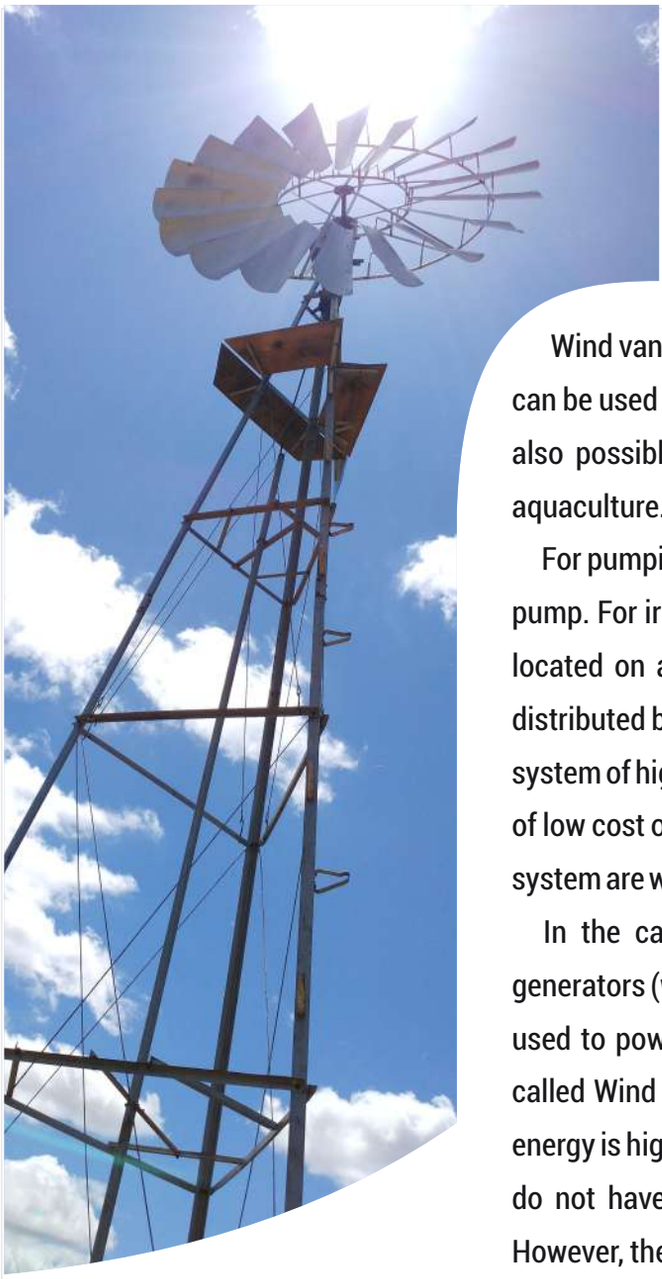
DIGITAL PORTFOLIO

WIND ENERGY

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



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

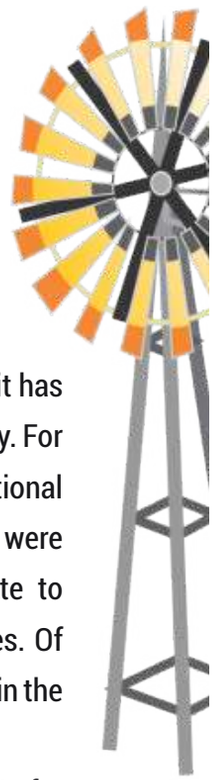
The reduction of CO_2 emissions in wind vanes systems can be calculated from the comparison with the consumption of electricity for pumping an equivalent volume of water (in the case of electric pumps) or by comparison with the consumption of diesel in the case of sets fuel pump. Although a case-by-case 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

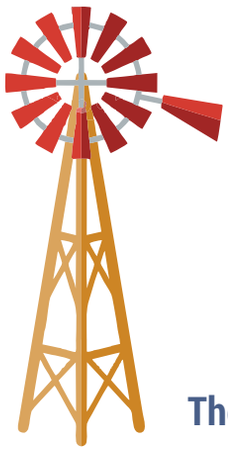
The scale of the technological maturity levels (Technology Readiness Level - TRL) allows to classify and monitor the degree of maturity of the development of a technology, in addition to enabling the direct comparison between different assets. For products that are already on the market, these assets 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.

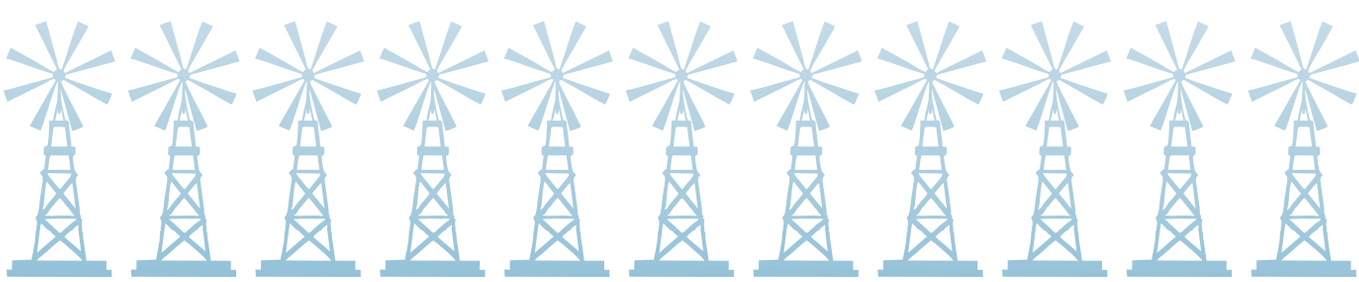
The origin of the wind vane goes back to the old windmills. This origin is not really clear, but some scholars believe it originated in Persia from 915 BC, i.e. Iran. However, there are indications about the use of more remote windmills in Iraq, Egypt and China. In Europe, windmills were introduced in 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).



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