The
ISPA Report

ISPA
International Society of Precision Agriculture

Newsletter 1, March 2012

From the President's Desk

Raj Khosla, ISPA President

Dear Precision Agriculture Community:

With great pride, I take this opportunity to welcome you to the first newsletter of the International Society of Precision Agriculture. Since the inception of our new society, ISPA in 2010, we have made progress every day. Success of any young scientific society depends upon its members, executive board leadership, and external support. I am pleased to share with you that we have accomplished a number of significant feats in these areas in a short period of time. These include but are not limited to (i) establishment of the society website www.ispag.org; (ii) establishment of online membership directory; (iii) establishment of country representative from over 25 nations; (iv) Corporate funding (>USD $25,000) in form of "founding sponsorship" of ISPA from International Plant Nutrition Institute; (v) formalizing partnership with two other major international conferences, ECPA or European Conference on Precision Agriculture and ACPA or Asian Conference on Precision Agriculture; (vi) formalizing Journal of Precision Agriculture as the society sponsored journal; and the list goes on….

It is indeed an exciting time for the young society since we are growing in numbers and the interest in membership is strong. This is also reflected in the diversity of papers submitted for the upcoming 11th International Conference on Precision Agriculture, July 15th-18th, 2012, Hyatt Regency, Indianapolis, IN. We have received over 300 scientific abstracts from nearly 50 countries around the world. The upcoming conference will also witness change in leadership as I pass the Presidential gavel on to the President-Elect, Dr. John Stafford. This would also be the time for the next executive board (President-Elect, Secretary and Treasurer) to be elected. I would encourage members of our society to step up and nominate a friend or colleague or yourself for leadership position(s) in the society. Our society needs you.

Although our formation as a society is new, our existence as a group by virtue of the ICPA conference has been around for over 20 years. I am truly privileged to be the first President of this fine group of experts, practitioners and students from world over. It has been a very interesting and rewarding experience. I continue to look forward to work with you in the coming months and year.

9th European Conference on Precision Agriculture Dates Set

Dr. Alexandre Escolà, Organizer

Dear colleagues,

It is with great pleasure that we invite you to the 9th European Conference on Precision Agriculture (ECPA) to be held in Lleida, Catalonia, Spain, under the auspices of the International Society of Precision Agriculture (ISPA) and the Universitat de Lleida (UdL). The conference will start on July 7th, 2013 and finish on July 11th. Lleida is a very important fresh fruit and wine production area in Catalonia and in Spain but Precision Fructiculture is still far from being adopted on a commercial basis. However, the Universitat de Lleida and specifically the Higher School of Agricultural and Forestry Engineering of Lleida (ETSEA), are working on developing tools for Precision Agriculture. Hosting such an important event as ECPA will surely help our region and other related areas to realize that PA is part of the future. We are grateful to the Universitat de Lleida and the International Society of Precision Agriculture (ISPA) for backing us in the organization of this event.

Precision Agriculture is as important now as when first developing in the late 80s/early 90s. ECPA conferences are a good focus in Europe and worldwide and are of a good size

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About ISPA

Our Society is very young and still developing! A prime aim is to communicate information on PA and network with fellow researchers, advisors, practitioners... after all, information is what PA is all about! Our three global conferences are designed to enable that interaction and exchange. In our first newsletter, you will find info on the two conferences held last year and details of forthcoming conferences. There are also reports on how PA is developing in 4 countries and, for a longer read, an article on the interesting area of precision crop protection.

Dr. John Stafford,
ISPA Newsletter Editor

In This Issue

Newsround

Prof Simon Blackmore set up a new National Precision Farming Centre at Harper-Adams University in the UK. The new Centre was launched in February 2012.

Prof Raj Khosla, ISPA President, has been appointed to the NASA Presidential Advisory Committee on Positioning, Navigation & Timing.

Events

7 March 2012

Precision Farming Event
East of England Showground, Peterborough, UK
http://www.farm-smart.co.uk/precision

15-17 May 2012

8th International Soil Science Congress (ISSC)
Çesme, Izmir, Turkey
http://soilcongress.ege.edu.tr

8-12 July 2012

CIGR-AgEng2012 International Conference of Agricultural Engineering, "Agriculture & Engineering for a Healthier Life"
Valencia, Spain – www.ageng2012.org

15-18 July 2012

11th International Conference on Precision Agriculture Indianapolis, USA
http://ispag.org/icpa

29 July- 1 August 2012

2012 Asabe Annual International Meeting
Dallas, Texas – www.asabemeetings.org

24-28 September 2012

19th ISTRO Conference IV SUCS Meeting
Venue: Radisson Hotel, Montevideo Uruguay
http://www.congresosrohr. com/istro2012

6-8 November 2012

The CropWorld Global Event
QE11 Conference Centre, Westminster, London, UK
http://www.cropworld-global.com/

7-11 July 2013

9th European Conference on Precision Agriculture
Lleida, Spain.
www.ecpa2013.udl.cat

16-18 July 2013

InfoAg, Springfield, IL, USA
http://www.infoag.org/

25-28 June 2013

5th Asian Conference on Precision Agriculture
Ocean Suites, Jeju, South Korea

9th European Conference *…continued from page 1*

to allow focusing on specific topics while discovering what our colleagues are working on, enabling synergies and co-operation. Moreover, 9th ECPA will keep the standard of its Proceedings by following a strict approach to paper acceptance and assessment by the members of the Scientific Committee and the Editor.

