

# WCCA 2009 - Abstracts

June 22- 24, 2009, Reno, USA

**Keynote: Food Quality, Carbon Footprint, or Fair Trade: The Global IT Challenge**  
Dr. Gerhard Schiefer, Germany

## Control, Data Acquisition, Monitoring and Sensing

### **An Online Humidity Transducer Based on Near-infrared Radiation**

*Diogo K. Takayama , José A. de França, Dari O. Toginho Filho , Maria B. de Moraes França, and Marcelo G. Canteri, Brazil*

In various sectors, humidity measurement is a crucial task, for instance in the food industry, grain processing/crushing, sugar plants, etc. The conventional humidity measurement method requires a lab sample analysis. This is a destructive, expensive and slow process. Besides, as raw material humidity may vary considerably during the day, many measurements are required throughout the period. On the other hand, with an online humidity measurement process, the water amount is known instantly, without physical contact with the sample. Thus, the production process control can be carried out without losses, with maximum profit and quality. In this work, a humidity transducer based on near-infrared radiation is presented. During its development, the main project focus was cost reduction. Due to this, LEDs were used for producing infrared radiation. This has eliminated typical problems in conventional online measurement tools, such as reduced useful life and too many moving parts which may complicate equipment installation in vibrating places. Through the inclusion of a temperature control system, problems with ambient temperature variation were solved. The equipment was tested on a laboratory, measuring coffee powder humidity. However, the system can be easily adapted to measure humidity on a variety of other substances. Our tests indicate that the proposed transducer has a high sensitivity and robustness to temperature variations and external radiation sources (solar and incandescent light, etc.) Besides, the measured equipment uncertainty is in the order of 0.2 %.

### **Anemometer 3D Based on Ultrasound**

*Marcela H. Koyama, Rodger V. Pereira, Tiago P. da Silva, José A. de França, Marcelo G. Canteri, and Dari O. Toginho Filho, Brazil*

The environmental variables influence in the development of plants and animals. One of these variables is the wind, which can be responsible to change the growing of plants and spread diseases. Therefore, the measure of wind speed is necessary to agriculture. Usually, such measuring is done by use of anemometers working with wind cocks which work in only two dimensions, measuring the wind speed and direction by a mechanical system. One disadvantage of this approach is the existence of mobile parts which does not render accurate speed measures, due to air friction and equipment inertia. In this work, an ultrasonic anemometer which measures the direction and speed of the air in three dimensions is presented. Such anemometer use only four piezoelectric sensors arranged in two orthogonal axes non-competitors. So that, joining together the points of each sensor it was get a structure in the form of a regular tetrahedron. The wind speed in three directions can be measured inferring the necessary time (transit time) so that a pulse of ultrasound, sent for one of the sensors, reaches the others three. Moreover, the tetrahedron-shaped structure allows to measure in four different coordinate systems. This adds redundancy to the system so that a better precision in the measures can be achieved. This measurement is performed by a microcontroller and is done to make the system immune to variations of temperature and air humidity. The microcontroller is also responsible for storage of data and later sending them to a microcomputer.

### **System of Microstations of Data Acquisition for Wireless Monitoring of the Microclimate in Crop Areas**

*José A. de França, Edson L. Burgo Júnior, Marcela H. Koyama, Rodger V. Pereira, Marcelo G. Canteri , and Maria B. de Moraes França, Brazil*

The weather is a key factor for outbreaks of plant diseases. Therefore, the monitoring of climate is essential to any intelligent system of cultivation. Usually, such monitoring is

carried through agrometeorological stations that acquire data like temperature, humidity, wind speed and leaf wetness. Unfortunately, the high cost of stations limits the number of monitoring points within the same area. This forces the use of tools of mathematical interpolation. However, such procedure does not lead to good results in the estimation of precipitation and leaf wetness. In this work was developed a monitoring system, composed for a set of microstations of data acquisition. They presented low cost and highest autonomy. Therefore, they can be installed throughout the area of cultivation, collecting data like temperature and leaf wetness. The microstations communicate with each other through wireless communication. Thus, daily, the data collected are transferred to a central station, where become available for analysis. The system made it possible to monitor the entire area of cultivation, providing reliable data, which make it possible to characterize the microclimate. This makes it possible to, for example, the efficient use of pesticides, reducing production costs and generating healthy foods.

#### **Developing a Wireless Infrared Thermometer with a Narrow Field of View**

*Susan A. O'Shaughnessy, Martin A. Hebel, and Steven R. Evett, USA*

Historically, wired infrared thermometers have been used in a variety of agricultural applications. These wired sensors can be expensive and are cumbersome to install and impractical at the commercial level. In this study, we built two prototype narrow field of view ( $10^\circ$ ) wireless infrared sensor modules (denoted  $\alpha$ , and  $\beta$ ) using two different manufactured thermopiles, both self-compensating, and compared their readings against a black body surface in a temperature controlled chamber at different ambient temperatures of  $20^\circ\text{C}$ ,  $25^\circ\text{C}$ ,  $30^\circ\text{C}$ , and  $40^\circ\text{C}$ . Additional tests were performed to investigate the amount of thermal mass required for sensor body temperature stabilization with the thermopiles exposed to direct radiation to intentionally cause sensor heating: (1) with no housing protection; (2) while embedded in an aluminum socket and enclosed inside of a white polyvinyl chloride (PVC) plastic sleeve; and (3) enclosed only in the plastic sleeve. Sensor readings with the detectors located inside the plastic sleeve provided ample reduction in heat transfer imposed by direct radiation. Embedding the detector inside an aluminum socket did not provide any additional temperature stabilization. The two prototype sensors were compared with measurements taken with a commercial handheld IRT over samples of vegetation and soil in a greenhouse environment. The RMSE for the corresponding calibrated measurements against a black body calibrator and soil and vegetation samples were  $0.12^\circ\text{C}$  and  $0.77^\circ\text{C}$  for sensor module  $\alpha$ , and  $0.15^\circ\text{C}$  and  $12^\circ\text{C}$  for sensor module  $\beta$ , respectively. Further testing and evaluation of

these prototype sensors in a field application is recommended.

#### **Evaluation of Sensor Readability and Thermal Relevance for RFID Temperature Tracking**

*C. Amador, and J.P. Emond, USA*

Radio frequency identification (RFID) offers a way to satisfy the current need of the produce industry for product identification and cool chain preservation. Its application in cold chain monitoring has been studied and results have shown that RFID temperature tags have a superior performance than traditional temperature monitoring devices. The main challenges for RFID temperature tracking in produce are the produce's high water content, which will affect the readability of the RFID systems and restrict the possibilities of sensor placement, and the cost of the tags, which will promote the minimization of the number of sensors being used. Therefore, the relevance of the temperatures recorded in them and the readability of the tags in these positions inside high water content loads are required to be studied. The objectives of this research were to find the temperature distribution inside a pallet of bottled water mimicking produce when subjected to heating and cooling conditions similar to the loading-unloading process, to identify a location able to represent 85% of the temperatures present on it; and to determine the level of readability of a commercially available RFID battery assisted passive tag in this thermally relevant position. Temperature differentials were found quite significant at the pallet level (up to  $30^\circ\text{C}$ ) and sometimes also at the primary package level. It was impossible to determine a single spot representing 85% of the temperatures in the pallet consequently; it is suggested to use a location with a temperature that will be the middle point of an interval that gathers the temperature readings of approximately 85% of the measured locations. In addition, results indicate that tag readability in this position varies depending on the configuration of the side of the pallet facing the antennas and the amount of air in the surroundings of the RFID tag.

#### **Low Cost Technology Applied to Thermometry of Grains**

*Marcelo Ferrasa, Marco Antonio Martin Biaggioni, and Marcelo Giovaneti Canteri, Brazil*

Modern agriculture demands investments in technology that allows the farmers to improve productivity and quality of their products, aiming to establish themselves in a competitive market. However, the high costs of acquiring and maintaining such technology may be an inhibiting factor to its spread and acceptance, mainly to a large number of small grain Brazilian farmers, who need low cost innovative technological solutions, suitable for their financial reality. Starting from this premise, this paper presents the

development of a low cost prototype for monitoring the temperature and humidity of grains stored in silos, and the economic implications of cost/benefit ratio of innovative applications of low cost technology in the process of thermometry of grains. The prototype was made of two electronic units, one for acquisition and another one for data reception, as well as software, which offered the farmers more precise information for the control of aeration. The data communication between the electronic units and the software was reliable and both were developed using low cost electronic components and free software tools. The developed system was considered as potentially viable to small grain Brazilian farmers; it can be used in any type of small silos. It provided reduction of costs of installation and maintenance and also offered an easy expansion system; besides the low cost of development when compared to similar products available in the Brazilian market.

#### **Automatic Monitoring of Turkeys: A Vision-Based Approach to Detect and Analyse the Behaviour of Turkeys in Transport Cages Based on Ellipse Fitting**

*Ahmad Poursaberi, Anette Wichman, Claudia Bahr, Laura Hänninen, Matti Pastell, and Daniel Berckmans, Belgium*

The aim in this project was to develop a tool which can reliably automatically score different behaviours performed by turkeys confined in cages of different heights. These behaviors may, after some further evaluation, be used as an assessment of welfare during transport. Eighteen weeks old male turkeys in two different cages with heights of 40 cm (low cage) and 90 cm (high cage) were followed. In the low cage the height was too low for the bird to assume a standing position whereas in the high cage the bird could stand in a normal position and had more opportunities to perform different behaviours like standing and turning. A camera captured videos simultaneously of one turkey in a low and high cage respectively. The four behaviours turning, lying, standing and wing flapping were chosen to represent different behaviours for welfare assessment. An algorithm based on image analysis was developed to classify the behaviour in real time and automatically. A coarse estimation of the bird was obtained through its colour filtering and shape properties. By using image enhancement and binarization techniques, a binary image is produced from each cage. Morphological operators were used to conclude if the cage was empty or not. Then, according to the binary image the boundary of the bird and the parameters of the best fitted ellipse are extracted. To speed up the procedure of finding the turkey the next time with the previous ellipse

parameters, the search area was limited in order to update the new position. According to the ellipse parameters in each frame the four behaviours were categorized. Since the distinction between lying and standing postures from single top-view image is difficult and not accurate with ellipse fitting techniques further solutions are tested based on area and functional shape descriptor of the bird. In comparison with the manually labelled reference frame by frame, the algorithm applied on 60 hours video resulted in 100% correct classification of turning, 94% wing flapping, 83% of lying and 71% of standing behaviors.

