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# Quality of life of beneficiary families of the One Million Rural Cisterns Program (P1MC) in the municipality of Moreilândia, PE

## *Qualidade de vida das famílias beneficiárias do Programa Um Milhão de Cisternas Rurais (P1MC) no município de Moreilândia, PE*

## *La calidad de vida de las familias beneficiarias del Programa Un Millón de Cisternas Rurales (P1MC) en Moreilândia, PE*

**Maria do Socorro da Costa Duarte**
Universidade Regional do Cariri (URCA)
Rua Cel. Antônio Luiz, 1161, Pimenta – Crato (CE), Brasil.
https://orcid.org/0000-0002-2028-7243
iaduarte2@hotmail.com

**Isabela Kristina Ferreira de Freitas**
Universidade Regional do Cariri (URCA)
Rua Cel. Antônio Luiz, 1161, Pimenta – Crato (CE), Brasil.
https://orcid.org/0000-0002-6246-7007
isabela.kristina@urca.br

**Eliane Pinheiro de Sousa**
Universidade Regional do Cariri (URCA)
Rua Cel. Antônio Luiz, 1161, Pimenta – Crato (CE), Brasil.
https://orcid.org/0000-0003-4088-0754
pinheiroeliane@hotmail.com

**Ahmad Saeed Khan**
Universidade Regional do Cariri (URCA)
Rua Cel. Antônio Luiz, 1161, Pimenta – Crato (CE), Brasil.
http://orcid.org/0000-0002-4079-7574
saeed@ufc.br



**KEYWORDS**
Quality of Life. Rural Cisterns. Family Farmers.

**Abstract:** Brazil is in a privileged position in terms of fresh water, considering that it is one of the largest depositories. The Northeast region, however, with a semi-arid climate, suffers from water shortage, requiring alternatives to facilitate coexistence with drought. In this context, the Brazilian Semi-Arid Articulation (ASA) arises, which developed the One Million Rural Cisterns Program (P1MC) as a measure to mitigate the effects of drought. In this sense, this study seeks to analyze the quality of life of P1MC beneficiary families before and after the implementation of this program in the municipality of Moreilândia - PE. For this purpose, tabular and descriptive analysis were used and the Beneficiaries' Quality of Life Index (IQVB) was measured, taking in consideration the following indicators: access to water resources, sanitary aspects, housing, employment and income, health, education, leisure, and maintenance. Parametric statistical tests were also used. The used data derived from a primary source, collected directly from 60 beneficiaries. The results indicate a significant improvement in the quality of life of the beneficiaries when one compares the period before and after the P1MC. 50% of the interviewees had a poor quality of life before P1MC, a percentage that dropped down to 5% after the execution of this program. In absolute terms, all the indicators increased after the P1MC implementation, with

the greatest increases occurring with indicators of access to water resources and sanitary aspects.

***PALAVRAS-CHAVE***
*Qualidade de Vida.*
*Cisternas Rurais.*
*Agricultores Familiares.*

***Resumo:*** *O Brasil se encontra em posição privilegiada quanto à quantidade de água doce, pois é um dos maiores depositários. A região Nordeste, porém, de clima semiárido, sofre com a escassez de água, sendo necessárias alternativas que facilitem a convivência com a seca. Neste contexto, surge a Articulação no Semiárido Brasileiro (ASA), que desenvolveu o Programa Um Milhão de Cisternas Rurais (P1MC) como medida de mitigação dos efeitos da seca. Portanto, este estudo busca analisar a qualidade de vida das famílias beneficiárias do P1MC antes e após a implantação desse programa em Moreilândia, PE. Para tanto, utilizou-se análise tabular e descritiva e mensurou-se o Índice de Qualidade de Vida dos Beneficiários (IQVB), considerando os indicadores: acesso aos recursos hídricos, aspectos sanitários, habitação, emprego e renda, saúde, educação, lazer e alimentação. Empregou-se também teste estatístico paramétrico. Os dados foram provenientes de fonte primária, coletados com 60 beneficiários. Os resultados indicam expressiva melhoria da qualidade de vida dos beneficiários quando se compara o período antes e após o P1MC. Enquanto 50% dos entrevistados possuíam baixa qualidade de vida antes do P1MC, essa participação passou para 5% após a execução desse programa. Em termos absolutos, todos os indicadores se elevaram após a implantação do P1MC, sendo que os maiores incrementos ocorreram com acesso aos recursos hídricos e aspectos sanitários.*

***PALABRAS CLAVE***
*Calidad de Vida.*
*Cisternas Rurales.*
*Agricultores Familiares.*

***Resumen:*** *Brasil se encuentra en posición privilegiada en cuanto a la cantidad de agua dulce, pues es uno de los mayores depositarios. La región Nordeste, de clima semiárido, padece de escasez de agua, siendo necesarias alternativas que faciliten la convivencia con la sequía. En este contexto, surge la Articulación del Semiárido Brasileño (ASA), que ha desarrollado el Programa un Millón de Cisternas Rurales (P1MC) como medida de mitigación de los efectos de la sequía. Por consiguiente, este estudio procura analizar la calidad de vida de las familias beneficiarias del P1MC antes y después de la implantación de ese programa en el municipio de Moreilândia, estado de Pernambuco (PE). Para tanto, se utilizó el análisis tabular y descriptivo y se mensuró el Índice de Calidad de Vida de los Beneficiarios (IQVB), considerando los indicadores: acceso a los recursos hídricos, aspectos sanitarios, vivienda, empleo y rienda, salud, educación, ocio y alimentación. Se ha empelado también un test estadístico paramétrico. Los datos fueron provenientes de fuentes primarias y se han colectado con 60 beneficiarios. Los resultados indican expresiva mejora de la calidad de vida de los beneficiarios cuando se compara el periodo antes y tras el P1MC. Mientras que el 50% de los encuestados poseían baja calidad de vida antes del P1MC, esa participación pasó al 5% tras la ejecución de ese programa. En términos absolutos, todos los indicadores se han elevado después de la implementación del P1MC, siendo que los mayores incrementos han ocurrido con el acceso a los recursos hídricos y aspectos sanitarios.*

## Introduction

The scarcity of water resources is a problem faced worldwide. In addition to the availability of potable water being relatively small, this is compounded by the fact that the global water demand has grown in conjunction with population size, in addition to more people consuming it directly. The increase in irrigated plantations for a greater supply of food, and the use of water in the supply and operation of factories have contributed to the growth in demand for this good, which has an inelastic supply, accelerating environmental degradation (Barros & Amin, 2008).

Concerning Brazil, according to Victorino (2007), the country is one of the largest depositories of fresh water on the planet, with a reservoir of approximately 12% of the total, where around 72% of this water is located in the Amazon Basin. However, the intense urbanization that occurred especially between 1970 and 2000 caused the urban population to increase from 55% to 82% of the country's total inhabitants. This fact causes an increase in the demand for water resources. Even with so much water availability, there is a risk of scarcity because of countless human actions that contribute to environmental degradation, such as waste, not all of the population has basic sanitation, and untreated sewage is dumped into rivers, aggravating the problem of pollution of freshwater sources, the occupation of river floodplains, and the waterproofing of soil in urban areas through paving and asphalting. These factors worsen the drought and the reduction in water volume (Rebouças, 1997).