The 9th European Conference on Precision Agriculture website will provide you with all the information related to the conference as it becomes available (www.ecpa2013.udl.cat). Check the website regularly so that you do not miss any piece of news. In addition, we kindly ask you to fill in a questionnaire in order to have a better indication of possible attendance and to register your name and contact information in a database with the sole purpose of keeping you up-to-date.

Lleida is a friendly town in Catalonia, the north-east of Spain, located between Barcelona and Zaragoza. It is a very accessible town since the population is around 140,000 inhabitants and its center and surroundings can be reached on foot. Agriculture outside the town is only 5 minutes by car. We would like to welcome you at the Seu Vella (our old cathedral) on Sunday, July 7th evening to show you the views of the town from the hill where it was built while talking with your colleagues.

We encourage all of you to come to Lleida to let your colleagues and the society know about your achievements and help us in having a successful 9th European Conference on Precision Agriculture.

We are looking forward to meeting you in Lleida!

Ens veiem a Lleida!

The 8th European Conference on Precision Agriculture

Organiser, Pavel Simek, Czech University of Life Sciences

8th ECPA was held 11 - 14 July 2011 at the Czech University of Life Sciences, Prague. The conference aimed to provide researchers and professionals with the opportunity to build networks between and among different precision agriculture professionals. The conference was co-organized with the 5ECPLF, the 8th EFITA/WCCA and the 17th ISAF conferences. The conferences were officially opened at the Monday afternoon Plenary session but participants had already met informally at a welcome social on the previous evening at the Crowne Plaza Hotel.

8th ECPA included 14 parallel thematic sessions with 55 peer reviewed papers. The main topics were:

- Auto-guidance
- Sensor and sensing technology and data collection
- High resolution remote sensing
- Plant scale precision
- Field robots
- Economics
- Spatial data infrastructure
- New technologies in horticulture and viticulture

There were 400 delegates at the 4 conferences with 120 at 8th ECPA. The conference was held under the auspices of the Minister of Agriculture and the Rector of the Czech University of Life Sciences, Prague.

There were several accompanying events during the conference, including Rural Inclusion, VOA3R workshop, agriXchange and Galileo - Space Technology for Agriculture.

The Organizing Committee also put on social programs for delegates including a welcome social, a traditional Czech pork banquet and a social evening in the historic Strahov Monastery. Participants could also go on sightseeing tours of Prague, Carlsbad and Moser (glass making with museum), Central Bohemia including Konopiste Castle and Kutna Hora and Karlstejn Castles.

4th ACPA 2011 in Obihiro, Japan 4-7 July 2011

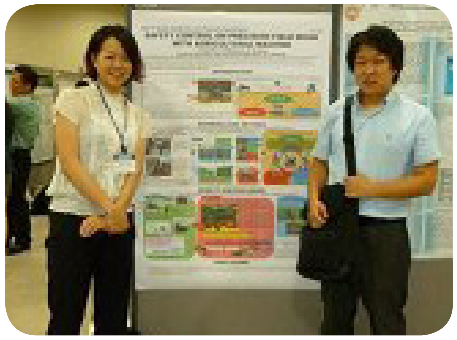
Sakae Shibusawa, Chair of 4th ACPA

The fourth Asian Conference on Precision Agriculture was held in Obihiro, Japan, July 4 - 7, 2011, with 131 attendants including 10 keynote speakers from 10 countries. The conference was city-sponsored and this time Obihiro city co-organized the conference and an international workshop on "Obihiro Food-valley Strategy with Community-based Precision Agriculture" on July 6th.

Remember that March 11th, 2011 was the day the northeast of Japan was attacked by a triple disaster; M 9.0 super earthquake, 10-m high Tsunami and Fukushima nuclear power station explosion. Twenty thousand people were killed or were missing, tens of cities and towns were flushed away along the 500 km coastline, and radioactive contamination was spread across tens of kilometres. The organizing committee were very sorry for refugees and sufferers from these disasters and also much appreciated the help and sympathy from all over the world. Under these circumstances, the 4th ACPA was held.


An un-manned helicopter with instruments was demonstrated to monitor crop growth and site-specific management in the field.

There were 56 oral presenters and 31 poster presenters. Topics of the concurrent sessions – with number of papers in brackets - were soil sensors and equipment (6), spectroscopy (6), field management (12), robot and navigation (6), irrigation (6), visualization and 3D (5) and image sensing (5). Most attendees were from China (45), followed by Japan (42), Korea (7) and Malaysia (7). The best poster award ("Safety Control on Precision Field Work with Agricultural Machine") was given to a student.


The best poster award ("Safety Control on Precision Field Work with Agricultural Machine") was given to a student.