#### **Synchronized Recording of Pressure Distribution and Posture for Automatic Lameness Detection in Dairy Cattle** *Arno Pluk, Claudia Bahr, Ahmad Poursaberi, Willem Maertens, Annelies Van Nuffel, Jurgen Vangeyte, Bart Sonck, and Daniel Berckmans, Belgium*

Lameness, an increasing animal welfare problem, has a negative impact on milk production, body condition and reproductive performance in dairy cows. This paper describes a synchronized system which might be useful for automatic lameness detection in dairy cattle. The system consists of a pressure sensitive mat, two cameras and a separation fence. The pressure mat measures the pressure distribution over time for each hoof of the cow. The cameras record the posture and movements of the cow. The separation fence ensures that there is only one cow passing the corridor with the synchronized system. When a cow passes the separation fence the recording of the pressure mat is started. The mat sends a synchronization signal to the camera system, which automatically triggers the cameras to start recording. When there is no activity on the pressure mat for some time, a signal is sent again to the camera system which stops the recording of the cameras. The recordings of the pressure mat and the cameras are saved together with (relative) timestamps so they can be combined afterwards. The setup of this system provides synchronized data on the pressure distribution under the hoof of the cow in combination with images of the posture and movement of the cow at the same moment in time. When combined in MatLab the information can be used for automatic lameness detection. Experiments with this system were performed on ILVO farm in Ghent Belgium in October 2008. The system recorded postures, movements and pressure distributions of 66 lactating Holstein cows while passing the corridor after milking. The pressure mat was recording at a rate of 60 frames per second, where the cameras were working at 20 frames per second on average. The average synchronization error between the

pressure mat and the camera was less than 16 ms tested on 30 recordings. It is assumed that synchronized data of pressure distribution and posture of cows increases the potential for early online and automatic lameness detection.

### **Estimating Broiler Breeder Welfare Using Image Analysis**

*Irenilza A. Naas, Marcus Laganá, and Mario Mollo Neto, Brazil*

The research proposes a methodology for estimating broiler breeder thermal welfare. Bird's behavioral responses are known as an important indication of well-being. The continuous video recording of a flock analyzed may offer interesting evidences of thermal comfort as well as other indications of welfare, and automation of the analyzing process is vital for getting knowledge, as a person watching the video and recording specific behaviors may induce to certain degree of error. An algorithm for classifying specific broiler breeder behavior was developed. Videos were recorded over three boxes where 30 breeder were reared. The boxes were mounted inside an environmental chamber where ambient temperature varied from cold to hot. Digital images were processed based on the number of pixels, according to their light intensity variation and binary contrast allowing a sequence of behaviors related to welfare. The system used the default of x, y coordinates, where x represents the horizontal distance from the top left of the work area to the point P, and y is the vertical distance. The video image was observed and a grid was developed for identifying the area the birds stayed. The sequence was analyzed frame by frame confronting the data with specific adopted thermal neutral rearing standards. The grid mask overlapped the real bird image. The resulting image after the analysis allows the visualization of cluster, as birds in flock behave in certain patterns.

### **PlayStation3 vs Pentium PC for Optical Fruit Calibration**

*Nicolás Narria and Per Bj. Bro, Chile*

The objective of this research is to compare two different computing systems for processing images on an optical cherry sorting line. The justification for interest in this topic is that optical cherry sorting is a computationally intensive task limited in many circumstances by the power of the image processor. A standard Dual Core Duo Pentium PC is compared with a PlayStation 3 (PS3). The PS3 is based on the CellBE, a heterogeneous multi-processor that contains eight vector processors. This permits parallel processing of multiple areas of interest within an image, such as the individual lanes on a

fruit sorting line. The results of the research illustrate that the PS3 is faster than the PC, however the level of skill needed to program the PS3 is significantly higher than the PC. The conclusion of this work is that the programming cost for developing on the PS3 is currently too great for general industrial use. This creates the opportunity to provide programming tools to facilitate application development, which would permit system developers to take advantage of the power of the PS3.

### **Automatic Inspection Using Machine Vision for Food Safety Control**

*Chun-Chieh Yang, Kuanglin Chao, and Moon S. Kim, USA*

The proposed research has created a machine vision system for automatic poultry carcass inspection. This system will be very useful for identifying unwholesome chickens for tracking and removal from the processing line for food safety control. The line-scan machine vision system uses an electron-multiplying-charge-coupled-device (EMCCD) camera and a spectrograph to acquire line-scan images to form complete hyperspectral images of whole carcasses spanning many wavebands across a broad spectral range. The system can be switched to acquire multispectral images using a few pre-selected wavebands, which increases imaging speed. The system scans the surfaces of poultry carcasses on a processing line, automatically recognizing each individual carcass as it is scanned, quickly locates the region of interest (ROI) for each carcass, and identifies in real-time those carcasses that are unwholesome. During in-plant tests, the line-scan machine vision system has successfully inspected over 100,000 carcasses on a poultry processing line operating at a speed of 140 carcasses per minute.

### **SMART Irrigation System Controllers**

*Edward M. Norum and Diganta Adhikari, USA*

There are currently available a number of sciences that make it possible to develop a SMART irrigation system that can operate without human intervention. This paper identifies these sciences and describes how they fit together to reach the SMART result. This integration of disciplines is somewhat unique as the scientific community tends to concentrate on an ever greater understanding of their specific disciplines. The SMART controller will integrate these disciplines to produce a significant improvement in crop production and resource management.

## **A Framework of Collective Intelligence for Building Virtual Agriculture Knowledge Repository and Services**

*Masahiko Nagai, Naiyana Sahavechaphan, Vasuthep Khunthong, Asanee Kawtrakul, and Ryosuke Shibasaki, Japan*

Providing information and knowledge services with collecting and maintaining weakly structured text sources is time-consuming activities. This project targets for building specific services and knowledge infrastructures to support decision-making and problem solving in Agriculture domains. It is composed of three essential components: iExtraction -- a tool that semantically extracts relevant information from textual representation sources embedded in each individual and related web site and transforms them into structured and standard format, iGrid -- a framework that supports virtual knowledge repository as well as discovers and integrates structured information distributed over different sources. Semantic Media Wiki is, then, applied to register and update of agricultural information as a semantic network dictionary. This constructed agricultural information is used for the reference information for interoperability for specialist and farmers, iVisualization -- a sophisticated tool that visually presents information in a specific semantic network model, called PMM: Problem-huMan-Method model. Moreover, in order to invite contributions from the user community in order to share the knowledge both tacit and explicit knowledge without the language barrier, it is necessary to provide more sophisticated tools and systems, such as reverse dictionary, ontology-based knowledge sharing and machine-aided translation for sustainable development of agricultural knowledge virtual repository and services. This collaboration project is currently implemented by using Rice domain as a case study. The generated PMM consists of Rice Disease Problems identification, rice huMan experts who could solve that disease problem and the Method for solving the disease problem both in corrective and preventive ways.

## **Lyra Virtual World Environment (Lyra VWE): Educational Applications in Agriculture and Natural Resources**

*Howard W. Beck, USA*

A prototype virtual world environment (VWE), called the Lyra VWE, has been developed to demonstrate a variety of educational applications of VWE technology in agriculture and natural resources. This Web-based environment will allow students to go on-line to explore various 3D worlds. VWEs support multiple users, and students and instructors

can interact and work collaboratively within these on-line environments. Most of the prototypes described here are virtual laboratories in which students can interact with 3D, simulation-driven learning experiences of biological and physical systems modeled after real laboratories. Examples include a greenhouse, a forest, 3D soil map, a food packaging machine, molecular shapes, and a visual dictionary. Lyra VWE is based on Java technology, and utilizes an object database platform (Lyra) common to several information systems being used in IFAS (UF's College of Agriculture and Natural Resources) including EDIS and the IFAS Extension on-line Training Portal (ExtensionU).

## **Advantages of Open Source Based e-learning Tools in the Collaboration and Training in the Agricultural Education**

*Miklós Herdon, László Várallyai, and Peter Lengyel, Hungary*

One of the primary benefits of open source software is that it reduces the costs to produce systems and services. Traditional proprietary software vendors are realizing this fact, and are beginning to build their closed software products quietly using lots of open source software. In the long-run, competition will force these cost savings to be passed to the consumer. In this paper the most important free and commercial e-Learning systems and their functional features, modules, standards, hardware and software requirements by Vendor's Web sites and different e-Learning service portals are shortly summarized and compared. We selected the Moodle system within an European projects, which is a software package for producing Internet-based courses and web sites. It is an ongoing development project designed to support a social constructionist framework of education. The aim of our European project was to promote the use of multimedia knowledge in adult training / lifelong learning in order to facilitate competitiveness, employability and mobility of adults who are victims of the digital divide or of some of its components such as distance, initial level of knowledge, language, use of complex technologies. One of the results of the NODES project is that we introduced the Moodle system into the graduate, postgraduate PhD, adult trainings programmes and it is a very successful system as an educational portal system for our faculty. We are using some extended tools in Moodle such as the Word templates for easy making Moodle questionnaires, Covcell Audio/Video Conferencing Tool, Inwicast Mediacenter, Audio recorder, AutoView Presenter which allows you to put video on-line with synchronised slides.

**Multidisciplinary Aspects of Learning Information  
Technology in Accredited Agricultural Education Programs**  
*Miklós Herdon and László Várallyai, Hungary*

During the transformation of the Hungarian Higher Education System new educational programs were developed on different levels in the agricultural higher education. The levels of the programs are Postsecondary, BSc, MSc and PhD programs. Most curricula required learning information technology on different content and level. These educational programs are accredited and the curricula are very similar in every university. The contents of the computing subject are almost the same on the BSc level. There are 15 BSc, 15 MSc programs in the Hungarian Higher Education System in 2009. The content of the informatics subject are the most important subtopics such as spread sheet and database handling, networking, etc. The professional subjects contain some informatics knowledge, but it depends on the educational program, subjects and professors. In the MSc programs the informatics topics differ by name and content according to the target of the training program. On this level more professional subjects can be found which contain applied informatics knowledge. But we think this is not enough in our education systems so we accredited the agricultural engineer in agricultural informatics and government BSc program. This program started 3 years ago and 5 Hungarian Universities offer this training program in 2009. The subject group of basic informatics has 36 credits and applied agricultural informatics subjects need 29 credits. It means that the rate of informatics and specialized informatics knowledge is more than 30% in the curriculum. The newest effort is that we have developed the Master of Business Informatics program with a "Informatics for Rural Development" specialization. The next development is a one year vocational training program in agricultural informatics. In the paper we discuss the demand of informatics knowledge on different educational levels and in programs based on the accredited training and outcome requirements as well as our training experiences.

**Online Learning Resources on Agricultural Topics: the case of Organic Agriculture & Agroecology**  
*Nikos Manouselis, Nikos Palavitsinis, and Xenofon Tsilibaris, Greece*

Organic.Edunet is a European initiative that aims to facilitate access to digital educational content related to Organic Agriculture and Agroecology. This paper presents the rationale of this effort, the overall architecture of the Web-based environment to be deployed, and a typical usage

scenario.

**Web Services, Portals, Internet and  
Web 2.0 Applications**

**The Role of Intermediaries in the Success of Electronic  
Claiming for Farm Subsidies in Hungary**  
*Miklós Herdon and Mihály Csótó, Hungary*

The main electronic government service in the Hungarian agriculture created by the Hungarian Agricultural and Rural Development Agency (ARDA) (Mezőgazdasági és Vidékfejlesztési Hivatal; MVH) and the Central Agriculture Office (CAO) (Mezőgazdasági Szakigazgatási Hivatal; MgSzH) started to introduce electronic filling and submission of application forms in 2008, aiming to simplify procedures in connection with applications for area payments which are the basic elements of the European Common Agriculture Policy (CAP). Already in 2007 it was possible for clients (with more than 200 ha area) to receive this payments (SAPS) through the electronic form submission system. In 2008 every client has the possibility to create and submit his/her application for area payment electronically with a PC. Although the internet penetration is quite low among Hungarian farmers, the majority of the documents (about 95%) were sent to the ARDA electronically. This process shows that the often mentioned "mentor", "moderator" or "social intermediary" approach is working perfectly to narrow the digital divide and to make better public services. The authors present the whole practice and experiences of the successful electronic e-claiming system.

