RENOVA SEMIÁRIDO

Renewable Energy

IACOC Compromisso com o desenvolvimento socioeconômico do Semiárido paraibano
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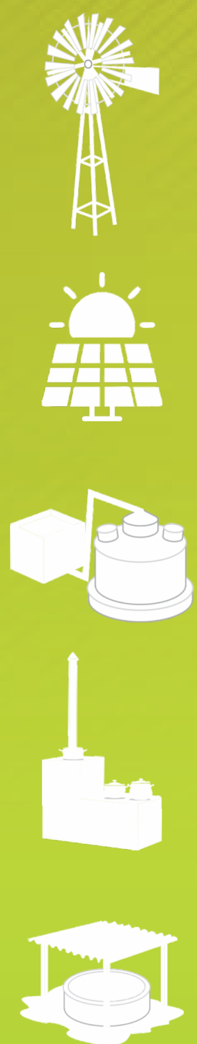
RENOVA SEMIÁRIDO

Energias Renováveis



Wind Energy

Solar Energy

Biodigester

Ecostove

Bioagua

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DIGITAL
PORTFOLIO

WIND ENERGY

Compromisso com o desenvolvimento socioeconômico do Semiárido paraibano
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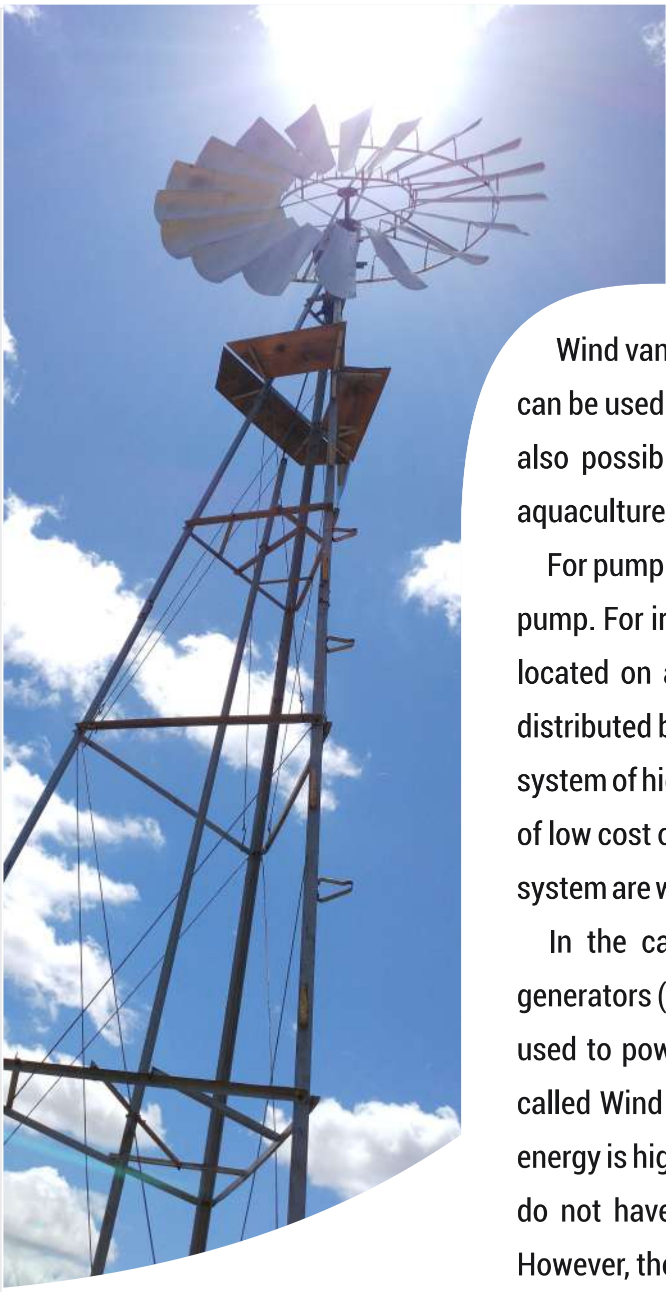


Wind vanes or wind mills are devices that utilize the energy of the winds. They can be used to generate electricity or to pump water for storage or irrigation. It is also possible to use them to move aerators for water treatment tanks or in aquaculture.

For pumping water, the wind vane must be installed together with a piston type pump. For irrigation purposes, it is generally used to pump water into reservoirs located on a larger height of the land. From the reservoir, water can then be distributed by gravity to drip, micro-sprinkler or surface irrigation systems. It is a system of high acquisition cost in comparison to the electric pumping system, but of low cost of operation and maintenance. A basic need for the installation of the system are winds above 2 m / s in the region.

In the case of electricity generation, wind vanes are coupled to electric generators (wind turbines) that are connected to the public electricity network, or used to power some batteries. The energy generated by these devices is then called Wind Energy. Although the Brazilian potential for the generation of wind energy is high, the regions with the highest percentage of installed family farming do not have the potential for the generation of energy by large wind farms. However, there is sufficient wind potential for generating electricity to be used in the family farming production process with irrigation.

As seen, there are several applications for wind vanes, which vary according to the need, mainly in remote areas, where they are used for domestic electricity generation and for pumping water. They are also used in tourist sites or in those far from the electrical networks, for the generation of electrical energy to operate all support equipment and processing machines. Small wind turbines are used to supply energy at different scales, to serve from an isolated community, to small arrangements to generate electricity in wind farms composed of small wind turbines. On these scales, small wind turbines are used for water supply, animal feed, irrigation and lowland drainage, and may or may not be associated with other energy generation and storage devices in hybrid systems, that is, systems with more than a source of energy. Local production, for example, small wind turbines, could also represent a definitive solution for your electricity needs or even the use of wind vanes in pumping water from the subsoil for agricultural and domestic use.

Both the wind vane intended for pumping water from the subsoil, as well as those intended for the production of electricity on a small scale are perfectly suited for use in agricultural communities, as they provide the means necessary for human, animal and plant subsistence. It must also be considered that the diversification of the rural energy matrix is essential, especially for the use of natural resources available on rural properties. It is also important to take into account that the use of technologies like this improves the farmer's income, as they reduce maintenance costs. The wind vane is a technology that brings to the perspective of the farmer to acquire an important technological resource that does not require advanced technical knowledge and does not present a high maintenance cost for its maintenance.

The possibility of turning the farmer's financial resources more profitable, preventing him from investing in equipments that requires specific technical knowledge and high acquisition cost, as the case with photovoltaic panels, enabled hundreds of rural properties to improve their quality of life through the transfer of wind vane kits with IFAD irrigation systems. Currently in the Brazilian semi region, the most used rural wind vanes are those intended for pumping water for consumption and irrigation. In Paraíba, for example, 498 wind vane were installed between 2016 and 2019, a partnership between the Government of Paraíba and IFAD, in communities benefited by Procase (Sustainable Development Project of Cariri, Seridó and Curimataú), in 56 municipalities in the state, semi region of Paraíba. In general, these equipments are popular and almost always have the same design, following the American model. They perform the mechanical work of pumping water and, once installed, their maintenance is easy and often spaced. They are really popular.

Promoting or limiting technology adoption factors

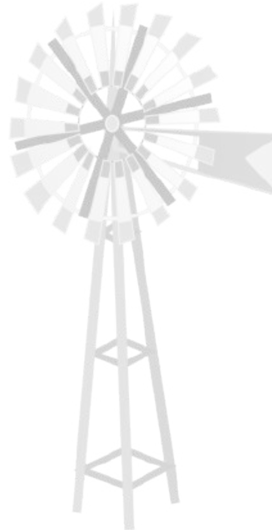
The use of wind energy presents several advantages of uses and challenges, whether for the hydraulic pumping of wells or for the generation of electrical energy. Unlike other sources of energy such as oil and even water, the wind is simply the air in circulation and, as a result, there is no chance of ending at the end of the day. Therefore, there is no restriction on the use and enjoyment of the benefits of wind energy. This energy source is so sustainable that there is no emission of any elements that pollute the air or the environment. If the preservation of the environment were not enough, wind energy is also economical. In family farming, the use of winds occurs mainly with the use of hydraulic wind vanes. The main advantage for using this equipment in family farming in the semi region is that wind vanes work under low and medium pressure conditions and can therefore be used for pumping low flow water sources. In addition, it does not require water filtration for pumping and allows localized application of water, with a lower investment cost compared to other irrigation systems.

However, some of these advantages presented may also be disadvantageous, since this type of technology is limited to regions with available winds. This fact is even more important when it comes to the use of wind vanes for irrigation, where the pumping needs to be more constant. In addition, the use for brackish water pumping also increases maintenance costs, as the equipment is constantly affected by scale and rust. Thus, this system is indicated for irrigation of areas smaller than 3 ha, which limits the expansion of productive areas. In general, the cost-benefit ratio is higher than the installation of electric pumps. The system showed efficiency for small areas in tests carried out by Embrapa in Pacajus-CE. In comparison with the electric pumping system, the use of the wind vane had a higher initial cost. However, at medium and long term, the irrigation system using wind energy has advantages, since there is no need to pay for the energy source, the maintenance of the equipment also has a lower cost, in addition to being a system that does not pollute the environment. Taking into account the average daily volume of water pumped, the use of a single-phase 1.0 CV electric pump set would be sufficient to meet the water demand in an area of 6,000 m^2 irrigated. However, must be taken into account the need for the existence of an electrical network and the monthly payment of the energy bill. Whatever the pump's drive system may be, small and decapitalized farmers cannot afford the costs of implantation.

But it is not just the acquisition process that can be considered a challenge that can be overcome by the use of this technology by family farmers in the Brazilian semi region. Although it is a popular and well-known technology in rural areas, the equipment generally requires routine maintenance and the repair must be done by specialized personnel. This can make maintenance difficult, especially in communities further away from urban areas. In addition, the equipment is often affected by rust encrustation, with heavy water pumping. Thus, training the farmer to carry out maintenance and carry out minor repairs is crucial for technological independence, empowerment and, consequently, a significant reduction in technical assistance costs.

Another challenge is the necessity to have permanent availability of winds in the locality, especially when the wind vane is intended for pumping water for irrigation, what requires a more constant wind flow. This can becomes yet another limitation of technology. In addition, the use of the wind vane for irrigation is proven to be effective for small productive areas, which can help the operation of small producers. Therefore, this is a challenge to be considered when it comes to its use in communities.

COST BENEFIT ANALISYS



Installation costs (R$ value):	7,000.00 (purchase + installation)
Maintenance costs (amount in R$):	500.00 / year
Technology lifetime (value in years):	30 years
Environmental impacts (percentage value):	0

SOCIAL IMPACTS

The long periods of drought, added to high temperatures, make a challenge for family farmers to live in the Brazilian semi, especially in poorer regions. For those who don't abandoned their land in search of sustenance in large cities, it is common to walk miles away in search of water. Therefore, this water, not always drinkable, is carried on donkeys, or even in heavy cans under their heads. For families, this task is almost always for women and children, as men are responsible for working in the fields, raising animals and selling family labor products. Indirectly, these challenging conditions have consequences even for health and the reduction of the educational level of these populations.

The expansion of the water supply promoted by IFAD, in partnership with the State Governments, had a positive impact on the lives of these people. With water, agricultural and livestock productivity increased in these regions and, as a result, the settlement of human being in the land, making it possible to expand the cultivated area and, consequently, offer food to everyone. With

Campo de palma irrigado com água obtida a partir do uso de catavento em Algodão de Jandaíra - PB.

the low human development index in inner regions of the Brazilian semi region, it is expected that the level of education, basic and financial sanitation of these communities will also be expected very low. Therefore, access to companies that can offer specialized technical assistance is also limited. Thus, for a given technology to be adopted by these communities, it is essential considering the resistance / durability, simplicity of operation and repair, as well as lower maintenance costs. Wind vanes comply with all these requirements, being a consolidated technology, an equipment considered resistant and long-lasting, with low cost of acquisition and maintenance and with easy handling. Although it has some limitations, especially regarding the capacity of use and the need for constant winds, it has been an inexpensive and important alternative to provide quality of life to the rural man in the Brazilian Semi.

There are several companies that manufacture, sell, install and provide maintenance services for hydraulic wind vanes in the Brazilian semi region. Nevertheless, even though it is a work of technological evolution, wind vanes are practical, as they can be adapted to different situations; durable, can have a useful life of up to 30 years; ecological, because they do not use any accessory energy source (only the movement of the winds); and easy to maintain, as its component parts are easy to purchase and can be repaired in small towns.

The acquisition and maintenance costs are proportional to the need for use and, consequently, to the desired water pumping flow and the average wind speed in the installation location. In 2020, the price of acquisition of this technology can vary from R $ 4,000.00 to R $ 10,000.00 depending on the flow. For example, a wind vane mounted on a 10 m high tower that provides a water flow between 10,000 and 15,000 L / day, can reach R $ 4,900.00. For the use of wind vanes in irrigation systems, a study carried out in 2003 by Embrapa Agroindustry Tropical estimated that around R $ 15,500.00 would be required to build an irrigated area of 6,000 m^2 with a hydraulic wind vane. Updated to 2020, this same system could cost around R $ 19,300.00.

CO_2 EMISSION ANALISYS

The reduction of CO_2 emissions in wind vanes systems can be calculated from the comparison with the consumption of electricity for pumping an equivalent volume of water (in the case of electric pumps) or by comparison with the consumption of diesel in the case of sets fuel pump. Although a case-by-case study may be necessary to verify the reduction of CO_2 emissions with wind vanes, the substitution of electric or fuel pumping with pumping by wind vanes can mitigate CO_2 emissions into the atmosphere. The technology falls within scope 2, which refers to the purchase of energy, according to the GHG Protocol emissions inventory.

TOTAL QUANTITY INSTALLED AND NUMBER OF BENEFICIARIES

Installed Quantity (total value): 498

Number of beneficiaries (total value): 3671 families

Municipalities (total value): 56

QUANTITY OF PATENTS

Although the wind vane is considered a very old invention, throughout history it has received several improvements aimed at increasing the efficiency of this technology. For example, searching for the keyword “catavento” (“wind vane”) at the base of the National Institute of Industrial Property (INPI) from 1992 to 2015, 27 patent applications were registered. However, of these, there were only 10 orders that effectively relate to improvements aimed at pumping water and irrigating crops for rural communities. Of these, the documents of patents PI 0012810-4 and PI 0000092-2 are not available in the INPI database.

