Proceedings of the
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"ICT's for future Economic and Sustainable Agricultural Systems"

Perth, Western Australia
29 September to 2 October 2014

Editors: Leisa J. Armstrong and Andreas Neuhaus

Editors: Leisa Armstrong

School of Computer and Security Science,
Faculty of Computing, Health and Science,
Edith Cowan University,
Mt Lawley, Western Australia 6060
Australia
Email: l.armstrong@ecu.edu.au

And

Andreas Neuhaus
CSBP
PO Box Box 345
Kwinana Beach Road
Kwinana WA 6966
Email: Andreas.Neuhaus@csbp.com.au

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Preface

The Australian Society of Information and Communication Technologies in Agriculture (ASICTA Inc) hosted the 9th Asian Federation for Information Technologies in Agriculture conference. The conference was organized by ASICTA, Edith Cowan University and CSBP and was held at Mount Lawley campus of Edith Cowan University, Perth Australia.

The conference was supported by Australian Centre for International Agricultural Research (ACIAR, Grains Research and Development Corporation, Food and Agriculture Organization of the United Nations, Global Forum of Agricultural Research (GFAR), ECU and CSBP .

Over the last few decades, several research and development efforts have been made to exploit the potential of Information and Communication Technologies (ICTs) to improve the efficiency of production in agriculture and to achieve sustainable development. Precision Agriculture involves identification, analyses and management of spatial and temporal variability in soils and crops for profitability, sustainability and protection of the environment. Precision Agriculture employs emerging technologies such as ICT; geospatial technologies such as Geographic Information Systems (GIS), Global Positioning Systems (GPS) and Remote Sensing (RS); Sensor Technologies and Wireless Sensor Networks (WSN).

This conference examined the role that ICT can plays in agricultural economic and environmental sustainability. The aim of the conference was to showcase how advances in ICT is leading to exciting developments in the delivery of knowledge to growers, researchers and agriculture industry in general. The agricultural sector is an important sector in the world economy and its sustainability is vital with increasing population growth and global environmental change. ICT has played a vital role in the push to deliver services to this industry and rural entrepreneurs.

Highlights of the conference included interesting sessions on precision agriculture and ICT applications, data mining, sensor networking. data mining , model optimizations, agricultural extension and agricultural value chains. There was also a grower's industry forum and workshops.

All participants including academics, researchers, practitioners, policy makers and farmers were invited to contribute, share, and disseminate their ideas, products, solutions, good practices or policies relevant to the topic and critical issues addressed in this international conference.

L. Armstrong
Conference Convenor

September 2014

Acknowledgements

The awarding of this conference would not have been possible without the support of the Perth Convention Bureau with a Professional Development grant to Dr Leisa Armstrong. The grant helped in the bidding of the 9th Asian Federation for Information and Communication Technologies in Agriculture at the last AFITA 2012 conference in Taiwan by ASICTA.

The conference would not have been possible without the tireless effort of the members of the eAgriculture Research group at Edith Cowan University or assistance with compilation of the proceedings and the running of the conference

Thanks must also go to members of the AFITA 2014 program committee who assisted with the blind reviewing of all papers.

Thanks to the School of Computer and Security Science at Edith Cowan University and CSBP for allowing Dr Leisa Armstrong and Dr Andreas Neuhaus to contribute their time towards the running of the AFITA 2014 conference.

The conference could have been possible without the support of ASICTA and other sponsors and organizers as mention in proceedings.

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Review of Papers

All papers submitted to the 9th Asian Federation for Information and Communication Technologies in Agriculture underwent a process of vigorous double blind peer review. Papers were sent for review randomly to members of the Program committee. The program committee consisted of experts in the field of Information and Communication Technologies and Agricultural Science disciplines.

Themes of Conference

Adoption of ICT for agricultural development
Sensor networks and agricultural applications
Precision agriculture
e-Agriculture and policy development
Farming information and management systems
Farm to market product tracking
Agriculture ontologies and the semantic web
Data mining for agriculture
Environmental monitoring and agriculture
Web-based and mobile farming advisory systems
Spatial information systems and resource management
Farming practices and climate change
Biotechnology and food quality
Optimization and modeling in agriculture
Sustainable agriculture
Agricultural systems and cloud computing
ICT and cropping
ICT and forestry
ICT and aquaculture
Greenhouse control systems
Artificial intelligence applications in Agriculture
Food security technology