**Specification of SOA Components and Web Services to  
Integrate Ecological Niche Modelling Systems and IABIN-PTN**  
*R. L. Stange, B. Buani, F. S. Santana, P. L. P. Correa, A. R. Hirakawa, and A. M. Saraiva, Brazil*

Information systems for biodiversity require information distributed in different data sources and the challenges are to combine data to obtain answers for most common ecological problems. Ecological niche modelling is a technique widely adopted by ecologists and experts in the area, applied to ecological maintenance, conservation and mapping, and several other studies involving species distribution. Occurrence species points are input data for ecological niche modelling. IABIN is a Web-based network designed to provide an infrastructure for biodiversity data exchanges in the

Western Hemisphere. IABIN aims to coordinate and promote technical collaboration among the members. The network may be used to obtain, share and apply biodiversity information in order to conserve natural resources and to improve education and sustainable development. IABIN is organized in thematic areas. IABIN-PTN (Pollinators Thematic Network) is a data repository containing species data related to pollinators, required for many agricultural and ecological purposes. IABIN-PTN represents an important data source for ecological niche modelling and their integration opens many possibilities for researchers. This work studies and details both ecological niche modelling and IABIN-PTN systems so as to provide their integration, based on Web services. Each business component required for the integration is presented, detailing the middleware technology and a solution for its implementation. Results are relevant because pollinators are species whose behaviour brings a lot of information about the situation of biodiversity around them. In addition, the solution presented here may be reused to integrate other similar data sources for ecological niche modelling systems using Web services.

#### **Reengineering Research Organizations with Web 2.0 Tools**

*Humphrey Keah, Kenya*

The World Agroforestry Centre (ICRAF) Headquarters in Nairobi, Kenya has the mission to generate science-based knowledge about the diverse roles that trees play in agricultural landscapes and to use its research to advance policies and practices that benefit the poor and the environment. Modern Knowledge Sharing (KS) tools (also known as web 2.0 tools) and technologies are strongly emerging as a potential means of accelerating the diffusion of information in various fields including scientific research. While research organizations such as The World Agroforestry Centre have been making use of the web (intranet and internet) to disseminate information on their core businesses, they have been doing so with regard to the web as a read-only (web 1.0) interface. Today's proliferation of internet technologies are rapidly enhancing a knowledge sharing culture, and it is becoming increasingly important for research organizations to take advantage of these tools and technologies to raise their institutional profiles. Knowledge sharing is vital in scientific research as researchers constantly undertake to submit their work to various institutional repositories including their own parent organizations' institutional databases for eventual dissemination of the knowledge to the global scientific community and the general public. Exploring the potential to automate various

opportunities for exchanging information to harness it for new uses is therefore, crucial to the success of any research establishment. Recognizing the potential of Web 2.0 technologies to transform the mode of sharing research information, this paper explores the various ways in which research organizations like the World Agroforestry Centre (ICRAF) can integrate Web 2.0 technologies to leverage institutional objectives.

### **Food Safety Control/Tracking-Tracing**

#### **Integrative Information Management Across Different Surveillance Areas: The Power of Classification Systems and a Need for Institutional Change**

*Johannes Otto, Matthias Frost, and Reiner Doluschitz, Germany*

Local surveillance authorities are commissioned with the control of feed and food products as well as the surveillance of livestock for epizootics. In each of these three areas classification systems are used for information management for the controlled items in order to generate valid data. Standardized data predominate within certain surveillance areas but do not provide means for data interchange due to different classification systems. Bearing in mind that streamlined data management is possible in closed supply chains, it is postulated that current obstacles can be tackled by surveillance authorities through a harmonization of different classification systems. It is the aim of this contribution to show, that harmonization of different surveillance areas leads to a more comprehensive knowledge of the whole agro-food chain. Additionally, institutional changes are recommended that comprise primarily the areas of coordination and cooperation. A SWOT-analysis of the information and classification systems of three surveillance areas is conducted. By means of an overarching classification system a semantic harmonization of these is presented. Secondly, an analysis is undertaken of the institutional framework, in which surveillance authorities act in Germany. The results offer an extended understanding of the functions of different public surveillance areas. Their information management is analyzed and compared. To illustrate the issues, one classification system for animals used in these surveillance areas is introduced and obstacles are identified. A system for harmonization using 'faceted classification' is presented. For acceptance of this harmonized system of information management, results of the institutional analysis offer the need for change.

## **Tracking Pests and Plant Diseases through Space and Time Using Geo-tagged Digital Images**

*Jiannong Xin, Carrie L. Harmon, Pete Vergot III, and Huafeng Jin, USA*

Plant pests and diseases cause significant economic losses in agriculture throughout the world. To enable accurate monitoring pest activities, pest detection data are collected, stored, manipulated and analyzed. The ability to track pests and plant diseases through space and time allows us to manage pests wisely and effectively. The use of GIS and GPS technologies has had a considerable impact on pest management. Unlike a traditional GIS application, this work focuses on geo-tagged non-map photographic media. Digital photos are widely used as pest samples for diagnosis. With advances in digital imaging technology, one distinct feature of current digital cameras is that images provide not only pictures of pests, but also the GPS coordinates where the photo is taken, and metadata named Exchangeable Image File Format (EXIF) embedded in the image. Such geo-tagged images provide us with information of what, when and where. Thus images with GPS coordinates can be seamlessly transferred to an information management system to assist with pest tracking and management. This paper describes a web-based system to dynamically extract the EXIF metadata from photos. The system provides an environment to track and map pest information based on the geo-tagged digital pest samples. Geo-based digital imaging is an effective means to collect data and track pests and pathogens.

## **Towards Developing a Edible Fungi Factory HACCP MIS Based on RFID Technology**

*Wang Yunsheng, Wan Changzhao, Cheng Jihong, Guo Qian, Yang Juan, and Zhao Jingyin, China*

According to the low yield of edible fungus and the poor quality of edible fungi in factory, the production management situation in edible fungi factory was analyzed. Then the solution of edible fungi factory HACCP(Hazard Analysis Critical Control Point) MIS(management information system) based on RFID(Radio Frequency Identification) technology was presented. Edible fungi production process by the hazard analysis to determine the raw materials, burden mix materials and bottling, inoculation, culture, and growth as the critical control points. For each critical control points, respectively, to develop appropriate critical limits, clearly defined monitoring objects, methods, frequency and corrective measures, critical control point of information collection for the use of RFID technology. Through the

implementation of HACCP MIS, edible fungi yield and quality have improved.

## **Modeling and Simulation**

### **AQUARIUS: A Simulation Program for Evaluating Water Quality Closure Rules for Shellfish Industry**

*Conte, F. S. and Ahmadi, A., USA*

The United States shellfish industry is regulated under the National Shellfish Sanitation Program, administered federally by the U.S Food and Drug Administration, and at the state level by departments of health or agriculture. Shellfish authorities are empowered to close shellfish harvest if water quality drops below food safety levels. Because monitoring for all human pathogens in growing areas is not feasible, fecal coliform bacteria are used as indicator organisms for the potential presence of pathogens from fecal contamination. Every decade, sanitary surveys are conducted during adverse pollution conditions to establish equations and rules for conditionally approved growing areas to predict rainfall levels when fecal coliform levels might exceed the "NSSP 14/43" safety standard. Modifying these rules requires an extensive sampling programs and analyses. As watersheds change, there is pressure to reclassify growing sites and to modify closure rules. The AQUARIUS program is the first tool developed to directly evaluate closure rules for the shellfish industry, and to perform a series of "what-if" scenarios for selected variables. AQUARIUS uses the actual rainfall data to simulate the open/close status of a given growing site for any length of time under two closure rules: one the current rule and the other proposed new rule. AQUARIUS then uses the actual fecal coliform data from the site to calculate the "NSSP 14/43" standards for three situations: "site open under current rule", "site open under new rule", and "site open during critical period". AQUARIUS then runs a series of statistical procedures to compare the fecal coliform level of "site open under current rule" versus "site open under new rule"; and to compare the fecal coliform level of "Site open under current rule" versus "site open during critical period". Based on the results of SSP 14/43" standards and T-Tests, the new closure rule is either accepted or rejected.

### **Assessment of Water Quality Calibration Criteria for Field-Scale Water Quality Model**

*Sang Min Kim, Choung Hyun Seong, and Seung Woo Park, Korea*

The objective of this study was to assess the statistics and associated criteria for field-scale model used to simulate nutrient concentrations in paddy field. CREAMS-PADDY, a modified version of the field-scale CREAMS model, simulates the hydrologic, sediment, and nutrient cycles in paddy fields was applied in this study. The model was calibrated and validated using data from study rice paddy fields in Republic of Korea. The calibration statistics include mean and the minimum-maximum range associated with a “temporal window” that spans a period of several days. Because nutrient concentrations in paddy field are typically sampled infrequently (on a weekly basis, at best) and represent only an instant in time, it is not reasonable to expect any model to simulate a daily average concentration equal to an observed value on a particular day. The 5-day window and related calibration statistics were applied in this study and the applicability of this concept was tested for field-scale water quality model. As a result of calibration and validation, the ponded water nutrient concentration values showed only small changes except the fertilization period. Because of the small changes in ponded water concentration, the size of 5-day window was too small to capture the observed values. Further study is required to establish the 5-day window calibration method for field-scale water quality modeling.

#### **Development of a Distributed Artificial Neural Network for Hydrologic Modeling**

*R.A. Logsdon, S.G. Bajwa, and V. Vibhava, USA*

Hydrological models are used to represent the rainfall-runoff and pollutant transport mechanisms within watersheds. Accurate representation of these dynamic and complex natural processes within a watershed is an important step in managing and protecting a watershed. Artificial neural network (ANN) models are often used in hydrologic modeling. Typical ANN models are trained to use lumped data. However, watershed characteristics used as inputs in hydrological modeling are spatially and often temporally dynamic. Therefore, a lumped model does not have the ability to represent changes in spatial dynamics of a watershed. Therefore, the purpose of this study was to develop and test a distributed ANN model for simulating the rainfall-runoff process in the L'Anguille River Watershed located in Eastern Arkansas. The watershed was divided into nine sub-basins to account for the spatial dynamics of flow within the watershed. Inputs for the model were rainfall, average temperature, antecedent flow and curve number. Output was runoff, collected from gage-stations at Colt and Palestine

representing two of the sub-basins. Daily SCS curve numbers were developed and adjusted for crop planting and harvesting dates and crop rotation practices in each sub-basin. The model had nine layers with one neuron each to represent the nine sub-basins. The layers were connected so that if one sub-basin spatially flowed into another, its output would be an input for the downstream sub-basin. The model performed well, showing R2 values of 0.93 and 0.98 and Nash-Sutcliffe Efficiency values of 0.92 and 0.97 for the validation and test datasets.