The document PI 0805788-5 A2 refers to a technology for generating electricity for small communities, and because of that, it was also considered relevant. Other technologies such as the patent BR 20 2012 012558 2, for example, deal with improvements in the structure of the water pump coupled to the wind vane. For this technology, the pump has its efficiency increased by the use of a double-acting piston providing a reduction in power and providing safety to the wind rotor and pump system. Another benefit of this invention is that the water discharge can reach up to 150 meters.

SOCIAL TECHNOLOGY TRL

The scale of the technological maturity levels (Technology Readiness Level - TRL) allows to classify and monitor the degree of maturity of the development of a technology, in addition to enabling the direct comparison between different assets. For products that are already on the market, these assets should be classified on the scale from 7 to 9. The wind vane in its current format is already a stable, improved, widely marketed and popular technology.

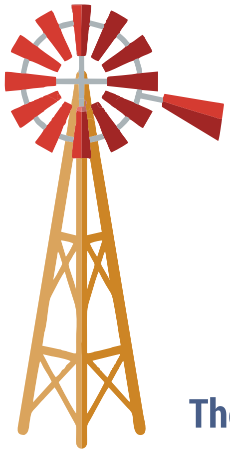
Although popularized and considered simple for use and maintenance, the hydraulic wind vane has undergone many technological improvements over the years, since its conception in Persia, 915 BC. Even so, any and all technology is still capable of being perfected, or reformulated for optimize its performance or use it for other purposes. For projects supported by IFAD, the wind vane has been associated especially with the cultivation of palm and vegetable gardens, promoting food for small herds and th agricultural population of the Semi.

REAL EXPERIENCES

LOCATION: Algodão de Jandaíra - PB

We visited the forage palm field and the garden of a family that benefited from a wind vane-powered irrigation kit financed with IFAD funds in the city of Coton de Jandaíra, inner of Paraíba. The property has a piece of land irrigated with water pumped by the wind vane. The images clearly represent the general condition of the property, with dry and cracked land. However, the installation of this project brought joy and quality of life to this family.

DID YOU KNOW...?



The origin of the wind vane is dated 915 BC.

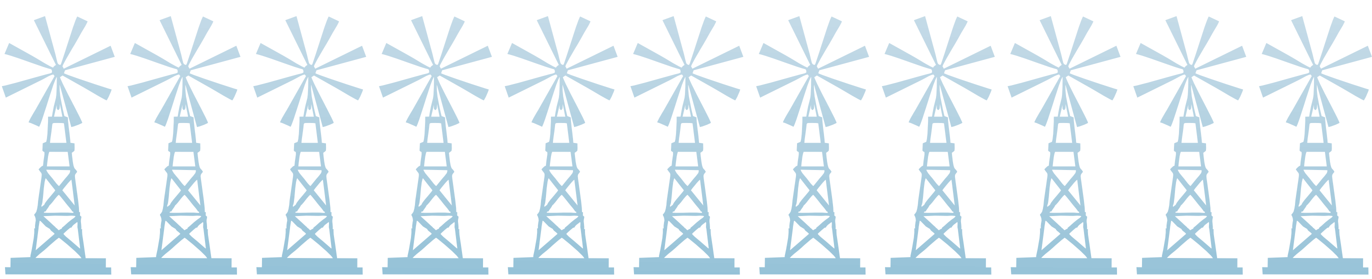
The origin of the wind vane goes back to the old windmills. This origin is not really clear, but some scholars believe it originated in Persia from 915 BC, i.e. Iran. However, there are indications about the use of more remote windmills in Iraq, Egypt and China. In Europe, windmills were introduced in the 12th century, but only in the 15th century did they spread across the continent. Over the centuries, the use of energy wind has been used for many applications such as grain milling, oil extraction, water pumping, among others.

Simple technology with an inexhaustible energy source for agriculture

The functioning of the wind vane is based on the movement of air masses, which cause their blades to rotate when passing through the propellers. For pumping water, the wind vane must be installed together with a piston-type pump. For irrigation purposes, it is generally used to pump water into elevated reservoirs. From the reservoir, water can then be distributed by gravity to drip, micro-sprinkler or surface irrigation systems. It is a system of high acquisition cost in comparison to the electric pumping system, but of low cost of operation and maintenance.

The transition from a windmill to electricity generation

Charles Francis Brush (1849-1929), one of the founders of the electrical industry in the United States, built a large windmill on his property in Cleveland. This was the first record of a wind-powered turbine to produce electricity. The diameter of the rotor was 17 meters, with 144 blades made of wood. The turbine ran for 20 years and was used to charge batteries that were in the barn of his mansion. This first version generated only 12 kilowatts (kW).



CONSULTED REFERENCES

BARROS, Pedro Paulo da Silva. Sistemas alternativos de irrigação para agricultura familiar. 2007. 42f. Monografia (graduação) - Faculdades Integradas da Terra de Brasília, Brasília, 2007.

BARROSO, Teresa. Energia eólica pode ser alternativa para pequenas propriedades. Embrapa. 2004. Disponible en: https://www.embrapa.br /busca-de-noticias/-/noticia/17961474/energia-eolica-pode-ser-alternativa-para-pequenas-propriedades. Acceso el: 27 nov. 2020.

BURGUEÑO, Luís Eduardo Torma; SILVA, João Baptista. O uso da energia eólica no bombeamento d'água, em Pelotas, RS. Revista Brasileira de Agrometeorologia, v. 11, n. 2, p. 167-172, 2003.

CANIVAROLLI, Devacil; TOMAZELLI, ldezio João; MOREIRA, João Antonio , CONRADO, Wesley Batista. Bomba de pistão de dupla ação com acionamento eólico. Depositante: Hidro Metalúrgica ZM Ltda. BR no. BR 20 2012 012558-2 U2. Depósito: 25 de maio de 2012. Concesión: 14 de julio de 2015.

Cata-vento. WIKIPEDIA. 2020. Disponible en: https://pt.wikipedia.org /wiki/Cata-vento Acceso el: 27 nov. 2020.

Catavento direto da fábrica (Cód. 69766), MFRural. Disponible en: https://www.mfrural.com.br/detalhe/69766/catavento-direto-da-fabrica. Acceso el: 27 nov. 2020.

Cataventos, Yvel. 2017. Disponible en: http://yvel.com.br/cataventos/ Acceso el: 27 nov. 2020.

Consulta à Base de Dados do INPI. Instituto Nacional de Propriedade Intelectual. Disponible en: https://gru.inpi.gov.br/pePI/jsp /patentes/PatenteSearchBasico.jsp Acceso el: 27 nov. 2020.

CRISÓSTOMO, Lindbergue Araújo. Sistema de irrigação localizada acionado por energia eólica. Fortaleza: Embrapa, 2003, 13p. Disponible en: http://www.cnpat.embrapa.br/docs/arquivos/Relatorio_Energia _eolica.pdf Acceso el: 12 ago. 2020.

FARIAS, Rogério. Bomba d'água eólica para poço profundo. Depositante: Rogério Farias. BR no. PI 0000092-2 A2. Depósito: 07 de janeiro de 2000. Publicación: 14 de agosto de 2001.

FEITOSA, Erialdo de Oliveira. Energia eólica aplicada ao bombeamento da água para irrigação por gravidade na agricultura familiar. 2014. 107 f. : Disertación (maestría) - Universidade Federal do Ceará, Fortaleza, 2014.

MARCOLIN, Neldson. Energia de cataventos. Revista Pesquisa FAPESP. 2007. Disponible en: https://revistapesquisa.fapesp.br/energia-de-cataventos/ Acceso el: 27 nov. 2020.

MELO, Silvia. Venda de água mineral ajuda a matar a sede no semiárido. Catracalivre. 2019. Disponible en: https://catracalivre.com.br /projetos/venda-de-agua-mineral-ajuda-matar-sede-no-semiarido/ Acceso el: 27 nov. 2020.

MONTENEGRO, Ricardo Cesar Porto. Bomba d'água de eixo vertical com rotor tipo rosca sem fio e válvula de pé acoplada. Depositante: Ricardo Cesar Porto Montenegro. BR no. PI 0012810-4 A2. Depósito: 14 de março de 2000. Publicación: 30 de abril de 2002.

NASCIMENTO, Mas Alexandre Seabra do. Ferramenta computacional para análise do potencial de bombeamento de água utilizando aerogeradores de pequeno porte acoplados a motobombas por meio de inversores de frequência. 2012. 106f. Disertación (maestría) - Universidade Federal do Pará, Belém, 2012.

Principais aplicações. Neoeolica. 2011. Disponible en: http://www.neoeolica.com.br /aplications.htm. Acceso el: 27 nov. 2020.

Ricardo lança pacote de ações do Procase com investimento de R$ 40 milhões. Governo do Estado da Paraíba. 2018. Disponible en: https://paraiba.pb.gov.br/noticias/ricardo-lanca-pacote-de-acoes-do-procase-com-investimento-de-r-40-milhoes. Acceso el: 27 nov. 2020.

RODRIGUES, Willy Pessoa. Projeto Mandalla - Desenvolvimento holístico sistêmico ambiental. Depositante: Willy Pessoa Rodrigues. BR no. MU 8402415-1 U. Depósito: 06 de julho de 2004. Concesión: 14 de febrero de 2006.

SANTOS, José Moacir dos. A bomba Volanta no Semiárido Brasileiro. IRPAA. 2012. Disponible en: https://irpaa.org/BAP/index.html Acceso el: 27 nov. 2020.

SCHISTEK, Haroldo. A bomba d´água popular. IRPAA. 2012. Disponible en: https://irpaa.org/publicacoes/artigos/bap-artigo-revisado.pdf Acceso el: 27 nov. 2020.

Secretaria de Pesquisa e Desenvolvimento. Manual sobre o Uso da Escala TRL/MRL. 2018. Disponible en: https://cloud.cnpgc.embrapa.br /nap/files/2018/08/EscalaTRL-MRL-17Abr2018.pdf Acceso el: 27 nov. 2020.

Sistema de irrigação localizada acionado por energia eólica. Embrapa. 2003. Disponible en: https://www.embrapa.br/busca-de-solucoes-tecnologicas/-/produto-servico/1872/sistema-de-irrigacao-localizada-acionado-por-energia-eolica Acceso el: 27 nov. 2020.

VIEIRA, Vinícius José de Souza; RICHE, Gilles Robert, TONNEAU, Jean-Philippe. Implantação de pequena irrigação com água de poços tubulares bombeados por catavento no trópico Semiárido - Massaroca, BA. In: SEMINÁRIO FRANCO BRASILEIRO DE PEQUENA IRRIGAÇÃO, 1990, Recife, PE. Pesquisa e desenvolvimento: anais. Recife: SUDENE/Embaixada da França, 1990. p. 113-130.

VOGT, Hans Heinrich. Análise estrutural de pás de gerador eólico de pequeno porte feito de fibra vegetal brasileira. 2010, 128 f. Disertación (maestría) – Universidade Estadual do Ceará, Fortaleza, 2010.

Realization:

Partners:

Sponsor:

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SOLAR ENERGY

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Solar Energy is an alternative, sustainable and renewable energy, having the Sun as its source and can be used mainly as photovoltaic and thermal electric energy. Photovoltaic energy is the direct conversion of the sun's rays into electricity. Thermal energy makes use of the sun's heat to heat water or to transform it into electrical energy.

The main investments made by IFAD are aimed at the implantation of photovoltaic systems in agro-industries and communities in the Brazilian semiarid region. Photovoltaic systems are composed of photovoltaic solar panels, which are basically devices used to convert sunlight into electrical energy in photovoltaic cells. Solar or photovoltaic cells are responsible for capturing and converting the sun's rays into electrical energy. The systems also provide a photovoltaic module that is the component responsible for generating energy, being basically a plate protected by glass where the solar cells are placed and connected to each other by wires, completing the assembly of a module. For the assembly of an autonomous photovoltaic system for the purpose of irrigation in agricultural areas, in addition to the equipment mentioned above, a charge regulator, a battery or battery bank and a direct current inverter for alternating current are required in order to attend the pump set and the possible electrical equipment of the irrigation automation system fed with alternating current.

In some cases no battery is used. When connected to the electrical network, there is a need for a solar inverter to promote the inversion of the electrical energy generated by the solar panel from direct current (DC) to alternating current (AC), required by most electrical equipment. This happen in addition to a light board which receives the energy that comes out of the solar inverter and distributes it to your home or business, as well as a clock that calculates and causes the excess electricity produced when there is too much sun or too little consumption to return to the power grid. This additional electrical energy is inserted into the distributor's network, becoming "energy credits" that can be used at night, on cloudy days or in the coming months. In addition, this clock also measures the input of public energy that is consumed when there is no sun, calculating in these cases the balance due to energy to the distributor. Unlike conventional means in the production of electricity that use the principle of electromagnetic induction to generate an alternating current in the circuit, photovoltaic conversion takes place directly, in which the photons coming from the Sun interact directly with the electrons of the cells of the semiconductor material, generating a one-way current, that is, a direct current.

What is the justification for it to fit into this project and examples of products / prototypes under development or installed (based on FIDA experiences)

The Brazilian semiarid region has great potential for the production of photovoltaic solar energy, which can be better exploited to transform this potential into real opportunities, capable of generating employment and income, with the greatest solar radiation in Brazil being in areas of low economic development, mainly those found in this region. Another important factor is linked to the reduction of environmental impacts when compared to conventional means of producing electric energy, since in the production of photovoltaic energy there is no emission of CO_2 and other gases, not even liquid pollutants or during the generation of electricity. With the large availability of solar energy sources in the semiarid region, IFAD has encouraged the use of photovoltaic energy in the region through various projects with the States.

