Agriculture

GNSS MARKET REPORT

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**Agriculture**

**GNSS applications**

*Precision agriculture* is the application of different technologies and solutions to manage the variability of agricultural production, in order to improve crop yield and reduce environmental impact. Key GNSS enabled applications include:

- **Farm machinery guidance** uses GNSS positioning to assist drivers in following the optimal path thanks to a digital display, thus minimising risks of overlaps.
- **Automatic steering** completely takes over steering of the farm equipment from the driver allowing the operator to engage in core agricultural tasks.
- **Variable rate application** combines GNSS positioning with information from other sensors and digital maps to distribute the right amount of agrichemicals.
- **Yield monitoring** enables site-specific monitoring of harvest, combining the output of a yield sensor with GNSS positioning of the harvester.
- **Biomass monitoring** enables site-specific monitoring of biomass in an agricultural field, providing up-to-date information on crop development.
- **Soil condition monitoring** enables updates of soil moisture levels, fertility or diseases to optimise their management. GNSS positioning and software applications identify the exact position of the soil samples sent to laboratories. Data from soil sampling is used in VRT application maps.
- **Livestock tracking and virtual fencing** use a GNSS-enabled portable equipment to track animals behaviour, leveraging tracking and virtual fencing.
- **Forest management** makes use of GNSS positioning for different forestry tasks such as identification and mapping of damage and areas under stress, location of clear-cut areas, sample plots and roads.

**Agri-logistic** applications help farmers to increase efficiency and to comply with number of regulations and new standards:

- **Farm machinery monitoring and asset management** use real-time GNSS information for monitoring the location and mechanical status of equipment and to manage work flows efficiently.
- **Geo-traceability** enhances the effectiveness of food, animal and product traceability by using transponders on animals and vehicle GNSS trackers, as well as by geo-referencing location and size of land parcels.
- **Field definition** is the activity of measuring precisely the boundaries and the size of agricultural fields. In the EU, GNSS-based operations using EGNOS and Galileo support a system of area-based subsidies for farmers within the Common Agricultural Policy (CAP).

**What you can read in this chapter**

- **Key trends**: GNSS stimulates integrated farm management’s uptake, as new applications take off.
- **User perspective**: Interoperability and ease of use are key requirements of precision farmers.
- **Industry**: List of main players by value chain segments.
- **Recent developments**: Precision agriculture solutions registered growth across applications.
- **Future market evolution**: Growth of emerging markets will further push adoption of GNSS.
- **Focus on European GNSS**: EGNSS to foster the further adoption of precision agriculture.
- **Reference charts**: Annual evolution of GNSS devices’ installed base and revenues by application and region.

**NEW**

**Key Market Trends**
- GNSS applications are used across all phases of the agricultural life cycle and represent a key enabler for the integrated farm management comprehensive concept.
- The drones uptake is increasing and growing in popularity in commercial applications, with agriculture likely to be one of the largest users of drone technology.
- IoT has been the source of new and more productive ways to farm, owing to the use of easy-to-install and affordable sensors. The US is leading and worldwide the segment is growing at a CAGR of 20%.

**Integrated farm management fostered by precision agriculture**

Integrated farm management constitutes a holistic management approach of the farm. The aim of integrated farm management is to increase the productivity of agricultural cultivation through informed management processes based on the big data paradigm, improving the efficiency of the utilisation of existing assets as well as of natural and anthropogenic resources, in line with sustainable agriculture principles.

Decisions are supported by software services based on data generated by space systems (GNSS and Earth observation), as well as by terrestrial technologies. In this context, precision agriculture perfectly fits the concept of integrated farm management, which is based on a cross-linked unit approach of the farm and it equally constitutes a tool for integrated farm management itself. The current uptake of integrated farm management is of approximately 10% in the EU and estimates place it at 30-40% by 2020. All major players involved in precision agriculture are currently equally developing integrated farm management solutions, offering farmers the possibility to maximise the performance of their machines, resources and businesses.

**Forest management market bound to grow and go mobile**

Since forest management constitutes an activity with an inherent locational component, GNSS is beneficial in different phases of forestry activities. The applications of GNSS are the following: handheld devices for field control, hardware in machine guidance and software. The market is in a rapid state of change at the moment. The potential of reaching higher accuracy (one meter), once turned into reality, will result in growing adoption of GNSS across forest applications.

