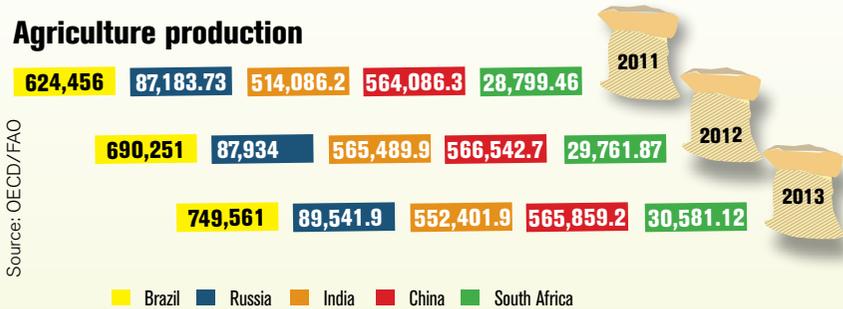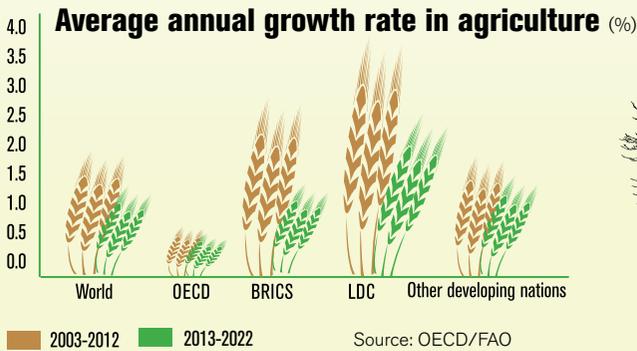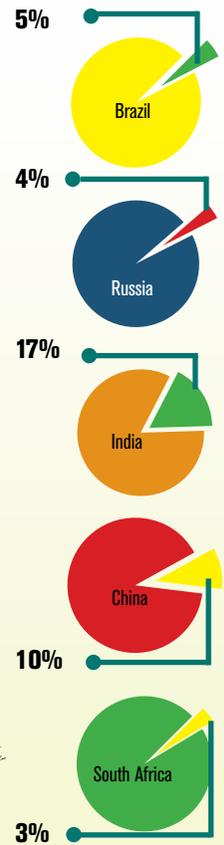# SO SHALL YOU REAP

The new 'agricultural powers' in terms of production, exports and imports, the BRICS are set to script new rules for tomorrow's agriculture. In terms of food security too, the BRICS will be key players in the world's fight against hunger because of their demographic and social characteristics.

Agriculture production

624,456	87,183.73	514,086.2	564,086.3	28,799.46	**2011**
690,251	87,934	565,489.9	566,542.7	29,761.87	**2012**
749,561	89,541.9	552,401.9	565,859.2	30,581.12	**2013**

Source: OECD/FAO

■ Brazil ■ Russia ■ India ■ China ■ South Africa

Average annual growth rate in agriculture (%)

World   OECD   BRICS   LDC   Other developing nations

■ 2003-2012 ■ 2013-2022   Source: OECD/FAO

Share of agriculture in GDP

5% Brazil

4% Russia

17% India

China

10%

South Africa

3%

Source : World Bank

Country	Agricultural Land	Arable Land
Brazil	31%	7%
Russia	57%	13%
India	60%	54%
China	13%	7%
South Africa	82%	12%

Smart Seeds for a Sustainable Future

BRICS nations must embrace cutting-edge geospatial technology and put in place well-thought-out policies to raise agricultural productivity to feed its burgeoning population and play a key role as a global economic force.

By Mark Noort, *Editor-Agriculture*

The growth of BRICS — in particular China, India and Brazil — is the story of our times. With the global power-base shifting to the rapidly evolving economies, agriculture is proving to be a predominant cultural and economic force in BRICS, home to 45% of the world population. On a global scale, the need to feed 8 billion people by 2025 requires production to rise from the current 3 tonne per hectare to 4 tonne per hectare. And BRICS are expected to play a significant role in this.

