Toward a precision agricultural implementation for sugar cane plantations in southwestern region of Colombia, South America

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Abstract. *The Colombian Sugar Cane Research Center, CENICAÑA, has initiated an ambitious project for the implementation of Precision Agriculture (PA) technologies in the Cauca river valley region, where one of its main objectives is to have the ability to collect large volumes of geospatial data. The main sugarcane growers in the country perform their work in the selected work area, which covers an area of approximately 242,000 ha, characterized by diverse topographic and edaphic conditions. In the search to apply and integrate geospatial and information technologies in the best way, the experiences of other countries have taken into account to improve and optimize the efficiency of production and the quality of crops. The first stage of the project is the installation of seventeen (17) stations: seven (7) GNSS base stations (Global Navigation Satellite System) and ten (10) radio repeaters, which make up a RTK (Real Time Kinematic) network that provides accurate spatial references for navigation and automatic guidance of agricultural machinery equipped with RTK technologies. Education and training in PA is a great challenge, this important issue considered and led by CENICAÑA for its implementation, which includes the barriers that exist in its adoption, learning processes and methodologies as well as the needs that arise from the use of PA technologies. In order to obtain reliable results of the position of the reference stations, GNSS network performed under a framework of collaboration with the Spatial Geodetic Research Group of the Colombian Geological Survey, which operates a national network of GNSS stations. In order to research the geodynamics of Colombian territory (GeoRED Project), following the standards that guarantee high precision positioning and supports the use of multipurpose GNSS signals. This approach is essential to establish additional research programs for geodynamic applications in scientific fields such as GNSS meteorology, among*

others. In this way, CENICAÑA supports the expansion of the national GNSS network to increase spatial coverage, in order to improve knowledge of the deformation of the earth's crust and its association with the possible occurrence of earthquakes in the northwest corner of South America.

***Keywords**. Precision Agriculture, Real Time Kinematic, GNSS, Geodynamics.*

Introduction.

The industry of sugarcane, in the way to improve the work done in the field put its efforts towards the adoption of new technologies that allow the optimization of inputs, improve operational performance and the quality of field works. For this purpose, the sugar cane agro-industry of the Cauca River Valley (Colombia) decides to install an *RTK* network that will provide fixed position signal with coverage in the entire area planted with sugar cane (242,000 ha), and with its implementation , support the automation of tasks such as furrowing, fertilization, harvest or sowing.

The monuments of GNSS stations is installed under support of Colombian Geological Survey, which provides the guidelines for antenna monuments to guarantee the quality of the data obtained; In return, *CENICAÑA* contributes by providing data to feed the GeoRed project.

One of the main characteristics of the network is its compatibility to support different PA technologies. Due to the variety of brands of farm machinery in the Colombian sugar cane agro-industry, and with it, different PA devices, it is necessary to implement a solution that allows connectivity with the equipment in the market.

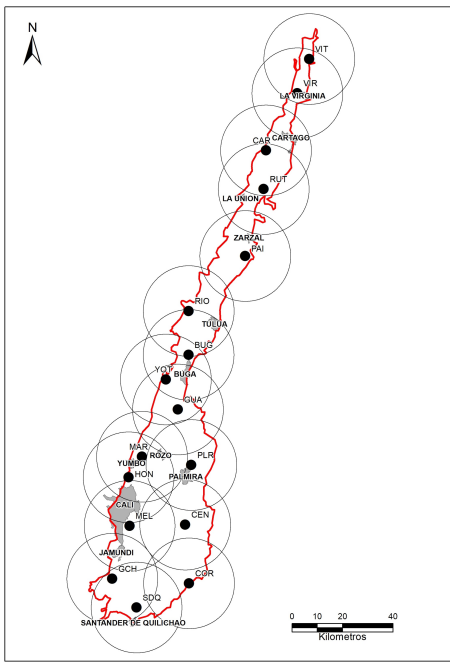

Fig 1. RTK network Coverage in Cauca river valley, Colombia.

Study and implementation.

In 2014, were analyzed many factors to determinate distribution and feasibility of the stations along the Cauca River valley, in which, the number of stations required to guarantee adequate coverage in the area of influence in sugarcane was determined. As well as the location of the sites for installation of base and repeater stations.

CENICAÑA has an Automated Meteorological Network (RMA) composed of 38 weather stations, where the structure of seventeen (17) of these was used and adapted in such way that they were used to the network of *RTK* stations, distributed as observed in the Fig. 1. One of the criteria was the coverage radius in each station it is approximately 15 km.

Compatibility.

The PA equipment market of the country is diverse, a criteria that was taken into account for design of the *RTK* network of sugarcane agro-industrial sector. The communication system has the capacity to be compatible with the main technologies, in such a way that most of the *PA* equipment benefits from the signal issued by the seventeen stations that cover an approximate space of 250 km from north to south.

Using one *GNSS* reference point for each station, two receivers and two *UHF* communication bands (450 and 900 MHz), reference stations of the network transmit a correction signal used in s sugar cane process year after year. In such a way, a work of furrow made using *PA* technology and later harvested implementing another system, its *GNSS* reference point is the same, allowing the repetitiveness of the agricultural work. This characteristic makes the *RTK* network of the sugar cane agro-industrial sector one of the few mixed networks in Latin America. *Fig. 2* illustrates an *RTK* station, describing as a characteristic the possibility of transmitting by two frequency bands.