The sales of smartphones’ complementary devices (via Bluetooth) that increase location accuracy will soar in the next years. The mapping software market is forecasted to increase by approximately 30% in the next 15 years, with the US and Europe having the highest sales. The GNSS hardware in machine guidance is relatively recent on the market and its use will increase across regions, with new equipment including machine guidance, positioning and additional maps. The current size of the market is estimated at around 13.5 million euros.

**Usage of drones poised to maintain its upward trend**

Drones are used in precision farming support, encompassing a wide range of applications, including crop and field analysis, mid-season crop health monitoring, planting, crop spraying and cattle herd monitoring.

It is estimated that the biggest growth area for drones’ use over the next decade will involve specifically precision farming, due to the possibility to acquire information cheaply, safely, and quickly. The Association for Unmanned Vehicle Systems International estimates that farms will eventually account for an 80% share of the commercial drones market. Regulation can come into play by either fostering or hindering the adoption of drones. The latter applies for instance in Europe. Drones are foreseen to bring substantial benefits: corn, soybean and wheat farmers could save an estimated 1.18 billion euros annually in the US by deriving the benefits of using drones, which include:

1. **Increase in yields** by spotting potentially yield-limiting problems
2. **Savings in time** by covering the entire field in less time than a crop scout could
3. **Ease of use**: drones are easy to operate and able to hover even in difficult access areas
4. **Removal of human error**, by capturing data that cannot be seen by the human eye
5. **Operational capability** also in case of clouds, as opposed to aerial and satellite imagery
Interoperability and ease of use are key requirements of precision farmers

Overview of the main user requirements in Agriculture

The table depicts, in alphabetical order, the key user requirements as assessed through the GSA’s continuous monitoring with the user community. Only high priority requirements are shown, i.e. other requirements might also be relevant for considered applications, and the table is subject to updates. Information on the parameters is provided in Annex 2.

How data are empowering farmers: from big data to smart data

The role of the farmer is the one of the principal decision maker, which poses important challenges. The farmers need support/guidance in the decision making process to be able to plan ahead, as well as during the harvesting cycle. The data collected from the field can have a double role in this regard, supporting on-the-field and on-the-spot decisions, hence operational needs, as well as more strategic solutions and decisions. The strategic solutions can refer to whether a certain type of crop should be cultivated or not, to the rotation of the crops etc.

Another salient aspect is the capability to use the information for reporting in the frame of legislative compliance. In this particular regard, automated digital documentation, within the digital farm, could alleviate the administrative burden of farmers to demonstrate compliance with legislation.

The above-mentioned ideas are in line with the rise of the farming 4.0, which refers to a farm that is data-pushed, GNSS-assisted, and IoT-ready. The challenge for the current technology is the transformation of the big data into smart data, which is easily used by farmers. By fully accomplishing this, the relation between the human, the technology and the animal or the land could be considerably improved.

Incompatibilities bring about difficulties for user

Some users have experienced difficulties, because of “language problems” between farm equipment, farm management programmes and software programmes, as well as incompatibilities between components. The standardisation of interfaces is the key solution to minimise the incompatibility between different brands of hardware and software.

Since the industry has been trying to tackle this difficulty, several initiatives were started. A case in point are the Agricultural Industry Electronics Foundation (AEF) activities, which provide the necessary support for introducing guidelines to ISO standards in agricultural electrical and electronic systems.

In both the US and Europe, projects dealing with the improvement of standardisation are under development. In the US, under the Standardized Precision Ag Data Exchange (SPADE) Project agricultural suppliers of hardware, software, services etc. cooperate for improved data exchange and interoperability. Their goal is to make Data Sharing & Interoperability a reality for precision agriculture. In Europe, the FP7 project FUTUREFARM dealt with data interchange standards and the adoption of standards in European agriculture. Europe has so far agreed on some data standards, for instance for animal ID in Precision Livestock Farming.
The European \(^1\) GNSS industry in the global arena

Europe covers 6\% of the global market for GNSS components and receivers, with Hexagon and Septentrio being the two main European players. The North American company Trimble is leading with 38\% of the market, the runner-up being another North American company, John Deere. European companies service 42\% of the global system integrator market, the main companies being Hexagon AB, CNH Industrial and Bernard Krone.

\(^1\) In the market share analysis, Europe is defined as EU28 plus Norway and Switzerland.