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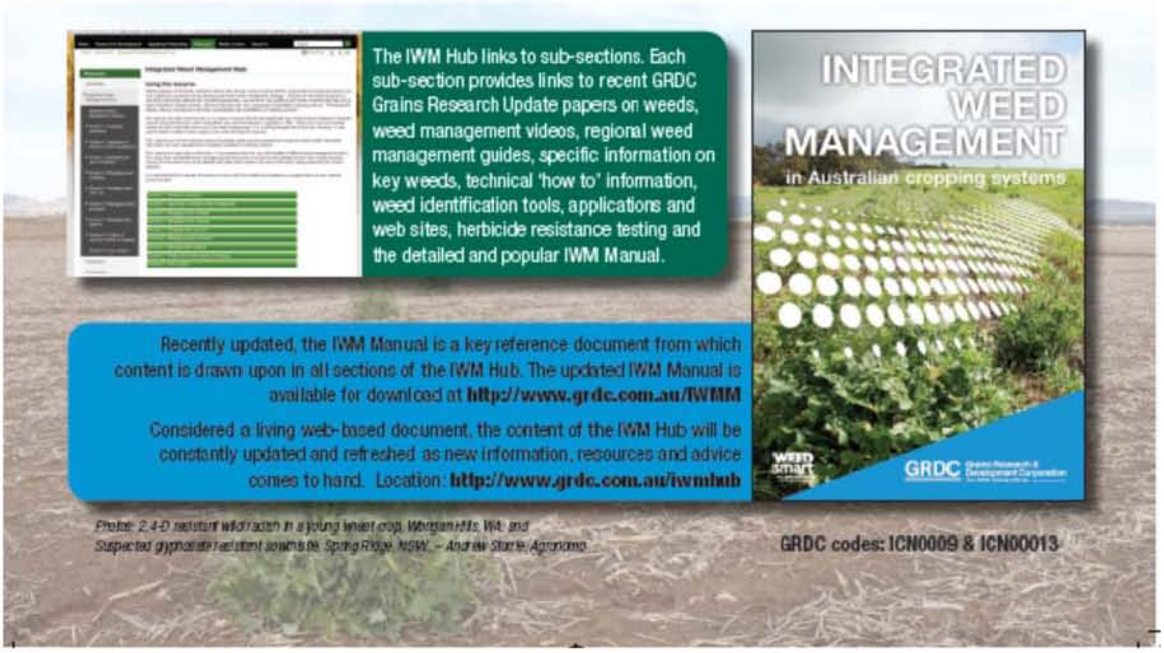
Grain growers and advisers across Australia are set to enter into a new long-term relationship with a partner they are being introduced to via the internet.

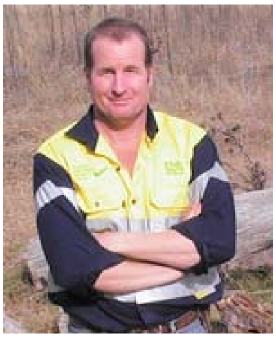
The Grains Research and Development Corporation (GRDC) has just launched a new Integrated Weed Management Hub that takes pooling of information and resources to another level.

The IWM Hub at http://grdc.com.au/iwmhub has been developed specifically to help Australian grains industry advisers and growers find the latest weed research and management advice quickly and efficiently.



Keynote Speakers

Professor David Lamb
Project Leader CRC for Spatial Information and Leader of Precision Agriculture Research Group at University of New England, Australia) (dlamb@une.edu.au)



The future of precision agriculture as it meets the internet of things (IoT)

The role of internet in agriculture is fast approaching a ‘third wave’; ‘Wave 1’ was connecting people to data via www (1990’s); ‘Wave 2’ was about connecting people to people, viz, Facebook and Twitter (2000’s); and ‘Wave 3’ will connect people to ‘things’ (2010-). Advances in wireless sensor networks (WSNs) coupled with in-situ, low-cost sensors of soil moisture, plant biomass and local climate conditions; the so-called ‘internet of things’, means our fields are set to become sources of high quality, local yet synoptic, real-time, biophysical data. This data is suitable to integrate with plant growth and water-nutrient flux models to quantify the growth and development of our crops and pastures in real time. Add to this intelligent and autonomous systems; both on ground and in the air to meet the needs of surveillance, timely management and improving workflow.

The future of PA future is inextricably linked to our ability to ‘connect’ farms via the internet. The recent review of NBN Co’s satellite and fixed-wireless programmes estimated the demand for high-speed internet in rural and regional Australia to be three times greater than originally anticipated only 6 years earlier. PA now, and certainly in the next 5 -10 years will be about our ability to communicate with, within and between farms. Connection and communication is the key.

Professor Fedro S. Zazueta
Professor in Agricultural and Biological Engineering at the University of Florida, USA.

Online Education in the XXIst century: Teaching and Extension

Information Technology (IT) has brought about a paradigmatic change to the delivery of educational materials in higher education and Agricultural Extension. This presentation focuses on the evolution of information delivery systems in this context, including vision, strategy, implementation and outcomes using the US Land Grant University System as an example, specifically the University of Florida. Key success factors, as well as a discussion of current IT drivers and their current and possible future impacts are presented. Finally, the importance of awareness of technological convergence and competency are discussed.

Dr Tim Wark,

Transformation Capability Platform Leader, Sensors and Sensor Networks (Computational Informatics, CSIRO Australia)

The role of information & communication technologies in increasing agricultural productivity

Productivity increases in agricultural enterprises are increasingly driven by the ability to reduce costs in the exchange of information or services, as well as improving the quality of information around which key management decisions are made. This talk will present an overview around key trends in emerging information & communication technologies and how these might impact the future of agriculture. The platforms described have the potential to greatly improve connectivity between the current state of the agricultural enterprise, its manager and a range of external service providers, experts, information sources, communities of interest, as well as markets both national and overseas. New business models will need to evolve which can take advantage of information which can be shared between multiple enterprises while still maintaining a competitive marketplace. These new technologies are expected to form the backbone of the next generation of agri-environmental service businesses linking data and translating it into insight.

Professor Gerhard Schiefer

Management Board Member, FoodNetCenter and Chair of Research Group "Food Chain Management" at University of Bonn, Germany schiefer@uni-bonn.de

Transparency for Sustainability: Food chain challenge and Future Internet opportunities

Transparency for sustainability covers a broad range of issues reaching from tracking and tracing along the chain (from farm to fork) to food safety and quality assurance, the consideration of environmental footprints of various kind, the matching of logistics with production and retail needs or the provision of appropriate information to consumers (forward information) and producers (backward information). As such it is a key success factor for the success of activities towards improvements in sustainability.