Brazil has a strong contradiction concerning water availability. While the country's northern region represents one of the largest water reserves in the world, the northeast region, more specifically in the semi-arid region, where temperatures are high and rainfall is scarce and irregular, experiences recurrent droughts. According to Nogueira (2017), the water availability in the national territory is not uniform and the supply of treated water reflects contrasts and asymmetries associated with the national development process, as well as the resulting social and regional inequalities.

In agreement with Law No. 7,827, of December 27, 1989, the Semiarid is “the natural region within the area of activity of the Superintendence of Development of the Northeast (in portuguese Sudene), defined in an ordinance of that Authority”. The characteristic that allowed classifying a region as semi-arid was the average annual rainfall equal to or less than 800 mm, but the Ministry of National Integration (MI) found that this characteristic was not sufficient for this classification, as what would characterize a region Semi-arid would be, in addition to this precipitation, the poor distribution of rainfall associated with a high rate of evapotranspiration leading to an aridity index of up to 0.5 and the possibility of drought occurrence greater than 60%. There was the installation of the Interministerial Working Group (GTI), which, according to these characteristics, was responsible for a new delimitation of the region considered as the Brazilian semi-arid region, and, on March 10, 2005, the geographic space of the semi-arid region increased by 892,309.4 km2 to 969,589.4 km2 (Brazil, 2005). Due to climate change and after studies were carried out by the GT-2014 Working Group, the need for a new delimitation of the semi-arid region was verified, currently covering an area of 1,128,697 km², 1,262 municipalities and 27,870,241 inhabitants (Sudene, 2017). In addition to climate change, Almeida, Araújo, Orrico & Cohim (2021) highlight that the reduction in rainfall and the lack of water management have increased the number of municipalities included in the semi-arid region.

Araújo (2011) states that the predominant characteristic of the region is the long periods of drought, which hinder the possibility of a large water supply for its inhabitants their livestock, and their plantations. Considering that water in the semi-arid northeast, in addition to the function of meeting human needs also has the function of being an agent of the economy, as the main economic activities in this region make use of this

resource, such as pastoral activities of raising cattle, goats, and sheep; and agriculture, whether family or in any of its forms. For these reasons, in the semi-arid region, according to Garjulli (2003, p. 38), there is "a strong dependence on human intervention over nature, to guarantee, through water infrastructure works, the storage of water for human supply and other productive uses".

Due to its climatic characteristics, the northeastern semi-arid region, or Drought Polygon as it is classified, needs public policies aimed at its coexistence. In other words, policies that provide drinking water for populations faced with this reality, so that, in addition to meeting physiological needs, they enable the development of economic activities, with emphasis on agriculture and livestock, which characterize the region and are means by which part of the population obtains some income.

In this context, Brazil has the National Program for Universal Access and Utilization of Water - WATER FOR ALL, from which the dam comes. This action is the most used in this region and can be done by excavating large reservoirs with a capacity of billions of cubic meters, dams, and by excavating small reservoirs with a capacity of containing a few thousand cubic meters, the so-called "*barreiros"* (Cirilo, 2008). In addition to these actions, there is also the implementation of cisterns, supply through water tankers, and the drilling of rural wells, along with the Transposition of the São Francisco River.

The issue of installing cisterns, now regarded as the most effective drought management measure, originated from the organization of civil society in a Civil Society Organization of Public Interest (OSCIP) named Brazilian Semi-Arid Articulation (ASA). ASA developed "intervention proposals in the semi-arid region with a focus on providing access to water for human consumption during drought periods" (Campos & Alves, 2014, p. 468).

Among the proposals prepared by ASA, their first project stands out, the One Million Rural Cisterns Program (P1MC), which aims to "improve the lives of families living in the Semi-Arid Region of Brazil, guaranteeing access to quality water [. ..] by storing rainwater in cisterns built with cement slabs next to each house" (ASA, 2018).

Based on Sudene (2017), the city of Moreilândia – PE, with an area of 637.60 km2 and a population of 11,238 inhabitants, is located in the semi-arid region and suffers from a lack of water. The One Million Cisterns Program was implemented in the city. According to ASA (2018), since the implementation of the program in the municipality, 583 cisterns have already been built to meet the water needs of the rural population. Considering data up to May 2018, the program has already built 615,216 rural cisterns (ASA, 2018), which reveals its importance, especially when taking into account that its beneficiaries are the same ones who fit the profile of the Bolsa Família Program, that is, a low-income population, which largely depends on cisterns to store water for their daily consumption, with the program being essential for the rural population, especially in the municipality of Moreilândia where the urban population has its demand for water exclusively served by the São Francisco River and the rural population depends on water supplies, artesian wells, and rainwater.

Therefore, studies that aim to understand the families' reality living in the semi-arid region, such as the municipality of Moreilândia, as well as changes in the life quality caused by the implementation of social technologies, such as the One Million Rural Cisterns Program – P1MC, is relevant and has not yet been discussed in the literature. In this sense, this study seeks to analyze the life quality of P1MC beneficiary families before and after the implementation of this program in the municipality of Moreilândia – PE.

## Theoretical elements of the research

### Contextualization of actions to live with drought: the case of P1MC.

The first initiatives aimed at dealing with drought took place through public social actions

aimed at "saving" the mitigation of the consequences of drought and lasted until the 1980s. From then on, new alternatives for the development of the semi-arid region emerged through civil society organizations (Morais, Paiva, & Sousa, 2017).

The droughts of 1997 to 1998 sparked social movements involved in combating drought. Civil society organizations chose to come together to propose an alternative project for the semi-arid region. In 1999, the Third United Nations Conference of the Parties to Combat Desertification and Drought (COP III) took place in Recife – PE. At that time, entities such as NGOs, unions, cooperation agencies, and entities linked to the Church, held a Parallel Forum to reflect on the reality of the national Semi-Arid region, which culminated in the Semiarid Declaration, which contained proposals for sustainable coexistence with the semi-arid region. This Forum also resulted in the founding of Brazilian Semi-Arid Articulation (ASA), and, in 2000, a plan was formulated to build cisterns in the semi-arid region, which resulted in the creation of the Training and Social Mobilization Program for Coexistence with the Semi-Arid: A Million Rural Cisterns (P1MC) (Santos, Fuentes, Melo & Chiarelotto, 2023; Almeida et al., 2021; Morais, Paiva & Sousa, 2017; Nogueira, 2017; Cordeiro, 2013; Santos, 2010; Duque, 2008).

Santos (2010) stated that purpose of this program is to form a space for articulation between institutions, communities, and families. Which seeks to reestablish population – Semiarid interaction, eventually forming the Civil Society Organization of Public Interest – OSCIP, named the One Million Cisterns Program for the Semi-Arid Program Association – AP1MC, which constitutes the legal entity responsible for managing the program. Morais, Paiva, and Sousa (2017) corroborate this by stating that this program involves mobilization meetings, socialization, training, community organization, and family involvement, assuming a commitment to coexistence with the semi-arid region.

