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Corporate Communication Department, Kubota Corporation
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Expanding the future of food, water and the environment.

The Quest for Precision Farming

From the Frontlines in the Netherlands, Germany, and France



The 1990s saw a remarkable evolution of information and communications technology (ICT) amid rapid technological innovation, which in turn drove major changes in societies and lifestyles.

The resulting ripples spread to every corner of the industrial world, and the farming sector was no exception.

New initiatives began for farm management utilizing ICT and other advanced technologies—something that is now known as precision farming.

It is estimated that the world population will top 9.8 billion by 2050, generating growing concern over shortages of food.

Precision farming is a trump card that can help to resolve the world's food problems.

In Japan's rice farming market, Kubota became the first in the industry to introduce precision farming, which Kubota refers to as "smart farming."

Furthermore, Kubota has recently commenced initiatives for precision farming in Europe's upland farming market.

Kubota has started taking on new challenges to resolve the world's food problems as it aims to become a "Global Major Brand" ("GMB").



▲ The Netherlands is a country of water and bicycles. This is because one-quarter of its land area is flat reclaimed land and the government put considerable effort into developing bike trails (photo: Amsterdam).

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Sakura Tomita, Instrumentation and Control Technology Center



FEATURE "Precision Farming"

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What is "Precision Farming"?

A look at precision farming in the Netherlands today



Overview of Agriculture, Forestry, and Fisheries in the Netherlands
(excerpts from the Ministry of Agriculture, Forestry and Fisheries of Japan website)

The Netherlands' land area is about the same as that of Japan's island of Kyushu. Among its total land area, 44% (or 18,400 km²) is farmland.

Located in wetland areas along the lower Rhine River, one-quarter of its land area is reclaimed land below sea level.

Making the most of its small land area, the country focuses on farming techniques that maximize revenues even for small farmers through production of flowering plants and vegetables in greenhouses and livestock (including dairy farming). Its farm produce is exported primarily to the European Union market.

Farm produce exports total US\$90.9 billion, the second largest such figure after that of the U.S. Three quarters of its exports are free of duty, with the main export destinations being European Union member countries with few quarantine restrictions (2013). Farm produce imports account for approximately two-thirds of its total exports. It is active in processing trade and intermediate trade.

The average farm area is 0.274 km² (2013).

Its main agricultural and livestock products are flowering plants (tulips, etc.), potatoes (world's largest exporter), onions, tomatoes (world's second largest exporter), cucumbers, bell pepper, raw milk (world's second largest cheese exporter), and pork (according to 2013 rankings).



With one-quarter of its land area being reclaimed land below sea level, its capital city of Amsterdam has an extensive network of canals.

A popular symbol of the Netherlands, windmills have been used to drain seawater from low-lying areas, irrigate farmland, and generate electrical power for industrial milling.



Higher yield/quality, lower environmental load

The definition of "precision farming" varies internationally. The U.S. National Research Council (NRC), for example, defines it as "a management strategy that uses information technologies to acquire and analyze data on crop production, and supports decision-making by scientifically elucidating how factors are interrelated." The Home-Grown Cereals Authority (HGCA) of the U.K.'s Department for Environment, Food & Rural Affairs (DEFRA) says that it is "a method of crop management by which areas of land or crop within a field are managed with different levels of input in that field." For Kubota, "Precision farming is a farm operation technique aimed at minimizing costs for fertilizers, chemicals, water, and fuel and maximizing yields by utilizing data. It also aims to improve the taste and

quality of agricultural products, ensure traceability, hand down knowhow, and reduce heavy labor." Precision farming was formerly focused solely on state-of-the-art technology, but it is now regarded as an advanced technique for farm management. It takes a comprehensive approach to maintaining soil fertility, increasing the yield and quality of crops, and reducing the environmental load by using factual records to finely manage intricate and varied types of farmland.

Supporting the implementation of precision farming are tools featuring information and communications technology (ICT), the Internet of Things (IoT), artificial intelligence (AI), and other cutting-edge technologies. A wide variety of support tools have been developed, including field sensors for gathering data on the weather and other environmental factors, soil sensors, drones for remote sensing of the growth situation, combine harvesters equipped with yield monitors, and farm machinery featuring

GNSS¹ technology that is capable of variable control of fertilizers and chemicals. Precision farming began to spread rapidly in the late 1990s, when one implement after another started to be developed. In the U.S., which is often regarded as the birthplace of precision farming, the main driver behind its diffusion was its higher productivity, due to the fact that there are many large-scale farms there that benefit most from its cost reduction effects. Meanwhile, in Europe, precision farming is being introduced for the purposes of environmental conservation by optimizing the use of fertilizers and chemicals, as well as increased productivity, and proactive initiatives are being undertaken in the U.K., France, Germany, and elsewhere.



Wageningen University & Research, nestled in the rural landscape outside of Amsterdam



Corné Kempenaar
Professor, Wageningen University & Research



Thanks to its large quantities of raw milk (cattle) production, cheese is one of its key exports.



The Netherlands is the world's largest exporter of tulips and other flowering plants.

The world's 2nd largest agricultural exporter – What makes the Netherlands' farming so competitive?

The Netherlands is a country known for advanced initiatives in precision farming. Some 40% (or 18,400 km²) of its approximately 41,500-km² total land area is farmland, and crops are cultivated in a narrow range of arable land (with nearly half of its farmland consisting of pastures). Despite these less-than-ideal conditions, the Netherlands is the second largest exporter of agricultural produce after the U.S. In 2016, the country's agricultural exports totaled roughly US\$96.5 billion (compared with US\$135.6 billion for the U.S.).² Following the Netherlands are Germany, Brazil, and China, the latter two of which boast vast expanses of arable land, thus making the Netherlands' inclusion in the list even more conspicuous. The agricultural sector in the Netherlands is highly competitive internationally, with some of its largest export items being tulips and other flowering plants (i.e. ornamental plants), prepared foodstuffs, tobacco, and cheese. The country possesses a unique model of agriculture that is akin to processing trade, in which they import raw materials and export them after adding value. A look at agricultural production output will show wheat and potatoes ranking high, but closer inspection of agricultural data on the Netherlands will show high added value (gross profit) from fruits and vegetables, such as tomatoes and cucumbers, dairy products from grasslands where high-yield herbage is grown, and intensive stockbreeding, such as hog and poultry raising, as well as from flowering plants.