#### **Investigation of Head Loss along Drip Emitter Channel by Using Computational Fluid Dynamics**

*Lu Gang, Wei Qingsong, Liu Jie, Shi Yusheng, and Dong Wenchu, China*

It is difficult to investigate how to achieve biggest head loss of the drip emitter channel due to the channel's minor and complicated structure. Four types of Super Typhoon emitter with trapezoidal channel were selected out for the investigation of the head loss along the channel, and the CFD (Computational Fluid Dynamics) method was applied to simulate the micro-field inside the channel. First, four different types of drip emitter and their channel models were modeled; then, three kinds of turbulent model provided by the commercial software Fluent 6.3 were used to get micro-field of channel, eight groups of working pressure named 2, 4, 6, 8, 10, 12, 14, 16mH<sub>2</sub>O were applied for the simulation; at last, the experiments between pressure and discharge were conducted, and the pressure corresponding to the simulation were used. The simulation results showed that the emitter discharge of different turbulent model is 4%-14% bigger than that of the experimental results, the average discharge deviation of  $\kappa$ - $\omega$  and RSM model is 5, 4.5 respectively, but the solving efficiency of the  $\kappa$ - $\omega$  model is obviously higher than that of the RSM model. The effect of working pressure on the distribution is evident when the water head is lower than 6mH<sub>2</sub>O, and the head loss distribution will keep stable when the working pressure is higher than 6mH<sub>2</sub>O except that near the inlet and outlet area. This may because the water flow inside channel except the zone near inlet and outlet is full turbulence when the working pressure is higher than 6mH<sub>2</sub>O.

#### **Modeling Top Soil Erosion and Mass Failures in Steep Agricultural Slopes: Integrating WEPP and a Landslide Model**

*Thomas A. Cochrane and Govind Acharya, New Zealand*

Steep agricultural hillslopes are not only subjected to soil erosion, but also have a probability of failure. In hilly country where both soil erosion and landslide processes are active, the interaction between these processes is critical. A model called WEPP-SLIP was developed that integrates erosion modeling and landslide prediction to determine sediment delivery pre and post landslide failures. Initially, WEPP is used to estimate pre-failure erosion. The landslide model then predicts where a mass failure may occur along the slope. Changes in topography and soil structure are estimated from the predicted magnitude of the landslide. The WEPP model is then used again with the new topography to predict post-failure erosion. A flume based experiment was used to validate the modeling with loess and sandy type soil representative of hilly sheep pasture land in New Zealand. Results showed a good correlation between predicted and measured erosion and runoff. In fallow conditions, post-failure erosion was shown to be smaller than pre-failure erosion due to changes in slope and soil properties resulting from the failure. The opposite is true for hillslopes covered with grass, as slope failures disturb the cover resulting in greater erosion. Flume based results indicate that sediment yields during failures were high. WEPP-SLIP can be applied for individual hillslope profiles; however, efforts are on the way to create a spatially distributed model. The model will be used to improve management practices and calculate the long term implications of mass movements in hilly slopes.

#### **Simulate Regional PM10 Dust Dispersion from Agricultural Tilling Operations Using Hysplit4**

*Junming Wang, Ted W. Sammis, David R. Miller, April L. Hiscox, David Granucci, Britt Holmén, and John Kasumba, USA*

Particulate matter (PM) of aerodynamic diameter less than or equal to 10 microns, PM10, is regulated by the U.S. Environmental Protection Agency (EPA) as part of the National Ambient Air Quality Standard (NAAQS) pollutants. PM10 emitted from agriculture field operations (e.g., disking, listing, leveling, planting, harvesting) can be dispersed downwind in the far-field (i.e., > 1 km). This paper used the Hysplit4 (HYbrid Single-Particle Lagrangian Integrated Trajectory) model to estimate regional dust dispersion from a disking operation. Hysplit4 is a dynamic regional model. It can have a minimum time step of 1 minute, which is an advantage compared to the Gaussian EPA models (Fugitive Dust Model, FDM; Industrial Source Complex Model, ISC3) that have a minimum time step of 1 hour. To evaluate the Hysplit4 simulations, disking operations from a cotton field at Las Cruces, N.M., were conducted, and an airplane flying at

between 250 m and 900 m and downwind several kilometers sampled PM10 concentrations. Primary comparisons show that, although the model simulated reasonable shapes of the plumes, the model may not capture the surface layer micrometeorology, and a surface layer model may be coupled with the regional model or to raise the dust source to an appropriate higher height in the regional model may improve the model performance.

#### **Applying Control Volume Finite Element for Modelling Direct Injection Boom Spraying Flow**

*Abdellah El Aissaoui, Frederic Lebeau, Marie-France Destain, and Karim Houmy, Morocco*

Assessment of injection lag transport and uniformity of direct injection boom sprayer is an important issue for successful variable rate spraying technology. To estimate the boom lag transport and pressure loss, a numerical model is formulated on basis of fluid hydrodynamic conservation equations. The software is implemented in visual basic. To solve the pressure – velocities equations, control volume finite element method (CV) is used to delimit elementary volumes of the boom. Linearization of the conservation laws is ensured by considering discrete form of the equations and calculating velocity and pressure step by step throughout the whole boom. The flow behaviour is simulated into a boom section divided into N elementary volumes, each of them including one nozzle. To assess test the model, three booms diameters (5, 6 and 8 mm) and two chemical viscosities (10-6 and 10-5 m<sup>2</sup>/s) are tested. Experimental trials are carried out on boom sections having 2.5 m length (5 nozzles) for measuring pressure gradient and lag transport. Results show that the model can predict the pressure losses and the lag transport accurately (error within 5%) to optimize boom designs.

#### **Computer Simulation of Thermal Processing for Canned Food Sterilization**

*R. Radrigán and J.A. Cañumir, Chile*

A computer-aided engineering model is described that is capable of simulating the thermal sterilization processing of canned foods. The use of the model to find optimum processing conditions, physical properties and container geometry is reported. This work describes the use of thermal properties and physical properties in the development of computer models that simulate conduction and convection heat transfer in canned foods, for one application in automatic control or on-line computer control in real time.

The present research in thermal properties it was compared by real-processes obtaining satisfactory results.

### **Combined Use of Simulation Modeling and Linear Programming for Logistic Design of the Slurry Distribution Systems**

*Patrizia Busato and Remigio Berruto, Italy*

The continuous development of new plants for anaerobic digestion has led to the need to manage in a rational and environmental way the distribution of the digestate that comes out of the process. The EU, national and regional regulation establish time windows when it is possible to carry the slurry and limits the amount of Nitrogen per hectare from livestock to be distributed in the field. Purpose of the study was to optimize the slurry distribution through the combined use of simulation and linear programming [LP], taking into account the regulation and the timeliness of the operation required by the crops. Based on the field trials was built a dynamic, discrete-event simulation model using Extendsim® software (Imagethat Inc, USA). The main results were the working chain field performance and the logistic costs, as a function of: field distance (1 to 10 km step 1 km), plot size (2, 4, and 6 ha) and rate of Nitrogen distributed per ha (170 and 340 Kg N.ha<sup>-1</sup>, as were the limit imposed by the European directive and Italian law on vulnerable and non-vulnerable soils). In particular, the simulation model showed how the cost of distribution per unit of fertilizer depends mainly on field distance from the slurry source and secondarily on the rate of application. The LP model, starting from the simulation results as input allowed to schedule the slurry distribution, the tillage and the crop planting. The following factors were considered: the spatial field distribution vs. the digestate source, the weeks of the year where slurry distribution is allowed by law, the timeliness factor to plant the crop and the weekly manpower available. LP model run for the whole year (52 weeks) and schedule, week by week, the area to be feed with slurry, the area to be tilled and the area to be planted. The tool will be further implemented to simulate many different distribution methods and options including umbilical systems. The long term goal is to provide an advanced support system for the logistic design and management of the slurry distribution system.

### **Mining Derived Weather Forecast Variables for Crop Disease Risk Prediction**

*Jason Smith, Kathleen M. Baker, and Robert Trenary, USA*

Changing climate conditions have increased the demand for

agricultural decision support systems to include true forecasts. Forecasting for crop disease risk can assist growers in reducing the costs and environmental impacts of pesticide use. This paper describes the development of techniques to establish an appropriate variable set from publicly available National Weather Service forecast data for use in crop disease risk forecast models. Our team has been working for several years on artificial neural network (ANN) models to predict disease risk, with potato late blight as our test case. Since the ANN uses a wide range of derived, measured and implied data values, selecting appropriate data is a challenge in its own right. To help gather and dissect data used by the ANN, various tools and methods have been developed to quickly test different ANN models. Automation of processes such as variable selection and derivation through an object oriented framework has the potential to measurably improve the accuracy of the ANN model, and allow for easier implementation of similar models for a variety of crop diseases.

### **SOC & SOA in Ecological Niche Modelling and Agribusiness: Discussion and Case Studies**

*Fabiana Soares Santana and Antonio Mauro Saraiva, Brazil*

Sustainable development demands the conservation of biodiversity while requires maintaining or increasing economic development. To study the biodiversity so as to obtain adequate approaches for sustainable development is a great challenge. There is much information supplied by several sources which must be treated and integrated before supporting any decision. The nature of the problem, however, requires systems with strong integration skills. Thus, biodiversity research communities are not completely integrated to each other and this lack must be treated by IT systems. SOC, Service-Oriented Computing, and their respective architectural paradigm, SOA, Service-Oriented Architecture, are recommended for such problems. This paper discusses the application of SOA & SOC in ecological niche modelling and precision agriculture systems. In order to clarify the discussion, case studies are presented for both problems, including a SOA-based solution and a SOC implementation for the specific process. This modelling technique is highly important for biodiversity studies because it allows mapping species distribution based on simple information, such as species occurrence points and environmental data. From the computing viewpoint, it requires many data from different providers, so case studies are very illustrative. Results presented here are important not only for biodiversity systems but they may be extended to

agribusiness, as shown in the work. In addition, other systems with similar requirements may use this paper as a reference to develop their own solutions applying SOC & SOA concepts.

### **Predicting the Impact of Supplemental Phytase, Wheat and Phosphorus on the Performance of Laying Hen**

*Forghany, Z., Davarynejad, M., and Zartash, L., Iran*

A Genetic Fuzzy Rule Base System (GFRS) for modeling the response of laying hen hyline W36 performance to dietary supplemental phytase source, wheat and phosphorus level is described based on experimental data. Using data obtained via measurement of various characteristics of laying hens prepared with different levels of dosage of a commercial phytase source proteinase, (0, 500 and 1000 phytase (FTU)/kg of feed) at 0.0, 25, 50, 75, 100 percent of wheat with 0.22 and 0.28 percent available phosphorus (AP), it is concluded that construction of an optimized fuzzy model for evaluation of different dietary supplemental phytase, wheat and phosphorus level is a reliable procedure. A comparison has been done between three statistically based regression models and one type of fuzzy inference systems. This qualitative fuzzy model may in fact help drive appropriate selection of combinations of potential feed parameters.

## **Information Systems and Databases**

### **DiagText: A Text Mining Tool for Agriculture**

*S. M. F. S. Massruhá, K. X. S. de Souza, H. P. de Lima, R. Ricciotti, and A. D. L. Zanchetta, Brazil*

In this paper a tool called Diagtext is presented. This tool aims to help the process of extraction of information from textual documents by identifying groups of similar documents in such a way that an expert can decide which category a document would better fit in. There are two main approaches to extract information from textual data. The first uses the semantic analysis that is based on the functionality of words in the corpora and the second uses statistical analysis based on frequency of terms. These approaches can be used together to analyze data in what is called a hybrid approach. In the scope of this work was adopted the statistical approach. DiagText allows the extraction of information from unstructured data in plain text format(.txt) or in PDF format. From the text, groups were generated and the trees were compared with the trees generated by experts in the field. Although the initial validation is on agriculture, DiagText can be used in several domains, since it was developed to be language and subject independent. Finally, future work using

an approach that incorporates fuzzy clustering techniques is also discussed in this paper.