The One Million Cisterns Program (P1MC) was the first social technology for living with drought developed by the Articulation in the Semiarid to meet the main demand of rural populations: drinking water for consumption. With this action, in which a 16,000-liter cistern would be built close to the beneficiaries' homes, families went from being dependent to managing their water, as the policy of building large reservoirs generally installed on private properties made families submissive, also made access to water difficult, especially due to the long distances traveled to obtain it. The Program's proposal is the democratization of access and use of water, an action aimed directly at serving 1,000,000 families that involves "the management of water resources, the construction of cisterns, the management of public resources and financial administration of resources coming from P1MC" (Brazilian Federation of Banks - Febraban, 2003, p. 05).

The One Million Cisterns Program for the Semiarid Association (AP1MC) first obtained funding from a consolidated agreement with the Ministry of the Environment (MMA), between 2000 and 2002. At that time, the GT Cisternas - Cisterns working group was created and linked to ASA, which "was responsible for preparing the methodological bases for the implementation of the P1MC, for family mobilizations, for the regional organization of forums and the execution of 500 cisterns" (Cordeiro, 2013, p.189). When this phase of the program ended, a new agreement was signed, this time, with the National Water Agency to build 12,500 cisterns (Cordeiro, 2013). In addition, "in 2004, through Budgetary Law 11,044/2004, the Program began to appear in the Union budget with its budgetary allocation"; however, the program also has funding from private and international institutions (Santos, 2010, p. 80).

According to ASA (2018), "the National Council for Food and Nutritional Security (CONSEA) recognizes and legitimizes the P1MC cisterns as an element of water and food security". This experience sets the path for the creation of public assistance policies for the semi-arid region, as it is born from the organization of the ideals of

civil society committed to solving the problem of rural populations ravaged by drought, which is to have quality water for consumption.

The program aims to establish a new vision of the country's people to their habitat, moving away from looking for a method to combat drought and starting to implement a solution to live with it. The proposal to build cisterns was the solution chosen when it was found that rainfall of 250 mm and above is sufficient to allow water to be stored in sufficient quantities to supply a family of five during the dry period. Rainwater would be stored through a system of gutters attached to the roof of the house and would be piped to the cistern. This technology was chosen due to its relative ease of construction, low costs, efficient storage, and environmentally correct nature, as it does not exploit groundwater or deposit any type of waste into the environment (Febraban, 2003).

Based on the literature, Almeida et al. (2021) point out that the use of cisterns as a source of water supply for hygienic and drinking purposes in isolated communities has been a successful practice due to rainwater capture being a simple solution, with low energy consumption and capacity for meet a minimum demand for water with a quality superior to other untreated sources.

The communities that receive priority assistance from the program are those that have the largest number of children and adolescents at risk. As for choosing beneficiary families, firstly, they need to be registered in the Single Registry, and the selection criteria in order of attendance are the woman as head of the family; the greater number of children aged zero to six; the greater number of children and adolescents at school; presence of adults aged 65 or over and presence of physically and mentally disabled people (Febraban, 2003).

## Quality of life: characterization and measurement

Even though it is widely used in scientific literature, the expression “quality of life” has not yet found consensus regarding its definition. For many, it is synonymous with health, for others it concerns access to goods and services; for still others, it is synonymous with happiness and personal satisfaction, and so on, so that as it is a complex and subjective concept, its definition varies according to the area of study and the investigation in which it is being addressed (Pereira, Texeira & Santos, 2012).

Regarding the quality of life, Brito (2013, p. 78) states that “in a pragmatic sense it can be understood as the satisfaction of a spectrum of basic needs that ensure a certain standard of living for the population”. Barbosa, Lima Júnior, Morais & Brito (2012) highlight that quality of life is closely related to development, as both refer to social well-being, and this depends on the satisfaction mainly of the individual's basic needs, such as food, health, employment and income, housing, etc.

Over the years, measuring the quality of life of populations has used different types of indicators. According to Brito (2013), although numerous indicators were developed in an attempt to measure people's quality of life, the most accepted indicator was that developed by the United Nations Development Program (UNDP): the Human Development Index (HDI), which:

> It uses the Geneva or Distance Method, which combines three basic components: i)longevity (which reflects the health conditions of the population, measured by life expectancy at birth); ii) level of knowledge (measured by the combination of the adult literacy rate and the combined enrollment rate at primary, secondary and higher education levels) and iii) income (measured by GDP per capita adjusted to the local cost of living) (Brito, 2013, pp. 78-79).

Using the same method as the HDI, we have the Municipal Human Development Index (MHDI) that incorporates three dimensions: “1- longevity measured by life expectancy at birth; 2- education, measured by the illiteracy rate and the average number of years of study; 3- income, measured by average family income per capita” (Brito, 2013, p. 79). Many Quality of Life Indexes have been constructed, especially concerning the evaluation of public policies that aim to meet the needs of the population.

## Methodological elements of the research

### Study Field

The study field is the municipality of Moreilândia, located in the Sertão Pernambucano mesoregion, in the Sertão do Araripe microregion. It has an estimated population for 2017 of 11,238 inhabitants. Moreilândia is located 587.8 km from the capital Recife and is characterized by a semi-arid climate, with an average annual temperature of 24.7°, caatinga biome and vegetation with a predominance of sub-evergreen forest (IF-PE, s/d). The municipality scored 0.600 on the Municipal Human Development Index (IDHM) calculated in 2010 (Prefeitura Municipal de Moreilândia, s/d).

### Data nature and sample size

The research used primary data which, according to Prodanov and Freitas (2013, p. 103), "receive this designation because they are "first-hand" information, that is because they are not recorded in any other document." Such data came from the application of questionnaires to beneficiaries of the One Million Cisterns Program (P1MC) in the municipality of Moreilândia, PE.

The sample size was determined using a simple random sampling calculation performed for finite populations. So, equation (1), indicated by Fonseca and Martins (2010), was developed:

$$n = \frac{z^2.p.q.N}{d^2(N-1)+z^2.p.q} \quad (1)$$

Where: $n$ = sample size; $z$ = abscissa of the standard normal; $p$ = estimate of the proportion of the characteristic researched in the universe; $q = 1 - p$; $N$ a total number of P1MC beneficiaries; e $d$ = sampling error.

According to the ASA technology map (2018), 583 families are benefiting from P1MC in the municipality of Moreilândia. Considering the estimation error of 10% (d=0,1), the abscissa of the standard normal is Z=1,64 at the 90% confidence level and p and q = 0,5 (in the hypothesis of admitting the largest sample size, since the proportions studied are not known), 60 questionnaires were administered to P1MC beneficiaries in Moreilândia, PE.