One factor underpinning the Netherlands' impressive agricultural results is the country's government-sponsored projects to bring about innovations in agricultural and food industries. In the municipality of Wageningen, located in the central eastern province of Gelderland, one can find the industrial cluster known as the "Food Valley" region, where agricultural research and development is carried out jointly by the public and private sectors under the lead of Wageningen University & Research, an internationally recognized authority on agricultural research. Precision farming is one of its key project themes. We were fortunate enough to have the opportunity to interview Dr. Corné Kempenaar, who studies precision farming at Wageningen University & Research.

Precision farming is essential for sustainable agriculture

Professor Kempenaar started his agriculture research in the fields of cereal science and crop epidemiology and, by extension, he became engaged in precision farming research. He is now one of the leading authorities on precision farming in Europe.

"Behind the rapid diffusion of precision farming is the fact that it is necessary for sustainable agriculture. Precision farming is extremely effective for gaining a high yield from scarce resources and developing agriculture that is resilient against rapid climate changes and reduces environmental load. As such, precision farming has the potential to realize sustainable agriculture and offer solutions to food problems the world over."

According to Professor Kempenaar, farming in the Netherlands is distinguished by the fact that it achieves high productivity with just a small amount of land, and precision farming has become rapidly diffused thanks to its compatibility with the country's pursuit of efficiency. However, he also pointed out that there are major challenges ahead to the further diffusion of precision farming.

"Precision farming is a knowledge-intensive farming system. We already have an abundance of tools and technology necessary for putting precision farming into practice, but the problem is that the situation is not yet well understood by farmers. They wonder how they can use the system, or how they can go about putting to use the data gathered by sensors. I feel that it is necessary to provide training and guidance through the precision farming promotion program and other means."

As one can see, precision farming is spreading across the globe, so what kind of approach is Kubota taking? Rather than simply moving ahead with precision farming, Kubota has gone one step further to come up with its own advanced concept of "smart farming," and it has already implemented pioneering experiments in the rice farming market of Japan.

¹ A Global Navigation Satellite System (GNSS) is a positional information measurement system using satellites such as the Global Positioning System (GPS) of the U.S. and Galileo of Europe.
² Statistics from the United Nations Conference on Trade and Development (UNCTAD)

FEATURE "Precision Farming"

Creating new values through innovative solutions to support farm management by utilizing data and automating farming machinery

Around 2011, Kubota became the first farm machinery manufacturer in Japan to begin studying precision farming. This proactive initiative bore fruit in May 2014, when Kubota announced the development of the Kubota Smart Agri System (KSAS), which supports farmers to achieve more efficient production. As indicated by the system's name, Kubota had already set its sights on "smart farming," which includes precision farming. While precision farming can be defined as a farming management technique that utilizes data by way of ICT and IoT to increase

operational efficiency, smart farming supports farm management by combining such data utilization with the automation of farm machinery. Satoshi Iida, who serves as Director, Senior Managing Executive Officer, and General Manager of the Research and Development Headquarters, explains the rationale behind Kubota's commitment to smart farming, which he plays a central role in promoting:

"In Japan, while the farming population has considerably dwindled and aged, the number of professional farmers who manage land areas of 0.05 km² or more, who are referred to as certified farmers, is on the rise, with the result that farmland is becoming concentrated and larger in scale. It is said that the percentage of farmland managed by certified farmers among the total farming

area will increase from the current 58% to reach 80% by 2023. As farmland concentration accelerates and the labor force decreases, farmers are faced with a diverse array of challenges, including appropriate management of multiple fields, improvement of yield and quality of crops,



Satoshi Iida
Director and Senior Managing Executive Officer, concurrently General Manager of Research and Development Headquarters

reduction of production costs, and the need to add extra value to their produce. In response, Kubota aims to create new value by delivering solutions focusing on farm management support through greater use of data and ultra-reduction of labor through automation of farm machinery."

Unified information management by the KSAS and development of automated/unmanned farm machinery

The centerpiece of farm management support through active use of data is the abovementioned KSAS. The basic architecture of the KSAS connects PCs and smartphones with farm machinery via cloud service to manage every single piece of overall farming information in

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an integrated manner. By accumulating/analyzing multiple types of information on fields, crops, and farm operations that are collected from farmland, farm management can be "visualized." This not only helps to reduce operational errors—it also reveals information on input of fertilizers and other chemicals, thereby allowing costs to be lowered. One feature of the KSAS that merits special attention is the "taste-yield combine harvester." This state-of-the-art farm machine simultaneously measures the yield and nutritional components of rice in each field and enters such information into a database as it performs harvesting and threshing.

"The taste of rice is determined by protein and water content, and so we equipped our combine harvester with a sensor that measures these nutritional components. The sensor allows monitoring of variances in the yield, protein, and water content in each field. Based on

the data, fertilizer application can be optimized, which then helps to produce high-value-added, delicious rice. If the data on fertilizer application design are transmitted to farming machines, the machines automatically set the application rate, making it possible for anyone to apply fertilizers easily according to plan. This marks a departure from conventional farming techniques, which relied on farmers' experiences and intuition." (Iida)

In addition to this data-driven farm management support, the other key initiative of automated farm machinery is well under way. The first phase in this regard is auto-steering. In September 2016, Kubota released a rice transplanter with the "Smart-Path" function, followed by a tractor equipped with the auto-steering function. There are technical difficulties in having a rice transplanter maintain a straight line in paddy fields, and existing auto-steering equipment was expensive



Top: Automated tractors with the auto-steering function (left: unmanned model; right: manned model)
Bottom: Rice transplanter with the Smart-Path function



Precision Farming According to Kubota

Putting smart farming into practice



Demonstration of automated operation (auto-steering) by the M7001 Series tractor

and unable to do the job. Therefore, Kubota came up with an original control system that combines an inexpensive DGPS unit with an Inertial Measurement Unit (IMU), thereby creating a mechanism capable of automatically controlling the vehicle with high accuracy (10 cm margin of error for every 100 m of straight movement). The current plan is to release automated/unmanned farm machinery (with human supervision) from 2020 (monitor marketing of automated tractors began in June 2017), toward the ultimate goal of releasing completely unmanned, remote-controlled machines. Meanwhile, monitor marketing of drones for spraying chemicals has begun as one of the initiatives for saving labor and reducing the work burden.