The implementation of solar panels in agro-industrial systems and in rural communities has been impacting on the reduction in the cost of electricity, increasing the competitiveness of rural businesses and increasing the income and sustainability of the projects. 33 investments were identified involving photovoltaic systems in the states of Paraíba, Piauí and Sergipe, encompassing 14 associations / cooperatives and benefiting 5,676 families, all of which are financed by IFAD and in partnership with other public agencies.

FACTORS THAT PROMOTE OR LIMIT TECHNOLOGY ADOPTION

Solar energy is an inexhaustible source with a low environmental impact, and it can satisfactorily complement the supply of energy generated from hydroelectric plants, whose supply is diminished by the recurring low water levels in the reservoirs, negatively impacting the generation of energy and requiring the activation and use of thermoelectric plants, which increases the release of greenhouse gases. The costs for the deployment of systems with solar energy are relatively high; however, the savings generated can be up to 5 times in relation to the conventional system, making its implementation be economically interesting over time, despite the existing obstacle to the acquisition of solar systems. In this way, the savings generated can be equivalent to the value of the investment made with amortization that occurs over the months of use, and with high durability and low maintenance cost.

Even so, in addition to the fact that there is no emission of CO_2 and other gases, not even liquid or solid pollutants during the generation of electricity, the emission volumes in the manufacturing stages of the equipment used in the photovoltaic sector are low and the amount of energy generated by the lifespan of photovoltaic systems is 8 to 17 times greater than the energy consumed in their manufacture, and is therefore a viable alternative in this segment. It is also important to highlight that, at the end of the life cycle of a photovoltaic system, about 85% of its components can be recycled and reused, so that the environmental impacts tend to become even smaller in the long run, already quite reduced.

COST BENEFITIC ANALISYS

Instalacion costs (Amount in R$):

RESIDENTIAL

The cost of a residential photovoltaic solar energy system (including installation and materials) is approximately R$ 19,520.05, considering the use of a 3.46 kWp generator installed in a residence with an average monthly consumption of 372.6 kWh.

COMMERCIAL

With an investment of around R$ 187,495.07 photovoltaic solar system, it is possible to obtain a commercial system with expected energy generation of 585,000 kWh per month.

Maintenance costs (Amount in R$):

This system has a maintenance (after 25 years) equivalent to R$ 5,000.00.

There is the maintenance cost, represented by the replacement of inverters in the 15th year, in the amount of R $ 22,131.40 and the depreciation of 1.5% in the first year and 0.7% of the acquisition cost in the others.

Technology lifetime (value in years): about 25 years.

SOCIAL IMPACT

In IFAD investments, priority is given to productive groups with a focus on women, youth, quilombolas, indigenous people, the black and brown population. With this focus, any investments that considers improving income generation, gender equity, increasing quality of life and improving working conditions are prioritized as a public policy. Solar energy is seen as a technology that goes beyond the environmental issue, as it is capable of reducing production costs with the potential to increase self-investment in other group needs. Such action has a positive impact on the income generation capacity of these priority groups, improving social welfare to all the community.

ADAPTATION TO THE REALITY OF FAMILY FARMING

The available technology allows several uses for family farming, either to reduce production costs or to completely replace the energy source. Practical examples include the installation of photovoltaic panels for pumping water for various uses, including the irrigation of production fields. Its use for capturing water has the advantage of being able to be installed in places where there is no conventional power grid. The presence of agro-industries making use of this energy source has been expanding in the country, improving competitiveness and better insertion in all the markets. It consists of a technology of simple management and requires basic maintenance to function and with great potential for use in family agriculture and emphasis on the semi-arid region, with a large supply of the main raw material - the sun.

CO_2 EMISSION ANALISYS

The reduction of CO_2 emissions with the use of photovoltaic panels was calculated considering the indirect emissions from the alternative purchase of electric energy, in the approach to the choice of purchase. Without considering the life cycle of the manufacture of photovoltaic panels, there was a 99.9% reduction in CO_2 emissions compared to the consumption of electricity from the conventional electricity grid.

The calculation was made by comparing the electricity consumption before and after the use of photovoltaic solar energy in a Picuí-PB Cooperative. The emission factors used were based on the Brazilian energy matrix.

Mês	Consumo (MWh)	Fator Médio de Emissão	Total de emissões (tCO_2e)
Agosto/2019	2206	0,1070	236
Agosto/2020	0,165	0,1070	0,018

TOTAL QUANTITY INSTALLED AND NUMBER OF BENEFICIARIES

Installed Quantity (total value): 2722

Number of beneficiaries (total value): 8,461 families

Municipalities (total value): 24 municipalities

SOCIAL TECHNOLOGY TRL

The photovoltaic panels fit into TRL 9 since they have already been tested, as well as they are already commercialized and used by the community successfully. All this, considering that this level is reached when the technologies in question are applied in systems that are successful in a actual operation. It is also noteworthy that the fundamental difference between TRL 8 and 9 is related to the operation of the system, being a basic example that the construction of a new aircraft fits into a TRL 8, but flying it the first time in a real way is TRL 9.

TRL : 9

LOCATION

We went to Picuí and Nova palmeira to see the actions carried out with IFAD financing. In Picuí, we visited the Cooperativa Agroindustrial do Seridó and Curimataú Paraibano - COOASC, both of which benefited from the installation of a photovoltaic solar system to reduce costs in the processing of fruit pulps. In Nova palmeira, we visited the property of Mr. Euclides and family, both in the Saquinho community, who were benefited with a solar photovoltaic kit for the purposes of irrigating their property. All families benefited from the experiences were satisfied and grateful for the concession of the technologies.

We visited a cooperative aimed at the production of pulps and a rural property that received solar photovoltaic systems, using resources from Procase / PB and IFAD. The cooperative located in Picuí has reduced production costs thanks to the reduction in expenses with electricity from now on, which is aided by the photovoltaic system. While the rural property has part of its production irrigated with water pumped by the photovoltaic system. The images portray well the experiences and the current situation of the systems in the localities.

DID YOU KNOW...?

That photovoltaic energy has been around since 1839?

Alexandre Edmond Becquerel discovered the photovoltaic effect in 1939, while conducting electrochemical experiments in his father's workshop. In 1873 the first photovoltaic cell that was made of selenium was created. Currently almost 80% of solar panels are made up of some variation of silicon thanks to Calvin Fuller who, in 1954, developed silicon photovoltaic cells. In 1973, the first house powered by solar energy was built, a fact performed by the University of Delaware in the USA. But it was in 2004 that millions of cells were produced worldwide with an efficiency of 16%, surpassing for the first time the barrier of 1 gigawatt of annual electrical power.

That besides to solar energy other devices are used to harness energy from the sun?

"Aqualuz": technology aimed at the treatment of cisterns, using only the sun, without the need to use chemical substances, sophisticated filters, or interventions in the cistern. Its assembly takes just 10 minutes, with daily use for 20 years, and its low maintenance is done only with soap and water. The technology consists of a stainless steel box covered with glass and a simple pipe connected to the cistern.

Solar distiller: it is a low cost and easy to operate robotic prototype (DSR), with a solar tracking system, aimed at residential, laboratory and industrial applications, for water distillation. The equipment consists of four fundamental parts: receiving chute; absorber tube; robotic antenna mobility system and condenser cooling system.

Solar desalinizer: the technology promotes solar distillation by completely eliminating all salts, heavy metals, bacteria and microbes present in polluted waters, as well as the removal of various pesticides, due to high temperatures and ultraviolet radiation. At the end of the process, a simple reconstitution of salts is made easily for use as drinking water.

Solar dryer: composed of a piece that simultaneously performs the function of collecting solar energy and serving as a drying chamber, where solar radiation affects directly the product placed in the dryer. The air is heated and the circulation is made by natural convection, being a quick and inexpensive drying.

CONSULTED REFERENCES

______. **Balanço Energético Nacional 2017**: Ano base 2016. Rio de Janeiro: EPE, 2017.

ABINEE, ASSOCIAÇÃO BRASILEIRA DA INDÚSTRIA ELÉTRICA E ELETRÔNICA, 2012. **Propostas para Inserção da Energia Solar Fotovoltaica na Matriz Elétrica Brasileira**. Disponível em: <http://www.abinee.org.br/informac/arquivos/profotov.pdf>. Acesso em: 16 out 2020.

ALMEIDA, E.; ROSA, A.; DIAS, F.; BRAZ, K.; LANA, L.; SANTO, O./ SACRAMENTO, T. Energia solar fotovoltaica: revisão bibliográfica. **Artigo científico, in: http://www2. aneel. gov. br/arquivos/pdf/atlas3ed. pdf, Outubro**, 2016.

ALVARENGA, A. C.; FERREIRA, V. H.; FORTES, M. Z. Energia solar fotovoltaica: uma aplicação na irrigação da agricultura familiar. **Sinergia, São Paulo**, v. 15, n. 4, p. 311–318, 2014.

BELLELIS, A. A.; DE MELO, D. D. C. P. USO DA ENERGIA SOLAR NO SEMIÁRIDO PERNAMBUCANO. **Educação Ambiental em Ação**, v. 67, 2019.

BEZERRA, V. R.; LIMA, C. A. P.; LEITE, V. D.; MONTEIRO, L. R. R. Implementação de sistemas autônomos de geração de energia para a região do semiárido paraibano. **MIX Sustentável**, v. 5, n. 4, p. 89–95, 2019.

BRASIL. Agência Nacional de Energia Elétrica – ANEEL. **Resolução Normativa n 676**. 2015. Disponível em: http://www2.aneel.gov.br/cedoc/ren2015676.pdf. Acesso em: 28 out. 2020.

BSW SOLAR - GERMAN SOLAR INDUSTRY ASSOCIATION. **A energia solar nos países em desenvolvimento e emergentes.** 2015. Disponível em:<http://www.solarwirtschaft.de/en/start/english-news.html>. Acesso em: 06 de out. 2020.

BUX, M.; BAUER, K.; MUHLBAUER, W.; CONRAD, T. Solar-assisted drying of timber at industrial scale. **The Southern African Forestry Journal,** South Africa, v.192, n.1, p.73-78, 2001.

CASTRO, R. D. D. **Energia solar térmica e fotovoltaica em residências: estudo comparativo em diversas localidades do Brasil**. Dissertação (Mestrado em Engenharia mecânica) – Universidade Estadual de Campinas, São Paulo, 111 p. 2015.

CEPEL – CENTRO DE PESQUISAS DE ENERGIA ELÉTRICA; CRESESB – CENTRO DE REFERÊNCIA PARA ENERGIA SOLAR E EÓLICA SÉRGIO BRITO. **Manual de Engenharia para Sistemas Fotovoltaicos**. Rio de Janeiro, RJ: Especial 2014.

CUNHA KEMERICH, P. D.; FLORES, C. E. B.; BORBA, W. F.; DA SILVEIRA, R. B.; FRANÇA, J. R..; LEVANDOSKI, N. Paradigmas da energia solar no Brasil e no mundo. **Revista Eletrônica Em Gestão, Educação E Tecnologia Ambiental**, v. 20, n. 1, p. 241–247, 2016.

DANTAS, S. G. **Oportunidades e desafios da geração solar fotovoltaica no semiárido do Brasil**. 2020. Disponível em :< http://repositorio.ipea.gov.br/handle/11058/9680>. Acesso em: 15 out. 2020.

ELÉTRICA, ENGENHARIA. **Sistemas de energia solar fotovoltaica e seus componentes**. 2018. Disponível em :< http:// https://www.stalengenharia.com.br/PDf-fotovoltaico.pdfAcesso em: 15 out. 2020.

ELLRAM, L. M. A taxonomy of total cost of ownership models. **Journal of Business Logistics**, v. 1, n.15, p. 171-192, 1994.

FIGUEIREDO, H. F. M.; PODOLAK, L.; SCHULTZ, L. R. K. PROJETO E. Desenvolvimento de um sistema fotovoltaico autônomo voltado a área rural. **Revista Técnico-Científica**, n. 15, 2018.

HAGE, H. E.; HEREZ, A.; RAMADAN, M.; BAZZI, H.; KHALED, M. An investigation on solar drying: A review with economic and environmental assessment. **Energy**, v. 157, p. 815-829, 2018.

IEEE - INSTITUTO DE ENGENHEIROS ELETRICISTAS E ELETRÔNICOS. **Energia solar fotovoltaica de terceira geração.** 2014. Disponível em :< http://www.ieee.org.br/wpcontent/uploads/2014/05/energia-solar-fotovoltaica-terceira-geracao.pdf>. Acesso em: 15 out. 2020.

MANKINS, J. C. Technology readiness assessments: a retrospective. **Acta Astronautica,** v. 65, n. 9, p. 1216-1223, 2009.

MORAES, A. DE; MORANTE, F.; FEDRIZZI, M. C. Bombeamento fotovoltaico no semiárido piauiense, projeto água no berço do homem americano. Congresso Brasileiro de Energia Solar–CBENS; São Paulo–São Paulo. Versão digital em CD. **Anais**...2012.

NASCIMENTO, C. A. **Princípio de funcionamento da célula fotovoltaica.** Monografia (Pós-Graduação Lato-Sensu em Fontes alternativas de energia) Universidade Federal de Lavras, 21 p. 2004.

SANTOS, E.C.; SOUZA,L.C.; SOUTO,J.S; FILHO,J.B.A. Energia Solar na Fruticultura Irrigada Familiar. **Tecnologia & Ciência Agropecuária**, v. 1, nº 2, 2007, p.1-7.

SHAYANI, R. A.; OLIVEIRA, M. DE; CAMARGO, I. DE T. Comparação do custo entre energia solar fotovoltaica e fontes convencionais. Congresso Brasileiro de Planejamento Energético (V CBPE). Brasília. **Anais**...2006.

SILVA, B. F.; DOS SANTOS FERREIRA, J.; BENARROSH, P. F. P. M. Energia solar: benefícios das placas solares em telhas de barro sustentáveis. **Revista FAROCIENCIA**, v. 2, p. 128–131, 2015.