Reaching transparency is dependent on cooperation among all actors in the chain, on agreements on the information flow, on the appropriate transformation of information into signals the recipient can deal with, and on the availability of a suitable communication infrastructure based on networked devices and a communication network that is easy to use, fits the needs of small and medium sized enterprises (incl. farms) which represent still the vast majority of enterprises in the food sector, and is flexible enough to support dynamically changing trade relationships.

The presentation will touch the various aspects but concentrate on the communication infrastructure and ongoing efforts to overcome the traditional barriers in the establishment of broadly accepted communication networks (which do not depend on centralized data bases or centrally managed information systems) through concepts and development activities utilizing capabilities of what is called the “Future Internet”. It is initiated by a major research and development thrust of the European Union to better match upcoming technological developments in the digital economy with business sector needs, and specifically in the food sector, to improve transparency for sustainability within the chain and towards consumers.

Mr Matthew Regan

Grain Quality Manager, Consolidated Bulk Handling (CBH, Perth Australia)

Optimising the Western Australian grain industry

The CBH Group is Australia's leading grain business, operating a unique integrated supply chain from grower to customer. Owned and controlled by around 4,300 Western Australian grain growers, the core purpose of the CBH Group is to create and return value to growers. With a network comprising of 197 receival points and 4 Panamax port facilities spread across a grain growing area of 320,000 square kilometres, harnessing developments in Information Technology for the betterment of the business and value return to grain growers has always been at the forefront of the CBH Group's operations. Mat Regan, CBH Grain Quality Manager, will present on the key projects implemented by the Group in recent years to showcase the innovative ways in which the business has used information technology to optimise the WA grain industry to deliver real value to grain growers.

Professor Mira Pamplino (International Plant Nutrition Institute, SEAP Phillipines)

Nutrient Expert®: a decision support tool for smallholder farmers

Mirasol F. Pampolino*, Ping He, Kaushik Majumdar, Shamie Zingore, Thomas Oberthür, Adrian Johnston

Intensifying crop production will require crop and nutrient management strategies that produce high yields and improve farmers' economic benefits, while protecting the environment. Nutrient Expert® (NE) is an easy-to-use, computer-based decision support tool that can rapidly provide fertilizer recommendations for an individual farmer's field with or without soil testing results. It allows users to draw required information from their own experience, farmers' knowledge of the local region and farmers' practices. NE recommendations are based on yield response functions using the QUEFTS model and the principles of site-specific nutrient management (SSNM). Versions of Nutrient Expert® have been developed for different crops (maize, wheat, rice, soybean) in different geographies (i.e. Southeast Asia, South Asia, China, sub-Saharan Africa). NE development involved the use of agronomic data collected from field experiments, consultation meetings with local experts and stakeholders, and multi-location field validation. NE recommendations were tested against farmer’s fertilizer practice (FFP) and local recommendations (if any) during 2010-14 for maize in China, India, Indonesia, and the Philippines and for wheat in China and India. Agronomic and economic benefits of using NE were assessed at all sites. Environmental benefits were assessed at selected sites through determination of fertilizer use efficiency and estimation of global warming potential. For both maize and wheat, NE recommendations for N, P, and K varied across locations reflecting the differences in site characteristics and farming practices (climate, soil, cropping system, farmers’ yield and inputs, residue management, etc). NE increased fertilizer rates where farmers’ application were below optimal rates, and reduced rates when farmers over applied fertilizer. In India, NE recommendations increased grain yield and economic benefits in maize and wheat over the current farmers’ practices; similar trends were observed for maize in Indonesia and the Philippines. In China, where farmers’ yields are already close to the attainable yield, NE improved fertilizer N use efficiency by reducing N application while maintaining high yields. In northwest India, lower global warming potential has been indicated in wheat with NE-based recommendations than FFP. NE promotes balanced application of nutrients and efficient use of fertilizers by providing recommendations based on crop nutrient requirements tailored to a farmer’s specific yield goals and location-specific conditions. NE is effective in providing recommendations that can increase smallholder farmers’ yields and profits. NE also helps reduce potential environmental impacts from excessive or inefficient use of fertilizers. Field-validated versions of NE are available for download at software.ipni.net.

Dr Robert Fitch Senior Research Fellow with the Australian Centre for Field Robotics (ACFR) , University of Sydney, Australia

Field Robotics on the Farm

Over the last five years there has been a rapidly growing interest in the use of automated machinery and software processes amongst various agricultural and environment groups. The farm of the future will likely involve a 'system of systems' where teams of relatively small robots and sensors work together to collect information and perform mechanical tasks. In this talk, I will present our work in the development of robotics and intelligent systems for improving land and labour productivity of farms, and will provide examples from the broad-acre agriculture, tree crop, and vegetable industries. With better sensing, data analytics, and real-time control, robots will be able to collect vast amounts of precise information about the health and maturity of crops. This information, along with the automation of mechanical processes, will help to increase the efficiency of farming, leading to better yield and profitability. We will also start to see new capabilities such as variable rate planting and fertigation, minimal (if any) chemical usage, and selective harvesting. Through these advances, agricultural robotics has the potential to transform the way food is grown, produced, and delivered.

Contents

Oral Papers

Poster Papers (Abstract Only)

An Intelligent System For Early Detection of Food Crisis And Spatial-Based Decision Making of Potential Land Evaluation For Food Production.