Agriculture is important for all these countries. It is therefore no coincidence that they adopted a cooperation plan earlier this year at the 3rd BRICS Ministers of Agriculture and Agrarian Development meeting to adopt tangible measures for boosting domestic agricultural productivity and dealing with global food crisis, promote global economic recovery as well as play a crucial role in global initiatives for food security.

Even not taking biofuel into account, increased urbanisation and rising living standards will lead to an increased demand for agricultural products. This is a global trend, but applies to the BRICS in particular. For most of these countries, extension of arable land is not an option anymore (with Russia and South Africa perhaps as exceptions). The focus should therefore be on increasing productivity and a more efficient use of resources. A parallel goal is to make the sector more resilient, to deal better with food price volatility and other disruptions, including those caused by climate change.
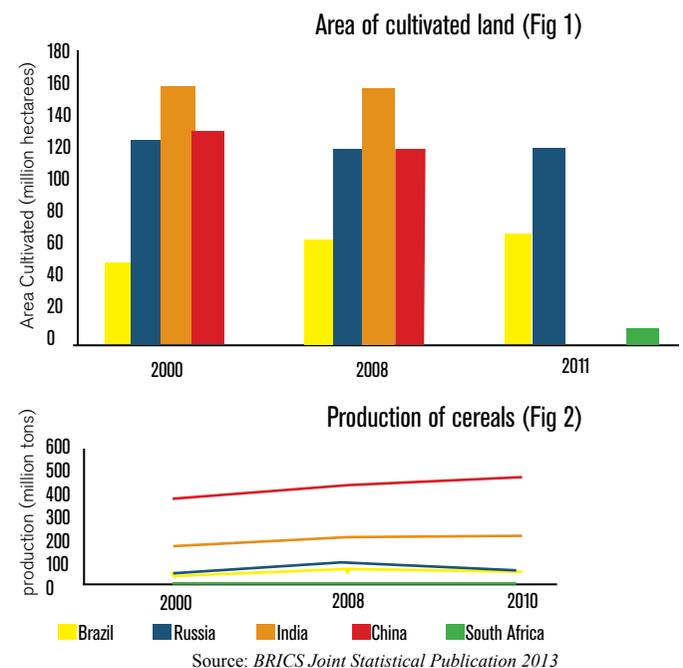
"The key word in agriculture is productivity. However, there are a number of critical factors that affect production including availability of land, accessibility of water and sustainability," says Claudio Simão, President Hexagon Solutions (South America & Asia Pacific). On the other hand, he points out that only 11% of the planet's land is fit for growing crops. Increased occurrences of natural disasters such as droughts and floods have had a catastrophic impact on the availability of usable land. Further complicating the problem is soil degradation, including erosion and nutrient loss, which causes an estimated 20% decline in food production in the world's most fertile areas every year.

Investments in technology can help BRICS increase productivity. Software solutions can not only optimise the utilisation of land and water, but fertilisers, pesticides, seeds and other farming resources. Furthermore, they also keep farmers abreast of crop management and production through digital workflows created from geo-enabled data. The information can be collected and analysed, and action can be taken to optimise the processes, thereby improving crop yields while saving costs.
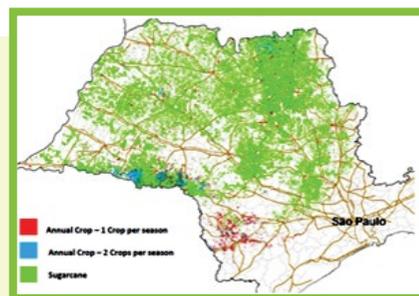
However, in the agricultural development plans of the BRICS countries, geospatial technology is hardly mentioned, or not at all. And whatever little is happening on the ground needs much harmonisation.