SOUZA, F. F.; MALDONADO, T. V.; DA SILVA JUNIOR, S. A. Avaliação do Custo Total de Propriedade do uso de energia solar fotovoltaica e da energia elétrica convencional. Anais do Congresso Brasileiro de Custos-ABC. **Anais**...2020.

WWF – WORLD WIDE FUND FOR NATURE. **Desafios e oportunidades para a energia solar fotovoltaica no Brasil**: recomendações para políticas públicas. Brasília: WWF, 2015. Disponível em: https://bit.ly>. acesso em: 06 out. 2020.

Realization:

Partners:

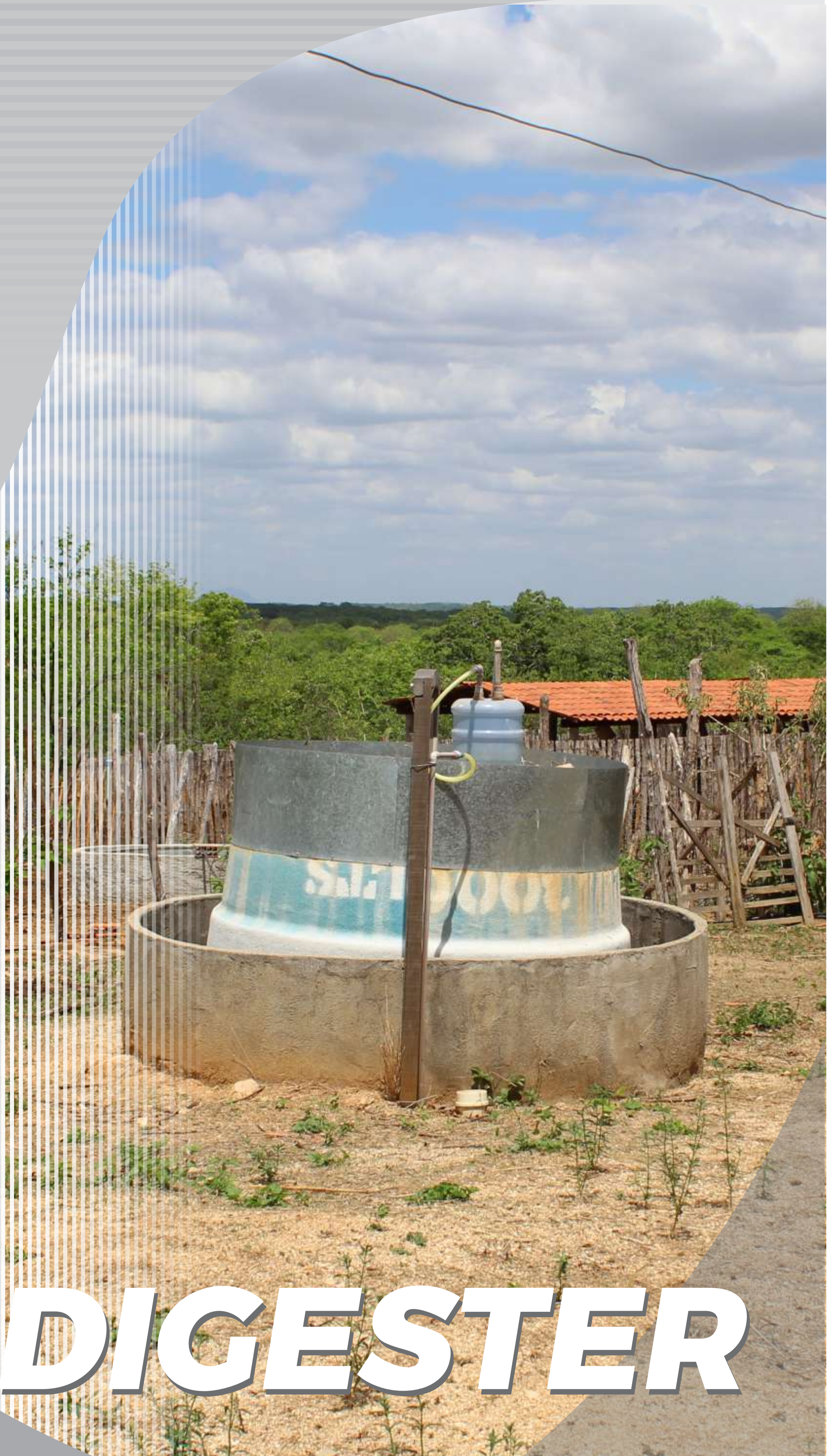
Sponsor:

FIDA

Investindo nas populações rurais

DIGITAL PORTFOLIO

BIODIGESTER



IACOC Compromisso com o desenvolvimento socioeconômico do Semiárido paraibano

PaqTcPB Fundação Parque Tecnológico da Paraíba

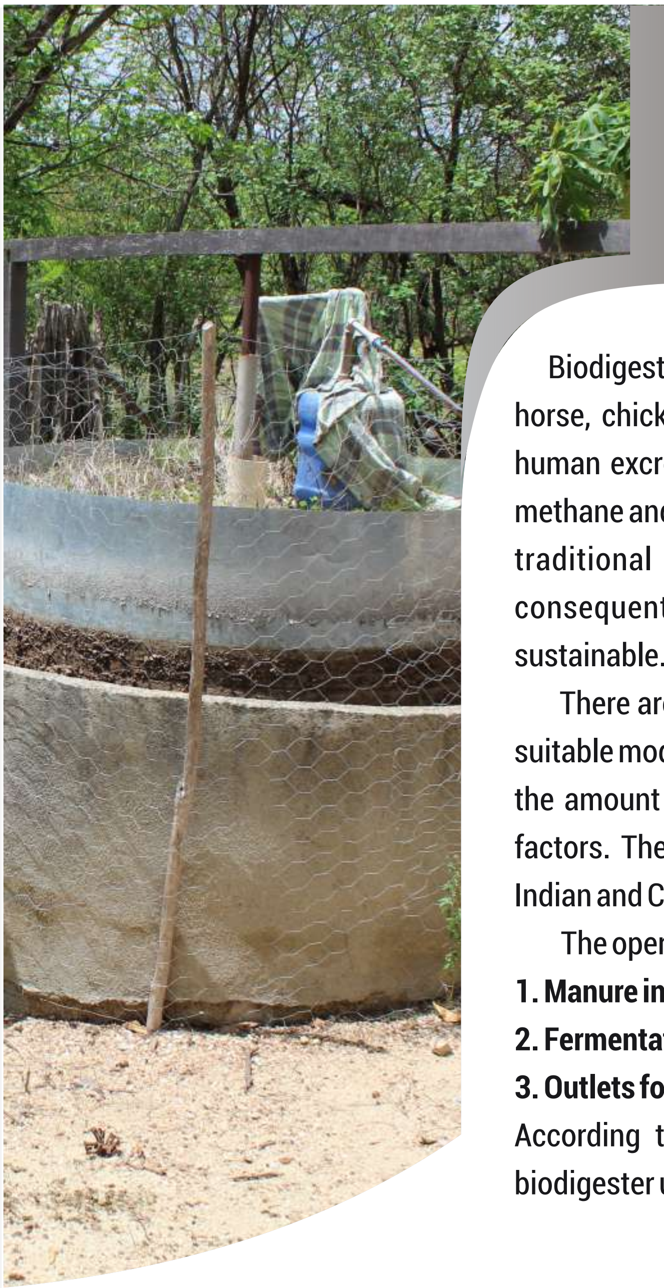
UFCG Universidade Federal de Campina Grande

INSA Instituto Nacional do Semiárido

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÕES

PÁTRIA AMADA BRASIL GOVERNO FEDERAL

FIDA Investindo nas populações rurais



Biodigester is a device that decomposes organic matter, such as cattle manure, horse, chicken, pig, vegetable remains of crops (straw, grass and leaves) and human excrement for the production of biogas. Biogas is mainly composed of methane and carbon dioxide, and due to this composition it can be used to replace traditional cooking gas, bringing an economic return for the user, and consequently, a beneficial environmental impact, as it is a technology sustainable.

There are several models available on the market, but the choice of the most suitable model of biodigester will depend on the need of the producer, for example, the amount of organic matter to be processed, the investment cost and other factors. The best known models of biodigesters in the world are the Chinese, Indian and Canadian.

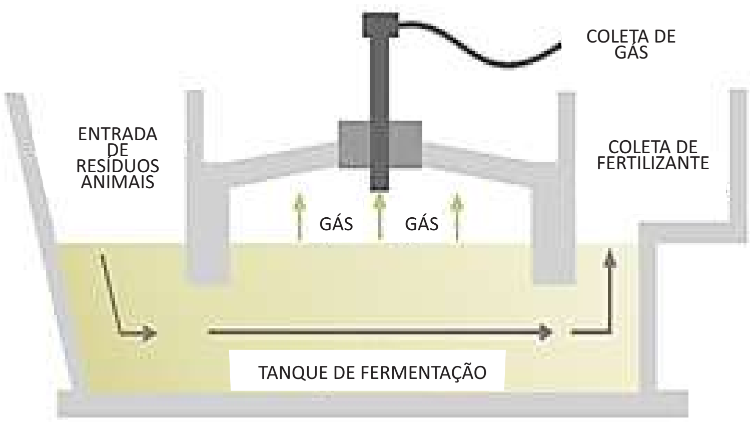
The operation of biodigesters has the following steps:

1. Manure inlet;

2. Fermentation tank;

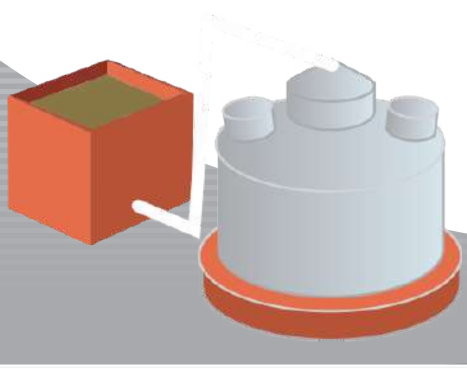
3. Outlets for biogas and processed waste.

According to the steps shown, we can present the physical structure of a biodigester using the Indian model, as shown in the following illustration:



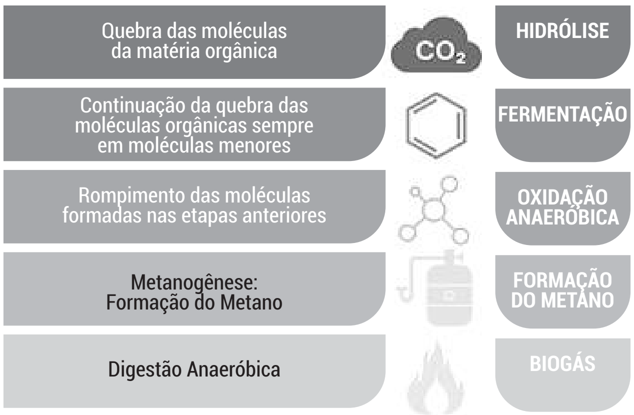
SALOMOM, K. R.; FILHO, G. L. T. Biomassa. 1ª ed. Itajubá, MG: FAPEPE, 2007

We see in the figure above that there is an entrance for animal waste, which is where the farmer puts animal waste every day; a fermentation tank, which is where the magic of transforming organic matter into biogas takes place; and we have two outlets: one to collect the biogas produced in the fermentation tank and the other to remove the rest of the organic matter that has undergone the transformation.



How is biogas made?

As mentioned, the magic of biogas production occurs in the fermentation tank. But who are responsible for this process? The magicians of this show are called microorganisms, very numerous living beings, but so small that we cannot see with our eyes, only with the help of a microscope. Each group of these microorganisms has a special job in the stages of the process of transforming organic matter into methane and carbon dioxide, and it is necessary to provide an anaerobic environment, that is, without oxygen. In the following illustration, it is possible to analyze the steps involved in this process and what happens



It is important to note that only anaerobic bacteria participate in the methanogenesis phase (formation of methane), in which methane gas is produced. These bacteria have a sensitivity to temperature variations, operating at a temperature between 10 and 45 ° C.

What is the justification for it to fit into this project

Considering IFAD's mission and challenges and highlighting the technology, the biodigester consists of a sustainable and economically viable technology for rural producers with an economic and environmental return. The biofertilizer can be used to enhance crops, eliminating the need to purchase industrial fertilizers. The biogas produced can be used to replace cooking gas (LPG), which saves users financial resources. In addition, the use of the biodigester can contribute to reducing greenhouse gas emissions when compared to energy sources used by family farming (such as burning firewood), following the objectives of the United Nations Framework Convention on mitigating gas emissions responsible for climate change and collaborating to reduce problems with issues such as the desertification of the Caatinga biome, in search for energy alternatives.

The International Fund for Agricultural Development (IFAD) aims to assist poorer populations in developing countries. In relation to the challenges that IFAD seeks to overcome, there are extreme poverty and malnutrition, scarcity of water for human consumption and productive use, low agricultural income, climate change and environmental risks, difficulties in accessing markets, public policies and programs with coordination problems, few non-agricultural activities for rural families, lack of access to agricultural and social welfare policies and programs, among others.

Factors that promote or limit technology adoption

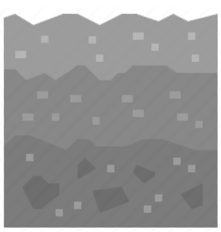
Parameters such as temperature, pH, concentration of nutrients, frequent maintenance and other factors, directly influence the performance of the biodigester and are fundamental and useful for the design and operation of efficient digesters and for understanding how adverse conditions can occur and how to get around them. It is important to emphasize that the factors mentioned are subject to external control in the process of anaerobic digestion.

TEMPERATURE

Temperature is an important factor for the production of biogas, the main product generated in the biodigester. The process can take place at a temperature between 10 ° and 60 ° C, depending on the type of bacteria. The biogas production process is not affected by the temperature increase by a few degrees. However, a decrease in some degrees can impair production of methane. It's necessary emphasize that the action of acidifying bacteria is not affected by the decrease in temperature, and because of this a possible accumulation of acids may occur resulting in a structural failure in the biodigester. A decrease in the production of biogas may occur during the cold seasons, due to the operating range of the microorganisms involved in the anaerobic digestion process. Mesophilic systems are quite sensitive to the issue of variation in ambient temperature, with the possibility of stopping or decreasing the production of biogas in the winter period in colder climates.