Kubota's entry into the European upland farming market and partnership with an implement manufacturer

Having declared its commitment to solution of the world's food issues, Kubota has embarked upon global initiatives for smart farming by tapping into the knowledge it has gained through farm management support provided to rice farmers in Japan. While precision

farming (or "smart farming") is expected to solve food-related issues stemming from the explosive increase of the world population, as it helps to increase yields and operational efficiency, Kubota has targeted the European upland farming market, which includes France, Germany, and the Netherlands. With the commencement of production and sales of the M7001 Series of large-sized tractors for upland farming in France in 2015, Kubota made a full-scale entry into the European upland farming market. The key component behind this strategy is the presence of the Kverneland Group (hereinafter "KVG"), a specialist implement manufacturer that joined the Kubota Group in 2012. Implements include different types of operating equipment pulled by tractors. For farmers, the crucial point when evaluating farming machinery is determining whether the machines can achieve efficient and accurate farm operations. In other words, they rate farming machines that achieve higher yields at lower costs. This can be realized only when the tractor, which is the power source, and the implement that performs the task are able to be united together to work as one. Implements represent an important key for Kubota's penetration into the upland farming market in Europe. Kubota's smart farming there is being promoted through collaboration with implements. Kubota and the KVG are constantly working together to promote smart farming in Europe.



Rake (implement that gathers cut grass into lines) connected to an M7001 Series tractor

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Kubota Working at the Forefront of Precision Farming in Europe

R&D in the Netherlands



Researchers at Kverneland Group Mechatronics B.V. work on advanced technologies incorporating cloud services and robotics.

Tractors + implements ICT-enabled integrated control

Implements are considered as the first runner in the European upland farming market; Ploughs for tilling, seeders for planting, mowers for cutting grass, balers for compacting hay, sprayers for sprinkling agricultural chemicals, and spreaders for distributing fertilizers, they are just a few of the diverse implements that have been developed for each aspect of upland farming work. In the tractor business,

Kubota is a newcomer to the European upland farming market, but its Group implement manufacturer, KVG has long made its presence known in this field. It has earned a high reputation for its engineering expertise not only in Europe, but also in the international market.

At present, Kubota and KVG are working together to reshape the concept of smart farming, and one of these projects is to exchange information between a tractor and an implement for integrated control that achieves higher-efficiency, yet lower-cost farming. Having a tractor and an implement share the operational data, such as driving

speed and number of engine revolutions, makes agricultural work more convenient and comfortable. When baling hay, for instance, the driving speed of a tractor and other parameters can be optimized by determining what the tractor needs to do based on the operating conditions of a baler, and having the implement communicating such data to the tractor. In the case of mowers for cutting grass, the operations of the implements are able to optimally be controlled based on the operational route of the tractor in order to avoid mowing the same area twice. Through such "tractors + implements" combinations, Kubota is making even greater efforts to achieve the optimization of farming.

Diffusion of the ISOBUS international communications standard is essential for the realization of smart farming

The key to information communications between tractors and implements is an international standard called ISOBUS. Conceived specifically for linking tractors with implements of any brand, ISOBUS is a globally shared communications standard. It was KVG that came up with the idea of ISOBUS, and it played the central role in

developing the standard. One of the key individuals responsible for making this happen was Ton van der Voort van der Kley, who is currently Business Development Director at KVG Mechatronics B.V.

"We first embarked on R&D for electronic implements in the beginning of the 1980s," he noted. "It then occurred to us that we needed a common platform that would allow a smooth connection and exchange of information between the farm machines of customers and those of other brands, and this served as the basis for the development of the ISOBUS international standards. By facilitating dialog between tractors and implements of different brands, ISOBUS offers innovative solutions not only to achieve high efficiency and low costs in farming, but also to make controlling farm machinery easier and more convenient."

The dedicated efforts of Ton and his team bore fruit in 2008 when the Agricultural Industry Electronics Foundation (AEF) was established as an organization to promote the diffusion and expansion of ISOBUS, after which adoption of the standard by the world's leading manufacturers of tractors and implements gathered pace. Peter van der Vlugt, CTO of KVG Mechatronics B.V., currently serves as chair of the AEF.

"The AEF supports the development of ISOBUS-compatible products by providing



Touchscreen terminal monitor for M7001 and other models

state-of-the-art software tools and products, with the goal of achieving global diffusion and expansion of ISOBUS. At present, it is being diffused in Europe, North America, and other parts of the world, but we are still dealing compatibility issues in certain markets. I think that the further spread and expansion of ISOBUS is essential for the evolution of precision farming throughout the world."

The technology pillars needed for advancement of smart farming

SOBUS provides the basis for smart farming, but there a number of technological breakthroughs are required for the further advancement of such farming. Alexander Sassenberg, Director of Sales and Marketing of Smart Farming Systems at KVG, spoke with us on the topic.

"KVG has identified five technology pillars needed for the strategic smart farming developments," he said. "They are: 1) ISOBUS, 2) telematics (remote data communication system), 3) smart sensors, 4) smart implements, and 5) cloud data management. If we add more, human interfaces, autonomous driving, and robotics are also elements required for the smart farming of the future. Through research and development of these technological pillars, we hope to develop smart farm machinery that customers will find even easier to use, increase the productivity of our machinery, reduce crop production costs, and contribute to increased world food production."

In particular, to raise the level of automation of farm machinery



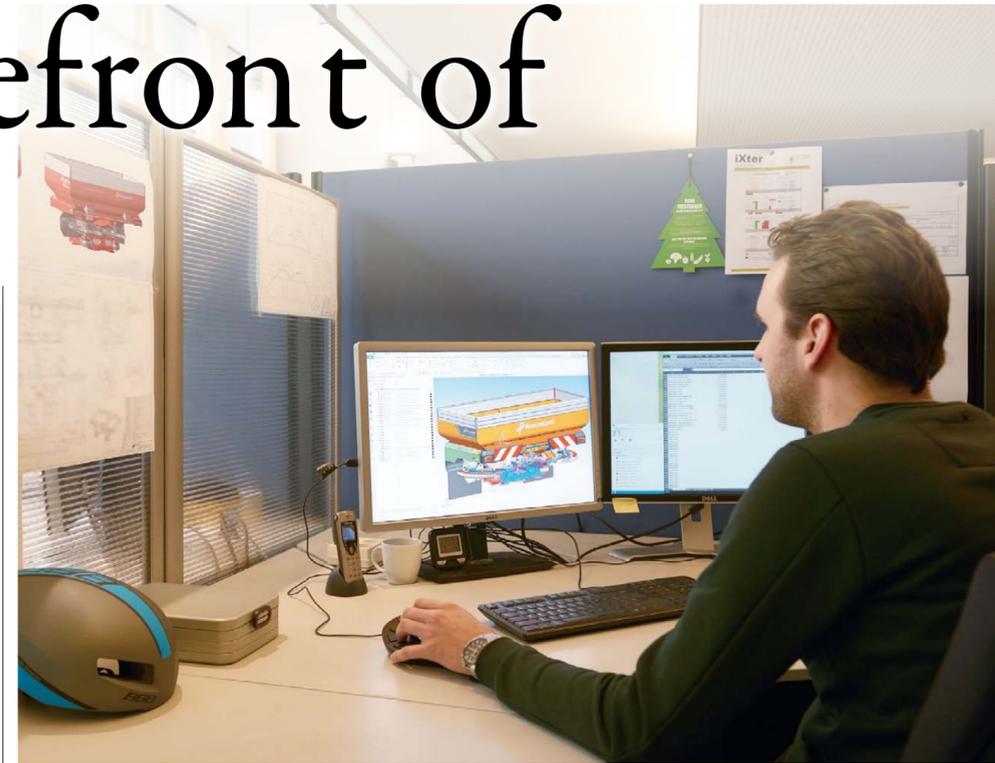
Peter van der Vlugt

CTO, Kverneland Group Mechatronics B.V.

