The Prospects of Precision Agricultural Development in Indonesia

A REVIEW

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Geography

- An archipelagic country extending 5,120 km(3,181 mi) from east to west and 1,760 km(1,094 mi) from north to south (latitudes 11°S to 6°N, longitudes 95°E to 141°E)
- 17,508 islands, only 6,000 inhabited
- Total land area :1,919,317 sq.km (741,052 sq mi), include inland seas: 93,000 sq.km(35,908 sq mi), total teritory: 5 million sq.km (+ EEZ: 7.9 million sq.km)
- Tectonically, Indonesia is highly unstable. Lies on the Pacific Ring of Fire. Of the 400 volcanoes, 150 are active.
  The volcanic ash has resulted in fertile soils.

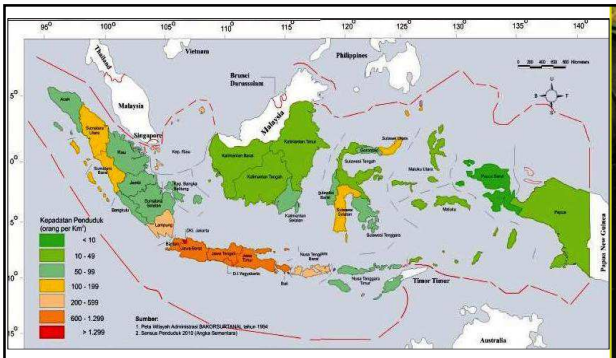
Climate

- Lying along the equator, Indonesia has a tropical climate, with two distinct monsoonal wet and dry seasons.
- wet season :October to April
- dry season :May to September
- Average annual rainfall in the lowlands varies from 1,780–3,175 mm (70–125 in), and up to 6,100 mm (240 in) in mountainous regions
- Temperature: The coastal plains: 28 °C (82.4 °F), the inland and mountain areas: 26 °C (78.8 °F), the higher mountain regions: 23 °C (73.4 °F).
- Relative humidity: 70 to 90%.
- Winds: moderate, with monsoons usually blowing in from the south and east in June through October and from the northwest in November through March.

http://en.wikipedia.org/wiki/Geography_of_Indonesia

Population (2010)

No.	Province	Population	In Cities (%)
1	Aceh	4.486.570	23.6
2	North Sumatra	12.985.075	42.4
3	West Sumatra	4.845.998	29.0
4	Riau	5.543.031	43.7
5	Jambi	3.088.618	28.3
6	South Sumatra	7.446.401	34.4
7	Bengkulu	1.713.393	29.4
8	Lampung	7.596.115	21.0
9	Bangka Belitung	1.223.048	43.0
10	Riau Islands	1.685.698	67.4
11	Banten	10.644.030	52.2
12	Jakarta	9.588.198	100.0
13	West Java	43.021.826	50.3
14	Central Java	32.380.687	40.4
15	Yogyakarta	3.452.390	57.7
16	East Java	37.476.011	40.9
17	Bali	3.891.428	49.8
18	W.Nusa Tenggara	4.496.855	34.8
19	E. Nusa Tenggara	4.679.316	15.9
20	West Kalimantan	4.393.239	25.1
21	Central Kalimantan	2.202.599	27.5
22	South Kalimantan	3.626.119	36.3
23	East Kalimantan	3.550.586	57.6
24	North Sulawesi	2.265.937	37.0
25	Gorontalo	1.038.585	25.5
26	Central Sulawesi	2.633.420	19.7
27	South Sulawesi	8.032.551	29.4
28	Southeast Sulawesi	2.230.569	20.8
29	West Sulawesi	1.158.336	--
30	Maluku	1.531.402	25.9
31	North Maluku	1.035.478	29.5
32	Papua	2.851.999	22.2
33	West Papua	760.855	--
	TOTAL	237.556.363	



- At least 300 different ethnic groups have been counted.
- Population: 237.6 million, population growth at 1.9%.
- 58% lives on Java, the world's most populous island.

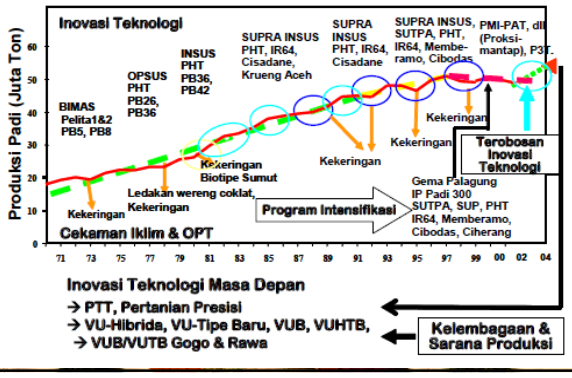
Facts

- The rice harvest area in 2011 was 13,201,316 hectare
- Rice productivity was 4.98 ton/hectare (BPS, 2012)
- More than three decades, domestic rice production was not able to meet its growing demand → rice import.
- Conversion of fertile lowland, climate change issue, limited resources, food security and global free trade → agriculture toward agricultural industrialization.

