sustainable development which contributes to improving the current situation in aspects related to social, environmental and economic.

D. Technical considerations from urban agriculture

In order to carry out urban agriculture, some technical aspects of management must be considered, such as those described below:

1) Space and soil.

When it is intended to establish an orchard in areas such as patios, balconies, roofs of the house or even when the ground is covered by some material such as debris, cement, bricks or wood, the use of containers is recommended, which serve to contain the substrate in urban agricultural facilities. These containers optimize the use of hard spaces, taking advantage of and reusing items such as buckets, bottles and plastic bags, tin jars, among others. It is a way that urban agriculture helps to recover materials and provides them with proper use, preventing them from being taken to landfills and also enabling the creativity of those who practice it [6].

2) Substrate.

For the establishment of the garden it is very important to have a good substrate, regardless of the source, it should be sought that it is free of pathogens, that it is light so that it allows good drainage and good root development and that it retains sufficient amounts of nutrients and water to allow a good development. Some recommended and widely used materials are compost, vermicompost, bocashi and rice husk, these well-managed substrates help improve the physical, chemical and biological conditions of the soil and avoid phytosanitary problems. The following composition is the one commonly used for the preparation of the germinator substrates in Cuba [6]:

- 50% Worm humus.
- 25% cereal husks.
- 25% Peat moss.

Therefore, the choice of a good substrate or a good mixture of substrates is of great importance, since the success of this agricultural activity will depend largely on the substrate.

3) Seedbed.

For small-sized seeds, it is necessary to make seedbeds where they receive special care regarding irrigation, type of substrate and light conditions, which guarantees a good germination and growth of the plant until it reaches a sufficient size and development to be transplanted to the final ground, where it will mature in its entirety [10]. For sowing in seedbeds, buckets, wooden crates, trays or containers 5 cm deep can be used, which are filled with a mixture of two parts of compost and one part of husk, and then the seeds are sown. It should be mentioned that if the plants remain long in the seedbed (more than 6 weeks), weak plants with root malformation and premature inflorescences are produced when they are transplanted [10].

7) Fertilization.

Biofertilizers are alternative products of application in urban agriculture for the fertilization of plants, they help to achieve a good foliar and root development, and they also contribute in a special way to the increase of beneficial microorganisms of the soil. The use of these products has been promoted in urban agriculture projects because of their low costs, easy preparation and the various properties they possess [6].

8) Management of pests and diseases.

Plants are more susceptible to attack by pests and diseases when, among other things, they do not have a balanced nutrition, in this sense, biopreparations can be useful for plant nutrition and for integrated pest management (IPM) programs as well as other cultural practices [5].

A useful biopreparation for the control of pests such as aphids, thrips, mites, whiteflies and miners in orchards is the alcoholic extract of Garlic (*Allium sativum*) and Chili pepper (*Capsicum sativum*) [6]. For

its preparation a mortar or container is required, in which 50 g of garlic and 50 g of hot pepper are crushed, then a liter of 90 ° ethyl alcohol is added and left covered for 7 days, then filtered very well and It is packaged in a non-transparent container. As for its application it is necessary to dose 5 ml per liter of water, finally, it is applied by spraying every week [6]. For the management of diseases it is suggested to take into account the following recommendations [6]:

- Disinfection of seeds.
- Use of resistant varieties.
- Proper management of soil moisture.
- Crop rotation.
- Proper management of fertilization.
- Elimination and destruction outside the cultivation area of infectious foci.
- Use of certified seeds.
- Permanent monitoring.

Taking into account the above, adequate management and favorable development of home gardens that are established in urban communities can be achieved.

4. Conclusions

The invasion community "La Carrilera" is a population of vulnerable conditions because they do not have the necessary resources to lead a decent quality of life and despite having few resources, these are used in inappropriate ways causing serious problems of environmental pollution that affect the entire community.

The diagnosis made in the study community was able to identify the different social groups that make up the population to understand their cultures, knowledge and preferences, taking into account their different needs in order to implement methods that strengthen community ties to increase interest and the participation of its inhabitants.

The characterization of organic waste was able to identify the waste that is generated in greater quantity in the homes of the community, presenting mostly fruits and vegetables, which suggested that the most viable practice to implement is the production of fertilizers organic to be made through composting and other fermentation processes, which contribute to soil fertilization and reduce pollution, obtaining a positive environmental impact to give proper use and management of organic waste.

With the measurement of the biological quality of the water and when defining that they are very polluted waters, some viable strategies were determined to implement in the community of "La Carrilera" in order to protect and conserve the water resource, and also to improve the quality of water so that the inhabitants obtain benefits such as disease prevention, among others.

Acknowledgements

The authors thank the inhabitants of the invasion community "La Carrilera" for the participation and support offered in the performance of each activity, and for allowing to carry out the evaluation and characterization of the place, as well as the Unidad Central del Valle del Cauca - UCEVA, to the Health, Care and Society, GIUR and Agricultural Production research groups for contributing to the development of this study.

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