From left Alexander Sassenberg Director, Sales & Marketing, Kverneland Group Mechatronics B.V. Sanne de Voogd Managing Director, Kverneland Group Mechatronics B.V. Ton van der Voort van der Kley Business Development Director, Kverneland Group Mechatronics B.V.



For example, rather than working field-by-field, in order to enable even more precise segmentation of one tract of land into smaller fields (i.e., meshing), appropriate fertilizer application and agricultural chemical distribution, irrigation, and other activities, accurate measuring (that is, sensing) is required. Another development



using ISOBUS, information must be smoothly integrated and distributed from farm machines to a data management system using cloud technology. Serving as a technological foundation for KVG's promotion of smart farming is the mechatronics technology that it has accumulated over many years. Mechatronics technology is used in sensors and software, and it is at the core of the technologies that support smart farming. Sanne de Voogd, Managing Director of KVG Mechatronics B.V., points out the social significance of smart farming.

"With the growing world population, it is necessary to increase food production using limited resources. Under such circumstances, smart farming practices will play an important role, as they are intended to achieve higher efficiency and labor conservation in farming. This lines up perfectly with the Kubota Group's brand statement of 'For Earth, For Life' and our business concept of 'Smart, Efficient, Easy Farming.' You could say that living up to these slogans is truly smart farming."

Development efforts are also being accelerated on the Japanese side. One such project involves the development of sensors, in which Kubota has a high degree of technological prowess.

"To further develop precision farming, it is necessary to utilize GNSS and have information systems that collect and manage various types of data. We are working hard on advanced research projects to facilitate the use of the growth sensors that are built into such systems." (Hiroyuki Araki, Manager, First Development Section, Instrumentation and Control Technology Center)

As one can see, a wide variety of technologies for implementation of smart farming are under development. Let us now take a look at the present state of Kubota's smart farming in the European market.



Hiroyuki Araki

Manager, First Development Section, Instrumentation and Control Technology Center



Susumu Umemoto

Manager, Electronic Development Office, Vehicle Base Technology Engineering Department

project being promoted along with sensing accuracy enhancement is the creation of a tractor that runs automatically on the basis of received information.

"To make a tractor that runs automatically and stably for any job and under any conditions, we need to develop a function that supports automatic operation using the Farm Management Information System (FMIS), which manages data from sensors in an integrated manner. This is one of the research topics that we are working on through close cooperation with KVG." (Susumu Umemoto, Manager, Electronic Development Office, Vehicle Base Technology Engineering Department)

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Kubota's Technology Supports Precision Farming

Strategic shift in the European market
Enhancing the brand recognition

As mentioned earlier, in 2015, Kubota made its full entry into European upland farming market in France by commencing manufacturing and sales of the large tractors :M7001 Series. Kubota is also developing the market for smart farming in Europe by offering solutions that combine the M7001 Series with implements supplied by KVG. More recently, Kubota has launched a new strategy to drastically change its approaches to the European market. In October 2017, Kubota Holdings Europe B.V. was established in the Netherlands with a view toward achieving optimal results in the machinery segment in Europe. Since the establishment of Kubota Europe S.A.S. in France in 1974, Kubota has steadily expanded its European machinery business in France, Germany, the U.K., and in Spain by establishing subsidiaries that manufacture and distribute farm machinery, construction machinery, and engines. This new initiative marks an about-face for its European marketing strategy, since the business is managed by segment, rather than by country as it was in the past. The president of this new company is Dai Watanabe: Kubota's Managing Executive Officer and concurrently the General Manager of the Agricultural Implement Division and also the CEO of KVG.

"The reason of establishing this regional headquarters for our machinery business was to increase the efficiency and viability of our organization in Europe by aligning all of our business units together," he said. "We are looking closely at European upland farming market, but the hard truth is that, as a newcomer to the market, recognition of Kubota brand is not very high. In European market, the Kubota brand has gained wide recognition for distinctive compact tractors, but the main player in the upland farming market is large tractors. For that reason, our immediate task is to increase our recognition by promoting sales of the M7001 Series. Therefore, we are working to empower the Kubota brand by reorganizing our sales network as 'borderless'."

Introducing smart farming to the European market through the "tractors + implements" solution

Now that a new organizational setup is in place, efforts to expand sales in the smart farming market are being orchestrated by the farm machinery segment, which offers the combined solution of "tractors + implements," rather than offering them individually in each national market. The powerhouse behind this strategy is the EU Agricultural Business



Members of the EU Agricultural Business Unit
From right
Mickaël Provost
Andreas Kaczmarczyk
François Julienne

Unit, which is a cross-functional team of members from Kubota's business units in Europe. Mickaël Provost is the product manager responsible for the introduction of tractors for farming use. Based in France, he currently plays a prominent role in promoting sales of the M7001 Series for the entire European market by reengineering regional sales strategies.

"Since its release in 2015, the M7001 Series, which comprises the first large tractors from Kubota, has seen steady growth in sales. We often hear our users say that the M7001 Series is simple and easy to use, and offers high operational efficiency. They also say they like its good compatibility with implements and its excellent operability."

Their approach to the smart farming market in Europe has already begun with



Dai Watanabe
Kubota's Managing Executive Officer and concurrently the General Manager of the Agricultural Implement Division, CEO & President of Kverneland AS, and President of Kubota Holdings Europe B.V.

the "M7001 Series tractors + implements" combination. It is equipped with a section control function for prevention of double spraying, a variable rate control function for

determining the amount of fertilizers and other materials being fed depending on the soil conditions, as well as an auto-steering



ISOBUS-compliant connector - a crucial data link between tractors and implements



Left: Automatic operation; Right: Manual operation. The operator on the right seems busy checking monitors while also steering.