All BRICS face common problems, but also have competing interests. Production capacity will struggle to keep up with food needs while sustainability is a key challenge. The international food policy research institute (IFPRI) states that "the availability of location-specific data to document changes in these variables [weather, soil, markets, prices] over time is [currently] extremely limited." A World Bank study on smart agriculture notes that many countries have not invested enough in the public good of weather and climate information. This includes a lack of integration of meteorological and hydrological information services, easy and timely access of which is extremely important for agriculture.

Area of cultivated land (Fig 1)

Production of cereals (Fig 2)

Source: *BRICS Joint Statistical Publication 2013*

Canasat to map cultivation

The Canasat project uses satellite images to identify and map the area under cultivation with sugar cane in South-Central Brazil. The project is carried out by the National Institute for Space Research (INPE), the Industry Sugarcane Association (UNICA) and others. Since 2003, thematic maps are produced every year, including ones with the spatial distribution of sugarcane. The maps are accessible through the Web. People can find where the areas with sugarcane are, how the crop is developing and what the trends have been over the years (by municipality and by state). The information is used by the agribusiness sector, but

Sugarcane expansion in Sao Paulo state, Brazil

also by environmental organisations: harvests are predicted and planned, and environmental laws and regulations are monitored.

On the positive side, the sector has grown considerably in the BRICS over the past decade. According to FAO, agriculture output has grown 39% since 2000 in the BRICS, while the figure is 14% for OECD countries over the same time span. However, the BRICS are not producing to their optimum capacity and there is also a big difference between performances when compared to each other. A comparative analysis of the total area of cultivated land and production of cereals in each of the BRICS nations (Figure 1 & 2) show that total cultivated land in India, China and Russia is twice as much as Brazil's, and all four dwarf South Africa's total area. China is the biggest cereal and meat producer, but Brazil's cereal production is of the magnitude as Russia's and its meat production — although not even a third of China's — is almost three times Russia's.

> Embrapa's ARAquáGeo tool allows estimates of water contamination, which are incorporated into geostatistical programmes to generate maps to show the risk to evaluated area.

Brazil: High on Tech

Brazil is an exception among the emerging nations in its use of hi-tech technology for agriculture. High R&D spending has been very effective, raising production by over 70% in the last decade. Led by the agricultural research institute Embrapa, Brazil proved the conviction wrong that high yields are only possible in temperate climates, and is, therefore, an example for other tropical countries. The results obtained in the Brazilian North-East, the Cerrado, are especially impressive.

The support for agricultural research is accompanied by financial credit and rural extension policies. Agricultural policy tries to cater to both large enterprise-like as well as small family farms, and combine the goals of expanding production while supporting eco-friendly agricultural measures. Still, the level of government support to agriculture is relatively low (6%, compared with OECD average of 26%). Policies focus on enabling sustainable private sector investments and supporting measures that increase the value of natural capital, as R&D investments show. Besides, loans for agricultural development are tied to environmental protection measures. In terms of improved land management, Brazil serves as an example for others.

Geospatial technology plays a supporting role in soil and water management, the use of no-tillage systems and land-use management in general. It is also being used for rural planning,

infrastructure and logistics issues, environmental impacts, crop forecast, expansion and intensification of agricultural systems, and cattle tracing.

Systems such as Canasat are used for monitoring sugarcane and its effect on the environment. The size and scale of operations lends itself to the use of satellite solutions. Embrapa's SOMABRASIL (system for agriculture observation and monitoring) is another example. "The project organises, integrates and makes geospatial databases available on the Web, thus contributing to the understanding of land use and land cover changes. It uses data from different sources: Google (hybrid, satellite, physical and street); Virtual Earth (hybrid, aerial, and roads), and Yahoo (hybrid, satellite, and street)," says Mateus Batistella, Director, Embrapa Satellite Monitoring.