### **Principal Components Analysis in the Software Assisted-Statistical Attendance**

*Francisco de Assis Santos e Silva, and Carlos Alberto Vieira de Azevedo, Brazil*

New routines were added to the software Assistat-Statistical Assistance, which became itself still more useful for experimental data analysis of the agricultural research and of works of dissertations and thesis. Those routines were the following ones: a) tests of Bartlett, Cochran and Friedman; b) principal components analysis (PCA); c) polynomial regression for quantitative treatments; d) confounding and other methods of ANOVA. An example of application of PCA was presented by using the Assistat and it was concluded that the software is an appropriate tool for use of PCA applied to data of food sensorial analysis. The new version of the software is available for free download in the following site: <http://www.assistat.com>.

### **Compare Different Methods for Extensibility of Measurement Results of Point Samples of the Soil Protection Information and Monitoring System**

*László Várallyai, Béla Kovács, and Miklós Herdon, Hungary*

The Hungarian Soil Information Monitoring System (SIM) covers the whole country and provides opportunity to create similar information systems for the natural resources (atmosphere, supply of water, flora biological resources etc). The aim of the SIM is to relate these databases. The SIM territorial measuring grid consists of 1236 measuring points with 21 elements content in Hungary. These points are representatives. Distribution of the points by soil types represents the variety of soil types of the country. The SIM is the essential basis of rational agri-environmental management and at the same time is an integrated unit of the environmental diagnosis of soils. Our aim is developing a statistical based information system from the data of the measured SIM points. We developed a method for estimating element content. To determine the concentration of the elements, need only the GPS co-ordinates of the place based on the number of nearest neighbouring points. This method does not calculate with spatial circumstances. The other possibility is using the kriging method (spatial interpolation) for estimating more precisely the element content. In this study these two methods are compared. After building our statistical based information system we can develop an

Internet-based service that makes it possible to reach the objectives through arranging the results of analyses into a database. Based on available data, the developed Internet-based service makes it possible to estimate element content at a certain diagnostic point with some statistical errors; it can also be applied in analyzing effects of environmental pollution.

### **Bringing Farmers to the Market with 3-Reforms and 3-platform Technologies**

*Asanee Kawtrakul, Vasuthep Khunthong, Thanaphat Suksaengsri, Patcharee Varasai, Amporn Poyai, Seksan Sartsatit, Anan Pusittigul, Kanok Lohapiyaphan, Srayut Tongnoy, Duangkaeo Pokawattana, and Werachai Narkwiboonwong, Thailand*

In order to ensure long lasting solution of agricultural economy, not only Land Reform is needed. It must be accompanied by supplementary reforms, i.e., Farmer Reform and Management Reform. With the Land Reform, the farmers could cultivate their own land which is the most important factor of production. With Farmer Reform, the productivity of farming could be improved by the skilled and knowledgeable farmers. With Management Reform, agricultural efficiency both in production and delivery to the market could be improved with cost reduction and fair trade. This work, then, proposes three-platforms technologies : 1) A wireless sensor network for controlling and monitoring the Agricultural Environment such as Humidity, Soil Moisture, Soil Nutrient N-P-K , Water Quality, and etc. 2) CyberBrain which is a framework that combines Knowledge Engineering, Information and Communication technologies to provide the effective knowledge service for supporting the farmers in problem-solving, decision making and early warning, and 3) e-community for changing the model of "Training and Visit" to be the Second Life in the Virtual space and changing the collective to be the cooperative problem solving.

### **Towards Cyberinfrastructure for Multi-scale Crop Disease Early Warning Systems**

*Kathleen M. Baker, Beth Plale, Ilya Zaslavsky, and Suresh Marru, USA*

Access to cyberinfrastructure is critical for regional forecasting of specific economically important crop diseases. We present our team's initial steps to create, implement, and validate a multi-scale, multi-regional crop disease forecasting system funded by the USDA. Rapid synoptic and mesoscale crop disease forecasting, especially for emergency decision-

making, requires that the model workflow relies on integration of real-time data services from multiple sources, and is executed over a pool of high performance computing resources. Spatially explicit weather forecast models runs are initiated through the Linked Environments for Atmospheric Discovery (LEAD) portal. Hourly forecast variables are extracted from LEAD workflow outputs and are used as inputs to crop disease forecast models implemented as ArcGIS workflows. Workflows include standard models for potato late blight and leaf spot of peanut as well as newly developed models for Fusarium head blight of barley. Resulting crop specific forecasts will inform farm management strategies with the goals of increasing product quality, limiting expenditures, and reducing the amount of chemical released to the environment. Initial results from the 2008 growing season are highly accurate and support continued development of such systems.

### **Developing Agricultural Research Information Systems: The Experience of the Global Forum on Agricultural Research**

*Ajit Maru, Mark Holderness, and Valeria Pesce, Italy*

The Global Forum on Agricultural Research (GFAR) is a platform at the global level for dialogue and action of all stakeholders of agricultural research and innovation for development (ARD). Improving sharing and exchange of information that contributes to agricultural research for development is one of the primary actions of GFAR. This paper will describe GFAR's experiences in fostering and supporting the development agricultural research information systems at national, regional and global levels, illustrating the evolution of the overall approach, the initiatives of the various stakeholders and the experiences with different technologies. A description of the evolution of the approach in building agricultural information systems and an overview of the major services implemented over the last decades and their technological features will demonstrate that creating integrated information services giving access and adding value to information that is electronically available, especially through semantics, remains a major challenge. In order for this to be achieved, the existing sources of information must become really interoperable and allow for easy automatic retrieval of information, and work on mapping between vocabularies or advanced natural language processing must be done for improving the semantic accessibility of information. of the current on-farm information needs and potential ways of addressing these through the adoption of new technologies and best practices

- resulting in enhanced agricultural productivity, profitability and sustainability.

### **Dynamic Mapping, a Flash Solution**

*Huafeng Jin and Jiannong Xin, USA*

Pest distribution information for a region is particularly important for specialists and decision makers. Dynamic map is an effective way for pest data visualization and analysis. Traditionally, GIS software is applied to create a visual and dynamic pest distribution map, in which different regions; county, state, or nation, are colored according to the number of pest occurrences. The use of GIS in many cases is only for data visualization. Adobe Flash provides a cost effective alternative in creating dynamic interactive maps based on database, XML representation and ActionScript. This paper presents a dynamic pest mapping mechanism using Adobe Flash instead of expensive GIS software. Flash map retrieves pest data from remote databases and presents the data on a regional demarcated map with proper color legends. Based on Flash map, a generalized map service is developed. This service enables users to create their own customized map which can be embedded in their applications. This solution serves as a useful tool for pest distribution analysis, diagnosing, and plant management. The Flash-based approach can also be applied to other mapping applications.

### **RPP - Rainfall Processing Program**

*F. S. Conte and A. Ahmadi, USA*

The Rainfall Processing Program (RPP) is a program used to process and prepare rainfall data files before the rainfall data is used in other programs and software. It consists of four modules: Dup, Rev, Sum, and Tip. (1) The Dup module removes the duplicate entries from a rainfall data file. (2) The Rev module reverses the sorting order of a rainfall data file from ascending (A to Z) to descending (Z to A, or vice versa). (3) The Sum module converts an hourly rainfall data file into the cumulative tip format. (4) The Tip module converts a cumulative tip file into the hourly format, and calculates 24 to 240 hours running cumulative rainfall values. The RPP program is written in C++ programming language and runs under Windows operating system. The program also supports the American and European date formats (MM/DD/YYYY and DD/MM/YYYY), and both the English and Metric systems (Inch and Millimeter).

### **Rural Amenity Survey and Evaluation**

*Oh, Yun-Gyeong, Choi, Jin-Yong, Bae, Seung-Jong, Lee, and*

*Sang-Hyun, Korea*

In the process industrialization and urbanization in Korea, rural area has been degraded with incurable problems including community aging and destruction of ancient cultural or natural rural amenities. However, the tangible and intangible resources in rural areas has highlighted in these days since the life quality elevated. Rural Amenity, the rural resources that give affection and agreeable feelings, is regarded as a solution that can revitalize the rural community. Therefore, Rural Development Administration (RDA) has been conducting nation-wide survey project for rural amenity resources to construct the databases of rural amenity distribution and richness. In this article, the survey project that was implemented from 2005 through 2009 was narrated in terms of methods and procedures. And, using surveyed data from the project, this study was implemented to evaluate rural amenity values based on Simple Additive Weighting (SAW) method considering living aspect and tourism aspect. For defining the set of evaluation criteria, rural amenity resources were classified into natural resources, cultural resources and social resources. The criteria's weights were evaluated from the step wise pair-comparison results by Analytic Hierarchy Process (AHP) method. The two aspects evaluation method was applied to the selected 18 towns (called eup or myeon in Korea) in Chungcheongbuk-do. The results demonstrated the differences of amenity values as living conditions or tourism conditions.

## **Geographic Information Systems**

### **Analyzing the Spatial Centrality of Rural Villages for Green-Tourism Using GIS and Social Network Analysis-Focusing on Rural Amenity and Human Resources**

*Sang-Hyun Lee, Jin-Yong Choi, Seung-Jong Bae, and Yun-Gyeong Oh, Korea*

The aim of this study is to analyze the green-tourism centrality considering spatial interaction using Gravity Model and social network method. The degree centrality and prestige centrality were applied as green-tourism centrality index. The rural amenity resources and human resources were counted as attraction factors, and a distance among villages was used as friction factor in gravity model. The weights of rural tourism amenity resources were calculated using the analytic hierarchy process(AHP) method and applied to evaluate green-tourism potentiality. The distance

was measured with the shortest path among villages using geographic information system\_(GIS) network analysis. The spatial interaction from gravity model were employed as link weights between nodal points; a pair villages. Using the spatial interaction, the degree-centrality and prestige-centrality indices were calculated by social network analysis and demonstrated possibility of developing integrated green-tourism region centered on high centrality villages.

#### **Study on Approaches of Land Suitability Evaluation for Crop Production Using Geographic Information System**

*Li Linyi, Zhao Jingyin, Yuan Tao, and Liu Zhaoli, China*

In this paper, an approach to assessing ecological suitability of crop growth was developed using GIS, through a case study of maize planting in Jilin Province, in the north-east of China, in order to improve the accuracy and objectivity of the evaluation and promote the rationality of crop distribution and increase the efficiency of the agro-resource utility. Climate and soil conditions in the region were taken into consideration in the research. The crop potential productivity under the climatic condition of 46 meteorological stations in the region, namely photo-temperature-water climatic potential productivity, were calculated based on the meteorological data of the precipitation, temperature, wind speed and sunshine hours from 1980 to 2006, and used as index to evaluate the climatic suitability for crop growth. The point data were interpolated in a GIS environment and formed climatic suitability map. The assessment of soil suitability for crop growth was derived from soil fertility map drawing on the basis of information on 12 parameters, such as terrain, depth of soil body, thickness of black earth, soil erosion and organic matter. The ecological suitability map is completed using methods of spatial overlay in GIS. Comparing with the crop yield map that based on the statistical yield of 30 years in every county, the result of ecological suitability assessment is consistent with the yield. So this method is feasible to assess the ecological suitability in the region.