PH

The anaerobic process is directly affected by small fluctuations in pH values . Methanogenic microorganisms, responsible for the production of methane, are more susceptible to these pH variations than other microorganisms.



BIOMASS COLLECTION PLACE

In corrals where the floor is made of earth, there may be contamination of the biodigester with other materials, and influence the production of biogas.

BIOMASS SHAKE

It is necessary to agitate the organic material to facilitate the contact of the microorganisms with the biomass. However, shaking too much can cause biomass dragging, and with that, there is a loss of production efficiency.

PREVENTIVE MAINTENANCE GUIDE

The maintenance of the structure of the biodigester is important due to the wear of the integral parts of the biodigester, such as, for example, valves, pipes and tanks, that can cause leaks of the biogas.

Methane under normal conditions of temperature and pressure consists of a colorless, odorless, flammable gas. The leakage of this gas in contact with the air can cause explosions, if handled indoors and in the presence of an ignition source.

As the biodigester is exposed to the sun and most parts of the biodigester are made of plastic, such as rubber hoses, PVC pipes, valves and others, the sun is going to cause over the years discoloration and dryness of the pipe, making it fragile structure. Therefore, any external impact can cause crack, break or some damage to the structure of the pipe, valve, hose and the like.

Due to these risks, frequent maintenance is essential to maintain the conservation of tanks, pipes of machinery and equipment, and thus, ensure that there are no leaks that may result in environmental contamination and damage to human and animal health (GOMES et al., 2015).

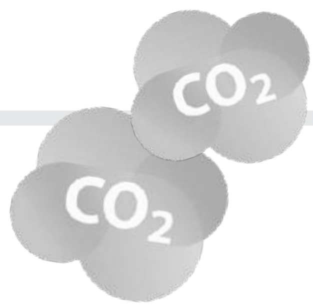
SOCIAL IMPACTS (ON WOMEN AND YOUNG PEOPLE, FOR EXAMPLE)

In the daily lives of large urban centers, technologies are used to assist and bring returns in the economic or welfare sphere, facilitating people's work. The use of adapted technologies should also be extended to rural areas, in order to help small farmers in their tasks. Because of various work difficulties that arise in the countryside, the small rural producer frequently needs to seek his source of income in the cities, being obligated to leave the place where he lived most of his life.

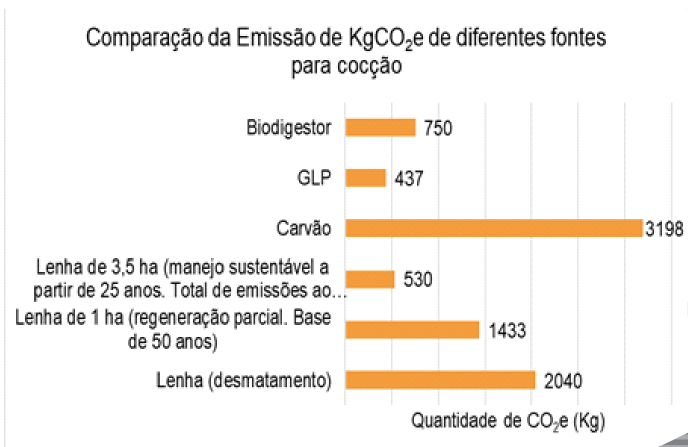
With this in mind, technologies can be used to reduce or eradicate possible problems that prevent the development of work in the field, as well as, they can be beneficial in economic and environmental terms. Most of the production of food available to the Brazilian population is produced by family farming, consisting of small rural producers, traditional peoples and communities. In view of this, it is verified the importance that the rural person has for society and, therefore, more tools must be made available in order to add value to rural work.

Projects like the ones that IFAD supports, in addition to bringing technological assistance and knowledge to the person working in the field, also positively impact the lives of women. The installation of the biodigester, in addition to the economic and sustainable return, brings a quality of life and generates a source of income for the farmers through, for example, the manufacture of cakes and bread from the use of the biogas generated on their property, in replacement to cooking gas (LPG). These projects also encourage the creation or strengthening of women's groups in the communities, so that they can generate income together. The biofertilizer produced in the biodigester can be used as organic fertilizer in fruit trees, vegetables and seedling nurseries, the product of which can be sold or subjected to a processing, as in the production of sweets and pulps from fruits produced on the property of these women. In addition, the manufacturing procedure is carried out in community kitchens in which all participate in the preparation of secondary products.

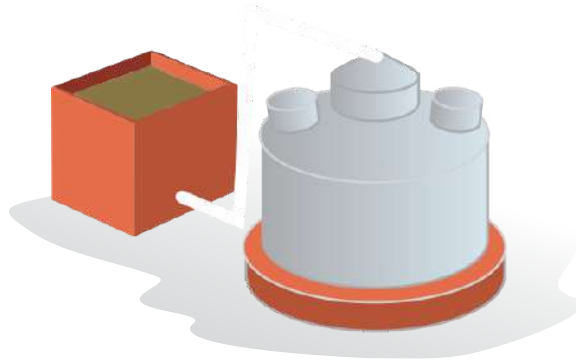
CO_2 EMISSION ANALYSIS



The biodigester has the advantage of generating biogas (CH_4) by anaerobic digestion of animal and vegetable organic matter. Among domestic fuels, biogas is considered to have the least environmental impact. In order to obtain CO_2 emissions by the biodigester, a case-by-case study is necessary to carry out an inventory considering the amount and type of organic material added (poultry, pork, cattle, plant material) and the chemical analyzes of the biofertilizer produced. The quantity emitted by the burning of biogas in comparison with traditional cooking gas (LPG) for cooking, within the scope of stationary combustion must count in the computation of the reduction of CO_2 emissions in the biodigester.



TOTAL QUANTITY INSTALLED



Installed Quantity (total value): 259
Quantity to be Installed (total value): 274
Municipalities (total value): 25 MUNICIPALITIES BENEFITING FROM TECHNOLOGY IN FOUR STATES

DID YOU KNOW...?

The implementation of the first biodigestors in Brazil took place in the 1970s after the oil crisis that started in the end of 1973. This crisis affected many oil-importing countries, especially those in development, such as Brazil. Therefore, there was a need to use other methods to obtain energy.

In Brasilia in 1979, the first biodigestors were built through the Energy Mobilization Program (PME) project, which consisted on a set of actions aimed at energy conservation and the replacement of petroleum products with alternative fuels.

The sertanejo (inner) biodigester, as shown in the following illustration, originated from the Indian model and the adaptation was carried out aiming at issues such as the availability of materials for its construction in building materials stores in the inner cities of Brazil.

I. Feeding box;

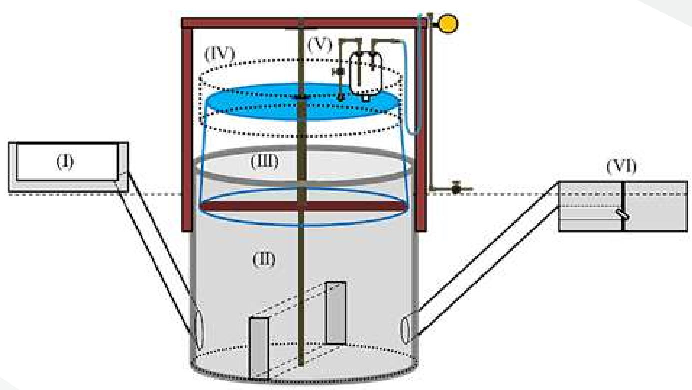
II. Fermenter;

III. Gasometer;

IV. Primary water filter / adapter;

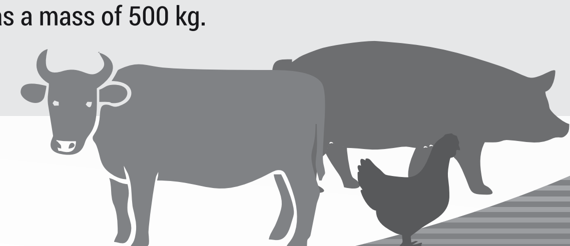
V. Biogas outlet tank;

VI. Output of waste.



In the feed box, the organic material is placed that will later supply the fermentation tank (fermenter), in which the biogas will be produced. This will be stored in the gasometer. In the outlet tank, a liquid product or residual material that can be called biofertilizer will be eliminated, that is, an organic fertilizer that can be used for liquid or solid fertilization. The biogas produced can be used for thermal heating, as fuel for engines and generators and as gas for cooking.

The production of biogas varies according to the type of manure that is placed in the biodigester. Thus, it is estimated that **BIRDS** can produce about 0.014 (m^3 / head / day) of biogas, taking into account that the animal has a mass of 2.5 kg; **PIGS** can produce about 0.240 (m^3 / head / day) of biogas, taking into account that the animal has a mass of 90 kg; **CATTLE** can produce about 0.240 (m^3 / head / day) of biogas, taking into account that the animal has a mass of 500 kg.



REFERENCES CONSULTED

ALVES, E. E. N .; INOUE, K. R. A .; BORGES, A. C. Biodigestores: construção, operação e usos do biogás e do biofertilizante visando a sustentabilidade das propriedades rurais (Biodigesters: construction, operation and uses of biogas and biofertilizer for the sustainability of rural properties). II Brazilian Symposium on Sustainable Agriculture, 2010.

BERNI, M. D .; BAJAY, S. V. O contexto dos biocombustíveis para o transporte rodoviário no Brasil (The context of biofuels for road transport in Brazil). Energy Meeting in Rural Areas, v. 6, 2006.

BIOGAS. Available at <https://www.agencia.cnptia.embrapa.br/gestor/agroenergia/arvore/CONT000fbl23vn102wx5eo0sawqe3qf9d0sy.html>. Accessed on: Nov 5, 2020;

BRAZIL [LAWS ETC.]. Decree No. 87.079, of April 2, 1982. Brasília: Department of National Press, 1982.

CASTRO, L. R. DE; CORTEZ, L. A. B. Influência da temperatura no desempenho de biodigestor com esterco bovino (Influence of temperature on the performance of biodigester with bovine manure). Brazilian Journal of Agricultural and Environmental Engineering, v. 2, p. 97–102, 1998.

CHERNICHARO, C. A. D. L. Anaerobic Reactors. 5. ed. Belo Horizonte: Department of Sanitary and Environmental Engineering - UFMG, 1997.

ENVIRONMENTAL COMPANY OF THE STATE OF SÃO PAULO (CETESB). Methane Technical Sheet. São Paulo, 2020.

EMBRAPA. Biofertilizer. Available at <https: //www.agencia.cnptia.embrapa.br/gestor/agroenergia/arvore/CONT000fj1gh4ku02wyiv802hvm3jd85f37c.html#:~:text = Under% 20form% 20I% C3% ADquida% 2C% 20o% 20biofertilizer, eradicating% 20 pests% 2C% 20doen% C3% A7as% 20e% 20insects>. Accessed on: Dec 8, 2020.

FARIA, R. A. P. Avaliação do Potencial de Geração de Biogás e de Produção de Energia a partir da remoção da carga Orgânica de uma Estação de Tratamento de Esgoto - Estudo de Caso (Evaluation of the Potential for Biogas Generation and Energy Production from the removal of the organic load from a Sewage Treatment Plant - Case Study). State University of Western Paraná, 2012.

IFAD. Investing in Rural Populations. Available at: <https://www.fida.org.br/>. Accessed on: Nov 12, 2020a.

GIACOBBO, G. et al. Influência da variabilidade da temperatura ambiente na co-digestão anaeróbia de dejetos de bovinocultura de leite e cama de aviário Acta Iguazu (Influence of room temperature variability on anaerobic co-digestion of dairy cattle and poultry litter Acta Iguazu). Rattlesnake, 2013.

GOMES, F. C. DE S. P. et al. TECHNICAL ENVIRONMENTAL GUIDE FOR BIOGAS IN AGROINDUSTRY. Belo Horizonte, State Environment Foundation, 2015.

GUNNERSON, C .; STUCKEY, D. Integrated Resource Recovery Anaerobic Digestion: Principles and Practices for Biogas Systems. Washington - USA: The World Bank, 1986.

JÚNIOR, F. A. DE O. RURAL BIODIGESTOR CONSTRUCTION MANUAL. Available at: <http://www1.pucminas.br/imagedb/documento/DOC_DSC_NOME_ARQUI20140917140023.pdf>. Accessed on: Dec 5, 2020.

KARLSSON, T. et al. Basic Biogas Manual. 1st ed. Lajeado: Univates, 2014.

KLUMB, A. et al. 12 Passos para Construir um BIODIGESTOR (Steps to Build a BIODIGESTOR). Diaconia ed. Recife - PE: Banco do Brasil Foundation, 2019.

MACHADO, C. R. Biodigestão anaeróbia de dejetos de bovinos leiteiros submetidos a diferentes tempos de exposição ao ar (Anaerobic biodigestion of milk cattle waste submitted to different times of exposure to air). PAULISTA STATE UNIVERSITY "JÚLIO DE MESQUITA FILHO", 2011.

MARTINS, D. S .; ASSIS, E. G. Estudo da viabilidade econômica da implantação de um biodigestor em uma granja de Perus (Study on the economic feasibility of the implementarion of a biodigestor in a turkey farm). Foz do Iguaçu - PR. XXVII National Meeting of Production Engineering, 2007.

MATTOS, L. C .; JÚNIOR, M. F. Biodigestor Sertanejo Manual. Recife - PE: Dom Helder Câmara Project Edition, 2011.

MINISTRY OF THE ENVIRONMENT. National Solid Waste Policy. Available at: <https://www.mma.gov.br/cidades-sustentaveis/residuos-solidos/politica-nacional-de-residuos-solidos.html #: ~: text = Law No. 12.305% 2F10, inadequate handling of solid waste.>. Accessed on: Nov 14, 2020

MORENO, M. T. V. Manual del Biogás (Biogas manual). Santiago de Chile: FAO, 2011.