Kudang B. Seminar[1], Yandra Arkeman[1] and Rakhmat J. Lahay[2],

1 Bogor Agricultural University (IPB) Indonesia, e-mail: kseminar@apps.ipb.ac.id
2 LPMP Gorontalo Indonesia

Abstract

Food crisis is now becoming critical issue in the global world and thus becoming a great challenge for many countries to cope with. In this paper we discuss the utilization of intelligent computation to support early detection of food crisis and spatial-based decision making of potential land evaluation for food production. The intelligent part of the proposed system comprises fuzzy logic, artificial neural network, and dynamic system models to cope with multi-criteria decision making for detecting early occurrences of food crisis and for examining the potential land for food production and food supply adequacy. The proposed system has been developed, implemented and tested with real data in Indonesia.

Keywords: food crisis, early warning system, multi-criteria decision making, spatial database.

Introduction

The common problem being faced globally is food crisis that may happen at any unpredicted time and situation. The impact of crisis is very critical and can introduce undesired situations such as hunger, diseases and catastrophe. Food crisis can be caused by several factors such as growth population, land decrease, raising cost of food production, climate change, economic problem, natural disaster, increasing needs of biofuels, and change of lifestyle. The perfect storm is that no single one of these causes, but a simultaneous occurrence of all nine of them. According to *New York Times* 19 January 2008, the prices of the sixty agricultural commodities traded on the world market increased 37 percent in 2007 and 14 percent in 2006. Corn prices also increased in the early fall of 2006 and within months had soared by some 70 percent. Rice prices have also risen over 100 percent in 2007 ("High Rice Cost Creating Fears of Asia Unrest," *New York Times*, March 29, 2008). The number of undernourished people due to the food crisis has declined but remains unacceptably high (FAO 2010).

Demand for information to devise policies and programs temporarily increases and policymakers discuss the need for strengthening data collection and surveillance systems and ensuring they address policymaking needs (ECA 2011). Some research work has addressed and proposed food crisis forecasting systems such as *agricultural production monitoring (APM), food and nutritional surveillance systems (FNSS), monitoring of vulnerable groups (MVG), market* *information system (MIS)*(FAO 2000*)* and MARS Crop *Yield Forecasting System (MCYFS*) (Baruth & Leo 2009). However, no system was developed to detect when crisis is starting to occur, and to detect whether the crisis is reaching an early, middle or chronic stage. Our paper proposes intelligent system for early detection of a food crisis occurrence and detection of potential land for food production based on preventive and curative approach scenarios.

Related Work

According to FAO (2010) food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. On the contrary, food insecurity exists when people do not have adequate physical, social or economic access to food. The situation of which food insecurity exists is called food crisis.

The Integrated Food Security Phase Classification (IPC) is a tool for improving the robustness, transparency, relevance and comparability of food security analysis. It was originally developed for use in 2004 in Somalia by FAO's (FAO 2010). The IPC includes five protocols: (1) severity classification and early warning, (2) evidence-based analysis, (3) linking to response, (4) core communication, and (5) technical consensus. The Food Security Information System (FSIS) has been developed to support monitoring of food security (**ECA 2011**). While mainly focusing on food supply, FSIS in the SADC region lack information about underlying livelihoods and assets, longer-term vulnerability analysis and poverty monitoring.

The use of spatial database technology to support food and energy security was developed to detect the potentiality of areas based on the status of bio-energy and food adequacy or index (Basuki et al. 2013). In this system land mapping optimization can be done to produce a map describing (i) forest areas, (ii) land areas, (iii) plantation areas, and (iv) agricultural zones for achieving optimal food and energy security. The System Approach to Land Use Sustainability (SALUS-WEBGIS) program has been developed to model continuous crop, soil, water and nutrition under different management strategies for multiple years based on a crop growth model and geographic information system (Chou et al. 2010). SALUS-WEBGIS enables the future multiyear simulation for land use sustainability as a one of critical supporting factors to support food security.

Development Rationale & Approach

The food crisis is seen to be critical issues in a global world context that introduces collective problems and challenges to many countries. Therefore, a set of collective smart solutions to food crisis must be developed.

Fig. 1 The need for developing a smart solution for food crisis.

The system that we are developing has been designed to integrate two sub-systems: (i) early warning system (EWS) for food crisis (Seminar et al. 2010) and (ii) DSS for land evaluation for food production (Lahay et al. 2011) to support both preventive and curative scenarios to cope with food crisis as shown in Fig.1.

The EWS Sub-System

The main function of EWS sub-system is to detect the occurrence of food crisis and its related patterns (i.e. combination of variables and progress of crisis stages) from the early stage of crisis condition until the stage of crisis before the start of the chaos condition (Fig. 2).

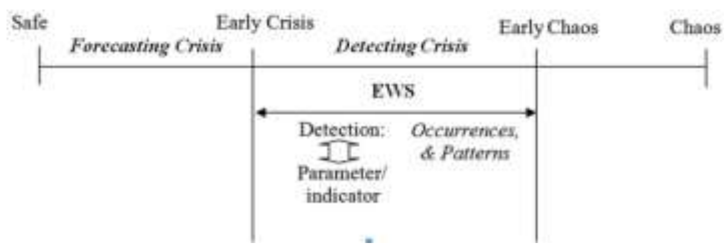


Fig. 2 The scope of food crisis detection of the EWS sub-sytem (Seminar et al. 2010).

EWS position in the period between the start of the crisis until the start of chaos is necessary because the rate of increase in food demand faster than the rate of increase in food production. When the crisis started to happen it would require detection and signaling systems to provide early signals of crisis policy-makers to take action before the condition continues to deteriorate achieve chaos (Barton et al. 2002, pp. 99-101).