**New lay-out of the value chain**

In this edition of the Market Report, additional attention is given to insurance providers, as agricultural insurance schemes have become more widespread, in both developed and developing countries. The value chain considers the key global and European companies involved in the GNSS downstream activities.
**Precision agriculture solutions registered growth across applications**

**Tractor Guidance** continued to constitute the most spread application from 2006 up to 2016, confirming the trend of the high penetration rate and accounting for 41% of the shipments of all devices in 2016 and more than 700,000 units as installed base in the same year.

**Automatic Steering**, the second application in terms of annual shipment, has grown at a higher rate than Tractor Guidance, showing that there is a growing interest and need for a superior level of accuracy. The adoption of automatic steering and the positive results obtained by farmers while using these systems have been encouraging farmers to subsequently use new, innovative farm practices with small investment costs attached.

With regard to **Variable Rate Technologies (VRTs)**, the application has been growing at a constantly high rate, reaching 67,000 shipments in 2016. It is often used in conjunction with other precision technologies, confirming through its increasing use the fact that agriculture is becoming one of the fastest growing tech sectors, across regions.

**Asset Management solutions** have annually increased in adoption since 2006, amounting to an installed base of 153,000 units in 2016. **Forest Management solutions** constitute a niche market, encompassing machine guidance and tree management solutions.

**GNSS supports the traceability of products across the supply chain**

Geo-traceability regards the collection of information about a product and the guarantee of the visibility of the data to other points in the supply chain. It creates trust for the consumers, through additional information on the origin of the ingredients and production methods. It can be used to supply proof of the origin of the processed products and their ingredients, which in turn is used by producers to potentially justify a higher price of the products. The food traceability market is projected to grow at a CAGR of 9% by 2019.

A variety of tools support traceability in general, amongst which GNSS, sensors, barcodes, RFID tags, label printers, etc. Cloud applications maintained by companies via cell signal or Wi-Fi address the collection of traceability data. The data are mostly stored in databases, which allow to follow products from their origin farm, processing, transportation, delivery and the end customer.

There is potential for GNSS to act in synergy with Copernicus to provide valuable data for traceability purposes. Copernicus can, for instance, provide support for the gathering of data through mapping services.

**GNSS-based applications make life easier for farmers**

From a technical standpoint, GNSS provides support in guidance system applications, for instance for the creation of straight and evenly spaced lines in the field or for curve guidance modes. Automatic tracking features are also supported by GNSS tracking. These systems are usually compatible with smartphones and tablets. Moreover, the GPS component supports mobile mapping, providing the data that can be afterwards downloaded into a GIS (geographic information system) to feed a range of software applications.

The software allows farmers to control farm operations by accumulating, analysing and exploiting data over several years. The precision farming software market is expected to reach 1.34 billion euros by 2020, at a CAGR of 15.1% from 2014 and 2020. In 2014, Europe and the Americas were the market leaders, with APAC being the fastest-growing region. Precision farming software applications’ growth depends on the expected improvement in their capability to help farmers achieve higher productivity, and increased financial gains, by helping them to efficiently plan and maintain data bases, thus making activities in farms easier.
Growth of emerging markets will further push adoption of GNSS

North America is currently the most technologically advanced region and the heartland of precision agriculture, with the highest installed base, followed by Asia-Pacific. The shipments in North America will increase more than two fold between 2015 and 2025, proving that precision agriculture is progressively prominent amongst farmers from this region and that the industry is committed to technological innovations.

Asia-Pacific will continue to expand its installed base, albeit at a slower pace than in the period 2006-2015, reaching 330,000 shipments in 2025. Countries such as China, India and Australia are the main adopters of precision agriculture. The burgeoning demand in food due to rising human populations and the economic growth of the region drives the interest for precision agriculture. The smallest farms, which is the case of most farms in the APAC region, will be the first ones to become mainstream adopters of autonomous feeding systems.

Europe (both EU28 and Non-EU28 Europe regions together) will grow at a moderately more sustained pace, reaching 157,000 shipments in 2025. The challenges faced by precision agriculture in Europe regard the size and diversity of agricultural structures.

Middle East and Africa, together with South America and the Caribbean will register the highest growth, partly due to the currently low levels of adoption and the fact that technology initially used in developed countries is becoming more accessible. Affordable and smart technology solutions are gaining ground in Africa, a region with much untapped potential. Maize and rice are amongst the cultures having benefitted from advanced technologies. In MEA, the shipments will grow from 14,000 in 2015 to 239,000 in 2025.