#### **GIS-based Impact Assessment of Climate Change for Cropland Suitability in Korea**

*Min-Won Jang, Suk Young Hong, and Yi Hyun Kim, Korea*

The purpose of this study is to estimate the amount and the distribution of agricultural water demand according to the change in crop suitability caused by global warming. Over the past thirty years, the annual mean temperature has risen by

0.7 Celsius degrees and by 1.4 Celsius degrees just during winter season in South Korea. The change in meteorology affects crop cultivars, the spatial distribution, the growing season, and so on, and it leads that cryophilic crops are shifting to northern area and crops preferring at high temperature are being adopted instead. This rushing and unfamiliar transition in agricultural environment throws the conventional farming system into confusion. Particularly on agricultural water management, the capacity and the management rules of irrigation facilities are required to be rearranged adapting to the varying environment, and so quantitative analyses on crops fit for cultivation and water balance change have to be prioritized. Hence, this study proposed the process of land suitability evaluation for crop and water demand estimation using GIS. Crop suitability was evaluated with the spatially interpolated surface temperature map and detailed soil map(1:25,000 scale) of the National Academy of Agricultural Science of South Korea, and the temporal and spatial distributions of water demand are supposed to be investigated with the suitability maps for different upland crops including cabbage and red pepper in the end.

### **Precision Agriculture & Wireless Sensor Networks**

#### **Designing, Modeling and Controlling a Novel Autonomous Laser Weeding System**

*E. S. Nadimi, K. J. Andersson, R. N. Jørgensen, Jørgen Maagaard, Solvejg Mathiassen, and S. Christensen, Denmark*

In this paper, the process of designing and developing a novel laser weeding test setup is explained. The main purpose of designing this system was to simulate the dynamic field conditions of a mobile vehicle capable of targeting weeds. This system consists of a rig containing three conveyor belts fully controlled by a Siemens PLC controller (programmable logic controller), a stereo vision system consisting of two cameras, a 2-axis laser beam deflection unit and a laser source. The main challenge in this project was to accurately estimate and reconstruct the weed growth center using the stereo vision system. The growth center was then targeted by a laser beam controlled by a deflection unit. The preliminary test results showed a good performance of the system than can replace usage of herbicides.

## **Development of a Novel Safety System for Remote Plant Nursing Robots**

*Jakob J. Larsen, E. S. Nadimi, and Palle Hermansen, Denmark*

In order to find a system that can localize the operator of a large remote controlled vehicle, the combination of the ESPAR antenna and the MUSIC algorithm is tested. The ESPAR antenna is a single port compact antenna that can be used for beam forming or as in this case for angle of arrival estimation. The basic principle behind the antenna is explained. The modified MUSIC algorithm is also explained. To test the performance of the system simulations were made. The simulations showed it to be possible to achieve accuracy less than 1 degree. It is concluded that the system is suitable for localizing the operator and improve safety when working around large remote controlled vehicles.

## **Simulated Slopes on a Test Rig Based Evaluating Continuous Cereal Yield Metering Accuracy**

*Sanaei, Akbar and Islamic Azad, Iran*

Yield mapping as a prerequisite of “precision farming evolution” needs more both field and laboratory investigations for wide varied slope effect based crops combining as an important influenced factor. Naturally, optimised precision and accuracy of continuous crop yield metering on combine harvesters requires more detailed studies on points such the field-slope variations which affect not only on soil characteristics and in-field spatial crop yield but it is a serious problem to measure the reliable continuous spatial variable yield variations during combine harvesting. Author through his practical studies conducted at Nafferton research Farm of Newcastle University in UK found out very varied topographic aspects. Previous author’s experiences in both workshop and fields showed that the slope affects accurate yield measurement through combining crops (Sanaei, A. 2008) and then the research was extended to design and construct a test rig using clean grain elevator’s parts of Class Combine for more controlled fruitful trials by simulating varied slopes (pitch and roll) in workshop site. Today, there are only a few harvester combines with installed full package of yield meter kits equipped with a slope (Pitch and Roll) sensor as well. These studies showed that the accuracy of Ceres2 also may be improved by addition of an optional hillside slope sensor. It measures the angle of side-slopes and the instrument will correct the yield measurement for the effect of the slope sensor location. This paper examined and analysed data of multidimensional detailed wide range of slope effects between 0-15 degrees on measuring yield

through accessing to algorithmic models by installing previous version of Ceres2 yield meter on constructed test rig which showed comprehensive results including significant differences on yield meter accuracy.

## **Topology of a Network for Wireless Transmission of Data for Use in Precision Agriculture**

*Alex L. Guedes, Maria B. de M. França, José A. de França, Marcela H. Koyama, and Marcelo G. Canteri, Brazil*

Weather conditions influences the plant disease progress. Precision agriculture, besides variability of soil, could measure meteorological variables like wetness and temperature for monitoring plant pathogens infection periods. This assessment is carried out in many points of crop area and data set could be sent remotely to a device called “coordinator”, using a cable as transmission line. However, a cable network in a crop area has a high cost and presents operational difficulties. The objective of this work was to develop a wireless data communication between meteorological stations. The “coordinator” device has total control over the network. It asks for data to be transmitted and which station will receive the data, creating a communication system type question/answer. The network also incorporates the multi-hop concept, where the data do not need to be transmitted directly, but through routers, increasing the depth of the network. This logic was implemented through the local address of each device. Prototypes of meteorological stations using microcontroller were built to tests the system. The results showed that the network work satisfactorily when the distance between meteorological stations was 1800 meters or less. This enables them to be installed throughout a crop area.

## **Study and Development of an Integrated System for Slurry Management Monitoring and Electronic Reports Drawing up in Cattle Breeding**

*F.M. Tangorra, S. Nava, E. Beretta, and M. Lazzari, Italy*

Over some years a new concept, identified as “precision farming”, was introduced to improve field and farm management from agronomical, technical, environmental and economical perspectives through the use of new technologies, such as global positioning systems (GPS), sensors, satellite images and geographical information systems (GIS). Environmental and food safety regulations are becoming more and more hard-and-fast asking farmers to increase their organizational and technical skills for a well-integrated agro-territorial management. Aim of the research

activity was the implementation of an integrated system for animal slurry management monitoring and electronic reports drawing up in cattle breeding in order to optimize the fertilization management and reduce the agricultural impacts. The developed system was based on the integration of the following mechanical, electronic and computational components: 1) slurry production control subsystem, based on ultrasound sensors applied to slurry pits and pressure sensors applied to a slurry spreader; 2) slurry spreading subsystem, constituted by an electronic card specifically developed and by a GPS/GSM device applied to tractors, able to automatically recognize the linkage with a slurry spreader and to notice its position on field; 3) recording and spreading data visualization subsystem, based on a GIS able to elaborate slurry distribution maps with relative distributed quota and spreading periods; 4) palm PC with a specific software (FarmWorks®) for field operations recording and data transfer to farm PC; 5) management software (FarmWorks®) for field data filling and electronic reports drawing-up. The developed system, tested in a Northern Italy farm during 2008, has shown full functionality enabling to monitor animal slurry management (storage, collecting, spreading) and to optimize agricultural operations and fertilization management under an economical and environmental point of view.

#### **Advanced Distributed Monitoring System for Agriculture Based on Wireless Sensor Network Technology**

*Luca Bencini, Giovanni Collodi, Davide Di Palma, Antonio Manes, and Gianfranco Manes, Italy*

Nowadays the precision farming concept is often related to new technologies, developed to give detailed information to improve farming production, while preserving the surrounding environment from a rash use of water and pesticides. To this aim, a fully distributed control of the environment must be provided, in addition to user friendly tools for data analysis. The integration of distributed sensors' networks, embedded computational units and intelligent user interfaces result as one of the newest and smartest solutions for precision agriculture. Using smart distributed sensors and implementing data fusing and mining algorithms the final user is enabled to access real time data, and, undertake appropriate actuation strategies, via Internet, anytime and everywhere worldwide. This paper describes a successful application of the above concept in a challenging environmental monitoring context, concerning the remote management of a vineyard. A real case study concerning the deployment of four pilot sites in four different vineyards

located in Italy, Chianti region, and in France is reported. The deployed systems, operating since 2005, exhibit unprecedented stand-alone operation capability, with millions collected data so far, thus representing the state-of-the-art in the application of this technology to wine production management. The systems, far beyond being a simple technology demonstrator includes advanced agronomic prediction models capable of supporting critical management decisions in irrigation and chemical treatment management at unprecedented time/space scale. In addition the VineSense system represents the first distributed monitoring system for agriculture, based on wireless sensor network technology, correlating plants' physiology to water management and soil retention capacity.

#### **Monitoring and Classifying the Behavior of a Herd of Sheep Using ad hoc Wireless Sensor Networks and Artificial Intelligence**

*E. S. Nadimi, R. N. Jørgensen, V. Blanes-Vidal, and S. Christensen, Denmark*

An in-depth study of ad hoc wireless sensor networks applied to monitoring the behavior of a herd of sheep in the field was carried out. Herd motion data such as head movements were monitored by IRIS motes and MTS310 sensor boards equipped with a 2-axis accelerometer in a multi hop wireless sensor networks. Acceleration measurements were transmitted through a wireless sensor network based on ZigBee (2.4 GHz) communication protocol. After data filtering, the measurements of the head movements were used to classify the animal behavior into two classes as grazing and non-grazing. Taking the advantages of artificial neural networks compared to the other classification methods into account, a standard two-layer feed-forward network was preferred. The neural network was constructed and trained based on the measurements of the head movements of some of the animals in the herd and was used to predict the behavior of other animals in the herd. The classification results showed the possibility of determining a general decision rule which can classify the behavior of each individual in a herd of animals. The results have been confirmed by manual registration.

#### **Wireless Sensor Network to Estimate Streamflow in Channel Networks**

*Christian Correa, Diego Rivera, and Sergio Villagrán, Chile*

This paper addresses the development and the implementation of a wireless sensor network for in situ

streamflow estimation in irrigation channels using gauging station network and transmission technologies. For short-range data transmission we used technologies under ZigBee<sup>®</sup> protocol, and for long-range transmission we used FHSS technology. We show in detail the hardware and ad hoc software development. The information is stored in a MySQL database and hosted on a local server for access through a Web platform. The data records are displayed in tables and Google Maps<sup>®</sup> for its spatial location. In preliminary tests, the sensors proved to be highly robust in the communication, as well as in speed, usability and accessibility to the system.

#### **Wireless Telemetry for Livestock Condition Monitoring**

*Kae Hsiang Kwong, Hock Guan Goh, Tsung Ta Wu, Bruce Stephen, Craig Michie, and Ivan Andonovic, UK*

The challenges faced by modern agriculture have never been greater. With feedstock and labour prices increasing and constant pressure from retailers to keep food prices low, profit margins are at a point where farmers cannot grow their business to longer-term economically viable sizes. Recent high profile welfare threats such as the BSE and Foot and Mouth outbreaks in the UK have further weakened the financial positions of many in the industry. This paper examines the application of WSNs to livestock monitoring and the issues that accompany the timely reporting of animal health or welfare conditions to farm management. The focus lies mainly on the challenges stemming from data transportation from cattle mounted sensory devices in particular and maintaining sensory node support independent of animal mobility. The core of this study is to overcome the aforementioned drawbacks by using alternative cheap, low power consumption sensor nodes capable of providing real-time communication at a reasonable hardware cost. In this paper, both the hardware and software has been designed to provide a solution which can obtain real-time data from dairy or beef cattle whilst conforming to the limitations associated with WSNs implementations.