### Analytical methods

Aiming to identify whether P1MC has contributed to improving the quality of life of beneficiary families, the situation before and after the implementation of this program was examined. The analysis method was based on studies developed by Brito (2004), Maia and Sousa (2008) and Justo and Lima (2016), applied, respectively, to the Associates of the Cooperativa Agropecuária de Brejo Santo - CE, to the Pronafians of Group C and non-Pronafians in Santana do Cariri – CE, and to PRONAF B beneficiaries in the municipality of Exu – PE.

The quality life level of P1MC beneficiary families was assessed using the Beneficiary Quality of Life Index (IQVB), resulting from the following indicators: access to water resources, sanitary aspects, housing, employment and income, health conditions, education, access to leisure and food conditions. The changes that occurred, between the two moments analyzed, in the variables studied allowed the verification of changes in the quality of life of the beneficiaries in question.

After defining the aforementioned indicators, they were assigned the same weights and scores. The scores were used on an increasing scale, from the worst position to the best, and values were assigned to them, which indicated the situation of the program's beneficiaries. As for the weights, they were weighted according to the opinion of the beneficiaries themselves, changing between 1 and 3, where 1 refers to low satisfaction, 2 is medium satisfaction, and 3 is high satisfaction. In this way, beneficiaries defined the relative importance of each indicator in constituting their quality of life.

Algebraically, the Beneficiaries' Quality of Life Index (IQVB) can be expressed by equation (2):

$$IQVB = \frac{1}{n}\sum_{j=1}^{n}\left[\frac{\sum_{i=1}^{m} E_{ij}P_{ij}}{\sum_{i=1}^{m} E\max_i \, P\max_i}\right] \quad (2)$$

The individual contribution of the Beneficiary Quality of Life Index (IQVB) indicators was obtained using equation (3):

$$C_i = \frac{\sum_{j=1}^{n} E_{ij}P_{ij}}{\sum_{j=1}^{n}\left(\sum_{i=1}^{m} E\max_i \, P\max_i\right)} \quad (3)$$

Where: $IQVB$ = Quality of Life Index of P1MC beneficiaries; $E_{ij}$ = score of indicator i-ésimo, obtained by the j-ésima family; $P_{ij}$ = weight of i-ésimo indicator, defined by j-ésima family; $i = 1,2,3,...,m$; $j = 1,2,3,...,n$; $E\max_i$ = maximum score of the i-ésimo indicator; $P\max_i$ = maximum weight of i-ésimo indicator; $C_i$ = contribution of indicator i in the Quality of Life Index of P1MC Beneficiaries; $n$ = number of families benefiting from P1MC, e $m$ = number of indicators.

The Quality of Life Index for P1MC beneficiary families ranges from zero to one. Thus, the closer to one, the better the level of quality of life, and the closer to zero, the worse the level of quality of life. Thus, considering the established interval, the criteria adopted in the studies by Brito (2004), Maia and Sousa (2008), and Justo and Lima (2016) were followed, in which a low level of quality of life is classified as $0 < IQVB \leq 0,5$; average level of quality of life if $0,5 < IQVB \leq 0,8$; and high level of quality of life if $0,8 < IQVB \leq 1,0$.

The change in the quality of life of the beneficiaries of the One Million Cisterns Program in the municipality of Moreilândia was determined through the difference ($\Delta$) observed between the quality of life indexes before and after the implementation of this program. This change was observed using the following criteria: if $\Delta < 0$, there is a reduction in the level of quality of life; if $\Delta = 0$, the level of quality of life is maintained; and if $\Delta > 0$, there is an increase in the level of quality of life.

The indicators with their respective scores that were used to measure the Beneficiaries' Quality of Life Index (IQVB) of the One Million Rural Cisterns Program (P1MC) are presented below.

The indicator of access to water resources was measured considering the type of water source used by the family, the time spent, and the distance traveled to fetch water. Regarding the type of water source used by families before and after the implementation of the cisterns, the following scores were assigned: (0) for exclusive water supply; (1) for water coming from a river, well, or reservoir; or (2) for water stored in cisterns (coming from rain or supplied by a water tanker). Regarding the time spent fetching water, the following scores were given: (0) for more than 30 minutes; (1) up to 30 minutes; or (2) spending no time at all. Regarding the distance traveled to fetch water, the following scores were considered: (0) for more than 1,000 meters; (1) up to 1,000 meters; or (2) travels no distance at all.

The measurement of the indicator referring to sanitary aspects was based on the analysis of the treatment of water for consumption, and the disposal given to garbage and human waste. About the treatment of drinking water, the following scores were considered: (0) for no treatment; (1) for boiled, filtered, or chlorinated water; or (2) for mineral water. Regarding the destination given to the garbage, the following scores were assigned: (0) for open air (in rivers, lakes, or on the surface); (1) to be burned or buried; or (2) when collected through collection. About the destination given to human waste, the following scores were awarded: (0) when there is no toilet or septic tank; (1) when it has a toilet but does not have a septic tank; or (2) when it has a bathroom with a toilet and a septic tank.

The housing indicator sought to measure housing conditions regarding property ownership, type of construction, and type of lighting.

Regarding property ownership, the following scores were assigned: (0) for rented; (1) for assignee; or (2) for own. Regarding the type of construction, the following scores were awarded: (0) for mud properties; (1) for unplastered brick houses; or (2) for a brick house with plaster. Regarding the type of lighting, the following scores were considered: (0) for lamp or lamp (gas); (1) for generator (battery) power; or (2) for electrical energy.

The employment and income indicator was calculated based on the beneficiaries' employment rate and their respective income. When asking whether they have paid work, the following scores were considered: (0) no work; (1) informal paid work; or (2) formal paid work. About the number of people responsible for supporting the household, the following scores were assigned: (0) for only one; (1) for two; or (2) for three or more. Regarding family income (in minimum wages), the following scores were given: (0) for less than one; (1) for one to two; or (2) for greater than two.

The health indicator sought to verify the availability of health care for the rural population of the municipality. Regarding access to health care in the municipality itself, the following scores were assigned: (0) for lack of medical care; (1) for care by a health agent; (2) for care at a health center; or (3) for care in hospitals. Regarding access to vaccination and medicines, the following scores were considered: (0) when there is no access; (1) if you rarely have access; (2) if you frequently have access; or (3) if you always have access.

The education indicator measured access to educational services by the population, as well as the illiteracy rate present in families. Regarding family access to educational services in the municipality itself, the following scores were considered: (0) when there is no access; (1) if you have access to Elementary Education; (2) if you have access to high school; or (3) if you have access to Higher Education. Regarding the number of illiterates in the family, the following scores were assigned: (0) for more than four; (1) if you have three or four; (2) if you have one or two; or (3) to none.

The leisure indicator sought to verify beneficiaries' access to leisure programs, as well as the type of leisure practiced by families. Regarding the frequency of access to leisure, the following scores were assigned: (0) if there is no access; (1) for rarely; (2) stops frequently; or (3) if always. Concerning the type of leisure practiced by the family, the following scores were considered: (0) when they do not enjoy any type of leisure; (1) for bathing in rivers or reservoirs; (2) for religious or other activities in the city in which you reside; or (3) for travel.