The guest speakers at the international workshop were Mr. Norihisa Yonezawa, City Mayor, Dr. Toshihisa Kanayama, Obihiro University of Agriculture and Veterinary, Mr. Marc Vanacht, AG Business Consultants, Dr. Raj Khosla, CSU, Ir. Sari Virgawati, UPN Veteran Yogyakarta and Dr. Seiichi Saito, Hokkaido University. The City Mayor declared a food-valley strategy in 2010, aiming to activate the local economy with a new industry-complex of food and agriculture. Panelists and audience discussed some aspects of local community development.

An un-manned helicopter with instruments was demonstrated to monitor crop growth and site-specific management in the field.

Looking back, the first conference was held in City Toyohashi, Japan in 2005, the second in City Pyeongtaek, Korea in 2007,the third in Beijing, China in 2009 and the fourth was in City Obihiro. The fifth ACPA will be organized in a Korean city in 2013 and the sixth in a Chinese city in 2015.

ISPA Elected Officers 2010-2012

Raj Khosla, President

Professor of Precision Agriculture
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John Stafford, President-elect

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Plant Nutrition and Crop Management Specialist
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Country Report 1 - New Zealand

Ian Yule, NZ Centre for Precision Agriculture, Massey University. (I.J.Yule@massey.ac.nz) & Craige Mackenzie, Agri-Optics NZ Ltd, and private cropping and dairy farmer.

Precision Agriculture is continuing to develop in New Zealand in ways that are unique and reflect the interests of the country. The main areas of development have reflected the farmers' need to make things easier rather than focus solely on additional productivity if it came at the expense of additional work or complexity. The last few years have witnessed strong interest in the pastoral and livestock sectors with precision dairying now being talked about as commonly as PA in cropping. The focus for significant numbers of farmers has been in reducing environmental footprint as well as improving productivity.

Greenseeker Sensors in action against a backdrop of the Southern Alps. Photograph courtesy of Agri-Optics NZ Ltd

PA Cropping: The biggest growth area has been in autosteer and guidance. It is now common for farmers to have the majority of their tractors fitted with this equipment. Sprayer and spreader tractors are now equipped with autosteer to make life easier and application more accurate. Many of these are also now equipped with variable rate capability. The Autosteer equipment has proved to be of tremendous benefit to farmers, with savings reported at around 10 to 15% of cultivation costs through reduced overlap and even spacing, improved timeliness through higher output and longer working hours. This technology has also facilitated the development of strip tillage in some areas where erosion has been a problem in the past. Some interest has been shown in crop sensors and these have been demonstrated to be of benefit to farmers but so far there has been little commercial uptake. Professional PA service companies are starting to appear with commercial services for soil mapping, data management and so on. Although it is in its infancy, there is strong interest as one of the major barriers to adoption has been the lack of farmer confidence in data management.

PA Dairying: There has been strong interest in developing precision dairying although in reality few farmers are practicing it to its fullest extent. Pasture production is the powerhouse of New Zealand dairying and there has been strong interest in improving pasture management through better measurement (yield mapping) of pasture to provide the basis for feed allocation to dairy cows. The concept of precision dairying recognises the variability between cows as well as the spatial variability encountered on the land. One element which is emphasised is the need for measurement and planning, automatic weigh scales have been used to good effect to assist in setting target weights for cows at various stages of the season and are being used in conjunction with in-shed feeders using EID to match feed with productivity. The concept of variable rate irrigation has also received strong interest from farmers from all sectors and is now available commercially. This has been shown to save water depending on the variability of soil moisture holding capacity and the type of season encountered. Water savings of more than 20% have been made. This is also giving the ability to variably apply effluent to reduce environmental impact. Variable rate fertiliser application, using the small paddocks used for rotational grazing as the smallest unit, has been demonstrated as having considerable potential both in financial savings for the farmer and providing increased nutrient use efficiency. There are a large number of ICT tools now available to dairy farmers and, as average herd size increases, the need for automation is increasing.

PA pastoral: The pastoral industries have been struggling with low returns for the best part of a decade but recent significant improvements have encouraged farmers to look at ways of improving their utilisation of fertiliser and other inputs. New Zealand is unusual in that it is hill country and, although often steep, will respond to fertiliser inputs. This has not yet transferred through to daily life on the farm but there is great interest in precision placement of fertiliser within these landscapes. This sector has also been disadvantaged by the lack of non-invasive regular measurement of production and this has prevented a higher level of planning and management.

Country Report 2 - Germany

Hans W. Griepentrog, MSc, PhD, Professor, University of Hohenheim, Germany

Currently there is a lot of movement in the precision farming area. High labour costs in recent years have encouraged larger, wider and faster machinery for cost efficient production. But bigger machines are being flanked by developments aiming to increase efficiency per machine unit. This relates to productivity and optimizing the use of farm inputs, as well as to energy consumption. The latest innovations in this development feature sensing and machinery control systems. New sensors record changing growth conditions of crops more sensitively and accurately. Hi-tech machinery and sub-systems adjust automatically and rapidly to changing operation conditions.