However, Brazil needs to shift uisfocus from science to applications At the local level, there are opportunities for precision agriculture applications, but also for more general issues, such as the use of geospatial technology for the development of disaster prevention and mitigation plans. Embrapa has also developed a system, ARAquáGeo, for environmental assessment of pesticides, based on geospatial technology.

CONAB (translated as the national supply company of Brazil) underlines the importance of geospatial technology for crop yields forecasts, such as for coffee. Currently, the crop forecast in Brazil is done by means of questionnaires to

producers and employees of institutions responsible for crop estimation. However, with variations in spectral behaviour due to factors such as spacing, age, time of year, this can better be identified and mapped on satellite images with reasonable accuracy, improving the results in terms of accuracy and timeliness.

Russia: A Land of Opportunities

Russia has a vast potential to increase agriculture output and productivity. With modernisation and vertical integration, the last decade has seen significant government investment in this field. What distinguishes Russia from the other BRICS partners is that only half of the arable land (60%) is used for agricultural production. Productivity lags behind the European Union and the US, which is partly due to unfavourable climatic conditions. But this also provides an opportunity for improvement, in terms of application of modern technology, equipment and machinery, fertilisers and better soil and water management. A government project is worth mentioning here — the System of State Land Monitoring. The project consists of two sub-systems — the Agricultural Lands Atlas and the Remote Sensing Monitoring System of Agricultural Lands.

Crop development and yield forecasting, fertiliser application, and soil and water management are other areas where geospatial technology can make a difference. At all levels, land-use planning and timely weather and climate information will become important to increase resilience with respect to climate change and meteorological phenomena.

"Russian farmers are mostly interested in such information services as inventory and mapping of agricultural lands, registration of field boundaries, assessment of crop conditions during different stages of vegetation, recommendations for differentiated application of fertilisers, yields forecasting and soil mapping etc," explains Michael Bolsu-

novsky, First Deputy Director General, Sovzond Company, which works with satellite imagery partners like RapidEye and DigitalGlobe to develop this market. Sovzond is investing in pilot projects for customers at minimum financing.

Smart technologies like precision farming have also taken off well in some parts of Russia since the technique provides each field lot with differentiated fertiliser and herbicide treatment, different seeding volume, and strict abidance by culture practices in soil treatment. The GLONASS/GPS navigation hardware installed on modern agricultural machinery allows accurate positioning of a unit within a field, adjustment of its trajectory and, depending on uploaded programme, activation of various modes of operation, say Ilya Farutin and Sergei Mikhailov of Scanex. Although incentives for implementation of innovative technologies could be improved, there is a growing interest in the use of precision agriculture techniques, simply because the benefit-cost ratio is high.

India: Battling Inner Devils

Self-sufficiency in agricultural production has been the top priority for India, which is home to 17% of the world's population and 15% of global livestock, but only 2.4% of the geographical area and 4% of the global water resources. Half the population depends on agriculture as principle source of income and agriculture accounts for about 14% of India's GDP and about 11% of exports.

"Since the net sown area is stagnated at around 142 Mha, further increase in production needs to come through an increase in gross cropped area (multiple cropping), coverage of area under irrigation and improvement in the productivity," underlines Dr G.P. Obi Reddy, Senior Scientist with the National Bureau of Soil Survey & Land Use Planning. This could be achieved by focusing on potential areas, regionally differentiated strategies, crop diversification and scientific

Satellite-based Crop Monitoring

The Russian company Scanex has developed a satellite-based crop monitoring system to improve the efficiency of the plant industry. The first step is to establish an accurate estimate of the area under cultivation. Overgrowing with shrubs and trees, loss of land by gully erosion, conversion of agricultural land into built-up areas, and withdrawal of land plots from agriculture are factors that have to be taken into account. Satellite images provide the information that is needed for crop monitoring. Substantial work goes into image classification and field visits to assess and validate photosynthetically active biomass. The results are used to advise on fertiliser application and optimal harvest timing (scheduling machine use).