### **Traceability, Food Safety and Marketing**

#### **Effects of Antenna Position on Readability of RFID Tags in a Refrigerated Sea Container of Frozen Bread at 433 and 915 MHz**

*M. Laniel, J.P. Emond, and A.E. Altunbas, USA*

Perishable foods are frequently exposed to temperature

abuse during transportation and distribution. The use of traditional data loggers do not permit the instantaneous data transmission that radio frequency technology offers. Temperature has a major impact on food quality and safety, particularly when long transit times are imposed by sea transportation. Consequently, using RFID (Radio Frequency Identification) to track perishable shipments and monitor their temperature will bring significant benefits to the cold chain, and will evidently result in healthier and safer goods. The goal of this study was to determine the optimal RF antenna placement inside the sea container to achieve total readability of the RFID tags present. Testing was made at two different frequencies (915 and 433 MHz) while the refrigeration unit was running at -25°C and the container was loaded with 16 pallets of frozen bread. The sea container was instrumented with 8 RFID antennas, three of which were tuned for 433 MHz and five for 915 MHz. All antenna wires were running outside the container. The RFID readers were connected to their respective antennas, one at a time. Thirty eight RFID tags were evenly distributed onto the pallets of frozen bread. All RFID tags were active tags capable of reading and recording temperature. Results at 915 MHz showed readability levels between 47% and 79%, with an average of 68.4%, whereas 433 MHz demonstrated 100% readability at all antenna positions. In conclusion, the 433 MHz RFID system appears suitable for real time temperature monitoring of frozen bread inside a sea container. This technology could be applied to other food items similar to frozen bread.

#### **Quality Assurance and Traceability of Foods of Animal Origin – Major Findings from the Research Project IT FoodTrace**

*Reiner Doluschitz and Barbara Engler, Germany*

Based on the information needs of stakeholders (from animal feed to consumers, including the authorities and organizations involved) an integrated IT-system without structural fractures and barriers shall be developed. It will be designed to enable the merging, internal exchange and utilization of relevant data and parameters. Subprojects of the interdisciplinary research consortium cover the entire supply chain and also address cross-section issues, such as logistics, costs and benefits, veterinarian services, quality assurance systems, a comprehensive IT-solution including data format standards (agroXML), and requirements for sustainability. Substantial added value has been generated from intensive interdisciplinary co-operation. The interdisciplinary research project IT FoodTrace ([www.itfoodtrace.de](http://www.itfoodtrace.de)) aims at achieving traceability and

quality assurance along the food chain of “meat and meat products”. The aim this paper is the presentation of a) the complexity of underlying problems, b) the project structure, c) available results from selected sub-projects and d) the added values from interdisciplinary co-operation. Selected findings include an optimized single animal data collection and information management in livestock systems, benefits gained by linking animal-health-related information to an integrated animal-health system, requirements and features of an integrated IT-System, including consequences for data protection and security, and findings from a Delphi-based cost-benefit-analysis of an integrated quality assurance and traceability system.

#### **Study and Development of an Integrated Automatic Traceability System for the Bovine Meat Chain**

*S. Nava, F.M. Tangorra, E. Beretta, and M. Lazzari, Italy*

In Italy, the bovine meat production chain is extremely complex both under structural and organizational profile. This is due to: high number of operators involved; large fragmentation in agricultural and industrial phases; existence of remarkable import flow of animals and meat; commercial channels complexity. Traceability can be easily reached in each single separate step of the food chain (breeding, slaughtering, packaging and selling). Problems arise in integrating each productive process subsystem. Aim of the project was to study and develop an integrated automatic traceability system for the bovine meat chain based on RFID technologies. RFID tags were used to identify: 1) animals; hooks used in the slaughtering for the carcass transport and storing; 2) anatomical cuts; 3) -flags for counter display. RFID readers were installed at: 1) farm livestock gates; 2) slaughtering entrance; 3) each working station in the dissection area; and 4) stock rooms. All the system was controlled by using a software divided into three main sections for the: livestock; slaughtering; stock room/shop. The system entailed the following phases: 1) Animal ear tag reading at farm level to identify and to record each productive step in the “Titvlvs” software; 2) Animal Ear tag reading through fixed antenna in slaughterhouse standstill corridor to send information to management software; 3) Animal Ear tag and hooks microchips combining in the evisceration area; 4) Carcass number attributing and label writing in weighing area; 5) Recording of carcass entry in dissection area, by using a photocell-spar system which identifies hooks; 6) Rewritable microchip adding in each vacuum-packed anatomical cut; and 7) Every selling action recording, in the store/shop area, by using weighting systems

connected to a web software able to perform a return control on the sold meat. The system was used in a cooperative productive organization of Northern Italy. Tests showed the functionality of the different components and the whole integration of the subsystems.

## **Decision Support Systems**

### **A Web-based Decision Support System for Surface Irrigation Design. Software Development**

*José M. Gonçalves, André P. Muga, and Luís Santos Pereira, Portugal*

This paper presents the Web-based decision support system SADREG for design and selection of farm surface irrigation systems: furrows, basin and border irrigation. The design component applies database information and produces a set of design alternatives in agreement with the user options through several simulation and computational tools. The selection component applies multicriteria analysis to rank those alternatives. Comparing with the conventional stand-alone PC-program, an Internet application has a larger flexibility enabling the access by users worldwide, particularly in areas where expert technical support for surface irrigation improvement is more incipient. Moreover, it allows an easier transfer and share of knowledge and tools to improve the procedures of irrigation design. The Web SADREG application includes the Web module that creates the user interface, data fluxes, showing numerical and graphical data, and the simulation engine, which runs the simulation models on the server. The development applies the PHP and C++ languages to achieve a better flexibility and to minimize client system requirements and SQLServer for data storing, thus allowing a simultaneous connection of several users. During the simulation process the users are informed about the input parameters, the design process and the output. An online help and information about irrigation equipments and guidelines for a good irrigation practices is available. This approach results on a better service quality, avoiding package installation and is more versatile to upgrade and to integrate other data and models. This software, available on <http://sadreg.safe-net.eu> Web site, is currently being tested.

### **A Website for Delivering Key Date Information to Farmers in Support of Legal Compliance**

*M. Hennessy and N.M. Holden, Ireland*

A DSS designed to support farmers participating in the Rural Environment Protection Scheme to remain compliant with legal requirements is described. There are 38 universal critical dates (e.g. "March 1st Bird nesting, hedgerow maintenance prohibited") and many farm plan specific dates (e.g. "shed painted by end of May 2009"). Farmers can incur financial penalties for non-compliance with key dates. Farmers register through a web site and provide farm plan specific information to the system. Thereafter the farmer receives reminders by SMS to a mobile phone on or before the key date. Some key dates have multiple messages delivered at various different stages warning of forthcoming events. The system also provides calculation explanation for targets set out in the farm plan and links to legislation documents that govern the scheme. This paper describes the dynamic web based system development and deployment. After trials with sample users of the system, it was concluded that there was a need, a demand and a place in the Irish farming community for such decision support systems. As implemented the DSS uses technology already adopted by the farming community, which was key to the successful deployment.

#### **From CyberBrain to Q&A Services: A Development of Question-Answering Services System for the Farmer through the SMS**

*Asanee Kawtrakul, Mukda Suktarachan, Patthrawan Rattanamane, Patrick Saint Dizier, Sudarin Rodmanee, Saovakon Laovayanon, Decha Jenkollop, and Anan Pusittigul, Thailand*

The Question-Answering Services System proposed in this article is designed to help farmers to get advices on SMS. It operates on top of search engines or on classical textual database querying tools by providing a layer that has natural language understanding and generation functions as well as some reasoning capabilities in order to provide users with responses. This is particularly crucial when there is no straightforward response. In this paper, we show how annotation guidelines can be developed to model the semantics of "What", "Why" and "How" queries and "Answer" in texts based on semantic roles. Finally, we show how these annotations and inference rule contribute to the generalization of the matching system over semantic categories in order to have a large scale question-answering system.

#### **The Linear Programming Module of CAPRICORN Package: A Windows Program for Formulating and Evaluating Rations for Goats**

*A. Ahmadi and P.H. Robinson, USA*

CAPRICORN is a package of least cost computer ration formulation programs for dairy and meat goats. The formulation engine of this program consists of a linear programming module based on the animal nutrient requirements and feed nutrient analysis in the US National Research Council Bulletin entitled 'Nutrient Requirements of Goats' (2007). The linear programming module is written in C++ programming language and can be re-used for other ration formulation programs. This paper describes some of the features and functions of the linear programming module.

#### **Selecting a Cattle Food Supplier as a Group Decision-Making Problem**

*Zorica Srđević, Snežana Trivunović, Bojan Srđević, and Tihomir Zoranović, Serbia*

Paper presents the result of a scientific experiment in which two multi-criteria decision-making tools are used for solving typical agricultural problem: selecting a cattle food supplier in presence of conflicted criteria. Decision makers who took part in this experiment came from different interest sectors (food industry, science, academy and private ownership), and they expectedly demonstrated different attitudes, interests and evaluation capacities. Four recognized national animal food suppliers are evaluated with respect to their performance in offering acceptable costs, food quality, supply reliability, prestige on the market and payment conditions. Decision-making methods involved are Compromise Programming and TOPSIS. A social choice method Borda count is used to aggregate individual rankings obtained by the decision makers into the group decision. Combination of multi-criteria and social choice methods described in this work at proof-of-concept level recommends itself as a trustful practice in related agricultural business.

#### **Development of Decision Support System for Sustainable Crop and Water Management in Rainfed Areas in the Philippines**

*Orlando F. Balderama, Philippines*

An integrated computer program called Cropping System and Water Management Model (CSWM) with a three-step feature (expert system-simulation-optimization) was developed to address a range of decision support for rainfed farming i.e. crop selection, scheduling and optimization. The system was used for agricultural planning with emphasis on sustainable agriculture in the rainfed areas through the use of small farm

reservoirs for increase production and resource conservation and management. The application of the model was carried out using crop, soil, and climate and water resource data from the Philippines. Primarily, four sets of data representing the different rainfall classification of the country were collected, analyzed, and used as input in the model. Simulations were also done on date of planting, probabilities of wet and dry period and with various capacities of the water reservoir used for supplemental irrigation. Through the analysis, useful information was obtained to determine suitable crops in the region, cropping schedule and pattern appropriate to the specific climate conditions. In addition, optimization of the use of the land and water resources can be achieved in areas partly irrigated by small reservoirs.

#### **Interfacing CCFARM Simulation Engine with Microsoft Excel's VBA Engine to Generate On-Demand Outputs**

*J. W. Oltjen, A. Ahmadi, A.J. Romera, and D.J. Drake, USA*

CCFARM is a computer program for simulating cow-calf herd dynamics over a long time horizon. One difficulty for most research-oriented simulation systems is its output interface which is written to be used by the researcher and not by ranchers. The PCRANCH software package addresses this problem by decoupling CCFARM from its research-oriented output interface and coupling it with a friendlier rancher-oriented output interface using the VBA (Visual Basic for Application) utility of Microsoft Excel program. This approach allows creation of on-demand outputs using the chart wizard of the Excel program.