Machinery manufacturers are actively pushing the ISOBUS standard. They realised that "island solutions" were not going to help anyone any longer. If data do not correspond to the ISOBUS format, this makes use of the machinery and equipment more difficult.

Site-specific applications are still dominated by operations like liming and sensor-based fertilisation. These systems generally cover biomass and chlorophyll density. Alongside sensors for recording crop properties, equipment for recording and describing soil physical and chemical properties should be increased in the future.

Increases in capacity with wider working widths have led to small-scale structures within the working width no longer being workable. Especially when tramlines no longer run at right angles to the headland, excessive dosing or failure to apply agents on partial areas can occur. Here, precise positioning systems have rectified the situation by automatically switching boom sections on and off and thus avoiding incorrect doses.

Optical sensors such as cameras can lead to essential relieving of the operator's workload with field choppers and harvest removal trailers. Optical identification and location of windrows can be used for automatic steering of forage choppers, while recognition of trailer dimensions and filling levels serves to control the position of the ejector manifold and flap. Camera systems on the exterior are difficult to realize due to changing light conditions and high computing performance required in real time. This system represents a new quality in machine controls. It helps to minimize harvest losses and relieve the workload significantly for operators of choppers and tractors.

Automatic steering systems are a commercial success. As they minimize areas of overlap, they save fuel and time and relieve the burden on the driver. Moreover, with these systems, it is possible to select completely free track guidance or have it optimized by a computer. This reduces turning times and routes.

Currently many farmers in Germany are reviewing precision farming in term of site-specific treatments with slightly more reservations. Often, machinery manufacturers simply promised too much, too fast. Or farmers with the new technology find themselves drowning in a flood of data without knowing how to apply it. Many have been overwhelmed by the new technologies. And mostly they haven't helped much as decision aids either. Decisions in plant cultivation are based essentially on space-related and time-specific information. Methods using single information systems are not well accepted and will hopefully be increasingly replaced in future by more automated knowledge-based systems that are distinctly easier to use. A variety of sensor techniques as well as all available on-farm information must be made usable for a system in order to allow individual, prompt and efficient decision-making aids. So far, techniques have not been able to fully exploit this potential.

Country Report 3 - Brazil

Jose Molin, University of Sao Paulo

It all started around 1995 when combines equipped with yield monitors were first presented to Brazilian farmers. Almost at the same time, the University of São Paulo started some academic discussions and research dedicated to precision agriculture (PA) practices. In the beginning, activities were related to grain crops (maize and soybeans). Later on, business and research related to PA moved to some of the tropical and highly important crops like coffee, orange and sugarcane.

We have almost 50 Mha of annual crops and more than 55% of that is under no-till. We also have about 9 Mha of sugarcane, 1 Mha of citrus, 2.5 Mha of coffee, 1.4 Mha of cotton, 4.6 Mha of eucalyptus, over 200 Mha of pasture, among others. Especially on annual crops and sugarcane, PA has been related to grid soil sampling followed by variable rate lime and fertilizers and the use of auto steering in tractors and harvesters. Grid soil sampling has been applied at densities of one sample per 2 to 5 ha, and data provided by composite soil samples. Under tropical conditions, we have a high demand for lime and it is still the most important input for variable rate applications.

The use of auto steering significantly improves parallel alignment of planting rows on sugarcane or grains. This device also facilitates other crop management procedures such as the regular and non-overlapped application of fertilisers and

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other inputs with sprayers and other devices, facilitating the work of machine operators. In addition, the autopilot allows the harvester to cut the sugarcane rows precisely, following crop mapping from planting for several years on the same tracks. This device significantly facilitates harvesting operations.

Studies have shown that on sugarcane, for example, at least one third of the mills are involved with grid soil sampling prior to planting (once every five years) and more than 40% of those are already using auto steering on agricultural vehicles, and some of them have the whole fleet equipped and the equipment are predominantly running with GNSS RTK. On the grain areas, the use of yield maps is evolving gradually but less than expected. The main reason is related to the lack of knowledge of farmers, consultants and dealers on how to deal with cleaning up row data and making good use of those maps.

Recently some of the new PA approaches have been practiced, like the use of variable rate insecticides and herbicides, the use of active optical sensors for nitrogen management, especially on sugarcane, small grains and corn, and the use of images from satellites, airplanes and UAV.

Every two years since 2004, we have had our local Conference on Precision Agriculture, and it has been a successful meeting that involves people from academia, industry, dealers, consultants and farmers.

Country Report 4 - Canada

Nicholas Tremblay & Guy Lafond, Agriculture and Agri-food Canada

The Canadian context

Canada is the second largest country in the world and it is characterized by a great diversity of soils and weather conditions. It has 3.2 % of the global arable land base. The Canadian Prairies account for 87% of the cultivated area in Canada. The Canadian Soil Information Service (http://res.agr.ca/cansis/) is responsible for the National Soil DataBase, an archive of soil and land resource information in Canada. Information on the types of soils and the Canadian System of Soil Classification is available here: http://sis.agr.gc.ca/cansis/references/1998sc_a.html

Canadian agricultural landscape is mostly located close to the USA border. The great variability of soils and weather conditions make it suitable for precision agriculture.