The main computational intelligent models of the EWS sub-system is comprised a system dynamic model and Artificial Neural Network (ANN) model, as shown in Fig. 3.

Fig.3 The computational intelligent engine of the EWS sub-system (Seminar et al. 2010).

The initial input is a set of crisis parameters from the actual data including rice production, rice stock previous year, price of rice, population of people, annual rainfall, poverty, infant health & mortality rate, malnutrition, exchange rate, and composite stock price index (IHSG). The final output of the EWS is the crisis level status (i.e. 1: highly vulnerable, 2: vulnerable, 3: caution, 4: safe, 5: highly safe). It is important to note the food production loss due to transportation activites are determined to be constant in this system.

The DSS Sub-system

The DSS sub-system, as shown in Fig. 4, is designed to compute food availability of a particular region based on land suitability analysis, forest coverage, crop productivity, harvest scenario, population of people, and food balance sheets (FBS), spatial and non-spatial databases are utilized to support the DSS sub-system functionalities.

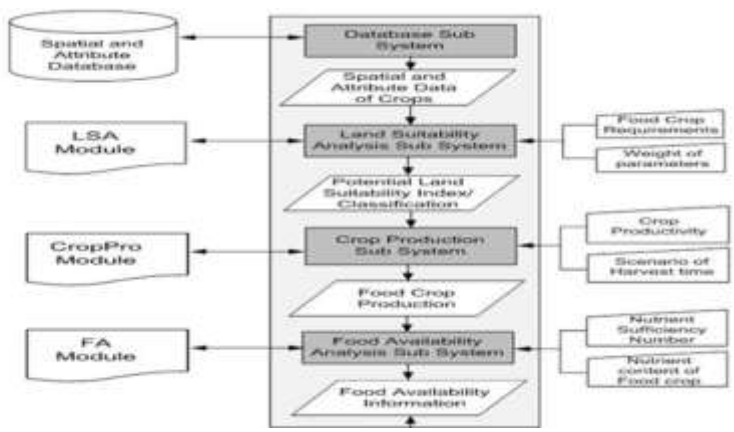


Fig. 4 The functional components of the DSS sub-system (Lahay et al. 2011).

To compute land productivity the computation of Land Suitability Index (LSI) must be done first using a multiplication function as follows:

$$LSI = JMF_{SOIL} \times JMF_{SLOPE} \times JMF_{FOREST} \times JMF_{LANDUSE} \,, \qquad \text{where}$$

LSI = Land Suitability Index
JMF_{SOIL} = Joint Membership of soil

JMF_{SLOPE} = Joint Membership Function of slope
JMF_{FOREST} = Joint Membership Function of forest
$JMF_{LANDUSE}$ = Joint Membership Function of land use

Furthermore, the LSI was converted into categorical suitability classes as shown in the Table 1.

Table 1 Land Suitability Index (LSI) and suitability class (Lahay et al. 2011).

LSI	Symbol	Suitability Class
0,80 – 1,00	S1	Highly Suited
0,60 – 0,80	S2	Moderately Suited
0,25 – 0,60	S3	Marginally Suited
> 0,00 – 0,25	N1	Currently Not Suitable
0,00	N2	Permanently Not Suitable

Afterward the land productivity can be computed based on LSI values as shown in Table 2.

Table 2 Productivity index for each of land suitability classes (Lahay et al. 2011).

No.	Suitability Class	Productivity
1.	S1	100 %
2.	S2	80 %
3.	S3	60 %
4.	N	40 %

The calculation of production also considered the productivity of each crop (e.g. 5,1 ton/ha for paddy). Calculation of crop production was employed by using the following equation, where the value of production generated from this calculation is gross production:

$$production_i = Area_i \times productivity \times AY_i \text{ , where}$$

$production_i$ = production of suitability class i (ton)
$Area_i$ = area of suitability class i (ha)
$productivity$ = maximum production of crop type (ton/ha)
AY_i = attainable yield of suitability class i (%)

Food availability was measured by using food Food Balance Sheets (FBS) as discussed in Jacobs & Sumner (2002).

Implementation Results

EWS Subs-System

The implemented prototype of the EWS Sub-system was tested using data from 265 regencies of 28 provinces in Indonesia. Of the 265 regencial data, 167 data were used for the ANN training and the remaing 98 regencial data for testing, as shown in Fig. 5. The accuracy performance of the EWS protype was fairly good, that was 96,9% with MSE = 0.11. The validation of this performance was based on the comparison between the output of our EWS system and the ouput of the food insecurity status of Indonesia (Food Insecurity Atlas/FIA) released by Food Security Council of Indonesia and World Food Program (WFP) in 2005. This comparison can be seen in Fig. 5, where the solid curve represents our food insecurity status from our EWS and the dots represent food insecurity status from FIA.

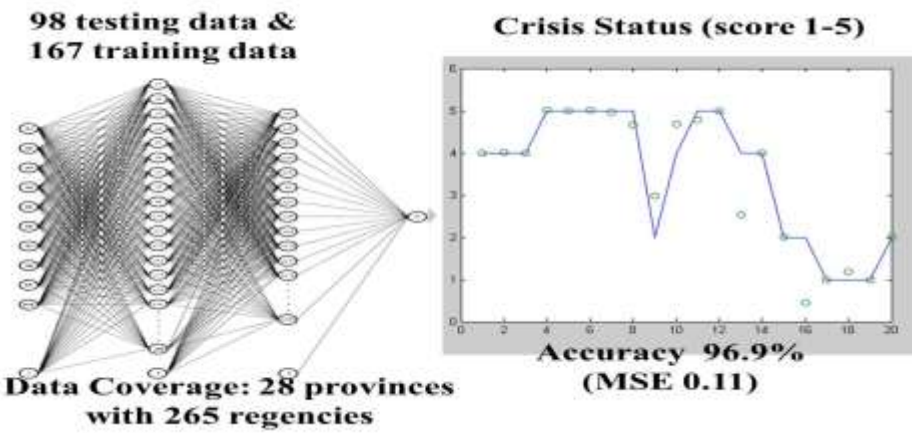


Fig. 5 Data training & testing for EWS subs-system (Seminar et al. 2010).