The food indicator measured beneficiaries' access to food, fruits, and vegetables. For your family's food consumption, the following scores were assigned: (0) for insufficient; (1) reasonably sufficient; (2) sufficient; or (3) if it is more than sufficient. Regarding the frequency of fruit and vegetable consumption, the following scores were considered: (0) for never; (1) for rarely; (2) stops frequently, or (3) forever.

To assess whether or not there was a variation in the quality of life of P1MC beneficiaries, the paired T test was used, considering that the samples are related to the same people, that is, there is a dependence between the samples in the period before and after of program implementation.

According to Justo and Lima (2016) when citing Hamilton (2009), the test of differences in means for paired data, in which the “before” and “after” situation is compared, can be expressed by equation (4):

$$t = \frac{\bar{d}\sqrt{n}}{S_d} \quad (4)$$

Where: $\bar{d} = \mu_d - \mu_a$; $n$ = number of observations; $S_d$ = standard deviation; $t$ = statistic t that has $n-1$ degrees of freedom.

## Presentation and discussion of results

Table 1 shows that the situation of P1MC beneficiary families has improved significantly in

terms of access to water resources, as, before receiving the cisterns, 96.67% of those interviewed went to get water from rivers, wells, or dams, and, after the program, 98.33% of those surveyed receive water directly in their cistern from rain or supplied by a water tanker, with 1.67% not receiving water in the cistern due to their contract having been canceled for violating an order not to use a pump in the cistern. It is also seen that there was an improvement for the beneficiary families in terms of the time spent fetching water and the distance traveled to fetch water. For Nogueira (2017), the main advantages of cisterns consist of water quality, proximity to the residence, and low cost.

Table 1
**Absolute and relative distribution of P1MC beneficiaries, according to the type of water source used, time spent fetching water, and distance traveled to fetch water, in the municipality of Moreilândia, 2018.**

| Considered variables** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | fi | % | fi | % |
| 1.1. Type of water source used | 1.1.a | 2 | 3,33 | 0 | 0,00 |
| | 1.1.b | 58 | 96,67 | 1 | 1,67 |
| | 1.1.c | 0 | 0,00 | 59 | 98,33 |
| 1.2. Time spent fetching water | 1.2.a | 28 | 46,67 | 1 | 1,67 |
| | 1.2.b | 29 | 48,33 | 9 | 15,00 |
| | 1.2.c | 3 | 5,00 | 50 | 83,33 |
| 1.3. Distance traveled to fetch water | 1.3.a | 29 | 48,33 | 1 | 1,67 |
| | 1.3.b | 28 | 46,67 | 9 | 15,00 |
| | 1.3.c | 3 | 5,00 | 50 | 83,33 |
| Test of differences in means | | 20,83* | | | |

**Source:** Compiled by the authors based on research data. * Significant at 1%.
****Notes**: 1.1.a. Exclusive supply by tanker truck; 1.1.b. Water from rivers, wells, or reservoirs; 1.1.c. Water stored in cisterns; 1.2.a. More than 30 minutes; 1.2.b. Up to 30 minutes; 1.2.c. No time spent; 1.3.a. More than 1,000 meters; 1.3.b. Up to 1,000 meters; 1.3.c. No distance traveled.

Table 2 shows that there was a major change in the treatment given to the water consumed by beneficiary families. Before the program, only 53.33% of families consumed boiled, filtered, or chlorinated water, while 45% did not use any type of treatment. After P1MC, it is noted that the majority (93.33%) of beneficiary families carry out some type of water treatment, as they stated that, when receiving water in the cistern, it already undergoes chlorine treatment carried out by the "piperine", and also filter the water, while 6.67% of those interviewed stated that they still do not treat water for consumption. These results are consistent with the findings of Almeida et al. (2021) when considering that the use of cisterns has proven successful in meeting a minimum demand for water with a quality superior to other untreated sources.

Table 2
**Absolute and relative distribution of P1MC beneficiaries, according to water treatment for consumption, waste disposal, and human waste disposal, in the municipality of Moreilândia, 2018**

| Considered variables ** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | fi | % | fi | % |
| 2.1. Water treatment for consumption | 2.1.a | 27 | 45,00 | 4 | 6,67 |
| | 2.1.b | 32 | 53,33 | 56 | 93,33 |
| | 2.1.c | 1 | 1,67 | 0 | 0,00 |
| 2.2. Waste disposal destination | 2.2.a | 2 | 3,33 | 2 | 3,33 |
| | 2.2.b | 57 | 95,00 | 57 | 95,00 |
| | 2.2.c | 1 | 1,67 | 1 | 1,67 |
| 2.3. Disposal of human waste | 2.3.a | 37 | 61,67 | 14 | 23,33 |
| | 2.3.b | 1 | 1,67 | 2 | 3,33 |
| | 2.3.c | 22 | 36,67 | 44 | 73,33 |
| Test of mean differences | | 26,15* | | | |

**Source:** Compiled by the authors based on research data. Significant at 1%.
**Notes: 2.1.a. No treatment; 2.1.b. Boiled, filtered, or chlorinated water; 2.1.c. Mineral water; 2.2.a. Open sky; 2.2.b. Burned or buried; 2.2.c. Collected through waste collection; 2.3.a. Does not have a toilet or septic tank; 2.3.b. Has a toilet but no septic tank; 2.3.c. Has a toilet with a septic tank.

From the data in this table, it is observed that there was no effect of the P1MC on the disposal of waste, as both before and after this program, the data remained unchanged, with the most significant participation (95%) among respondents being families that burn or bury their waste.

Regarding the disposal of human waste, a significant improvement is evident, as before the implementation of cisterns, 61.67% of respondents did not have a toilet or septic tank, and only 36.67% had a toilet with a septic tank. After the program, the relative participation of beneficiary families who had a toilet with a septic tank increased to 73.33%. This result can be attributed, in particular, to the fact that the majority of P1MC beneficiaries also benefited from the National Health Foundation's (Funasa) Home Sanitation

Improvement Program, through which toilets were built in these households. Comparing these results with those obtained in the study by Gomes and Heller (2016), it is noted that the situation is analogous, as only 29% of beneficiaries lack hydrosanitary facilities.

From Table 3, it is evident that only one beneficiary transitioned from a borrowed property to owning their own after the P1MC, and none were living in or moved to rented accommodation. Regarding the type of construction, it is noted that before the arrival of the cisterns, 48.33% of respondents lived in adobe houses and 46.67% in brick houses with plaster. After the program implementation, there was a significant improvement, as the relative participation of adobe properties decreased from 48.33% to 25%, while that of brick houses with plaster increased from 46.67% to 73.33%. The data show that there was no effect of the P1MC on the type of lighting in households. All respondents already had electricity in their homes before receiving the cistern due to the Rural Electrification Program - Light for All.