OSORIO, R. H. et al. Avaliação de um Sistema de Biodigestores (Gtz E Taiwan) em série em clima frio na etapa de estabilização (Evaluation of a Biodigester System (Gtz E Taiwan) in series in cold weather in the stabilization stage). Cuiabá, XL Brazilian Congress of Agricultural Engineering - COMBEA, 2011.

SALOMOM, K. R .; FILHO, G. L. T. Biomass. 1st ed. Itajubá, MG: FAPEPE, 2007.

SANTIAGO, F. DOS S. et al. Estimativa na redução de gbases do efeito estufa com biodigestor no semiárido (Estimate in reducing greenhouse gases with biodigestor in the semiarid). X National Congress of Environment of Poços de Caldas, v. 5, p. 1–6, 2013.

SEIXAS, J .; FOLLE, S .; MARCHETTI, D. Construction and operation of biodigesters. Brasília - DF: Embrapa: Agricultural Research Center of the Cerrados, 1981.

SILVA, E. M. C. A. et al. Project for the Rural Unit for the Generation of Biogas Distribution. Environmental Education & Biogeography, v. 2, p. 1675–1685, 2016.

SOUZA, A. D .; HERCULANO, M. C. R. Biodigesters: management booklet. Cartilha Técnica (Technical Booklet), v. 3, n. 1, p. 14–19, 2016.

Realization:

Partners:

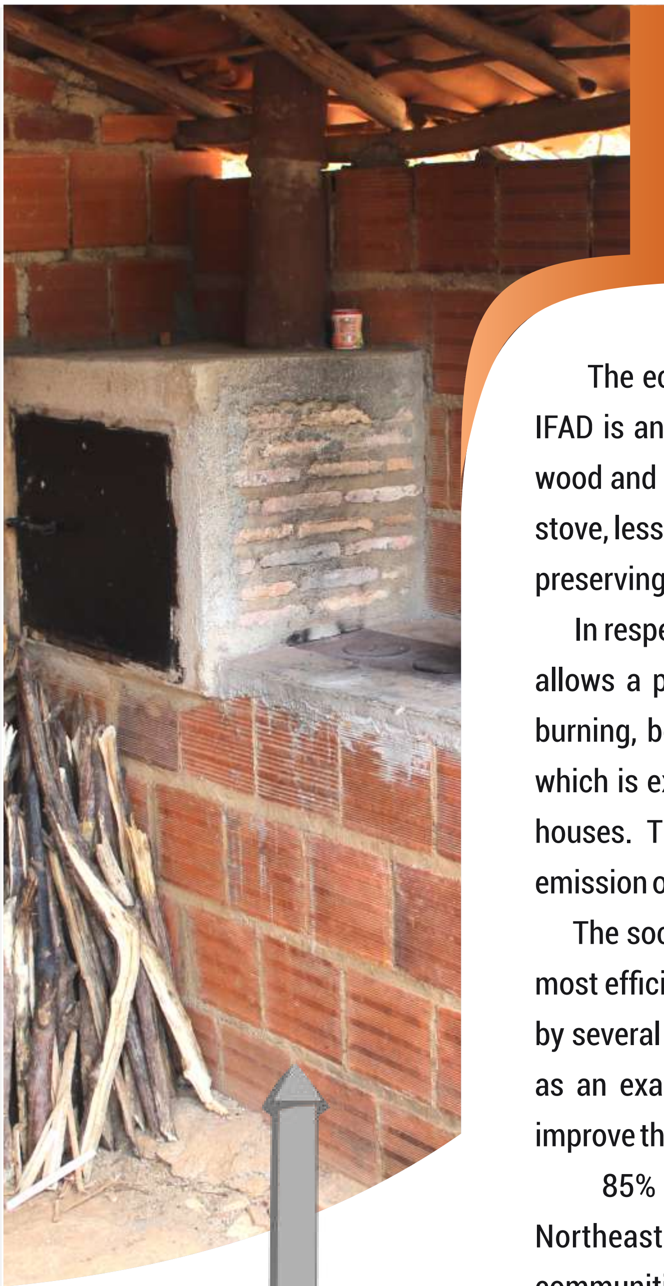
Sponsor:

FIDA
Investindo nas populações rurais

DIGITAL PORTFOLIO

ECOSTOVE

IACOC — Compromisso com o desenvolvimento socioeconômico do Semiárido paraibano
PaqTcPB — Fundação Parque Tecnológico da Paraíba
UFCG — Universidade Federal de Campina Grande
INSA — Instituto Nacional do Semiárido — Unidade de Pesquisa do MCTI
Ministério da Ciência, Tecnologia e Inovações
Pátria Amada Brasil — Governo Federal
FIDA — Investindo nas populações rurais

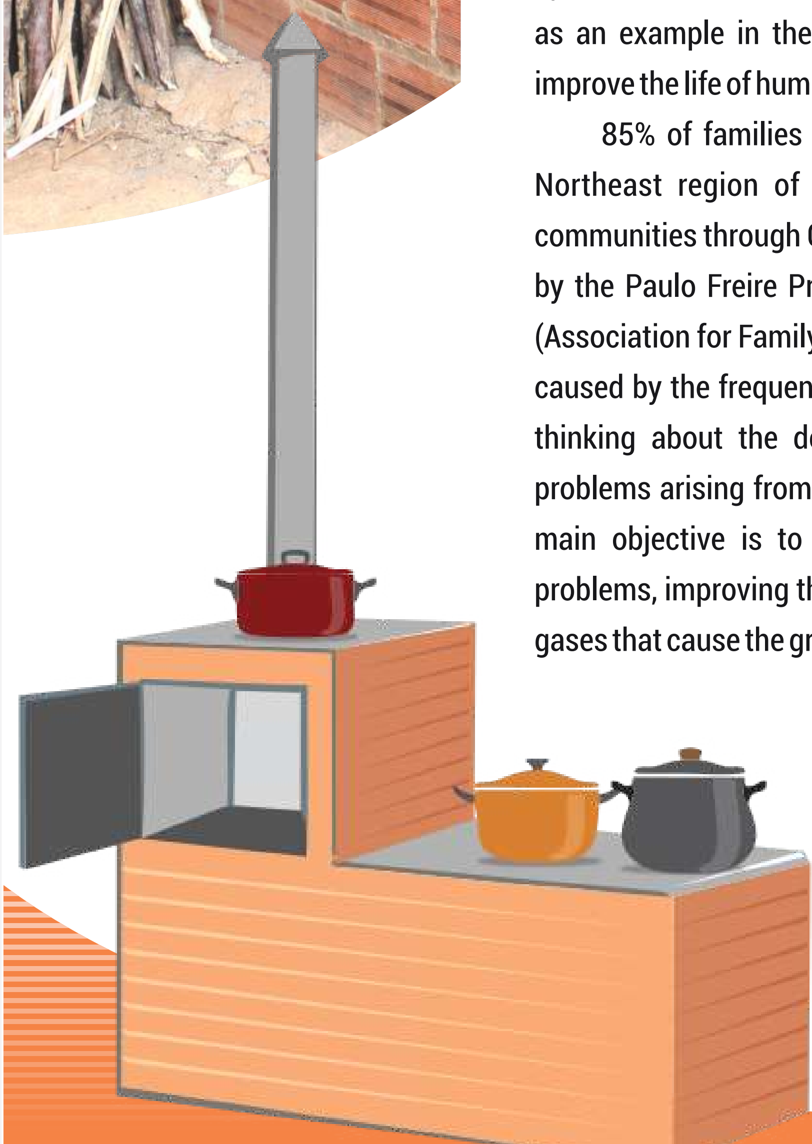


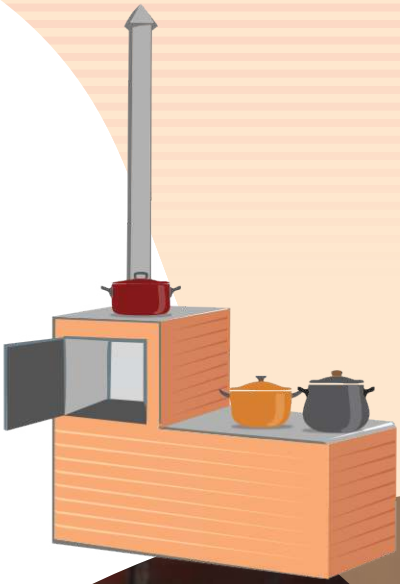
The ecological stove or ecostove (ecofogao) used in projects financed by IFAD is an improvement on the traditional wood stove, which consumes less wood and has an oven attached. For the use and preparation of the ecological stove, less financial resources and less natural resources are used, in addition to preserving one of the peasant traditions, the foods prepared in the wood oven.

In respect to the traditional wood stove, the closed chamber of the ecofogao allows a production process with more heating, making better use of wood burning, becoming more efficient and with a minimum of smoke production, which is expelled through a ceramic chimney to the outside of the roof of the houses. This reduces the consumption of firewood and, besides that, the emission of smoke.

The social technology of eco stoves / ecological stoves is presented as the most efficient alternative to traditional wood stoves. This technology was used by several renewable energy projects and the strengthening of family farming, as an example in the Paulo Freire Project (PPF) in Ceará, to facilitate and improve the life of human being in the countryside and to preserve more nature.

85% of families in the rural area use firewood for cooking food in the Northeast region of Brazil. The model of ecological stoves installed in communities through CETRA (Center for Labor Studies and Worker Assistance) by the Paulo Freire Project is based on the eco stove developed by AS-PTA (Association for Family Agriculture and Agroecology) to reduce harmful effects caused by the frequent use of conventional wood stoves. This is important in thinking about the deforestation of native vegetation and the respiratory problems arising from the inhalation of the smoke released by the stove. The main objective is to make the use of wood sustainable, avoiding health problems, improving the quality of life of families and avoiding the emission of gases that cause the greenhouse effect.

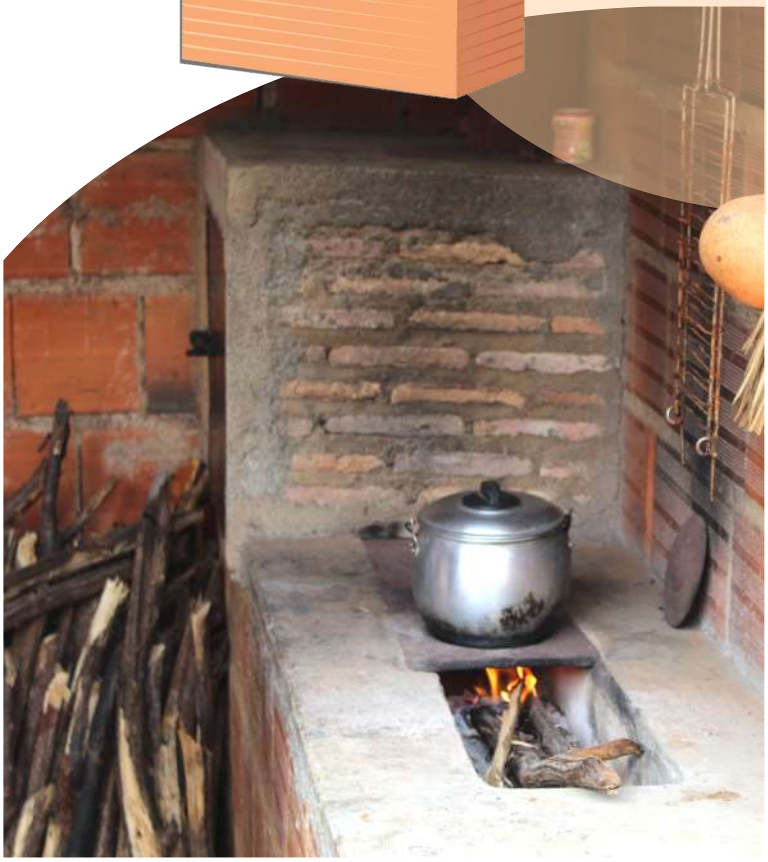




Most wood stoves used for cooking have low energy efficiency, generally less than 10%. Because it is incomplete, the burning of firewood enhances emissions of carbon dioxide, sulfur dioxide, carbon monoxide, nitrogen dioxide, in addition to particulate organic compounds to which exposure causes respiratory diseases.

Thus, the spread of the use of sustainable technologies began about applying and improving a technology for the social inclusion of populations with less financial conditions. Social technologies can be defined as techniques, products and methods multiplied, tested and proven, as part of the solution of a social demand and its respective capacity for solution and transformation, within the community.

Aside from the need for proper management for firewood extraction, the way of preparing food on these stoves requires special attention, since they cause damage to health, due to the high rate of smoke emission. Another concern related to the use of wood stoves is the situation of women who devote around 18 hours a week in the search for firewood for the preparation of food, exposed to situations that bring life risks in accidents.



Thinking about the environment, traditional ways of cooking food involve a high consumption of vegetable fuels such as firewood and charcoal, resulting in incomplete combustion, where gases are emitted that aggravate the greenhouse effect and other products that contribute to global warming. In addition, about 30% of the wood consumed is collected in an unsustainable manner, resulting in emissions equivalent to 2% of global CO_2 emissions and deforestation causing loss of local biodiversity.

As a factor that promotes the adoption of the ecofogao (eco stove), it stands out its greater efficiency in relation to the traditional wood stove because it uses less wood and is more ecological from the point of view of emission of toxic and greenhouse gases, becoming a ideal technology for the sustainable coexistence of the farmer with the environment. Considering that the stove is one of the most used and important objects in our house (as it is where family food is prepared every day), some farmers point out that they prefer to use the wood stove to cook over the gas stove, because they say that the food is much tastier and they still don't have to spend money buying gas. This fact makes the advantage of the eco stove even more relevant in relation to the traditional wood stove.

On the other hand, the farmers or their children face some difficulties to continue using their wood stove, because getting the wood requires heavy and tiring work, even being dangerous. Lately, women have to walk farther and farther to gather a bundle of firewood. If it is hard work to go far, even worse is having to bring the weight to the door, a process often done manually and even with the help of children. The most serious of all is that this activity is contributing even more to reduce the forests and native vegetation, repeatedly for days. Using firewood harvested in large quantities damages the balance of the ecosystem and the population that lives and depends on that location.