Crops which are particularly amenable to precision applications in Canada are corn, potato and vegetables because they are intensively farmed and usually grown in environmentally sensitive areas. Spring cereals, pulse crops and canola are grown mainly on the Canadian Prairies in a more extensive manner but are also amenable to precision applications because large spatial variability is observed in fields.

In general, the country is home to considerable spatial variability and data availability, and is hence well suited for precision farming applications. However, due to its low population density and its good access to potable surface water, Canada is relatively less at risk from water contamination issues than other parts of the world. For historic reasons, many fields in the eastern provinces were surveyed into long narrow strips which require pixel sizes less than 30 x 30 m for most precision agriculture applications. In the western provinces, the fields were surveyed as large square sections of 1.61 km x 1.61 km making these fields more suitable for coarser satellite sensors to be useful.

Research, extension and implementation

Current investigations in precision agriculture in Canada tend to address mainly the spatially variable application of fertilizers (mainly N) based on crop remote observation and soil properties. More recently efforts have been directed towards real-time optical sensors that are more able to take into consideration temporal variability. The characterization of management zones and their subsequent use as a base for adjustments of inputs is also given much attention.

Universities with precision agriculture elements in their programs are mainly: University of Guelph in Ontario (http://www.uoguelph.ca/), and Université Laval (http://www2.ulaval.ca/en/home.html) and McGill University (http://www.mcgill.ca/macdonald/) both located in the province of Quebec. At the governmental level, Agriculture and Agri-Food Canada (http://www.agr.gc.ca/index_e.php) is involved in Precision Agriculture research together with partners from academia, private industry and provincial agricultural departments. The Canadian Space Agency (CSA) also helps funding research projects in precision agriculture (http://www.asc-csa.gc.ca/eng/newsletters/eo_express/2011/0913.asp). The CSA is behind the RADARSAT-2 programme (http://www.asc-csa.gc.ca/eng/satellites/radarsat2/applications.asp#agriculture) featuring a Synthetic Aperture Radar (SAR) sensor that can provide information on crop structure and moisture content, even in the presence of clouds.

Governmental and private bodies are involved in precision agriculture knowledge diffusion. Many provincial extension services (when they still exist) have

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gradually given way to private consulting. These have often looked at precision farming strategies as an opportunity to expand their knowledge-based service offers. Suppliers of inputs also offer precision agriculture technologies or services as a way to secure business with clients in a highly competitive environment. An example of private service offer in the French-speaking province of Quebec can be seen here: http://www.lacoop.coop/cooperateur/articles/2011/07/p36.asp

Examples of major services in Western Canada include Farmers Edge (www.farmersedge.ca) or Echelon: The next level of Agricultural Solutions (www.echelonag.ca) or AGRI-TREND (www.agritrend.com).

The Canadian company Geonics (http://www.geonics.com/index.html) is well known for being the manufacturer of the EM38, a recognized standard for the characterization of soil sub-surface properties within the global agricultural community.

Auto-steering has been widely deployed over recent years in Canada with a high level of adoption. Sectional controls on sprayers and seeders as well as yield monitoring is quite common, while variable rate applications of nutrients is only sparsely used. Yield maps or satellite imagery are also used to diagnose problems areas in fields where improvements would be warranted. Soil maps are generally not available at a scale detailed enough for precision applications. Electro-magnetic induction sensors are used to derive soil surface textural properties. On-board crop sensing is still in its infancy.

Canada is well positioned to value the many opportunities that precision agriculture has to offer. Its dynamic agronomic research sector is translating new knowledge into best management practices many of which now rely on GPS, sensors and other sophisticated PA-related technologies. The country is vast. Its agriculture is productive and central to the economy in many parts. Challenges are also there: loss of productive soils to urbanization, highly competitive production environment in a changing climatic context. As the former Canadian astronaut Steve MacLean who flew over the earth in the International Space Station said in September 2011, "Precision farming is likely one of the most important opportunities for progress that are available to Canada right now..."

Precision Crop Protection

Erich-Christian Oerke,

Dr Oerke leads a group at the Institute of Crop Science and Conservation, University of Bonn, researching the application of the precision agriculture concept to crop protection. He has been responsible for several biennial precision crop protection conferences.

CONCEPT

The occurrence of many pests – weeds, arthropod pests, nematodes, and viruses, bacteria, and fungi causing plant diseases – in crops is reported to be heterogeneous, at least at some growth stages of the crop / early stages in epidemic development of the pest. The control of these pests often is necessary in order to avoid economic losses; however, it may be restricted to areas and times where and when the pests actually occur. Awareness of potential negative side-effects of agricultural practices on the environment has been a major driver for the concept of precision crop protection.

Site-specific management is doing the right thing, at the right place, at the right time. Spatial and temporal variability of pests on the field level is no longer ignored, but used in a systematic approach that minimizes the amount of pesticide applied by stipulating demand-oriented application without reducing the efficiency of crop protection and crop productivity. Information on soil status and crop growth from maps and online sensing is typically used in combination with GNSS data in order to optimize the control of weeds, animal pests and diseases of crops to match natural heterogeneity in the field.