Table 3

**Absolute and relative distribution of P1MC beneficiaries, according to property ownership, type of construction, and type of lighting, in the municipality of Moreilândia, 2018**

| Considered variables ** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | fi | % | fi | % |
| 3.1. Property ownership | 3.1.a | 0 | 0,00 | 0 | 0,00 |
| | 3.1.b | 6 | 10,00 | 5 | 8,33 |
| | 3.1.c | 54 | 90,00 | 55 | 91,67 |
| 3.2. Type of construction | 3.2.a | 29 | 48,33 | 15 | 25,00 |
| | 3.2.b | 3 | 5,00 | 1 | 1,67 |
| | 3.2.c | 28 | 46,67 | 44 | 73,33 |
| 3.3. Type of lighting | 3.3.a | 0 | 0,00 | 0 | 0,00 |
| | 3.3.b | 0 | 0,00 | 0 | 0,00 |
| | 3.3.c | 60 | 100,00 | 60 | 100,00 |
| Test of mean differences | | 52,96* | | | |

**Source:** Compiled by the authors based on research data. * Significant at 1%.

**Notes: 3.1.a. Rented; 3.1.b. Borrowed; 3.1.c. Owned; 3.2.a. Adobe house; 3.2.b. Unplastered brick house; 3.2.c. Brick house with plaster; 3.3.a. Oil lamp or lantern (gas); 3.3.b. Generator-powered electricity (battery); 3.3.c. Electric power.

In regards to paid employment, according to Table 4, before the program, 78.33% of respondents had informal paid work, 13.33% were unemployed, and 8.33% were formally employed. After the P1MC, the relative participation of beneficiaries engaged in informal and formal paid work changed to 65.00% and 6.67%, respectively. These data indicate a considerable reduction in beneficiaries who are employed. This result can be explained by two main factors: first, the high unemployment rate and also the increase in informal employment. According to IBGE (2018), the unemployment rate in the country is at 11.6%, and informality has increased by 4.5% in the number of employees in the private sector without formal contracts and by 2.3% in the number of self-employed individuals. In the second aspect, this increase in beneficiaries who have stopped having paid work may be due to retirement.

Table 4

**Absolute and relative distribution of P1MC beneficiaries, if they have paid employment, number of people responsible for household support, in the municipality of Moreilândia, 2018**

| Considered variables ** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | Fi | % | fi | % |
| 4.1. Has paid employment | 4.1.a | 8 | 13,33 | 17 | 28,33 |
| | 4.1.b | 47 | 78,33 | 39 | 65,00 |
| | 4.1.c | 5 | 8,33 | 4 | 6,67 |
| 4.2. Number of people responsible for household support | 4.2.a | 23 | 38,33 | 26 | 43,33 |
| | 4.2.b | 28 | 46,67 | 27 | 45,00 |
| | 4.2.c | 9 | 15,00 | 7 | 11,67 |
| 4.3. Family income (in minimum wages) | 4.3.a | 40 | 66,67 | 22 | 36,67 |
| | 4.3.b | 18 | 30,00 | 35 | 58,33 |
| | 4.3.c | 2 | 3,33 | 3 | 5,00 |
| Test of mean differences | | 21,98* | | | |

**Source:** Compiled by the authors based on research data. * Significant at 1%.

**Notes: 4.1.a. No employment; 4.1.b. Informal paid employment; 4.1.c. Formal paid employment; 4.2.a. One; 4.2.b. Two; 4.2.c. Three or more; 4.3.a. Less than one; 4.3.b. From one to two; 4.3.c. Greater than two.

Regarding household support for beneficiaries, both before and after the P1MC, it is mostly provided by two people, with the lowest relative participation occurring with three or more people. The data also show that 38.33% of beneficiary households were supported by only one person before the program, which increased to 43.33% after the program.

Concerning family income, it is noted that before the P1MC, 66.67% of respondents survived on less than one minimum wage, 30% had incomes ranging from one to two minimum wages, and only 3.33% had incomes greater than two minimum wages. After becoming program beneficiaries, there was an increase in the number of beneficiaries whose incomes expanded from less than one minimum wage to one to two minimum wages or more than two minimum wages. These improved income conditions were also verified by Nogueira (2017), who analyzed the contribution of the P1MC as an adaptation strategy to mitigate the impact of drought on the poorest population of the Brazilian semi-arid region, considering rural communities in two municipalities in Paraíba and Pernambuco as a case study.

In Table 5, it is possible to verify that both before and after the program, the majority of respondents (78.33% and 70%, respectively) receive healthcare at hospitals when needed. Next in the ranking is healthcare at health centers, with 11.67% of families having access to this type of healthcare before the P1MC, while after the program, this participation increased to 25% of families. This data does not necessarily represent a setback, as it is due to the creation of the Family Health Program (PSF), in which some rural communities received health centers, allowing family care within the community without the need to travel to urban areas for hospital care, except in more severe cases. The data also show that one interviewed family that did not receive medical care began receiving care at a health center.

Table 5

**Absolute and relative distribution of P1MC beneficiaries, according to access to healthcare in the municipality of Moreilândia and access to vaccination and medication, 2018**

| Considered variables ** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | Fi | % | fi | % |
| 5.1. Access to healthcare within the municipality | 5.1.a | 1 | 1,67 | 0 | 0,00 |
| | 5.1.b | 5 | 8,33 | 3 | 5,00 |
| | 5.1.c | 7 | 11,67 | 15 | 25,00 |
| | 5.1.d | 47 | 78,33 | 42 | 70,00 |
| 5.2. Access to vaccination and medication | 5.2.a | 11 | 18,33 | 8 | 13,33 |
| | 5.2.b | 27 | 45,00 | 27 | 45,00 |
| | 5.2.c | 7 | 11,67 | 8 | 13,33 |
| | 5.2.d | 15 | 25,00 | 17 | 28,33 |
| Test of mean differences | | 36,05* | | | |

**Source:** Compiled by the authors based on research data. * Significant at 1%.

****Notes:** 5.1.a. Absence of medical care; 5.1.b. Care by health agent; 5.1.c. Care at health center; 5.1.d. Care at the hospital; 5.2.a. No access; 5.2.b. Rarely have access; 5.2.c. Frequently have access; 5.2.d. Always have access.

Regarding access to medication and vaccines, it is noted that 45% of respondents reported that, both before and after the implementation of cisterns, they rarely have access. However, the other options indicate that this variable has improved, as there has been a reduction in beneficiaries who do not have access to vaccination and medication and an increase in beneficiaries who now have always access. This result may be linked to the increase in income and purchasing power of beneficiaries, which are not necessarily related to the P1MC.

Regarding the variable of family access to educational services within the municipality, as shown in Table 6, before the P1MC, 46.67% of respondents stated they had access only to Secondary Education. After the program, this participation increased to 50%. The data reveal a significant change regarding access to Elementary Education, with 28.33% of families having access before the P1MC, which reduced to 5% after the program. Another notable change occurred with access to Higher Education, which was only accessible to 10% of families before the program and increased to 33.33% after the program. These results demonstrate an improvement in access to education, which can be explained by the fact that access to Higher Education was previously more challenging both financially and in terms of transportation. Additionally, the municipality now offers a Nursing technical course, and branches of History and Pedagogy courses are offered on weekends in municipal and state school buildings.