There are positive and negative points of the Ecofogao technology. Being positive are: when the equipment eliminates the exhaust of smoke that, before, circulated inside the kitchen and even in the house; uses less wood and consequently contributes to preserving the environment; emits less toxic gases to the atmosphere, reducing the greenhouse effect; it brings an economic benefit as it reduces the consumption of cooking gas (LPG-Butane); decreases the risk of occupational accidents in management;bavoids exhaustive work in extracting wood from the environment and does not give smoke a taste for food, as it uses a chimney to throw the smoke out of the house. The negative points are that, unfortunately, it still uses wood to generate heat; produces soot and CO_2; it still carries risks of burns and requires maintenance of cleaning the soot in the chimney when it clogs.

COST OF INSTALLATION

IFAD, through the Paulo Freire Project in Ceará, invested through Productive Investment Plans in social technologies that enabled, in an agroecological way, the sustainable and social development of production practices (agricultural and non-agricultural) for household consumption and commercialization, thus generating income and live well with the country human being. In this sense, productive investments for the implementation of ecological stoves were financed.

Investimentos produtivos
232 Fogões Ecológicos
Valores dos Investimentos
266.800,00 Reais
Comunidades
09

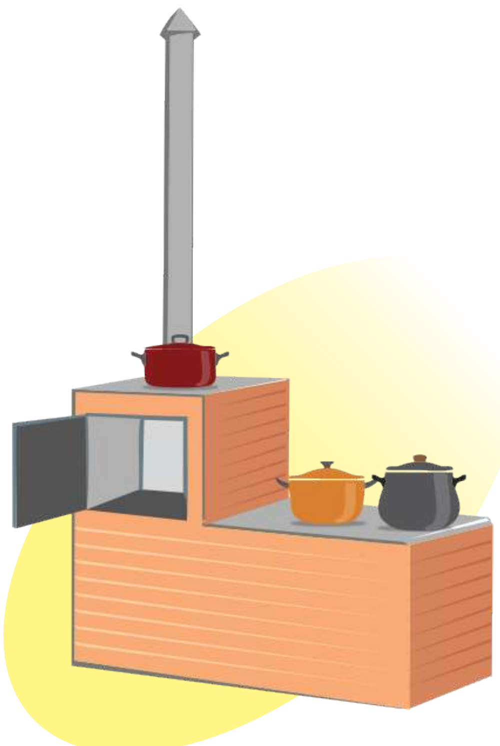
A implantação de um fogão ecológico pode custar em torno de: R$ 1.150,00

Os valores variam de acordo com a tabela de preço dos materiais e mão-de-obra.

TOTAL QUANTITY INSTALLED AND NUMBER OF BENEFICIARIES

Installed Quantity:	994	Number of beneficiaries:	2982	Municipalities:	27

To build an ecological stove 2 meters long, 50 centimeters wide and in height ranging from 80 to 90 centimeters, we need, on average, the following materials:



- Between 300 to 350 solid manual bricks. It will depend on the size of the brick shape
- 10 cans of masseur or saibre clay
- 1 bag of cement
- 20 cans of sand to fill the hollow part of the stove
- 1 Oven built with 16 plates 40 cm long, 40 cm deep and 35 cm high. When ordering the oven at the locksmith, it is good to order two grids: the first 2 cm high, so that you do not place the food directly on the plate and the other half in the oven. Finally, it is important for the locksmith to build rods above 5 centimeters in height.
- 3 clay shackles 50 cm long and 100 mm in diameter for the chimney - To finish the chimney, use a spreading knee or a zinc hole.
- Mining plate with 3 mouths.
- One liter of colorless varnish or resin for finishing the stove.

A. MAINTENANCE COSTS

According to users, the maintenance in the ecofogao is minimal and varies according to the use and the way of handling with the firewood in the combustion chamber. Another accessory that requires care is the chimney, that must be cleaned every 6 months due to the accumulation of soot that can clog and make the smoke go back into the house. Maintenance can be carried out by the beneficiary himself, according to the need and use of the ecofogao, where it is usually necessary to repair the cracks in the masonry caused by heat and in the chimney that can detach from the masonry. Also, and less frequently, in the iron parts (plate and oven) due to the greater durability of the material. It is connected to maintenance by use, since some beneficiaries also have a gas stove.

The cost of maintenance varies according to the part that damaged, varying from R $ 15.00 to 300.00, as stated by a user who received the training to build the eco stoves in the communities.

B. TECHNOLOGY LIFE TIME

The Ecofogao's social technology has a useful life of more than 10 years, but none of those that have been visited have this time of use. This useful life was analyzed as it is made of masonry, iron and ceramics. According to testimonials from users and builder, this period may vary more or less depending on the care, care and maintenance with your equipment. With the Ecofogao everything is very much related to its use and care by the user.

C. ENVIRONMENTAL IMPACTS

Studies and research in comparison with the conventional wood stove showed that the Ecofogao presented a saving of 53.4% in the consumption of wood. Ecofogao produces more heat with less firewood and charcoal, thus protecting the environment. The consumption of wood per family fell from 270 to 135 kilos per year, a reduction equivalent to 50%.
The main difference from the conventional stove to the ecofogao is the use of firewood, where the amount used is greater and the wood is more exposed, emitting more soot. The conventional has no oven and heats less, the combustion chamber is more open and emits more smoke and soot, polluting the kitchen and the environment more.

The studies showed an increase in efficiency of 64% in the Ecofogão compared to the conventional stove and also indicated that the Ecofogao used between 53 and 57% less firewood than the conventional stove. As a consequence, it reduced the work of collecting and storing firewood at home.

The testimonies of the relatives refer that Ecofogao can work with secondary vegetation, rest of wood and alternative materials such as corncobs, coconut husks, sticks and thicker bark. It was also visible that the Ecofogao produces less smoke than normal.

D. SOCIAL IMPACTS (ON WOMEN AND YOUNG PEOPLE, FOR EXAMPLE)

In addition to being a demand for environmental preservation, the use of Ecofogao is also a matter of public health, since most women and children, who are conditioned to housework and are users of the conventional wood stove, sicken with respiratory problems due to the inhalation of the soot expelled. Studies say that breathing smoke in these cases is equivalent to smoking two packs of cigarettes a day. In Brazil, there are 21 deaths per year due to smoke aspiration.
Improving the quality of life of families by reducing soot that causes damage to health, especially that of women and children, is also associated with a decrease in the workload to search for firewood in the forests.

In view of these observations, we conclude that the distribution and use of this Ecofogao social technology in the semi-arid region must bring positive impacts to the environment and improve the quality of life of rural families.
Another benefit is economic. The consumption of cooking gas decreased due to the greater use of the agroecological stove: the gas cost R $ 75.00 per month for the family and, today, half a canister is more than enough to handle the kitchen.

E. ADAPTATION TO THE REALITY OF FAMILY AGRICULTURE

The ecological stove has the objective of avoiding smoke inside the house, improving the heating providing quickness in the preparation of food, burning the wood completely, being resistant avoiding the appearance of cracks, being suitable for work due to the technically recommended height and surface, and also look good and satisfy the whole family.

For the benefited families, the equipment brought many advantages, especially for health, due to the reduction of smoke and soot, in addition to not dirtying pots and kitchen walls. Ecostoves also allow financial savings for families by reducing the use of firewood, gas and coal.

Families in the Brazilian semiarid region use cooking gas, coal and firewood as fuels to cook. This was confirmed in the field visits carried out. The use of one or the other depends on the type of food that will be prepared, on the availability and price of each type of fuel, and on the economic situation of the family at all times.

The Paulo Freire Project aims to reduce poverty and raise the standard of living of family farmers in 31 municipalities in Ceará, through social and economic inclusion in a sustainable manner. Rural communities have some of the lowest Human Development Indexes (HDI), a criterion adopted by the International Agriculture Development Fund (IFAD), and the project's priority audience are young people, women, people and traditional communities.

CO_2 EMISSION ANALISYS

The reduction of CO_2 emissions with the ecofogao was calculated in comparison with the traditional wood stove. The ecofogao has the advantage of using less wood, producing less soot and smoke. With this, ecofogao is the best alternative for cooking food using firewood, reducing the emission of CO_2 by 58.4%.

Gás	Fogão a lenha tradicional tCO_2e	Ecofogão tCO_2e
CO_2	22,17	9,23
CH_4	1,65	0,68
N_2O	0,26	0,11
Total	**24,08**	**10,03**

SOCIAL TECHNOLOGY TRL

The degree of technological maturity - TRL - of ecofogao is classified between grades 8 and 9 because the real system was developed and approved through successful operations. TRL 9 is achieved when the element is integrated into the final system and in operation.

It is noticed, through the studied concepts, that the levels of technological maturity of an element are not delimited in relation to the activities carried out. In addition, it is worth noting that the same element can present different levels of technological maturity, as it depends on its application and the final system to be integrated.

PATENTS

Ecofogao was the pioneer in the development of the ecological wood stove in Brazil and its history comes from PROLEÑA, an NGO in Central America that was a global pioneer in the development of the ecological wood stove. The development of the ecological wood stove came from the observation of Rogério Carneiro de Miranda, a forest engineer.

Thus began in 1994 the first steps in the development of the ecological wood stove. Currently, an ecological wood stove has a high energy efficiency, with the transformation of wood into more energy and less smoke.

From 2003 back in Brazil, he started to develop the company Ecofogao Indústria de Fogões Ltda which adapted the Ecostoves to Brazilian conditions, with better materials, new models and new applications such as oven and coil.

Patent application number at INPI: PI 0303647-2 A2

Consulta à Base de Dados do INPI

[Início | Ajuda?]

» Consultar por: Base Patentes | Finalizar Sessão

Anterior 2/2

Depósito de pedido nacional de Patente

(21) Nº do Pedido: PI 0303647-2 A2

(22) Data do Depósito: 14/10/2003

(43) Data da Publicação: 31/05/2005

(47) Data da Concessão: -

(51) Classificação IPC: F24C 1/08

(54) Título: FOGÃO DE LENHA ECOLÓGICO, EFICIENTE E SEM FUMAÇA

(57) Resumo: "FOGÃO DE LENHA ECOLÓGICO, EFICIENTE E SEM FUMAÇA". O fogao em questão visa a modernizar o uso da lenha para cocção doméstica com uma forma mais eficiente de combustão e prover melhores condições de trabalho para a cocção sem a contaminação direta de fumaça e fulizem no interior da cozinha ou morada. Adicionalmente permite um aproveitamento optimo da energia térmica gerada com um forno para assados caseiros e um sistema de serpentina para aquecimento de agua. Todo o conjunto é costruido de uma forma compacta e portátil, permitindo o facil transporte e instalaçao. O fogão em questão é constituido de uma camara de combustão em forma de 'L' (A) imersa em um ambiente de isolante térmico (C), uma chapa de ferro fundido (D), uma chaminé (F), tudo estruturado por cantoneiras(H) e laminas galvanizadas ou anti-corrosivas (I). Adicionalmente este fogao poder ter um forno (E) e um sistema de serpentina (G) para aquecimento de agua acoplado alredor da camara de combustão, ou sobre a chapa, ou mesmo na base externa da chamine.

(71) Nome do Depositante: Rogerio Carneiro de Miranda (BR/MG)

(72) Nome do Inventor: Rogerio Carneiro de Miranda

DID YOU KNOW...?

DRYING CLOTHES

In the community of Santa Luzia, farmers used to dry the clothes washed near the Ecofogao due to the heat emitted by the iron plate and, curiously, the clothes do not smell like smoke. The reason is that because the Ecofogao does not let the smoke escape except through the chimney, where the exit stays out of the roof. Therefore, drying clothes close to the Ecofogao leaves no smell of smoke.

ECOLOGICAL STOVE REDUCES THE EMISSION OF POLLUTES UP TO 82%

According to Envirofit®, ecological stoves reduce fuel consumption by up to 60% and reduce pollutant emissions by up to 82%. Envirofit calculates that, over a five-year life cycle, its stoves will provide a reduction in CO_2 emissions of around 17 million tons, equivalent to the estimated annual consumption of more than 1 million cars. 3 billion people around the world still cook over an open fire (small fires directly on the floor) or rudimentary, highly polluting stoves.