Comparing the vegetation index of winter crops

management of natural resources. The Bureau is conceptualising a project to generate high resolution soil resource database at 1:10,000 scale for site-specific agricultural land-use planning. "Geospatial technology plays a key role in all these endeavours," he adds.

For years now, ISRO's National Remote Sensing Centre (NRSC) has been working on crop pattern/system analysis, crop monitoring, crop acreage and production assessment,

drought assessment etc; and farmers are provided assistance through village resource centres. Recently, the government recommended remote sensing and GPS-based support system for land rejuvenation while pilot studies are being planned for land-use planning and precision farming. NRSC's Bhuvan also provides thematic data for agriculture, water and ecosystem management at national, state and district level on 2D/3D mode on the Web and Mobile.

The Ministry of Agriculture's Mahalanobis National Crop Forecast Centre was established in 2012 to provide crop forecasts and assessment of drought situation. "We use remote sensing data from various satellites (Indian and foreign) for crop and drought assessment. GPS is used for field data collection, while GIS is used for integrating thematic information from multiple sources and generating maps," says Dr Shibendu Shankar Ray, the Centre's Director.

Ray adds there have been several end-user oriented applications of geospatial technology, such as watershed development, site suitability and precision farming. An example is the work carried out by the North East Space Applications Centre towards horticultural development in the region. Satellite data was used to delineate the area under 'Jhoom' (shifting) cultivation. Then, village-level horticulture development plans were generated, based on site-suitability for fruit cultivation, to directly benefit the farmers. Another example is the use of remote sensing and GIS for post-harvest infrastructure (cold storage) planning for potato crop in the state of West Bengal.
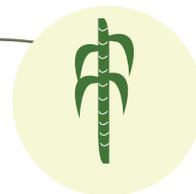
ICRISAT and ICARDA are two other organisations promoting the use of geospatial technology for agriculture. The Indian Council of Agricultural Research has also launched a $250-million World Bank-funded initiative called the National Agricultural Innovation Project which uses geospatial data to develop innovative ways of farming.

Suhas P. Wani and A.V.R. Kesava Rao of ICRISAT note that developments in the field of GIS that synthesise thematic information with ancillary data have not only made this technology effective and economically viable but also an inevitable tool to arrive at sustainable development strategies for land and water resources management.

Dr Chandrashekhar Biradar of ICARDA confirms the paradigm shift from landscape-level information to farm scale. In particular, very high resolution (VHR) satellite imagery now provides unprecedented opportunities for standardised farmscape to landscape metrics and analytics to inform sustainable agricultural intensification in smallholder settings.

Agriculture is the responsibility of the states in India. This means there are different policies to support the sector. In addition to the variety of climatic and economic circumstances, this makes the picture very diverse. There are some general issues, however, such as the continuing fragmentation of land holdings and the ever-increasing pressure on land and water. This calls for a sound land-use policy that facilitates rural area development, sustainable natural resource management and eco-restoration. For such a policy to be effective, computerisation of land records and mapping of land and water use and resources, as well as soil characteristics is necessary, and the potential for geospatial technology is obvious. Further, countervailing measures like subsidising water, electricity and fertiliser should be phased out or at least balanced, to enable productivity gains and modernisation of the sector.

It is interesting to note that use of water and power for agriculture is heavily subsidised in India, contributing to excessive drawing of power and depletion of groundwater resources. Water-use efficiency can be increased with rain-

Indian Sugar Mills Association has used geospatial technology to map sugarcane crop in India. This enables it to predict crop acreage, drought impact on crops, water utilisation, etc for the entire country.

ISRO takes the lead

The Indian Space Research Organisation (ISRO) coordinates a wide array of remote sensing applications for agriculture. For crop production forecasts a mixture of space, agrometeorology and land-based observations is used. For the early-season crop monitoring the soil moisture conditions are critical, rainfall monitoring and drought assessment are therefore very important. This combined with an analysis of cropping patterns and crop rotation increases productivity by crop intensification and diversification. Advice on fertiliser and water use is another objective.