It is also noted that the number of illiterate individuals remained the same for both periods considered. Out of the 60 respondents, 20 of them (which corresponds to 33.33%) reported having one or two illiterate family members. This data reveals that the illiteracy rate was higher than the participation of families who did not have access to educational services. This might occur because some of the beneficiaries, although they responded that they had access to Elementary Education,

cannot read. However, it is a concerning reality that needs to be addressed.

Table 6
**Absolute and relative distribution of P1MC beneficiaries, according to access to educational services within the municipality of Moreilândia and the number of illiterate individuals in the family, 2018**

| Considered variables ** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | fi | % | fi | % |
| 6.1. Access to educational services within the municipality | 6.1.a | 9 | 15,00 | 7 | 11,67 |
| | 6.1.b | 17 | 28,33 | 3 | 5,00 |
| | 6.1.c | 28 | 46,67 | 30 | 50,00 |
| | 6.1.d | 6 | 10,00 | 20 | 33,33 |
| 6.2. Number of illiterates in the family | 6.2.a | 0 | 0,00 | 0 | 0,00 |
| | 6.2.b | 0 | 0,00 | 0 | 0,00 |
| | 6.2.c | 20 | 33,33 | 20 | 33,33 |
| | 6.2.d | 40 | 66,67 | 40 | 66.67 |
| Test of mean differences | | 42,89* | | | |

**Source:** Compiled by the authors based on research data. * Significant at 1%.
****Notes:** 6.1.a. No access; 6.1.b. Access to Elementary Education; 6.1.c. Access to Secondary Education; 6.1.d. Access to Higher Education; 6.2.a. More than 04; 6.2.b. 03 or 04; 6.2.c. 01 or 02; 6.2.d. None.

Table 7 depicts the frequency of leisure access among P1MC beneficiary families. Following the program's implementation, modest changes were observed, with the participation of families who had no access to leisure decreasing from 50% to 45%, and those who frequently have access increasing from 5% to 11.67%.

Table 7
**Absolute and relative distribution of P1MC beneficiaries, according to the frequency of leisure access and the type of leisure activities practiced by the family, in the municipality of Moreilândia, 2018**

| Considered variables ** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | fi | % | fi | % |
| 7.1. Frequency of access to leisure | 7.1.a | 30 | 50,00 | 27 | 45,00 |
| | 7.1.b | 22 | 36,67 | 23 | 38,33 |
| | 7.1.c | 3 | 5,00 | 7 | 11,67 |
| | 7.1.d | 5 | 8,33 | 3 | 5,00 |
| 7.2. Type of leisure activities practiced by the family | 7.2.a | 30 | 50,00 | 27 | 45,00 |
| | 7.2.b | 12 | 20,00 | 8 | 13,33 |
| | 7.2.c | 14 | 23,33 | 16 | 26,67 |
| | 7.2.d | 4 | 6,67 | 9 | 15,00 |
| Test of mean differences | | 10,63* | | | |

**Source:** Compiled by the authors based on research data. * Significant at 1%.
****Notes:** 7.1.a. No access; 7.1.b. Rarely; 7.1.c. Frequently; 7.1.d. Always; 7.2.a. Do not engage in any leisure activities; 7.2.b. Bathing in rivers or reservoirs; 7.2.c. Religious activities or other activities within their city; 7.2.d. Travel.

It is also noted that before the P1MC, 50% of families did not engage in any type of leisure activities. This participation decreased to 45% after the program. Regarding the type of leisure activities practiced, there is a reduction in families enjoying bathing in rivers and reservoirs, while families participating in religious activities or other activities within their or traveling increased, which could be associated with improved incomes.

Table 8 reveals that none of the beneficiaries consider their food consumption to be more than sufficient, both before and after the P1MC. Before the P1MC, 58.33% of respondents considered the amount of food to be sufficient, which increased to 76.67% after the program. In addition to this positive result, another data point indicating an improvement after the P1MC is that the percentage of beneficiaries who considered their family's food consumption to be insufficient decreased from 16.67% to 8.33%. This result reflects the increase in family incomes following the program.

Table 8
**Absolute and relative distribution of P1MC beneficiaries, according to family food consumption, in the municipality of Moreilândia, 2018**

| Considered variables ** | | Before P1MC | | After P1MC | |
|---|---|---|---|---|---|
| | | fi | % | fi | % |
| 8.1. Food consumption of your family | 8.1.a | 10 | 16,67 | 5 | 8,33 |
| | 8.1.b | 15 | 25,00 | 9 | 15,00 |
| | 8.1.c | 35 | 58,33 | 46 | 76,67 |
| | 8.1.d | 0 | 0,00 | 0 | 0,00 |
| 8.2. Frequency of fruit and vegetable consumption | 8.2.a | 3 | 5,00 | 1 | 1,67 |
| | 8.2.b | 18 | 30,00 | 10 | 16,67 |
| | 8.2.c | 5 | 8,33 | 5 | 8,33 |
| | 8.2.d | 34 | 56,67 | 44 | 73,33 |
| Test of mean differences | | 29,67* | | | |

**Source:** Compiled by the authors based on research data. * Significant at 1%.
****Notes:** 8.1.a. Insufficient; 8.1.b. Reasonably sufficient; 8.1.c. Sufficient; 8.1.d. More than sufficient; 8.2.a. Never; 8.2.b. Rarely; 8.2.c. Frequently; 8.2.d. Always.

From Table 8, it can also be inferred that both before and after the arrival of the cisterns, the majority of beneficiaries always have access to fruits and vegetables. This can be attributed to the fact that most respondents work in agriculture and grow a significant portion of their food, especially

grains, fruits, and vegetables. Before the P1MC, 56.67% always consumed fruits and vegetables, and after the program, this participation increased to 73.33% of respondents. Regarding those who never have access, they were 5% before the P1MC and decreased to 1.67% after the implementation of the cisterns.

Com base no teste T pareado, foi constatado que todos os indicadores analisados apresentaram diferenças estatisticamente significativas before and after the P1MC at a significance level of 1%.

Table 9 provides a comparison between the Quality of Life Index of the One Million Cisterns Program beneficiaries before and after the program. It shows the absolute and relative contributions of the indicators composing the QoL index in both situations, as well as the relative increase of each of the analyzed indicators. With these data, it is observed that there were improvements in all indicators, which is supported by the difference in the means test. The indicators that contributed the most to the formation of the QoL index before the P1MC were Housing (0.1017 or 19.66%), Education (0.0872 or 16.85%), Health (0.0854 or 16.51%), and Nutrition (0.0747 or 14.44%).