Livestock tracking: potential and barriers

Livestock tracking refers to the monitoring of herds from overhead, tracking the quantity and activity level of animals on one's property, especially for night-time monitoring. Farmers can monitor the movements of livestock throughout the landscape, plot grazing patterns and see in what areas the livestock have been depleting nutrients in the soil. Moreover, GPS live tracking data gives farmers the possibility to understand how livestock interact with the land.

The barriers faced by these solutions are related to the communication of the position of the animal in environments with limited connectivity, as well as to the battery life. Both device manufacturers and telecommunication providers have been putting forward solutions to these issues. Overcoming these challenges will push the market for wearable electronic devices for livestock. Several companies have developed products with GNSS tracking capability, including features such as geofences.

An FP7 funded project, E-Track, worked on a user-friendly tracking software solution, using EGNOS for higher accuracy. Some experts expect livestock tracking to be substantially used by farmers in the next 5-10 years. The expected growth of the market is from around 750 million euros currently, to 1.89 billion euros by 2025.
The use of GNSS in precision farming often means positioning services with sub-decimetre level accuracy, which can only be achieved using augmentation services. Galileo Open Service in combination with RTK or PPP, as well as Commercial Service High Accuracy (CS-HA), features excellent positioning that will further improve the performance of GNSS-assisted agriculture and bring benefits in every phase of the farming operation. As Galileo Initial Services were declared in December 2016, farmers may already benefit from Galileo in a multi-constellation configuration. The resulting benefits to precision farming are many, e.g., better operation in harsh environment, availability, continuity and reliability.

EGNOS improves precision agriculture solution by providing metre-level accuracy that is widely available. Thus EGNOS eliminates the need for complex and costly equipment and software solutions, and the investment in the required infrastructure of augmentation service providers. EGNOS provides farmers with the opportunity to better control applications, monitor the harvest yield, perform effective in-field data collection, and use manual guidance in cultivation. In the next years, EGNOS is on its way to becoming the preferred entry level technology for precision agriculture in Europe, Africa and the Middle East. This is confirmed by the fact the vast majority of GNSS devices offered today are EGNOS enabled.

The current CAP reform raised a new opportunity for GNSS due to new requirements, which directly affect how farmers in Europe claim aid for agricultural parcels, new elements in their aid applications as well as subsequent process of administration and control of area-related payments. In particular, GNSS plays a role in measurements needed to prove eligibility for funding and for the performance of on-the-spot checks performed by the public authorities in charge. In conducting such activities, GNSS solutions, often used in a combination with Earth Observation (EO), guarantee time and cost efficiency while minimising the volume of low added-value activities. In this frame, EGNOS and Galileo can offer affordable improved accuracy, in addition to increased availability and continuity. The Galileo Open Service Navigation Message Authentication (OS NMA) will potentially simplify and reduce the need of checking activities performed by the authorities through the provision of certified measurements.

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The aim of the prize is to promote Europe’s GNSS and EO services in agriculture. The prize rewards new ideas and innovations, especially those integrating EGNOS, Galileo or Copernicus. The 2016 Prize winners, from ISA Lille, worked on the optimisation of the properties of the cover crops to improve soil composition by using earth observation data.

The F7 GEOPAL project dealt with a GNSS-based system used for planning logistics in agriculture. The successful results are implemented by the project in the product lines of their respective companies, therefore transferring the R&D outcome in marketable solutions and generating revenues. In addition, at Agritechnica, the CLAAS Group was awarded a silver medal for the solution that was developed within the GEOPAL project – its field route optimisation system that enables 6% average cost reduction for farmers.

More information on: [http://www.geopal-project.eu/](http://www.geopal-project.eu/)

The objective of AUDITOR is to develop an improved ground-base GNSS augmentation system in terms of both performance and cost and to deliver services based on the augmentation system for agriculture applications. The target group of the project are farmers around Europe who live in areas where EGNOS coverage is poor or small and medium-sized farms, which cannot afford the cost of a private RTK solution.

The consortium is composed of both companies and research centres working together to advance the objectives of the project, which will finish at the end of 2017.

More information on: [http://www.auditor-project.eu/index.html](http://www.auditor-project.eu/index.html)

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GNSS penetration is defined as the proportion of all high-powered tractors that is equipped with GNSS.