Soil erosion pattern in Karnataka as shown by ISRO's geoportal Bhuvan.
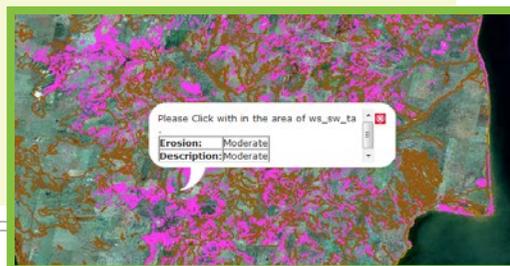
water harvesting, micro-irrigation and watershed management, an area where geospatial technology is a valuable tool.

To boost its stagnating agriculture, India has to switch from traditional grains to high-value crops and livestock products. It also needs to change its production based on low labour costs to efficiency and productivity-driven growth. As elsewhere, promotion of geospatial technology in India would make use of a two-fold strategy — showing the potential of concrete geo-based applications and transforming a science and government-dominated discipline into one that also includes the private sector.

China: Farming Out

Although China is a big producer, it is also the biggest net importer of agricultural products in the world. China has invested heavily in R&D and the creation of support infrastructure in rural areas (electricity, irrigation) and aims at modernising agriculture through market development, technical innovation, intensification, food safety, regional development, land tenure security, disaster management and climate resilient low-carbon agriculture.

Agricultural production has grown considerably over the last few decades; since 1980, production increased by a factor of 4.5 (over the same time span GDP increased by a factor 20). Food security has therefore increased significantly, but demand has also risen sharply owing to improved living standards and urbanisation. The increased pressure on land leads to land degradation, soil salinisation, acidification and pollution and water scarcity and pollution.

All this notwithstanding, the achievements of China in increasing productivity and sustainable environmental management are remarkable. In Northern China, for example, water saving is practiced to reduce evapotranspiration. Proper watershed management not only increased productivity, but also helped extend the area under agriculture while maintaining

the water balance. In Central China, the successful restoration of the Loess Plateau (fencing, grazing right, planting of grasses, trees and bushes) is an example in ecosystem-friendly management. In South China, afforestation and rainwater harvesting have been implemented. Paddy cultivation changed from continuous flooding to superficial drainage at midseason, increasing yields and reducing methane emissions. China is now a net 'sequesterer' of carbon from land use and forestry, according to the World Bank.

Additionally, the government aims at improving the efficiency of fertiliser use, which is currently still low. Tao Xiang, CEO of Hexun Science and Technology, a local player, confirms that thanks to state support agriculture production unit-scale is growing. This enables the application of modern technology for massive production, which in turn increases the demand for monitoring and decision making supported services. GIS is still the most popular concept, but other types of innovation are actively supported by the government.

The National Agriculture and Rural Information Development in the Twelfth Five-year Plan had listed "accelerating the pace of information technology of modern agriculture" as one of the major tasks. It had also called for digitisation of agricultural production data and development in precision agriculture, besides actively promoting farm management GIS, meteorological monitoring system of soil moisture, soil testing and fertilisation system, crop growth monitoring system and other information technology applications in field planting, points out Tao.

He Hui, Deputy Manager (Remote Sensing), Wuhan Zondy Cyber Science and Technology, confirms the active role of government in stimulating geospatial implementation. This means GIS, remote sensing and other forms of spatial information technology have greater role to play as the government promotes modern, information-oriented farming. The

future prospects for the development of agriculture in China are vast, and will gradually develop in a scientific manner keeping the ecological and environmental concerns in mind.