Information technology is used to tailor crop protection activities to achieve effective control when and where needed by monitoring the crop using DSS for site-specific decision making and by controlling the actuators during application of control options (Fig. 1). Decision support systems are based on algorithms that simulate crop growth, the epidemic spread of pests in space and time, and the final yield loss of the crop to be prevented by suitable control measures. Information from various spatial scales – plant, canopy or growing region – may be used to assess the variability of crop status.

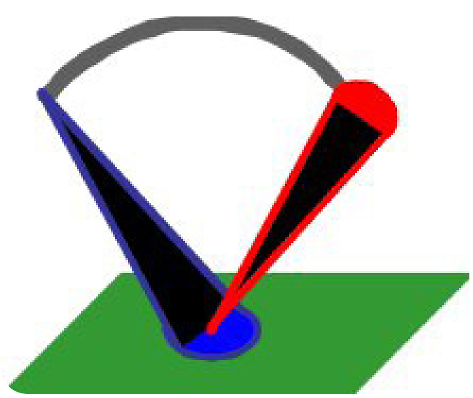

Fig. 1 Precision crop protection: large-scale monitoring for pests and site-specific management linked by data management.

Site-specific demand has to be assessed by detailed recording of spatial distribution and development of pests and the evaluation of their potential economic impact on crop yield. This situation-specific, threshold-oriented and environmental friendly form of pest management requires large-scale and geo-referenced monitoring of pests in the crop for precise timing and application of control measures. In addition to high capacities in data processing and exact regulation of actuators, innovative sensors are crucial for site-specific management (SSM) as they generate the input information needed for decision making.

Sensing of heterogeneities in the field is the prerequisite for timely and spatially adjusted management (Fig. 2). Sensors may be space-borne (satellite), air-borne (airplane, unmanned aerial vehicle) or ground-based (handheld, vehicle-mounted) and provide spatial information that has added value to conventional methods of soil and crop monitoring. The detection of within-field differences in crop status or growth conditions enables farmers to streamline input factors thereby optimizing profit margins, while simultaneously improving the overall stability of agro-ecosystems.

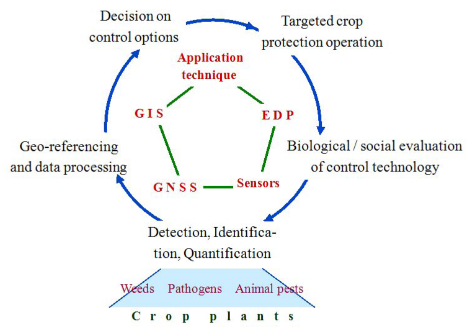

Fig. 2 The components of precision crop protection.

At the University of Bonn, Germany, the inter-disciplinary Research Training Group 722, financially supported by the German Research Foundation (DFG) has worked on sensor-based approaches for the control of weeds and pathogens in wheat and sugar beet as model systems. Research topics have covered three sub-areas, (I) detection (and identification) of pests using near-range and remote sensing technologies; (II) dynamics of and interactions among pests, and long-term effects of precision crop protection; and (III) sensor-regulated pest control activities.

SENSING OF WEEDS AND DISEASES

Site-specific and accurate control of pests is based on spatially explicit information on the within-field heterogeneity of weeds and diseases. The pest groups to be monitored for precision crop protection differ greatly in size, patterns of incidence and epidemic spread within and between growth periods of crops. Heterogeneity of weeds is often obvious and applications for site-specific control of weeds by targeted mechanical or chemical control have reached an advanced stage (Table 1). In contrast, the detection, identification and quantification of plant diseases which are highly variable in space and time, is still in developmental stages.

Table 1 Status of the control of various pest groups using precision crop protection technologies.

Trait	Weeds	Nematodes	Insects	Pathogens
Size of organism [mm]	10 – 1000	0.1 – 1	0.1 - 100	0.0001 – 1
Cycles per season	1	1 – 5	1 – 8 (?)	1 – 9 (?)
Mobility	Very low	Low	Low to high	High
Field heterogeneity	XX(X)	XX (X)	X(X)	X(-)
Detection	Individuals XX	Disease sympt. X(X)	Individuals, sympt. (X)	Disease sympt. (X)
Identification	XX	-	?	?
Quantification	XX	(X)	(X)	(X)
Prognosis / DSS	X(X)	X (X)		(X)
Data management	Off-/on-line	Off-line		
Application technique	XX(X)	X	(X)	(?)

XX advanced stage; X first steps / moderate knowledge; ? not known / not feasible; - knowledge low

Weed control

Commonly the distribution of weed populations within agricultural fields is heterogeneous in time and space. They often occur in patches of varying size or in stripes along the direction of cultivation. Large within-field variation in weed occurrence allows for threshold-based patch spraying which reduces treatment costs as well as herbicidal loading to the environment. Powerful sensor techniques for automatic and continuous determination of within-field variation in weed density are the basis for site-specific weed management in various crops including grassland. Systems include online weed detection using image analysis and weed species classification, computer-based decision making and GNSS-controlled patch spraying. Currently online systems for the detection and –chemical or mechanical - control of weeds in a single field path are under development.