#### **Objective Evaluation of Walnut Cultivars by the Analytic Hierarchy Process**

*Zorica Srdjevic, Bojan Srdjevic, and Kosana Suvocarev, Serbia*

The walnut cultivars selection, supported by computerized multi criteria decision-making tools, has been initiated in Serbia 10 years ago. Recent case studies proved that Analytic Hierarchy Process (AHP) is a tool capable to integrate biological and technical aspects of the selection process and to link the expertise and standardization in fruit selection in general. AHP also performed very well in group contexts. In real-life AHP applications walnut experts liked to participate in computer-based decision-making sessions and commented that sessions were user-friendly and that derived weights, as global AHP outcomes indicating the walnut nuts' quality, are of trustful reliability. However, analysts have been aware that experts' opinions are based mostly on personal feelings about what they expected as the outcome of AHP session. To

develop more objective approach, an original AHP prioritization method, eigenvector method (EV), which has been used in former applications to derive weights of compared decision elements, is compared with other two well known methods. Leading idea was to check which method produces 'objectively trustful' weights, i.e. assures best consistency and coherency, minimizes violation criteria, and all this - regardless of experts' opinions. Two prioritization methods used along with eigenvector method are the logarithmic least square method (LLS) and fuzzy preference programming (FPP) method. Weights obtained by different decision makers are tested on consistency and it was shown that one of the two methods in some aspects outperform eigenvector method. Conclusion derived is that in real-life AHP applications an objective interpretation of results is necessity and that this can be achieved if several prioritization methods are used on competitive basis. Example includes 2 experts, 5 national and foreign cultivars and 7 criteria: kernel's color, kernel's portion, nut's weight, taste of the kernel, shell, storage quality, and trade value.

### **Adoption, Extension and Rural Development**

#### **The Open Academy for Philippine Agriculture (OPAPA): Enhancing Extension Services to the Farmers of Northern Philippines through Information and Communication Technologies (ICT)**

*Orlando F. Balderama, Philippines*

This paper presents a study on various ICT modes tested by the Open Academy for Philippines Agriculture (OPAPA) in Northern Philippines in bringing timely information to the farmers. There were five ICT intervention employed as follows: 1. Farmers' Internet; 2. Farmers' Text Center; 3. Mobile Internet Cab; 4. e-content and; 5. ICT trainings. Extension workers and farmers are given access to the internet to be able to solve the problems in the field. Farmers also get information and consult experts thru the farmers' text center. The mobile internet cab is used to build awareness on ICT and train farmers on basic computer operation in the villages. Building up localized e-content is the key factor for ICT applications in agriculture since these are the information eventually disseminated to farmers and extension workers. The above interventions were piloted through a network called "Isabela cyber community" composing of a farmer's group, a local government unit (LGU), the Philippine Rice Research Institute and Isabela State University as knowledge centers. The ICT extension delivery

modes introduced and tested were found effective and practical and now gaining popularity not only in the pilot site but nationwide. As a result more farmers are benefiting on these ICT services.

### **The e-readiness of Hungarian Farmers**

*Mihály Csótó, Hungary*

Information and Communication Technologies (ICT) can contribute to rural economic and social life through numerous applications and reduce the deficit caused by mainly the geographical isolation. ICT can play a crucial role to make farms more competitive and to live up to the expectations of modern life and competitiveness. This facts are extremely relevant in Hungary, where rural areas cover 87% of the territory of the country and are inhabited by 45% of the population. Agriculture also a significant part of the economy of the country: more than 200 000 active, registered farmers are in Hungary. The majority of those farmers are in the wrong side of the so called digital divide, because of there rural background, their age or education. The digital exclusion in Hungary is a real factor. Sixty percent of the adult population is digitally illiterate, and moreover, the majority of the excluded do not have a direct connection with characteristic tools (computers and the Internet) or with people who use them on a regular, daily basis. These numbers are valid or a bit worse if we take a look at the farmer community. There are some governmental and civil programs to narrow the divide, but up to this point their focus was on the infrastructure. The results of recent surveys show that the lack of motivation and interest are also a huge factor and a significant part of the population is not aware of the advantages they can obtain from the digital world.

### **Web Customer Care: An Empirical Analysis of Italian Wine Companies**

*Riccardo Vecchio, Italy*

The promises of the Internet as a platform to reach new outlets, markets of global dimensions, intimate customer relationships, low cost and streamlined distribution chains have largely been disappointed in the wine industry. The current work used a typical e-mail commercial survey to investigate web customer service offered by 300 wine companies across Italy. The final outcome was an overall 55% response rate. Among these firms there was a clear difficulty in providing timely and informative e-mail responses to their customers. Specifically, only 18% replied within 4 hours, 37% taking into account answers given within 12 hours. The

results also exemplify significant differences in e-mail customer service, based on the business location. The poor responsiveness and quality of the information provided by many wine companies illustrate that better web policies and training would give these firms an immediate competitive advantage via improved e-mail customer service.

### **Rinfo- a One Stop Information System for Rural Development– a Prototype**

*J. Adinarayana, D. Sudharsan, and A K Tripathy, India*

The proposed paper focuses on developing a new approach to provide rural information service with experts' interactive system, to the rural extension community. The proposed portal tentatively we named as Rinfo1, which is using open source/free, tools such as PrimaGIS, GRASS, OpenJUMP, MapServer and GeoVISTA Studio for Geovisualization of sensor data and Plone as a Content Management System (CMS) and Skype for Interactive Voice System (VIS). Our aim is to give a cost effective, robust rural information system with expert interactive service to the rural extension community to assist for better and mutual decision making in omnipresent manner. Rinfo1 provides (1) Land Information (LI) which will give both on parcel and non-parcel basis information, (2) Agriculture Information (AI) about crop and pest management aspects at different levels of admissible spatial limits and (3) Watershed Information (WI) to support in thematic information raster and vector modes, on watershed basis. It is also proposed to utilize Wireless Sensor Network (WSN) for providing online information service on dynamic weather, agriculture and its related information to the rural community as a part of Indo-Japan GeoICT and Sensor Network project. Based on the WSN entity, plan to generate the sensor database and its corresponding thematic maps to monitor/mitigate/protect abrasive weather/agriculture systems. Rinfo1 integrating with Multi Evaluation Decision Support System (ME DSS) for enhances judicial decision making spatial and non-spatial querying entity. Plans are also afoot to provide rural information service through Village Resource Centre (VRC) in a typical semi-arid tract in India.

### **Brand-Variety Performance Information System for Crops in India: A Study and Design for Cotton**

*Vasant P. Gandhi, India*

Cotton is a major cash crop in India and is grown in many parts of the country under rainfed as well as irrigated conditions. India is among the largest producers of cotton in

the world (after China and USA) but its productivity is very low in India. A major reason is the pest problem which is among the worst in all crops. The main pest is boll worm and the highest amount of pesticides among all crops is used on cotton to control this and other pests – often with little success. A spate of suicides by cotton farmers in the country is seen largely linked to this. Cotton cultivation had become uneconomic in many parts of the country due to the high cost of pesticides and the low yields. The introduction of pest resistant Bt cotton took place in India in this background in 2002 after much government hesitation. The crop has become the front runner in biotechnology introduction in the country but the farmers have to make tough variety decisions.

## Farm Management

### **Managing My Total Acre: An Integrated Systems Approach to Farm Management**

*Pradip K. Das, Beth A. Holmes, and Greg E. Knoblauch, USA*

With the recent advances in agricultural science and technologies, combined with the ever increasing demand for real-time actionable information on the field, times have never been more propitious to incorporate a more integrated systems approach to agricultural farming. This paper presents description of the current on-farm information needs and potential ways of addressing these through the adoption of new technologies and best practices - resulting in enhanced agricultural productivity, profitability and sustainability.

### **The Role of I-SCADA System and Specialized Software in Energy and Water Efficiency on a 104 Square km<sup>2</sup> (40 ml<sup>2</sup>) Large-Scale Drip Irrigated Agro-Forestry Farm, USA.**

*Nabil Mohamed, USA*

In the semi-arid Pacific Northwest of USA, where less than 20 centimeters (8 in) of total annual precipitation occurs, exists the world's largest contiguous drip irrigated farm of 10 360 hectares (25 600 acres), managed by Greenwood Resources Inc. and known as the Boardman Tree Farm (BTF). On this farm, 10 000 000 fast-growing Pacific Albus (Hybrid Poplar) trees are irrigated by a massive and complex automated water distribution system. Irrigation pumping energy is a major crop production cost, so a very aggressive and determined effort is made to operate the irrigation system efficiently and cost effectively. Some of the practices are the use of innovative design for closed-loop drip irrigation system, Advanced Scientific Irrigation Management (ASIM),

automated soil moisture sensing and the use of one of the most advanced and sophisticated Irrigation Supervisory Control and Data Acquisition (I-SCADA) systems in the world. Additionally the use of an original and innovative methodology incorporating a customized Advance Hydraulic Balanced Irrigation Scheduling (AHBIS) computer program, for smooth and steady multiple pump stations hydraulic operation. With the impressive use of innovative computerized irrigation water management methodologies, together with precise and accurate automated application of irrigation water quantities, the Boardman Tree Farm achieves astonishing high overall on-farm irrigation efficiencies. The Boardman Tree Farm offers a show-case example where latest computerized technology and human ingenuity are utilized to drip irrigate vast areas of semi-arid land, while minimizing the use of scarce water and energy resources and still maintaining a eco-friendly sustainable rate of fiber production. On a global scale, the Boardman Tree Farm can help foster global advancement of large-scale drip irrigation projects that efficiently use water and energy to produce cost effective and sustainable eco-friendly production of Agro-Forestry crops and help mitigate effects of global warming.

### **An Agricultural Field Work Management System for Rural Farmers in Sri Lanka**

*P.K.S.C. Jayasinghe, Masao Yoshida, and Takemi Machida, Japan*

Information and Communication Technology (ICT) has created a new opportunity to increase the food productivity by introducing a number of online applications. The online agricultural information on the relevant crop to the field would be a great support for the rural farmers to make the decisions without delay. Moreover, timely application of agricultural fieldwork is necessary throughout the farming process and delaying fieldwork due to various reasons can reduce the agricultural production. A combination of internet and cellular phone technologies can be utilized to develop a crop information system. This system can be used to provide the latest agricultural information such as crop production, diseases, varieties, pesticide, irrigation, harvesting etc. Furthermore, the same system can be used as a simple and portable application to remind the expected fieldwork on time. The purpose of this application is to provide the agricultural information to the farmers who are in remote area of Sri Lanka. Internet enabled cellular phone is an appropriate device to use for this, because it is one of the most common devices used by everybody. To access some components of the system (latest crop information/fieldwork

reminding) farmers are required to be subscriber of this online service and during the registration; the farmer should specify the crop name. Therefore, the crop name will be the key word to find relevant information. System was designed to send most up-to-date crop information to the relevant user even without any reminding message. To develop this

system, MS Access database, ASP, HTML, VBScript, IIS web sever and some graphic application and WAP technology were utilized.