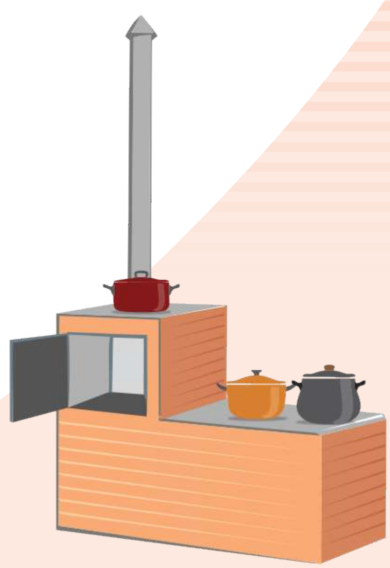
Realization:

Partners:

Sponsor:

FIDA

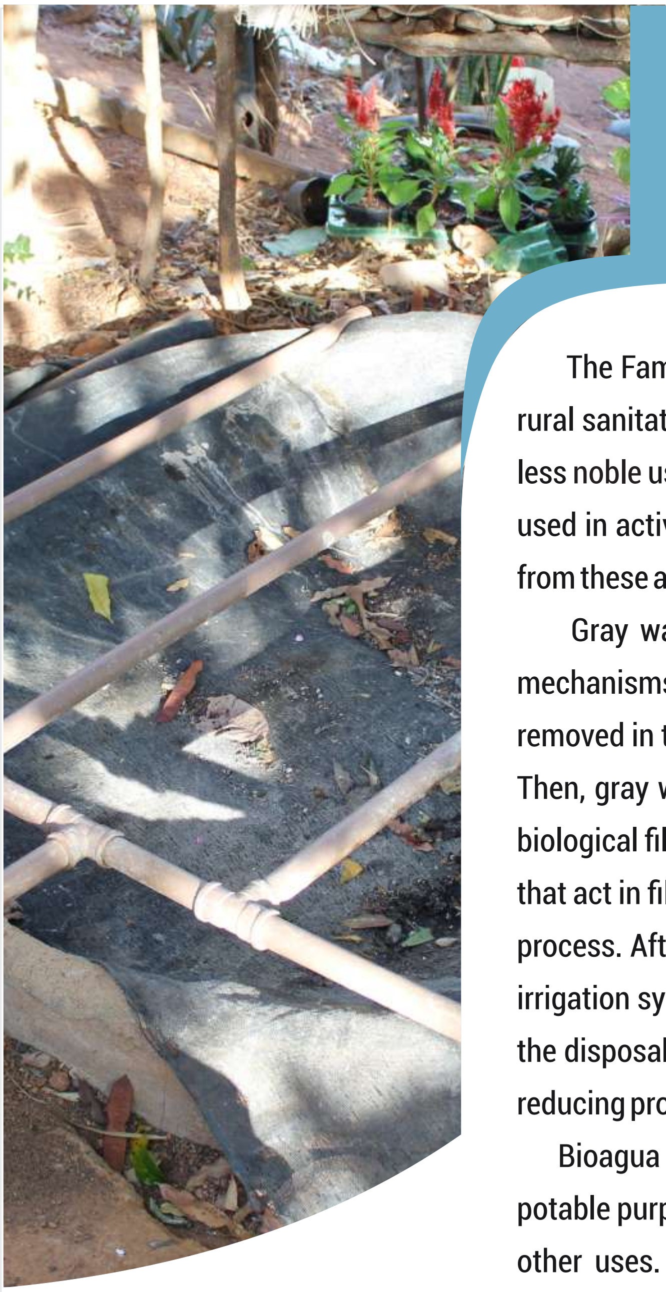
Investindo nas populações rurais



DIGITAL PORTFOLIO

BIOAGUA

IACOC
Compromisso com o desenvolvimento socioeconômico do Semiárido paraibano
PaqTcPB Fundação Parque Tecnológico da Paraíba
UFCG Universidade Federal de Campina Grande
INSA Instituto Nacional do Semiárido
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÕES
PÁTRIA AMADA BRASIL GOVERNO FEDERAL
FIDA Investindo nas populações rurais



The Family Biowater System is a social technology for water treatment and rural sanitation that makes it possible to generate water for irrigation and other less noble uses. This system aims to treat and make available the water that was used in activities such as bathing, washing clothes, dishes and pots. The water from these activities is called gray (or grey) water.

Gray water treatment by this kind of technology occurs through filtering mechanisms and by physical and biological processes. The coarse residues are removed in the treatment through a component of the system called the fat box. Then, gray water continues through a hydraulic network that distributes it to a biological filter. There is an action of organisms and microorganisms in this filter that act in filtering compartments, where the water goes through the purification process. After filtering, the treated gray water is stored to be pumped into a drip irrigation system. This social technology is considered a suitable alternative for the disposal of effluents, helping to meet the nutritional requirements of plants, reducing production costs and increasing the biological activity of the soil.

Bioagua System promotes water saving, allowing the user to reuse it for non-potable purposes, such as growing plants, washing sidewalks and floors, among other uses. This is essential in periods of water crisis, even more so in the Brazilian semiarid region, which has a climatic characteristic as an intense water evaporation and average annual precipitation less than 800 mm. The Projects financed by IFAD that involve the installation and implementation of social technologies such as the Bioagua System are quite relevant, as the reuse of treated gray water for agricultural purposes is a viable alternative that increases water availability and helps to overcome scarcity, mitigating the severe impacts of drought.

Bioagua System implementation, in line with the family farmer's experience, allows for a more sustainable and careful management of the land, guarantees food security and the commercialization of production surpluses. Thus, during raining periods, families can store treated gray water, and in critical periods, can irrigate crops, and consequently, maintain family income. In view of this scenario, living with the Semi-arid region allows rural communities to adapt and learn to use natural resources in a more rational way, especially water, the most scarce resource in the region.

Factors that promote or limit the technology adoption

Bioagua System is a complementary action that can ensure a better supply of water at a low cost, based on the rational use of water and adequate destination of effluents, especially in regions where access to water is a limiting factor. In general, this technology is followed by training and contributes to water and food security within the concept of the circular economy. With respect to the limiting factors of the technology, there is the possibility of contamination by pathogenic microorganisms, needed the management of the technology following the good practices of use of Bioagua and the periodic monitoring of the quality of the treated gray water.

Installation cost analysis

Installation costs (value in R$):	**R$ 3,500.00 to R $ 7,500.00**
Maintenance costs (value in R$):	**R$ 0.00 to 600.00**
Technology lifetime (value in years):	**up to 20 years**

Environmental impacts

According to the National Sanitation Information System (SNIS), the population's attendance to sewage collection corresponds to 53% in Brazil. From this scenario, it is possible to observe a chain of possible negative impacts. In places that lack sanitation, the main problem is related to the fact that untreated sewage is discharged without any criteria. This action generates a domino effect, because with the indiscriminate increase of organic load in the soil, infiltration through the water table can reach the water bodies and increase the nitrogen and phosphorus rates in the water. The excess of these elements cause chemical, physical and biological reactions and can cause the death of aquatic organisms, origin waterborne diseases, among other problems. Although water has an incredible power to recover, the self-cleaning, a large amount of sewage released makes it difficult to treat it so that it becomes potable again.

With the treatment by Bioagua System, it is possible to reduce this indiscriminate discharge of sewage, taking advantage of the organic matter present in the treated gray water to irrigate crops. Some studies show the importance of organic matter and other elements present in reused water and its application in agriculture for improving the physical, biological and chemical conditions of the soil. One of the factors is related to the increase of some chemical elements such as phosphorus and nitrogen, which are a problem for water bodies due to eutrophication, but which would be a solution for some classes of soils in the Brazilian semiarid region, such as the litolic Neossol, as they are elements rarely found in these locations and are important nutrients for the development of crops.

Social impacts on women

In comparison to the reuse in the disposal of gray water, Bioagua System facilitates the work of the farming family, because to make the reuse of disposal they would have to gather the water after each use in the kitchen and washing clothes and store this volume in buckets or compartments, usually, 100 or 200 liters. After all this work, gray waters can be used to irrigate the plants around the houses, even if manually, plant by plant, making the activity even more tiring. In Bioagua System, the waters used are sent through hydraulic pipes to the biological and physical filters, where treatment and subsequent storage takes place in larger and appropriate reservoirs. From this reservoir, water can be pumped into a drip irrigation system, simplifying all work with the reuse of household effluent and also expanding the plant production system, providing more free time for other activities. More income is generated.

CO_2 EMISSION ANALYSIS

For the computation of CO_2 emissions in Bioagua System, chemical analysis of the reused water must be performed, for comparison with fertilizers made with chemical fertilizers. Another possibility is the use of sensors in the places where effluents are released into the Bioagua System to obtain the emissions index.

The reduction in CO_2 emissions related to the Bioagua System must be calculated on a case-by-case basis, taking into account emissions from the discharge of effluents in the absence of this technology. The great highlight of Bioagua System is the saving of water through reuse, reducing expenses with the use of treated water, which can also serve as a basis for calculating reductions in CO_2 emissions.

TOTAL QUANTITY INSTALLED AND NUMBER OF BENEFICIARIES

Installed Quantity (total value): **494**

Number of beneficiaries (total value): **494 families**

Municipalities (total value): **21 MUNICIPALITIES BENEFITED IN FOUR STATES**

SOCIAL TECHNOLOGY TRL

To assess the technological maturity of Bioagua System, the Technology Readiness Level - TRL was used, which is a methodology that measures this maturity, using a scale with nine levels: each level corresponds to a development phase. Based on this concept, it is possible to assess that the Bioagua System fits into the TRL from 7 to 8, because TRL 7 consists of demonstrating the prototype of the system / subsystem in an operational environment and TRL 8 is a real system developed and approved.

DID YOU KNOW...

Water is a vital asset for different cultures, and, since antiquity, civilizations have developed in places close to water courses, such as rivers, lakes, the sea and others. Water quality had been a concern since 2,000 BC, as Persians punished anyone who polluted water resources. Water treatment has been recorded in ancient Egypt, around 1,500 B.C. There was a concern on the part of Egyptians about inappropriate water due to the transmission of diseases. For this reason, they carried out the water treatment using aluminum sulfate in order to clarify the water. The treatment of water was recommended by the ancient Sanskirts and Greeks. They carried out the storage in copper vessels, removed the "cloudiness" from the water by filtration processes, exposure to sunlight and boiling.

In 1855, John Snow proved that cholera was a waterborne disease. This happened through a case study in which he observed a street where there was a well or pit that was contaminated with water from a sewer, and on the other side, the waters ran away. He realized that people who drank water contaminated with sewage water almost all got sick, and with that, he was able to prove his theory. In the late 1880s, Louis Pasteur demonstrated the "Germ Theory" for disease. This theory explains how microscopic organisms can transmit diseases from water.

The origin of the word sanitation derives from the Latin and can have several meanings, among them is: to make healthy, habitable, to heal, to turn healthy and to restore. In Brazil, basic sanitation is a right ensured by the Constitution and by Law no. 11,445 / 2007. Sanitation consists of a set of services, infrastructures and operational installations for the supply of drinking water, sanitary sewage, urban cleaning, solid waste management and rainwater drainage. Use of water is necessary for the most diverse purposes, including for drinking purposes, such as: basic hygiene, domestic chores, irrigation, cooking and sanitation of food, among others. There are records that the Greeks used the water disposed in the sewers to irrigate the plantations, thus reusing the water.

REFERENCES CONSULTED

ALVES, P. F.S., SANTOS, S. R .; KONDO, M. K .; ARAÚJO, E.D .; OLIVEIRA, P. M. Fertirrigação do milho com água residuária tratada: crescimento e produção (Fertigation of corn with treated wastewater: growth and production). Revista Brasileira de Engenharia Sanitária e Ambiental (Brazilian Journal of Sanitary and Environmental Engineering). v. 23, nº 5, 2018.

Access water handbook on December 11, 2020: https://www.ufjf.br/nates/files/2009/12/agua.pdf.

Bioagua Booklet on Clima da Caatinga accessed on November 14, 2020: https: //www.noclimadacaatinga.org.br/wpcontent/uploads/no_clima_da_caatinga_cartilha_bioagua.pdf

GOUVEIA, A. R. Manual for use and maintenance of the Bioagua System. Project Enel Shares Infrastructure: Family Biowater., 2019.

LANDO, G. A .; QUEIROZ, A. P. F .; MARTINS, T. L. C. Direito fundamental à água: o consumo e a agricultura sustentável pelo uso dos sistemas de cisterna e bioágua familiar nas regiões do semiárido brasileiro. (Essential right to water: consumption and sustainable agriculture through the use of cistern and family bioagua systems in the regions of the Brazilian semiarid). Revista Campo Jurídico (Legal Field Magazine), v. 5, No. 1, p. 35-64, 2017.

OLIVEIRA, J. F .; FIA, R .; FIA, F. R. L .; RODRIGUES, F. N .; OLIVEIRA, L. F. C .; LUIS CESAR FILHO, A. L. Efeitos da água residual de laticínios na respiração basal do solo, produtividade e remoção de nutrientes por Tifton 85 (Cynodon sp.) (Effects of dairy wastewater on basal soil respiration, productivity and nutrient removal by Tifton 85 (Cynodon sp.)). Revista de Ciências Agrárias (Agricultural Sciences Magazine), vol. 42 (1), p. 155-165, 2019.

Revista Questão de Ciência (Science Question Magazine) accessed on December 11, 2020: http://revistaquestaodeciencia.com.br/questao-nerd/2019/04/15/john-snow-na-guerra-das-epidemias.

SAMPAIO, E.V.S.B .; SALCEDO, I.H. & SILVA, F.B.R. Fertilidade de solos do semi-árido do Nordeste. (Soil fertility in the semi-arid region of the Northeast). In: PEREIRA, J.R. & FARIA, C.M.B., eds. Fertilizantes: Insumos básicos para a agricultura e combate à fome. Fertilizers: Basic inputs for agriculture and fighting hunger. Petrolina. Embrapa, 1995. p.51-71.

SANTIAGO, F. DOS S .; JALFIM, F. T .; DOMBROSKI, S. A. G .; SILVA, N. C. G. DA; BLACKBURN, R. M .; SILVA, J. K. M. DA; MONTEIRO NETO, L .; VALENÇA, J. R. DE F .; NANES, M. B .; RIBEIRO, G. A. Manejo do Sistema Bioágua Familiar. (Management of the Family Bioagua System). [s.l: s.n.]

SANTOS, C. F .; MAIA, Z. M. G .; SIQUEIRA, E. S .; ROZENDO, C. A contribuição da Bioágua para a segurança alimentar e sustentabilidade no Semiárido Potiguar brasileiro. (Bioagua's contribution to food security and sustainability in the Brazilian semi-arid region). Sustentabilidade em Debate (Sustainability Debate). v. 7. Special Edition, p. 100-113, 2016.

SCHAER-BARBOSA, M .; SANTOS, M. E. P .; MEDEIROS, Y. D. P. Viabilidade do reúso de água como elemento mitigador dos impactos dos efeitos da seca no semiárido da Bahia. (Viability of water reuse as a mitigating factor for the impacts of drought effects in the semiarid region of Bahia). Revista Ambiente e Sociedade (Environment and Society Magazine), v. 17, p. 12-32, 2014.

SILVA. M .; OLIVEIRA, A. Processo de revitalização do sertão: uma prática necessária sobretudo em Quixeramobim-CE. (Process of revitalization of the hinterland: a necessary practice especially in Quixeramobim-CE). Revista de Geografia e Ordenamento do Território (Geography and Spatial Planning Magazine), nº 9, p. 263-279, 2016.

http://revistaquestaodeciencia.com.br/questao-

nerd/2019/04/15/john-snow-na-guerra-das-epidemias

https://www.ufjf.br/nates/files/2009/12/agua.pdf

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