Long-term investigations on the effect of site-specific control on epidemic spread of annual and perennial weeds in crop rotations over a period of several years will result in establishing action thresholds for major weed species in site-specific weed control systems.

SOIL CHARACTERISTICS AND INCIDENCE OF PESTS

The variability of soil characteristics affects the incidence of pests as well as the efficacy and fate of pesticides on the field level. High-resolution soil information from optimized minimal and non-invasive sensor techniques may be successfully implemented into crop protection decisions. Information on soil organic carbon content and soil texture measured by different infrared sensors and apparent electrical conductivity (ECa), respectively, may be used for the prediction of and sampling for nematodes. Similarly, patchiness of weed species proved to be closely linked to soil properties measured by sensors.

Diseases

Remote sensing (from airborne sensors) has the potential to detect and quantify disease in crops; however, suitability depends on spatial, temporal and spectral resolution of multi-spectral and hyperspectral data. Relevant spectral ranges and areas of redundant data can be identified and the reliability of extracted information may be increased by data reduction. Hyperspectral imaging has a huge potential but it requires advanced and innovative methods of image analysis. Diseased plants have a disease-specific spectral signature that may be recorded with non-imaging as well as with imaging sensor systems (Fig. 3). Spectral information of crops delivers a large amount of information which may be used for the analysis of the causal agent as well as for the severity of the deviation from the status 'healthy'.

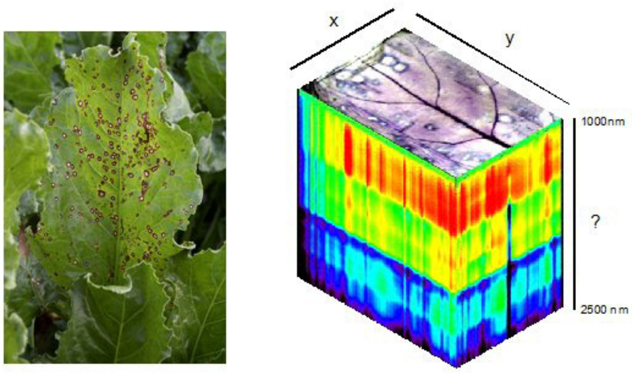

Fig. 3 Hyperspectral signature of Cercospora leaf spot of sugar beet; non-imaging spectrometry and hyperspectral imaging.

In addition to spectral information, spatial information from imaging sensors may give additional information useful for the differentiation of diseases in space and time. Image analysis has a high potential for the identification of disease symptoms and the combination of spectral signatures and spatial patterns are promising to optimize disease detection by technical sensors.

Various fluorescence techniques - PAM, laser-induced chlorophyll fluorescence, laser-induced fluorescence with spectral and temporal resolution – are being investigated for the identification of specific stress situations in early stages as well as the differentiation between biotic and abiotic stresses.

Digital thermography has been used to detect leaf diseases as well as to record leaf wetness of plants, an important environmental factor influencing the risk of pathogen infections. Leaf temperature is highly sensitive to major diseases and may be used for the detection of diseases, some even before the appearance of visible symptoms (Fig. 4). The method, however, largely lacks diagnostic potential for disease identification. Nevertheless, airborne thermal images of fields at various growth stages may be used for the delineation of management zones based on soil conditions and crop biomass (Fig. 5).

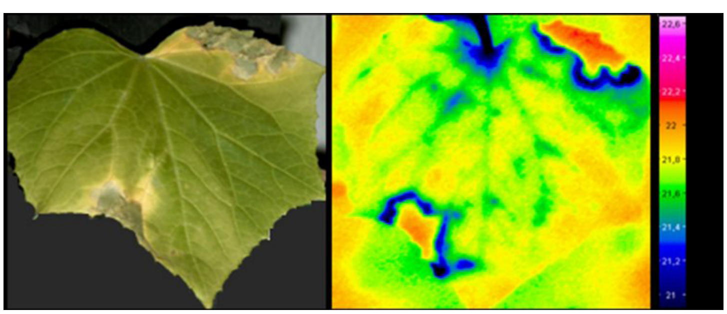

Fig. 4 Effect of downy mildew on transpiration of cucumber leaf measured by digital infrared thermography (EC Oerke et al. 2006, Journal of Experimental Botany 57: 2112-2132).