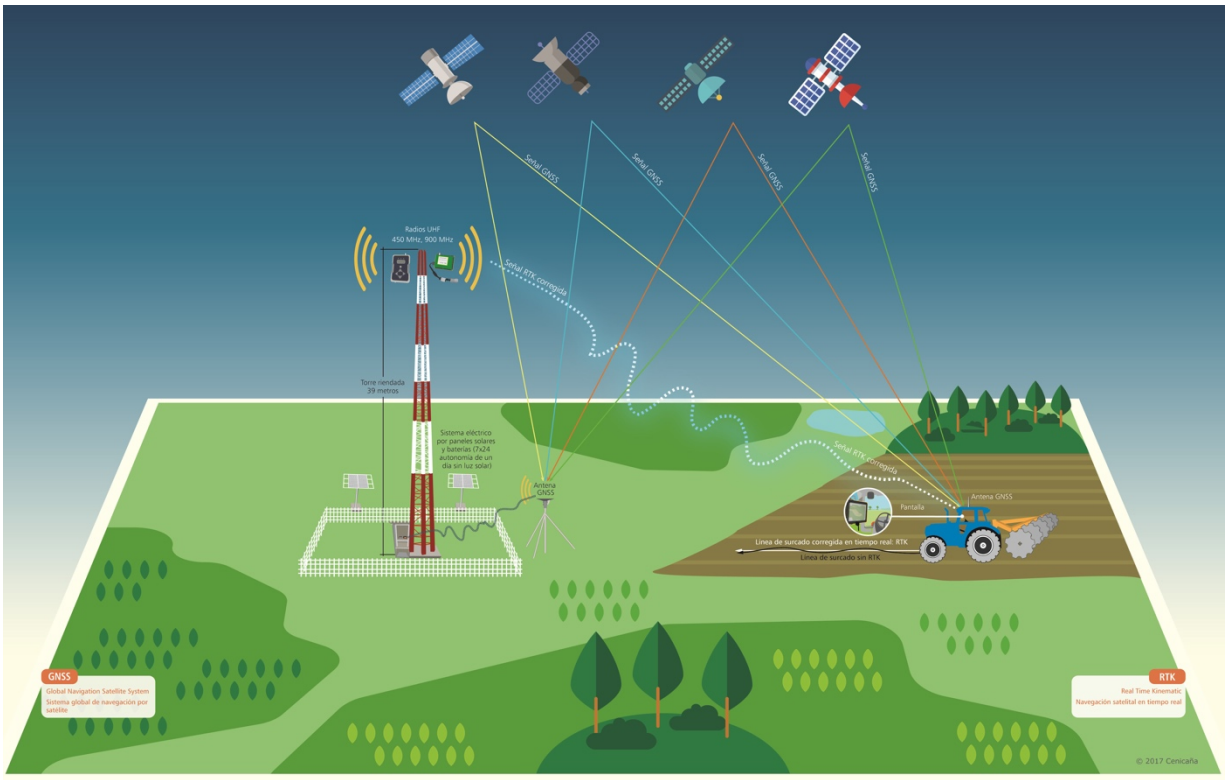

Fig. 2. *RTK* station scheme. Font: Carta Informativa ISSN 2339-3246, Cenicaña.

Other applications.

Works using Unmanned Aerial Vehicles (*UAV*) connected to *RTK* network.

Data obtained in each of the seven *GNSS* stations of the network uses for differential correction with precision and accuracy required in *UAV* surveys in crops no greater than 45 days of growth. Using the *PPK* (Post Processed Kinematic) technique, generates filters with furrow lines for automatic pilots that allow harvesting using AP compatible with the signal of the *RTK* network.

Geodynamic studies of the Colombian territory.

GeoRED research project of the SGC researches the current state of deformation of the earth's crust. With data obtained in more than 110 permanent *GNSS* stations of continuous operation, distributed throughout the Colombian territory, in a first stage determines the geodetic speeds generated by the action of the tectonic plates that converge in the northwest corner of South America. As well as along active faults, in order to establish their possible association with the occurrence of earthquakes. *CENICAÑA*, with the network of 7 *GNSS* stations implemented in the sugar area of the Cauca River Valley, not only generates benefits for the farming of sugarcane, but also provides significant support for geodynamic studies, especially in the southwestern region of Colombia, an area that is prone to the occurrence of significant earthquakes.

Conclusions.

RTK network of sugarcane agro-industrial sector provides compatible with different kinds of technologies offered by the market, adapting to the needs of agricultural work in southwestern Colombia.

The information collected by each station of the network allows, in addition to facilitating the use of autopilots, the processing of aerial photographs using *PPK* used in agricultural work that adopts Precision Agriculture performance.

SGC, through GeoRED project, incorporates data obtained in the stations of the *GNSS RTK* network of the Cauca River geographical valley for the study of geodynamics in the national territory, as an input in risk management due to natural phenomena (Mora-Páez, 2006; Mora-

Páez et al., 2018).

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