Our EWS sub-system was also tested the real data in 2007 from Indramayu district, West Java Indonesia and the EWS concluded that food crisis status of Indramayu district is *Safe*. Furthermore variable's analysis can be done to examine what variables with the most influence level to the crisis status as shown in Fig. 6.

Variables (Xi)	Year = 2007
Normative consumption ratio (X1)	0.31
% of infant weight below standard (X2)	18.80
Infant mortality (X3)	39.00
Procentage of population under poverty line (X4)	20.96
Procentage of crop failure (X5)	25.14
Potential rice production area (x6)	77.00
Annual Rain (X7)	1519.00
Price of rice (X8)	5255.83
Exchange Rate (X9)	9179.55
Composite stock price index (X10)	2087.59
Crisis Status	Safe

Fig. 6 EWS testing result on Indramayu District, West Java Indonesia year 2007 (Seminar et al. 2010).

DSS Sub-System

The DSS susb-system for to compute food availability of a particular region was also implemented and tested using the real data of Gorontalo Province of Indonesia to compute land productivity for paddy and maize crops as shown in Fig. 7. The colors on the maps shown in this figure represent the suitability classes of the land for crops.

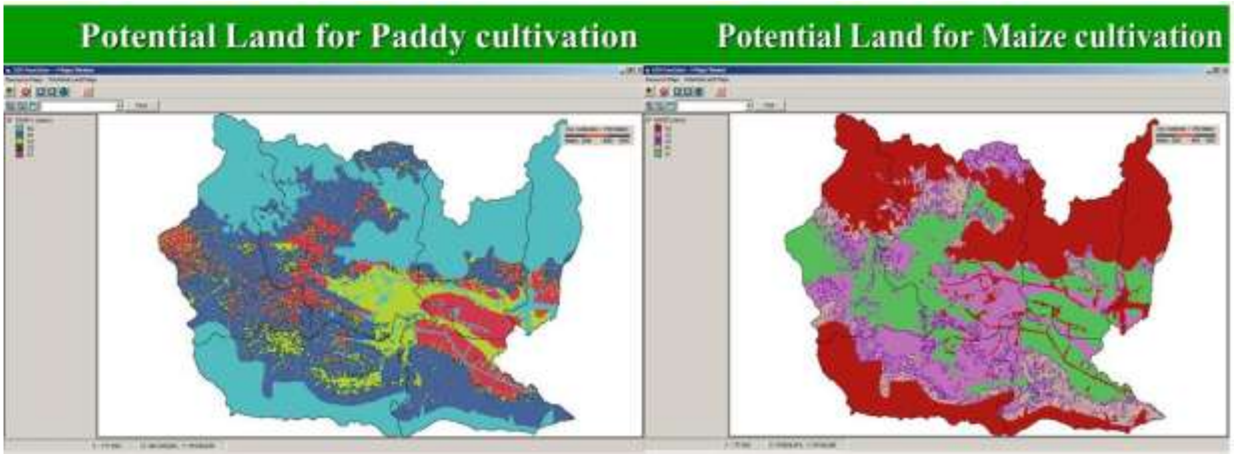


Fig. 7 Sample computational results of Land Suitability Classes for paddy & maize (Lahay et al. 2011).

The detailed recapitulation of total area for land suitability classes (referring to Table 2) for paddy and maize is displayed based on total or every sub-district land as shown in Fig. 8.