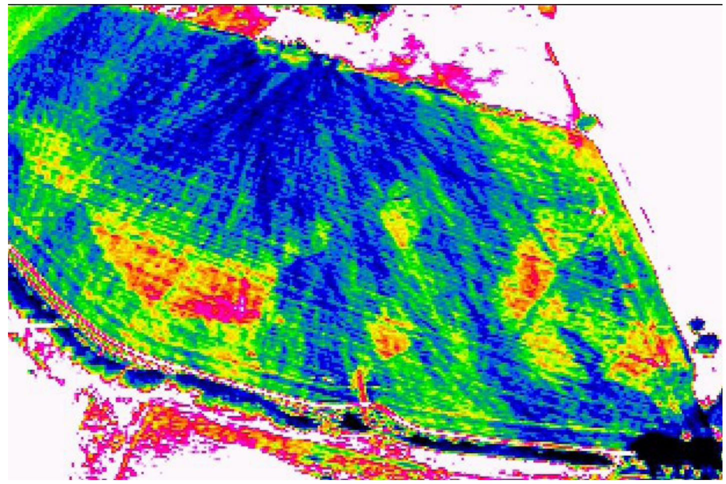

Fig. 5 Within-field heterogeneity in canopy temperature of wheat at growth stage 63 (JH Lenthe et al. 2007, Precision Agriculture 8: 15-26).

SENSOR-REGULATED APPLICATION TECHNOLOGIES

The detection and identification of weeds by sensors has enlarged the potential tools for weed control, because direct-injection systems for spray-application of herbicides have become interesting as alternatives for uniform applications. For the site-specific application of pesticides and mechanical weed control, map-based (offline) and real-time (online) approaches are under investigation. Application maps for off-line systems are produced based on interpolated maps of weed distribution and economic weed thresholds. Application maps for three different herbicides may be realised simultaneously using a multiple sprayer with three hydraulic circuits.

In a different approach, herbicides and carrier are kept separate on the sprayer. According to the information from the weed sensing systems, the herbicides are metered into the carrier and mixed immediately before entering the nozzles. Currently the use of direct injection systems is limited by the lag time, i.e., the time it takes for the mixed solution to flow from the injection point to the spray nozzles and inadequate mixing of herbicides and carrier in the nozzles due to varying physical properties of herbicides.

Mechanical weed control may be an alternative to chemical control. Guidance and control of hoeing tools have been demonstrated to be useful for inter-row as well as intra-row weed control in row crops. Weed harrowing may be adjusted to heterogeneities in weed density as well as soil properties using sensors for the detection of weeds and soil resistance. Scientists are still looking for alternative methods of site-specific weed control, e.g. use of lasers, mono-droplets for pesticide application and their potential for environmentally friendly pest control.

ISPA Officer Nominations and Elections

Nominations for the next executive board of ISPA are currently open. The elections will take place at the 11th International Conference on Precision Agriculture.

The ISPA is a non-profit professional scientific organization with the mission to advance the science and practice of precision agriculture globally. It is governed by an international Board of Directors consisting of elected officers (President, President-Elect, Immediate Past-President, Secretary and Treasurer). In addition, ISPA has a part-time paid position of an Executive Director who provides administrative management and support to the society activities.

The ISPA nomination committee is currently requesting nominations for the following offices:

1. President Elect – (Two year appointment) to serve from Jan 2013 to Dec 2014, and then move up to President for Jan 2015 to Dec 2016 and then Immediate Past-President.
2. Secretary – (Two year appointment) to serve from Jan 2013 to Dec 2014
3. Treasurer – (Four year appointment) to serve from Jan 2013 to Dec 2016

When it comes time to solicit nominations for the above elected positions, please feel free to nominate yourself! This is perfectly acceptable! The name of all nominators will be kept confidential.

Please forward nominations to nominations@ispag.org.

11th International Conference on

Precision Agriculture

JULY 15-18, 2012 • **Hyatt Regency** Indianapolis, Indiana USA

The 11the International Conference on Precision Agriculture is fast approaching, find below is important information related to the conference:

I. Awards, Awards, Awards (Deadline Monday April 2nd, 2012): Nominations for several awards in different categories will close on Monday April 2nd, 2012. Brief descriptions of the awards are listed below:

Graduate Student Award(s): Approximately 10 awards will be made to graduate students presenting their research work (oral or poster paper) at the 12th ICPA conference. The award will consist of waived conference registration fees and US$500 cash award. The selected candidates will be honored during the conference.

Pierre C. Robert Precision Agriculture Award(s): The Pierre C. Robert Precision Agriculture Award honors individuals who have made significant contributions to precision science and technology. Two awards will be given in this category to a Young and Senior Scientist/ Professional.

Complete details of the awards and submission procedure with requirements are available online at www.ispag.org.

II. Early bird Registration for the conference is available. Conference registration fees are as follows:

- $650 Full Conference Registration for ISPA members (including up to 2yrs of ISPA membership)
- $750 Full Conference Registration for non-members
- $350 Student Registration
- $350 Precision A to Z for Practitioners registration

Full conference registration includes access to all plenary and breakout sessions, exhibit hall, and poster session; Sunday evening reception, Luncheon on Monday and Tuesday and all breaks; a proceedings CD, conference program, and conference portfolio bag.

III. Make Hotel Room Reservations Early:
The conference will be held at the Hyatt Regency, Indianapolis, Indiana USA. Please make your reservations early to secure a room at the discounted conference rate of $129.00/night plus tax. The cutoff date for the conference room block and special rate is June 20, 2012, but rooms may sell out sooner. See the http://www.ispag.org/icpa/HotelTravel/ for more details.