A series of operations from grass collection to packing/discharging by the baler is performed seamlessly upon command from the terminal and vehicle controller by the driver's seat.

function for automatic operation. All of this has been made possible through ISOBUS-enabled data communication between tractors and implements.

farming. In other words, our customers are interested in the outcomes of technology, rather than the technology itself. "Go to Market" is our slogan for this initiative. We hope to satisfy customer needs by living up to the "Priority Onsite" principle."

The "Kubota Farm Solution" for any farm management issue

Emphasizing Kubota's originality is important," says Andreas Kaczmarczyk, Marketing Manager of the EU Agricultural Business Unit.

"Whether it be in upland farming or precision farming, Kubota is a newcomer in the European market," he noted. "So, the crucial question is, how we can distinguish ourselves from the other players who arrived before us? Our approach to this involves helping our customers to resolve their problems by offering a 'Kubota Farm Solution' package, which includes a tractor, implements, applications, and service contracts. The important thing here is to understand what customers need and deliver what they want. They wish to know how much benefit they can expect from smart

As a liaison between Kubota and KVG, François Julienne is taking the lead in promoting smart farming. He is a former KVG employee who became involved early on in the smart farming business of tractors + implements.

"Precision farming and smart farming not only reduce the costs of farm operations, but benefit farmers, since they no longer have to depend on their own experience and intuition," he said. "As such, I believe that the introduction of smart farming will be accelerated. For Kubota to be chosen by customers as each player competes in terms of product development, we must definitely enhance ease of operation and comfort for operators who are on the frontline of smart farming, and improve the level of process automation. What we want to achieve are total solutions that customers find reasonable and easy to use. We will pursue simple yet unique solutions going forward."

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“Kubota Smart Farming” in Germany AGRITECHNICA - The World's Largest Agricultural Machinery Trade Fair

The theme of the 2017 AGRITECHNICA was “Green Future – Smart Technology.” Kubota and KVG displayed the advanced technologies for “tractors + implements” solutions that fulfill the concept of smart farming.

View of the Kubota booth at AGRITECHNICA, the world's largest agricultural machinery trade fair. The fair was participated in by 2,803 exhibitors from 53 countries and attended by 450,000 visitors.

Strategies for penetrating European upland farming market Marketing that “visualizes” benefits

In AGRITECHNICA, the world's largest agricultural machinery trade fair in Hanover, Germany in November 2017, Kubota and KVG exhibited their “tractors + implements” solutions with smart farming features including many new developments.

Exhibiting not only at AGRITECHNICA, but also at other international trade shows, is one of Kubota's key marketing practices.

“At AGRITECHNICA, we used simulations to show visitors the benefits that can be generated through smart farming, such as higher efficiency and lower costs. What we did was to summarize the higher efficiency and lower cost effects, but we also presented what smart farming can do for them before their very eyes using simulations.” (Andreas Kaczmarczyk, EU Agricultural Business Unit)

Such simulations are run not only at trade shows, but also on the farmlands of customers, who can then gain firsthand training for smart farming.

“It is important that farmers really see how they can improve their current situations by introducing smart farming. This means that we need to illustrate how smart farming can give each farmer what he or she wants, such as comfortable and trouble-free operation or lighter labor, as well as higher efficiency and lower costs. Then we can develop a value chain using training seminars and other opportunities to support farmers by helping them learn how they can benefit from smart farming.” (Alexander Sassenberg, KVG)

As pointed out earlier by Mr. Watanabe, one of the biggest challenges facing Kubota in promoting smart farming in European upland farming market is its low brand recognition. No matter how excellent its technology and quality services may be, Kubota cannot hope to diffuse smart farming if customers do not even know about it.

Such being the case, the EU Agricultural Business Unit is pouring its utmost efforts into brand recognition enhancement. Following the establishment of Kubota Holdings Europe B.V., an attempt has been made to launch a brand profiling process for Europe as a whole, rather than for each individual country. The idea is to strongly

forge ahead with enhancement of brand recognition by sending out messages via multifaceted media, including SNSs, websites, and advertisements.

For realizing sustainable agriculture – Smart technology is the focal point

AGRITECHNICA, the world's leading trade fair for agricultural machinery, showcases state-of-the-art machinery from around the world, including tractors, implements, harvesters, components, and precision farming systems. The theme chosen for this year's event was “Green Future – Smart Technology,” with a focus on technology that is useful for achieving sustainable agriculture and trends in product development in our increasingly digitalized network society. On display was a large collection of farm machinery featuring precision farming (or “smart farming”) technologies for sustainable agriculture. As many as 2,803 exhibitors from 53 countries participated in this biennial event, which was attended by 450,000 visitors from around the world.

The “tractors + implements” formula for success in smart farming achieved by Kubota and KVG drew considerable attention at the trade fair. One relevant item

was the “TIM baler,” which is a solution for non-stop baling. Using GNSS data and laser scanner signals, steering is automatically regulated to follow lines of cut and raked hay. With an emergency stop function and automatic bale discharge, this solution aims to achieve even more efficient non-stop operation. In addition to enhanced operational accuracy, the utmost care is given to reduce the burden on operators and maximize user friendliness.

Another popular attraction was Kubota's collection of hybrid implements. A tractor can be equipped with the e-Platform

generator, which is able to supply extra electrical power and transmit it to an e-Spreader. Through hybrid system, implements can be controlled even more accurately than is possible with conventional mechanical regulation. When the tractor nears field borders or operates on different types of terrain, rotation speed is regulated automatically to ensure that an appropriate amount of fertilizer is sprayed for greater operational precision.

Meanwhile, at KVG's implement booth, highlights included the GEOCONTROL system, which can guide and support

operations to optimize sowing and fertilizing by accurately regulating the tractor's position via a GNSS, remote data communication system “telematics,” and the “variable rate control system,” which determines the amount of fertilizer and other materials being fed depending on soil fertility and crop growth. The exhibit successfully impressed many visitors with the smart farming direction being pursued by the Kubota Group.

“We are hoping to diffuse our smart farming throughout the European market by offering Kubota value, which

comprises ‘tractors + implements’ along with additional smart functions. Our competitors in Europe and North America are talking about precision farming, but our smart farming goes beyond that. You don't have to own vast tracts of farmland to appreciate the convenience and efficiency of smart farming. Right now, our smart farming solution is based on the M7001 Series of large tractors, but we aim to expand the coverage soon by offering smart solutions in lower horsepower ranges.” (Dai Watanabe, Managing Executive Officer, Kubota)



GNSS sensor placed on the cabin of the M7001 tractor



TIM baler (implement for gathering and packing hay) connected to the M7001



GEOSPREAD (implement for spreading fertilizers) connected to the M7001. This hybrid implement combines an electric motor with PTO horsepower.