Table 9
**Absolute and relative participation of indicators in the composition of the QoL index before and after the implementation of the P1MC, in Moreilândia, 2018**

| IQVB indicators | Participation of indicators in the IQVB before the P1MC | | Participation of indicators in the IQVB after the P1MC | | Increase in indicators (%) |
|---|---|---|---|---|---|
| | Abs.* | Relat.** | Abs.* | Relat.** | |
| Water Resources | 0,0441 | 8,52 | 0,1170 | 17,76 | 165,31 |
| Sanitary Aspects | 0,0479 | 9,26 | 0,0712 | 10,81 | 48,64 |
| Housing | 0,1017 | 19,66 | 0,1125 | 17,08 | 10,62 |
| Employment and Income | 0,0434 | 8,39 | 0,0448 | 6,80 | 3,23 |
| Health | 0,0854 | 16,51 | 0,0878 | 13,33 | 2,81 |
| Education | 0,0872 | 16,85 | 0,0983 | 14,92 | 12,73 |
| Leisure | 0,0330 | 6,38 | 0,0392 | 5,95 | 18,79 |
| Food | 0,0747 | 14,44 | 0,0878 | 13,33 | 17,54 |
| IQVB | 0,5174 | 100 | 0,6587 | 100 | 27,31 |

**Source:** prepared by the author based on research data.
***Abs**. refers to absolute values and Relat. refers to relative values.

In the situation following the implementation of the program, the indicators that contributed the most to the formation of the QoL index were Water Resources (0.1170 or 17.76%), Housing (0.1125 or 17.08%), Education (0.0983 or 14.92%), Health (0.0878 or 13.33%), and Nutrition (0.0878 or 13.33%). Therefore, it is noticeable that the indicators that contributed the most to the formation of the QoL index before were also the ones that contributed the most to the formation of the QoL index afterward, except for the Water Resources indicator, which had the highest participation in the composition of the QoL index and a significant increase of 165.31%. It is also noted that, in addition to the Water Resources indicator, the Sanitary Aspects indicator recorded a strong increase of 48.64%.

As per Table 9, when comparing the situation before the P1MC and after the implementation of this program, all analyzed indicators showed a positive variation in absolute terms, with the smallest increases occurring in Employment and Income and Health, with 3.23% and 2.81%, respectively.

Regarding the QoL index, there was an increase of 0.1413 in absolute terms, as the QoL index before the implementation of the P1MC was 0.5174 and increased to 0.6587 after this program. This variation represents an increment of 27.31%. Despite this increase, it is observed that both before and after the implementation of the P1MC, beneficiaries are characterized as having average quality of life since they fall within the range of $0.5 < \text{QoL index} \leq 0.8$.

According to Table 10, before the One Million Cisterns Program, 50% of respondents were in the low quality of life interval, which changed to 5% in the subsequent scenario. Before the P1MC, 48.33% of beneficiaries were characterized as having average quality of life, while after the program, 90% of beneficiaries were classified as such.

Regarding the high quality of life, in the period before the P1MC, only one family, corresponding to 1.67% of the respondents, was in

this category. After the program, three families, equivalent to 5%, belong to this class. Thus, it is evident that the One Million Cisterns Program brought substantial improvement in the quality of life of its beneficiaries.

Table 10
**Absolute and relative frequencies of the quality of life level of P1MC beneficiaries, in Moreilândia, 2018**

| Quality of life | Before P1MC | | After P1MC | |
|---|---|---|---|---|
| | fi | % | fi | % |
| Low | 30 | 50,00 | 3 | 5,00 |
| Medium | 29 | 48,33 | 54 | 90,00 |
| High | 1 | 1,67 | 3 | 5,00 |
| Total | 60 | 100,00 | 60 | 100,00 |

**Source:** Compiled by the author based on research data.

According to Morais, Paiva, and Sousa (2017), the effects of the P1MC are widely satisfactory and, therefore, fulfill the analyzed assumptions, strengthening self-esteem and citizenship, which contribute to an improvement in the quality of life of its beneficiaries. The satisfaction with the use of cisterns was also observed by Santos et al. (2023) in their research conducted with beneficiaries of this program in the community of Riacho do Pintor, located in the municipality of Riachão das Neves, Bahia.

## Final considerations

The main successful aspect of the P1MC mentioned by the interviewees was the reduction in time and distance spent fetching water. At the same time, 40% did not mention any deficiencies in the program, and among those who did, the main ones were the appearance of cracks and leaks, requiring repairs, in some cases more than once; and the need to travel to fetch drinking water at the residence registered by the Agronomic Institute of Pernambuco (IPA) or by the army, which in certain situations led to conflicts. Regarding the quality of life of cistern beneficiaries, it was found that there was significant progress when comparing the situation before and after the P1MC, as the average IQVB increased from 0.5174 to 0.6587, classifying the beneficiaries as having medium quality of life.

When observing the IQVB individually, it is noted that, before the program, the quality of life of the majority of beneficiaries was between low and medium, after the installation of the cisterns, the classification of most families shifted to medium quality of life.

It was found that all the indicators used increased in absolute terms. It was also observed that the same indicators had greater participation in the formation of the IQVB before and after the P1MC, added in the subsequent situation by the indicator Access to Water Resources, which was the most significant for the calculation of the IQVB after the program. Although the Sanitary Aspects indicator was not among the most significant for the calculation of the IQVB, in the period after the P1MC, it showed significant expansion, which is because, after the installation of the cisterns, more than 90% of the beneficiaries started consuming water treated with chlorine, and also because they built or received bathrooms with toilets and septic tanks through the Home Sanitation Improvement Program of the National Health Foundation (Funasa).

In the Housing indicator, its increase after the program was due to the replacement of mud houses with brick houses with plaster. In the Employment and Income indicator, there was a reduction in the number of employed people, however, this indicator showed an increase due to the increase in family income. The Health and Leisure indicators showed modest positive changes in the period after the program, as for health, the majority of treatments were and continue to be done in hospitals, but now beneficiaries also have access to the Family Health Program. In the leisure indicator, there was an increase in the number of people with access and an improvement in the types of leisure activities enjoyed by the family. In the Education indicator, the improvement occurred especially because, in the period after the P1MC, families had more access to Higher Education. As for the Food indicator, the improvement occurred because, in the period after the P1MC, more families had sufficient food, as well as more access to fruits and vegetables, which can be explained by

the increase in family income.

Based on what was explained, and the evaluations during the field research, it is suggested to better plan the cisterns, improve the training of the workforce, and supervise the material used for the construction of the cisterns, to avoid or reduce cracks and leaks, which, in several cases, render them unusable. It is also suggested, for the next cistern implementations, to replace the slab cistern with the polyethylene cistern to solve leakage problems.

Another recommendation is the registration and provision of water for all cisterns in the program to further facilitate the lives of the beneficiaries, even if, instead of receiving all the "truckloads of water", they are divided among all those who were beneficiaries. Further studies are also suggested to prove the effectiveness of the Program, and the investigation of the suggestions made by the beneficiaries to solve the existing problems. It is also necessary to study more indicators and variables that allow a better understanding of the changes in the quality of life provided by the P1MC to its beneficiaries.

Moreover, it is concluded that the One Million Cisterns Program as a drought-coping technology has fulfilled its main objective, providing beneficiary families with a methodology for harvesting and storing rainwater for human consumption, and assisting in the survival of these families in periods of drought and dryness with a reservoir, where they can store water for their needs.

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