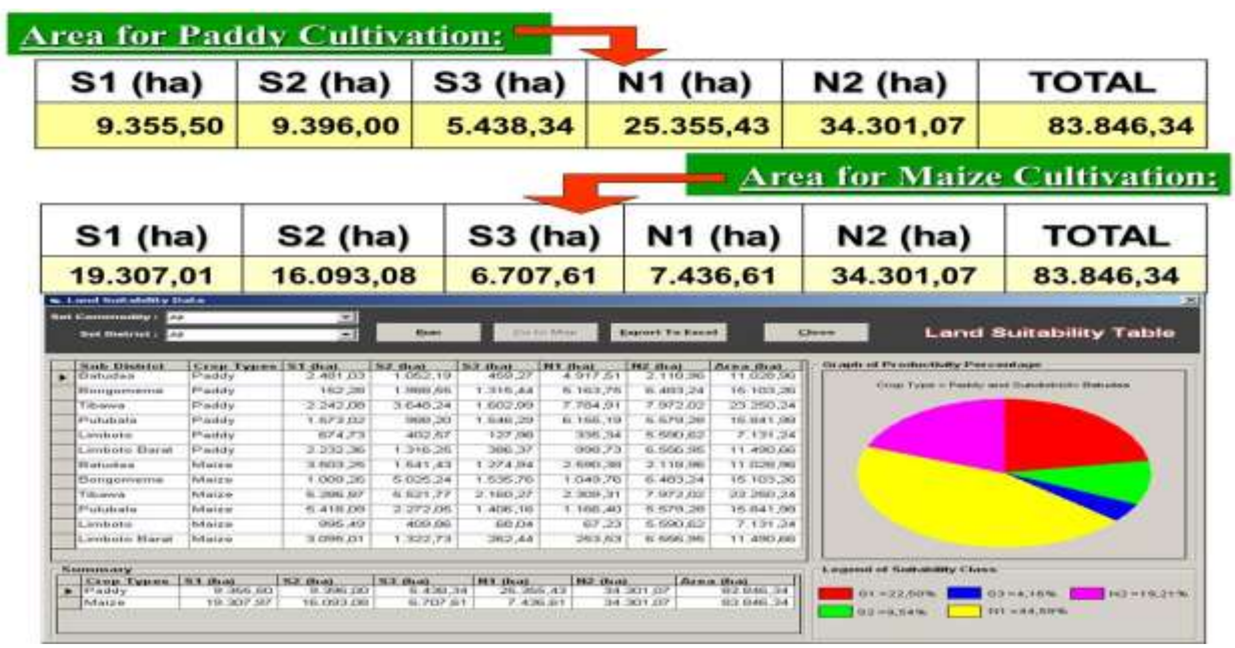


Fig. 8 Detailed recapitulation of land suitablity analysis for paddy and maize (Lahay et al. 2011).

The food production estimation can also be justified from the haravesting scenarios for paddy and maize, such as shown in Fig. 9.

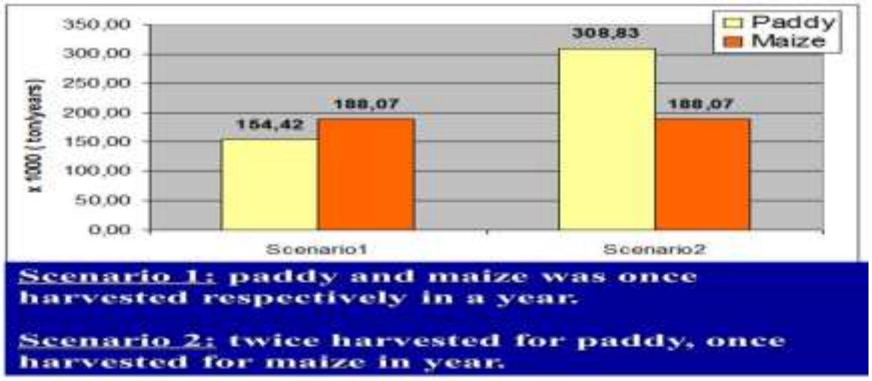
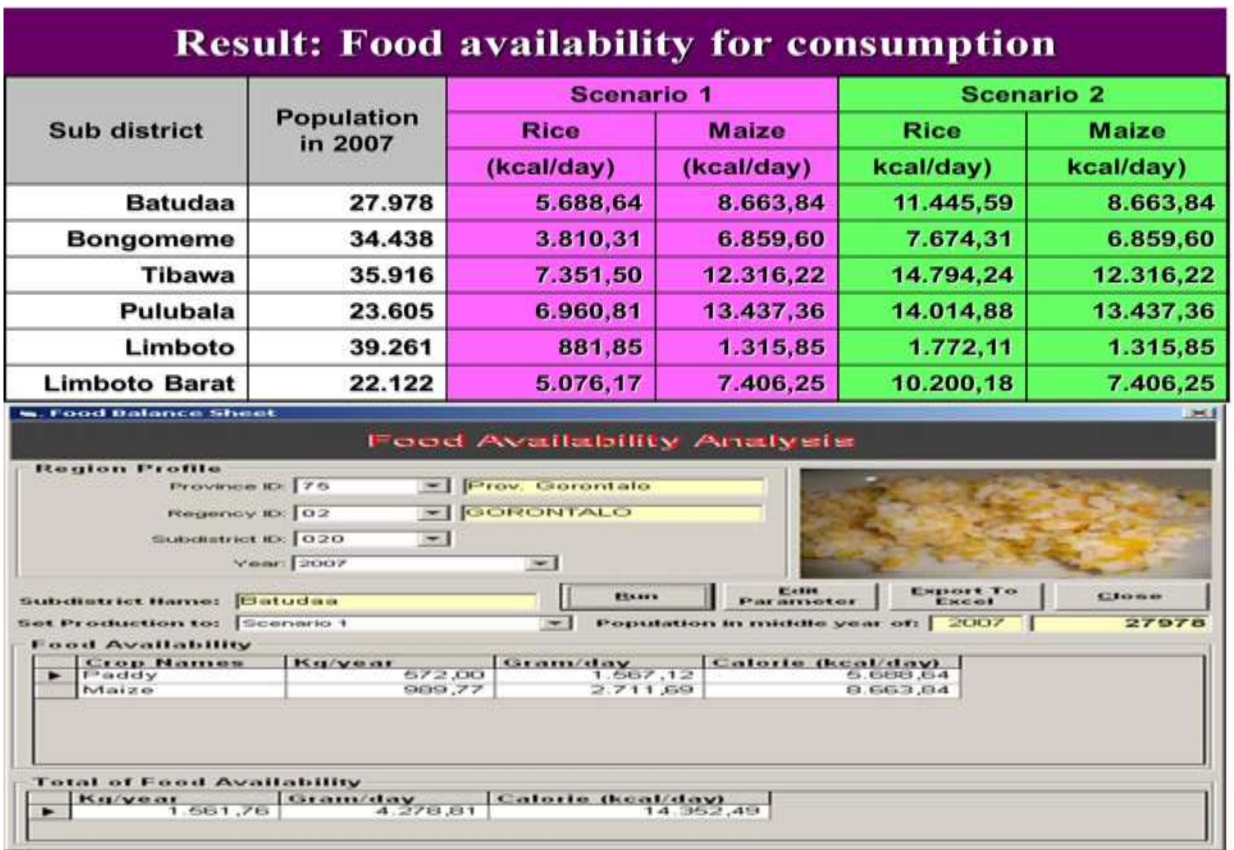


Fig. 9 The food production analysis based on harvest scenario (Lahay et al. 2011).