FEATURE "Membrane Solutions"

Expanding the future of food, water and the environment.

Purifying Industrial Effluent from Food Processing Plants

Ecology and Submerged Membrane Units

Kubota's submerged membrane bioreactor (MBR) system is gaining ground across the globe

Since its launch of submerged membrane units in 1991, Kubota has pioneered the membrane bioreactor (MBR) market, constantly honing its technology for over a quarter century as it learned from experience working directly with customers. As the business expanded across international boundaries along the way, Kubota established Kubota Membrane Europe Ltd. (KME) in 2001, Kubota Membrane U.S.A. Corporation (KMU) in 2005, and Kubota Environmental Engineering (Shanghai) Co., Ltd. (KEES) in 2011. This has allowed Kubota to better supply its submerged membrane units for treatment of municipal and industrial sewage, thereby offering solutions to water-related and environmental issues around the world. As of 2017, Kubota has delivered its submerged membrane units to approximately 4,600 sites in Asia and Oceania, approximately 600 sites in Europe and Africa, and approximately 400 sites in the Americas, making it the second largest supplier in the global market.

Kubota's MBR system offers greater advantages as compared to the conventional activated sludge process, which is a common traditional process used for treating sewage and industrial effluent. MBR purifies domestic and industrial effluent through a combination of "degradative treatment by microorganisms" and "membrane filtration." MBR completely eliminates suspended solids as well as organic substances that are difficult to decompose via conventional processes. In addition, MBR almost completely eradicates Escherichia coliforms. As such,



EcoFuels neighbors a scenic national park.



MBR-treated water does not merely satisfy effluent standards, but also is able to be discharged into rivers and the environment and to be recycled for irrigation and flushing toilets purposes. Other elements of Kubota's MBR system that are highly evaluated include easy maintenance and significant conservation of space.

MBR making inroads into Europe

Meeting the EU's strict water quality standards

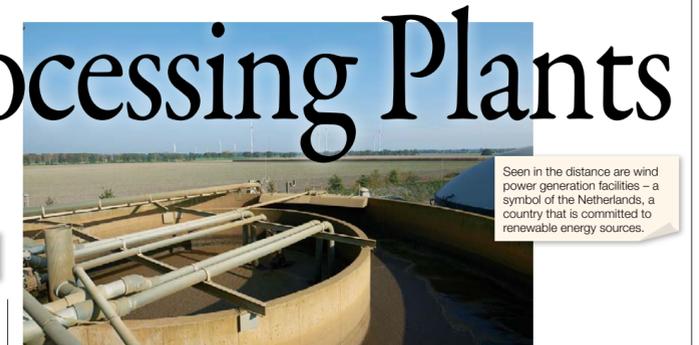
Located in the U.K., KME is responsible for sales and after-sales services of submerged membrane units in Europe, Africa, the Middle East, and South America. In Europe, the membrane/sewage treatment market demands vary. Western European countries, such as the U.K., Germany, and France, have already developed their own infrastructures, and thus the majority of demands there are for expansion of existing treatment plants and replacement of membranes, with demands for new facilities few and far between. In countries that have recently joined the EU, however, demands for new facilities are high, as their governments are contributing funds so as to satisfy EU environmental standards. Also, in countries that face chronic water shortages yet emphasize tourism, such as Turkey and Israel, demands for effluent purification are high. MBR is one of the preferred effluent treatment technologies in Europe because chlorination is not well received there, and also because MBR is capable of satisfying various water quality standards required in the EU.

Supporting a Dutch food processing company's water treatment plant

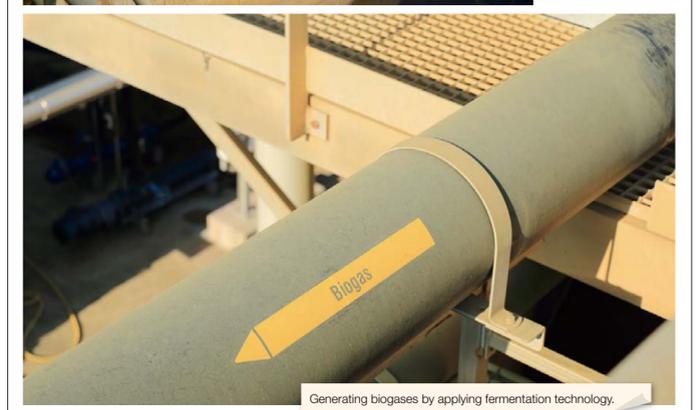
We visited a treatment plant that uses Kubota's submerged membrane units in a farming region in the Netherlands near the German border. It is there that Laarakker Groenteverwerking B.V., one of the country's leading food processors, is



EcoFuels' effluent treatment facility, where biogas is generated and Kubota's submerged membrane units are used to purify sewage from the process.



Seen in the distance are wind power generation facilities - a symbol of the Netherlands, a country that is committed to renewable energy sources.



Generating biogases by applying fermentation technology.

engaged in the EcoFuels' business, the key component of which is biogas generation. Using its advanced fermentation technology, waste from food processing is used to generate approximately 100,000 tons a year of biogas, which is a sustainable energy source. Kubota's submerged membrane units are used to purify effluent generated in the biogas generation process. Treated water is discharged into a river or recycled for cleaning and irrigation. The residual waste is then sold to compost manufacturers and used as compost and culture media. Mr. Twan Geraedts, the EcoFuels plant manager, told us the story behind the introduction of Kubota's submerged MBR.

"We used membranes from another supplier previously, but were considering switching suppliers because the membranes often became clogged. Then we were contacted by Colsen, an engineering firm, asking if we were interested in using Kubota's submerged membrane units. We put a great deal of trust in Colsen, and they told us that Kubota's membranes are highly durable and can realize stable operations, so we readily agreed. The most important thing for any effluent treatment plant is, in addition to precise purification of effluent, stable operation of the plant. This is because any interruption of effluent treatment can result in discontinued operation of the plant and, by extension, the entire factory. The other factor that convinced us was the high reputation earned by Kubota's submerged membrane units at other facilities in the Netherlands."

Biogas generation plants do everything in their power to avoid interrupted operations due to unexpected contingencies. Mr. Geraedts also appreciated the fact that Kubota's membranes require little maintenance. Submerged membrane units need to

be cleaned periodically using chemicals, but the frequency of cleaning differs greatly depending on the quality of raw water being treated. Simply put, the lower raw water quality is, the more frequently membranes need to be cleaned with chemicals. Mr. Geraedts also rates this advantage highly.