South Africa: Diversified Approach

The total amount of agricultural land in South Africa is in the order of magnitude of 100 million hectares, of which 14 million receive sufficient rainfall for arable farming. A large part of the available land is used for extensive grazing (72 million hectares) and the rest for nature conservation and forestry. As in most other BRICS countries, distinction can be made between large commercial

CropWatch for crop monitoring

CropWatch is a crop monitoring system supported by the Chinese Academy of Sciences, the National Development and Reform Commission, the Ministry of Science and Technology and others. In its 15 years of existence, CropWatch has developed into a quantitative and dynamic monitoring system. CropWatch delivers information for decision support and policy evaluation on environmental impact, biomass, cropping activities, crop condition and crop production. All this is done not only for China, but also globally. Another use of CropWatch is to monitor and mitigate disasters, such as drought and snow damage.
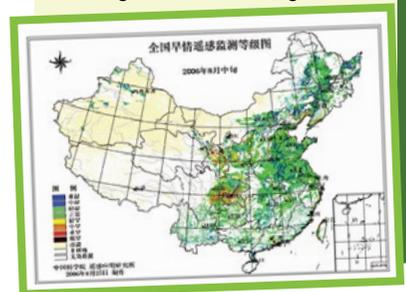
Precision agriculture has taken off well in the BRICS, especially in Brazil & Russia

farms (owning 87% of the land) and small family farms. These small farms are usually (communal) subsistence farms and the situation is an inheritance from the 'apartheid' era. Improving the low-input, labour-intensive production methods of the small farms poses a special challenge, making land reform programme an urgent need of the hour.

South Africa exports one-third of its agricultural production (amounting to 8 to 10% of total exports) and this has increased steadily over the last decade. Here too the inheritance from the 'apartheid' period plays a role: the sector had to adjust from a protected market to global market conditions. One trend, for example, is the shift from producing large quantities of cheap wine for the domestic market to high-quality wine for the international market.

It seems that productivity gains in commercial agriculture have been quite limited and are mainly caused by reducing the number of farm workers. Diversification has been the answer to threats of instability: investing in different crops and/or a geographical spread of risk by growing the same crop in different regions. Although productivity has not increased much, production has increased steadily over the past decades. There has been innovation, for example in the application of minimum tillage and the introduc-

tion of improved (genetically modified) seeds. South Africa also faces a number of infrastructural constraints, including access to electricity.

The country's agricultural policy favours innovation as a growth engine and the challenge is maintaining a balance between efficiency and equity. Apart from the land reform programme, technology transfer by entities such as the Agricultural Research Council is very important. South African farmers have always been successful in importing technology and adapting it to local circumstances. The challenges for geospatial industry are similar: the same opportunities as for the other BRICS are there, but solutions will have to be tailored to the specific characteristics of the country, which differs in nature from the other BRICS countries.

Maturity of Technology Adoption

Remote sensing and GIS have played a key role in agriculture in the all these countries in some or other capacities since the 1980s. In the initial stages, the technology helped in areas like land resource management, agricultural resources information manage-

ment, regional agricultural planning to present crop yield estimation research, regional sustainable development of agriculture, agricultural production potential research and other aspects. The current trend is the increasing interest in technology tools like GNSS, big data analytics and integration of geospatial with broader information technologies.

"Currently, traditional agriculture is developing gradually toward modern agriculture, which needs IT as technical support and foundation," says He Hui. In such a scenario, integrated solutions provide a wide range of information management tools for agricultural resources, regional agricultural zoning, agricultural land suitability evaluation, agricultural ecological environment research and so on.

Even advanced technologies like precision agriculture are rapidly picking up in the emerging nations, in particular BRICS. The focus of technology adoption is toward integration of various technologies into the operations of farms such as planting, spraying and harvesting. Examples include auto-steering with GNSS positioning and automatic shut off for individual rows of a planter or tips on a sprayer.

Michael Gomes, Director, Topcon Positioning, identifies two important developments for precision agriculture portfolio: the application of low-cost indicate-only systems and the application of fully automatic systems. Typically, the adoption begins with the lower cost 'indicate-only' systems, where the user reacts to a signal and performs manual control. The second and more advanced step is full automation of that particular aspect or operation, whether it concerns earth-moving operations or the ability to steer the tractor or agricultural vehicle for tillage or harvesting.