Finally the food availability for consumption in each sub-district and overal province can be computed based on the nutrition content from paddy and maize, as shown in Fig.10.



Result: Food availability for consumption

Sub district	Population in 2007	Scenario 1		Scenario 2	
		Rice (kcal/day)	Maize (kcal/day)	Rice kcal/day)	Maize kcal/day)
Batudaa	27.978	5.688,64	8.663,84	11.445,59	8.663,84
Bongomeme	34.438	3.810,31	6.859,60	7.674,31	6.859,60
Tibawa	35.916	7.351,50	12.316,22	14.794,24	12.316,22
Pulubala	23.605	6.960,81	13.437,36	14.014,88	13.437,36
Limboto	39.261	881,85	1.315,85	1.772,11	1.315,85
Limboto Barat	22.122	5.076,17	7.406,25	10.200,18	7.406,25

Fig.10 Food availability analyis for each district and overal Gorontalo province (Lahay et al. 2011).

Conclusions & Future Directions

The design of intelligent system for detecting food crisis and the computation of food availability has been developed, implemented and tested for the real data in Indonesia. The novelty of the proposed system lies on the integrative approaches (i.e. currative and preventive) for dealing with food crisis as part of food security and sovereignty. The EWS sub-system allows the detection of food crisis occurence, the food crisis status dan the pattern of crisis occurences that to assist for currative action plans. The DSS sub-system allows the analysis and estimation of food availability to assist for preventive action plan. This integrative approach can be utilized to developed the more comprehensive protocols for handling food insecurity in certain regions.

The main difficulty for future implementation the proposed system is the availabilty of timely periodic datasets required. Therefore, the future recomendation for enhancing the applicability of the proposed system is to develop a real-time integrated data acqusition system and unified databases (spatial and non spatial) from all provinces in Indonesia. Other food resources beyond paddy and maize can also added to our system to support more comprehensive analysis of food availability and adequacy based on more diverse crops for food. This system is going to be integrated with our collaborative and integrated research framework SMART-TIN© (Arkeman 2013).

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References

1. Y. Arkeman (2013), SMART-TIN©: An Integrated and intelligent System for the Deisgn of Adaptive Agroindustry. Proc. of 2nd International Conference on Adaptive and Intelligent Agroindustry, pp.1-9. Sept. 2013.
2. S.C. Babu (2013), Food Security and Nutrition Monitoring Systems and the Food Crisis: Lessons from the Last Three Decades. http://ppafest.nutrition.cornell.edu/authors/babu.html 2013.
3. B. Baruth, & O. Leo (2009), The MARS Crop Yield Forecasting System – introduction by JRC. @gro-informatika. August 2009.
4. Barton, D., Newell, R., Wilson, G. 2002. Dangerous Markets: Managing in Financial Crisis. Willey Finance Series. ISBN 0-471-22686-6. USA
5. A.P.M. Basuki, Y. Arkeman, Musthofa (2013), The Design and Implementation of Geographic Information Systems to Support and Energy Security. Proc. of 2nd International Conference on Adaptive and Intelligent Agroindustry, pp.181-191. Sept. 2013.

6. T.Y. Chou, C.Y. Chien, C.W. Kuan, Y.W. Chang, M.L.Yeh, Y.C. Lai, B. Basso (2011), Development of a New System Approach to Land Use Sustainability with Various Interfaces. Proc. AFITA International Conference, pp.247-252, Oct. 2010.
7. EAC (2011), Enhancing the Effectiveness of Food Security Information Systems in SADC. Issues Papers, Economic Commission for Africa, Dec. 2011.
8. FAO (2008), Handbook for Defining and Setting up a Food Security Information and Early Warning System (FSIEWS). FAO 2008.
9. FAO (2010), The State of Food Insecurity in the World - Addressing food insecurity in protracted crises. FAO 2010.
10. K. Jacobs, D.A. Summer (2002), The Food Balance Sheets of the Food and Agriculture Organization: A Review of Potential Ways to Broaden the Appropriate Uses of the Data. FAO 2002. http://182.160.112.236/agridrupal/sites/default/files/FBS_Review_of_Potential_Ways_to_Broaden_the_Uses_of_Data.pdf
11. R.J. Lahay, K.B. Seminar, A.K. Mulyana (2009), Spatial Decision Support System for Identification of Potential Land for Food Production. Journal of IT for NRM, vol.II, no.1, May 2011.
12. K.B. Seminar, Marimin, N. Andarwulan (2010), Early Detection System for Food Crisis Management Simulation Model With Dynamic And Intelligent Computing. In Crisis Management. Ed. Lala Kolopaking, pp.125-162. IPB Press 2010.
13. D. Tanjung (2009), Kebijakan Sistemik Menuju Pemantapan Ketahanan Pangan Nasiona. Majalah Pangan, hal 43-53, no.53/XVIII/Januari-Maret 2009.