"Kubota's membranes are capable of stable treatment no matter how raw water quality changes, thereby ensuring advanced quality of treated water. We don't have to use chemicals to clean the membranes as frequently as we did before, which helps us to reduce costs. Also, the large amount of effluent treatment per unit of time and area translates into higher efficiency. Overall, we're extremely satisfied with Kubota's submerged membrane units, and we hope that Kubota will maintain their current technological level into the future."

The water and environment field is, like that for agriculture, expected to assume greater importance in the world going forward. In April 2017, Kubota released in Japan the Kubota Smart Infrastructure System (KSIS), which does remote monitoring and diagnosis of factories and plants effectively. Kubota will remain committed to solving the water-related and environmental issues of the world by constantly advancing the development of leading-edge technologies.



Twan Geraedts
Plant Manager, EcoFuels B.V.

PEOPLE

Kubota Professionals Taking on the World

With a heartfelt desire to be of service to people the world over, each Kubota person is taking on challenges throughout the world to make dreams come true. Two mid-career sales and development professionals share their thoughts on their wishes to tackle the demanding global arena.

Mito Kanai

Area Manager
Kubota Membrane Europe Ltd. (KME)
Joined KME in 2005

Joined the Kubota Group in London as a submerged membrane unit sales engineer

After receiving my master's degree from a graduate school in Japan, I continued my academic career in a doctoral course at Queen Mary University of London upon the recommendation of my academic supervisor. I studied physical chemistry and worked on surface structure analysis. Specifically, I was researching nitrogen-containing incar-fullerenes, which are cage-shaped carbon molecules that contain nitrogen atom inside and have the potential for a diverse range of applications, including novel materials for drugs, organic light-emitting diodes (OLEDs),

new photovoltaic panels, and hydrogen storage. After completing the doctoral program, I assumed a position at KME based in London. Because of my scientific background, I underwent engineering training and then was assigned to a team of submerged membrane unit sales engineers.

Established in 2001, KME is Kubota's vehicle for sales and after-sales services of submerged membrane units. While distributing submerged membrane units for MBR effluent treatment plants to engineering firms and contractors in Europe, Africa, the Middle East, and South America, KME provides both technical support and after-sales services. I am an area manager for the U.K., Ireland, the Netherlands, Belgium, Scandinavia, and South Africa.

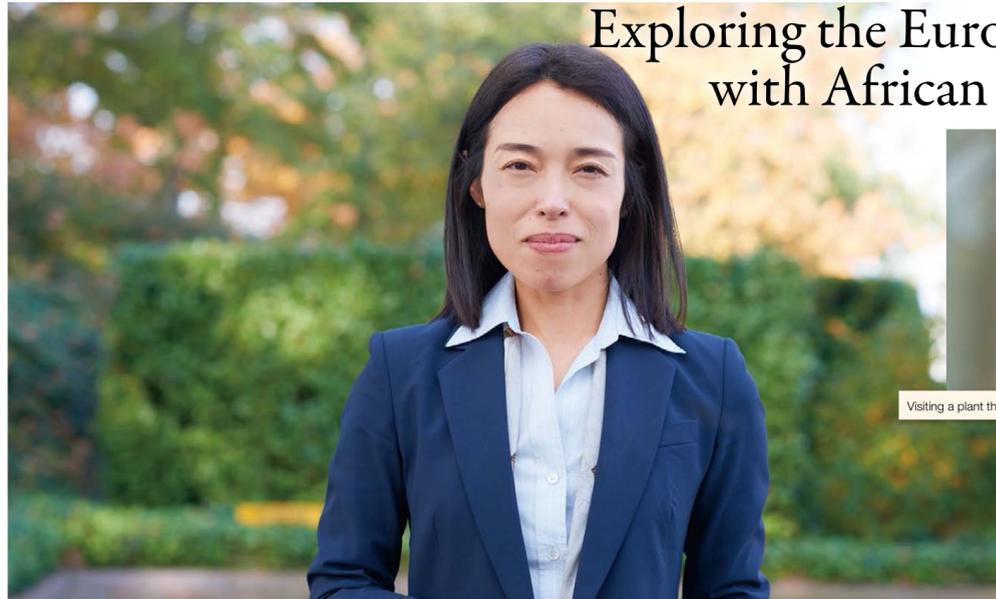
Establishing relationships of trust with customers through problem solution can be a weapon

My job begins by contacting consultants, engineering firms, contractors, and end users in each country of my area. For example, if I learn about a new project for an effluent treatment facility, I contact the project owner to convince them to use Kubota's submerged membrane units for the effluent treatment process, which will be the key component of such facilities. I also have an increasing number of opportunities to directly deal with end users for many reasons, including replacement of membranes at existing facilities. For the type of submerged membrane units supplied by Kubota, we used to share the global market with a North American player, but now we find ourselves engaged in intense competition in the European market, with many membrane manufacturers from China, South Korea, and Taiwan offering low-priced products. Amid this adverse environment, how can Kubota boost the

sales of its submerged membrane units? I've often asked myself this question, and reached the conclusion that, in addition to appealing to the superiority of our brand, it is essential to establish relationships of trust through constant visits. While it is my permanent goal to gain as many new orders as possible by working with customers from the design stage, it is also an important mission to build lasting relationships with existing customers. To make this happen, I think it is important to keep abreast of any technical issues that customers may have by maintaining close communications with them, so that I can then work on solutions to such issues.

The market that I would really like to break into is South Africa. While European countries – particularly those in Western Europe – have nearly completed their infrastructure projects, African countries offer huge business opportunities, as there are still some

Global Work Style 1 Exploring the European Continent with African Market in Mind



Visiting a plant that introduced an MBR

areas where infrastructure has yet to be developed. Other members of my team have begun cultivating the African market, and I hope to take the opportunity of breaking ground in that untapped market, not only in my area of responsibility in South Africa, but also from a broader perspective.

BUSINESS TOPICS



Complying with EU Stage V Emission Regulations Certification Obtained for Small Diesel Engines

In Europe, the new regulation for engines in non-road mobile machinery (Regulation (EU) 2016/1628, commonly known as "EU Stage V Emission Regulations") will come into force between 2019 and 2020. These regulations are even more rigorous than the emission regulations currently in force in Japan, North America, and Europe.

Going one step further to reduce environmental load, Kubota obtained certification for its compact diesel engines (11 models) under 19 kW (equivalent to 25.5 horsepower), which comply with these new regulations. The new diesel engines will be built into Kubota's tractors, combine harvesters, and construction machinery. Following this, they will be supplied to leading overseas manufacturers of construction/industrial machinery, generators, and welding machines on an OEM basis.