The technology works best on very large corporate-owned farms, referred to as 'mega-farms' (typically sizes of 20,000 to 250,000-plus hectares), especially in Brazil and Russia where tech-

nology is becoming engrained as process and operational control. Gomes is of the view that some of these farms are even far more streamlined and automated than the smaller scale farms in the more 'mature' and English-speaking markets. Economies of scale drive technology adoption and practices are being determined very differently as farms retool from a emerging economy to a first world economy of mass-scale production.

"The services add a lot of value to them and are based not only on hardware/software distribution for data collection, but on delivery of information which is unavailable or expensive when ground based data collection technologies are used," says Bolsunovsky. It concerns mainly applications of satellite monitoring, yield forecasting, assessment of vegetation phenology, study of soil characteristics.

Even in India where farm holdings are small and fragmented, precision agriculture is taking off well. For instance, sugarcane farmers are reaping the benefits of precision farming through an efficient application of crop inputs and mapping yields and crop quality, says Amit Bhardwaj of the Indian Sugar Mills Association. The technique helps measure the localised environment conditions, thus determining whether crops are growing efficiently, while identifying the nature and location of problem is any.

State regulations and initiatives are driving the adoption of automation and machine control technologies. An apt example is the enforcement of air pollution standards to lower burning of sugarcane in Brazil. While this reduces air pollution, it would also help create higher value jobs for streamlined farm operations from planting through harvest. Regulations around usage of radio frequencies for communication and import tariffs on foreign manufactured goods could be considered hurdles to streamlined adoption of those technologies. "These things, however, can vary with country, technology and crop type," adds Gomes.

An Eye on Future

There is strong evidence that there will be an increased demand for agricultural products in the coming days and production will have to grow to keep up with the demand. As in most cases, extension of the area under cultivation is not an option and huge gains in productivity are needed, which is only possible with investments in technology. Parallelly, measures will have to be taken to combat price volatility and mitigate the consequences of extreme events. Further, for most BRICS countries even a steady rise in food prices will be unacceptable, as they may lead to social unrest.

The BRICS nations should increase their investments in geospatial projects and develop new policies to improve economic opportunities and reduce hunger, underlines Simão. "Furthermore, from the technical side, it is nec-

Mapping boundaries

In South Africa, satellite images are used to estimate the area under cultivation and to map field boundaries. This information is complemented by field visits and airborne surveys. Crop development is then monitored and yields are estimated per crop and per district. A very important aspect is monitoring of the water balance. The findings of the surveys and analysis are used as decision support for government and for advice to farmers on, for example, sowing dates for maize.

essary to develop regulations, policies and procedures to support technology dissemination in these countries."

The 6th BRICS summit, to be held in Brazil in 2014, will be a key event for further development of the sector, and there are high expectations in terms of open access to data, partnerships for sustainable agricultural development, new remote sensing applications and business opportunities. "In view of globalisation of economy and trade, there is a need for a common platform among the BRICS centuries to address many common issues like impact of climate change on agriculture and food security," says Reddy. Accordingly, agriculture stakeholders and geospatial players both have an eye on the summit for exchanging the technical knowhow and strengthening cooperation in agricultural information technology. "From the technology side, the summit should focus on enhancement of agricultural technology cooperation and innovation, as well as promotion of trade and investment in agriculture," adds Simão.

The BRICS need to improve their basic agricultural information exchange system and develop a general strategy for ensuring access to food for the most vulnerable sections of the population. Besides, it is important to undertake measures to reduce the negative impact of climate change on food security.

Geospatial technology is part of the agriculture sector in the BRICS in various levels, from (mostly Web-based) national agricultural information systems and regional watershed and land management tools, to provision of weather information at the local level and precision farming. Going forward, the challenge will be to underline the importance of this technology, devise harmonised policies and increase the role of the private sector in agriculture. 🌐

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