From Europe I

01

Expanding the future of food, water and the environment.

Global Work Style 2 I Want to Become a Person Who Advances ICT-Mechanical Collaboration



is now on the market. Since I built up my knowledge of software as well, I was able to broaden my technological skills.

Field research on European PF in the Netherlands

In the spring of 2015, a cross-sectional project on PF in Europe and North America was launched, and I was among those who joined the team. Then, in the autumn of that year, I was sent as a trainee for two years to Wageningen University & Research, with which I am now affiliated, with the main purpose of extending my research on PF in Europe.

Meanwhile, I am expected to follow up on the European/North American PF project, and so I investigate trends in the PF market in Europe. I also attend various conferences and am actively working in a variety of different fields. I have attended large-scale ICT trade fairs to absorb knowledge

and information on ICT, visited farm machinery factories in Europe to actually touch the farm machines there, and conducted surveys of French farmers. As a result, I have come to realize how important it is to visit actual farming sites. I feel the difference between the Netherlands and Japan most keenly at conventions and

meetings because, in the Netherlands, no one will pay any attention to you unless you speak out. Because of this, I have now become more proactive in speaking my thoughts and opinions than when I was in Japan. When I return home, I hope to involve others as an engineer/coordinator who is well versed in both mechanics and ICT, so that I can promote collaboration between those two areas.

Sakura Tomita

Instrumentation and Control Technology Center (Human Resources Department trainee)
Wageningen University & Research (The Netherlands)
Visiting Researcher
Joined Kubota Corporation in 2013

Applying my knowledge of sensor technology from graduate school to solve agricultural issues

In graduate school, I studied sensor technologies in a department of agriculture. When I went to find a job, I considered places in which I could apply my expertise in sensor technology to resolve issues faced by people in workplaces. One field that attracted my

attention was precision farming and farm machinery. A professor from my laboratory would often talk to me about precision farming, and I was always very impressed by its enormous potential. If we could make precision farming happen, I was told, we would then be able to offer solutions to issues facing farmers on a daily basis. This in turn would contribute to the sustainability of agriculture not only in Japan, but also throughout the entire world. I was so attracted to the potential presented by this area that I decided to become a precision farming researcher. I chose Kubota because I empathized with its "Priority Onsite" principle and, since it operates globally, I thought that I would be able to accomplish something to resolve the world's agricultural problems.

After I joined the company, I was assigned to a section working on precision farming (hereinafter "PF," which is also referred to as smart farming ("SF") at Kubota) as



With an academic advisor at her host institute of Wageningen University & Research

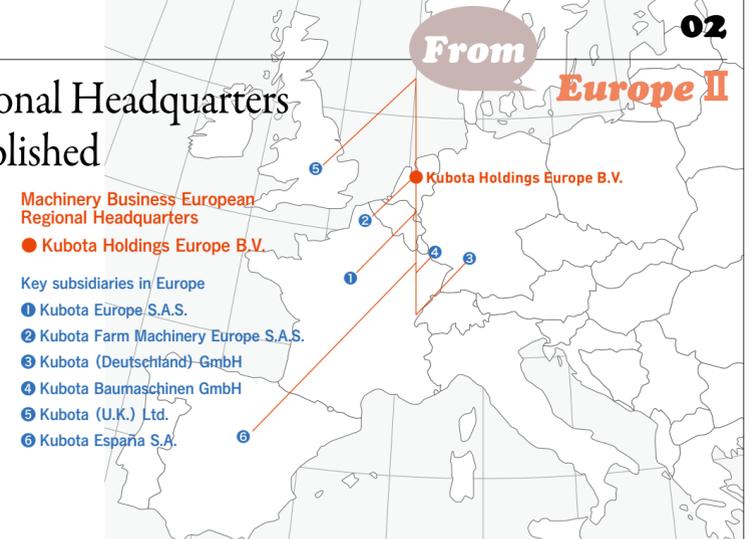
I had wished. There, I was a member of a research team on PF, in which Kubota was seeking opportunities for the rice farming market at the time. Our research bore fruit in the form of the Kubota Smart Agri System (KSAS), which supports farmers and service staff. Of the many projects that we worked on, I was in a group doing basic research on automatic operation for a "taste-yield combine harvester," which

BUSINESS TOPICS

Machinery Business European Regional Headquarters Kubota Holdings Europe B.V. Established

Kubota established Kubota Holdings Europe B.V. in the Netherlands as a regional headquarters for its European machinery business.

Since the 1974 establishment of Kubota Europe S.A.S. in France, Kubota has set up manufacturing/sales subsidiaries for farming machinery, construction machinery, and engines in each country to expand its machinery business in Europe. With the establishment of a European Regional Headquarters of its machinery business in Nieuw-Vennep, the Netherlands, Kubota has shifted its business management from a country basis to a Pan-European business basis, with the aim of optimizing its business management in Europe. Going forward, Kubota will use the new European Regional Headquarters of the machinery business to accelerate its challenges of realizing the "Global Major Brand" ("GMB") Kubota through its dedicated pursuit of the "Customer First" and "Priority Onsite" principles.



For Earth, For Life



Smart farming as pursued by Kubota is most certainly an innovative initiative that has potential to prompt a major shift in the way that farming is done. However, not every initiative in Japan, with the KSAS serving as a representative example, can be successfully transplanted just as it is into Europe's upland farming market. Land for rice farming and land for upland farming are decidedly different in almost every aspect. Moreover, while further enhancement of ICT, including the IoT and AI, is required, this does not guarantee that Kubota's smart farming will be able to expand into the European upland farming market. Kubota is keenly aware of the importance, both in Japan and overseas, of being "onsite," where customers actually manage their land. The practice of this "Priority Onsite" principle does not change in the promotion of smart farming. What do customers want and expect, and how can smart farming meet their demands? The future of farming will come into view after this customer-oriented product development approach has been taken. In the world of the future, many types of data gathered by drones from above could be reported to tractors via cloud service, with fully automatic tractors crisscrossing the farmland. There is no doubt whatsoever that future agriculture will be more efficient and less labor-intensive, but what Kubota really wants to accomplish with smart farming is to help dramatically increase the production of food and resolve the food-related problems that the world may face as the global population continues to expand.



The Future of Smart Farming as Shaped by Kubota's "Priority Onsite" Principle

The contents of the articles included in this volume are accurate as of September through November 2017, which is when the interviews were conducted.

Notice on "GLOBAL INDEX" back numbers

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