Wetland area prone to drought by province (ha)

Wilayah/ provinsi	Sangat rentan	Rentan	Luas baku Sawah
Jawa Barat	-	30.863	971.474
Banten	-	26.588	192.904
Jawa Tengah	2.322	142.575	1.053.882
DI Yogyakarta	-	3.652	69.063
Jawa Timur	1.580	70.802	1.313.726
Bali	-	14.758	85.525
Nusa Tenggara	38.546	105.687	214.576
Lampung	29.378	168.887	278.135
Sumatera Selatan	-	184.993	439.668
Sumatera Utara	2.055	342.159	524.649
Jumlah	73.881	1.090.964	5.143.602

Innovation vs. Climate stress & pests toward rice production



Policy

- The aim of food and agriculture policy ; to realize a competitive nation by making efficiency, modernization, and increasing agricultural value so that it can compete in local and international market for strengthening the food security
- The development of domestic production capability needs to be supported by food security institution that can guarantee the sufficiency of food requirement in the household level, including the quantity, the quality, the security, and also the affordable price, from many kind of local food resources.

Problems in agricultural management

- The farmers still use conventional farming system by applying same treatment to their crops.
- Fertilization practice does not consider spatial variability of soil fertility → wasting of fertilizer, decreasing productivity, increasing production cost, decreasing profit, negative impact to environment
- Low capital and limited knowledge of technology in the farmer level
- Inconsistency of determining program orientation and the seriousness to implement it.
- The existing technology has not been utilized optimally, possibly because it is still considered as an experiment.

Some opinions about PA

- PA is often defined as an expensive and unreachable technology.
- PA has many challenges as a plant production system so that it needs many technologies that have to be developed in order to be adopted by the farmers.
- The concept of PA can only be implemented by agribusiness companies that have capability to use expensive technologies and have wide area of land
- In the future, it is not impossible to have a thousand hectare of field that is handled with capable technology and management, and have high productivity, but it is owned by private institutions similar to what is happening in oil palm plantation. This will eliminate small farmers; exacerbate social, knowledge, and education imbalance

Problem solving

- Agricultural land reduction → increasing the production through intensification
- Climate change → eco-friendly agriculture system
- Agricultural products that cannot fulfill international quality standard will not be accepted in the global market → a careful treatment in all of the agribusiness chain structure starting from on-farm activity until off-farm activity
- Agricultural paradigm that gives careful or precision treatment is PA → obtain optimization for the land management → land management cost can be efficient.

Precision Agriculture

- PA as technology should be developed immediately in Indonesia → give more opportunities for more precise treatment toward every parts of land → increase the productivity level by increasing the product result, pressing the production cost and reducing the environmental effect.
- With PA, it is expected to be able to fulfill the balance of three integrated subject:
  - Sustainable economic development through the addition of food product value and the increase of food product output.
  - Social justice through the equality of rights and opportunities to access efficient technology in the food production system.
  - Environmental conservation especially natural resources conservation which means to conserve land by preserving its fertility.

Researches on PA

- PA strategy in Indonesia is implemented in partial researches. While looking at technology mastery, Indonesia has developed the RS/GIS, DSS, and ICT to support PA.
- Agricultural automation technology: microcontroller to control automatically which has high accuracy level and high precision level
- Agricultural E-commerce: The market expansion through internet network, online transaction that can increase the agricultural product competitiveness.
- Information system technology: artificial neural network, database system, image processing, and so on that are upgraded continually in order to be integrated with the other agricultural system
- Agricultural policy: The technology has to be tested immediately by introducing it to the farmers. Socialization and application of agricultural technology need capability, energy, fund, and support from government policy.

Research products

- Nutrient Manager for Rice (IRRI and (Agric. Dept.- research division)
- e-*petani* (e-farmer) (FEATI and Agric. Dept.)
- Cyber extension (Agric. Dept.- extension division)
- Automated irrigation system (Univ. of Agric., Bogor)
- Sensor to detect soil Phosphate (Indonesian Institute of Science)
- Remote sensing for Chlorophyll identification (Sam Ratulangi Univ.)
- UV and near infrared images for leaf area identification (SGU Asia, Jakarta)
- Assembly humidity sensor using nanotechnology (Agric. Dept.- hydrology division)
- UAV for rapid aerial photo system (Inst. of Technology, Bandung)
- Efficient rice seeding machine (Agric. Dept.- machinery division)
- Digital image and automatic control on planter (Univ. of Andalas)
- Real time VRA using camera (Univ. of Agric., Bogor)
- 8 bit microcontroller to upgrade VRA precision (Univ. of Agric., Bogor)
- GIS mapping C and N status on rice parcel (UPN Veteran Yogyakarta)
- GIS mapping NPK status on Sugarcane plant(Univ. Lampung)
- Digital Mapping of natural resources (Agency of Survey and Mapping)
- Planting calendar for rice (Agric. Dept. – research div.)

PA approach on farmer level

- Many researches from institutions and corporations have been conducted on PA technology to revitalize Indonesian agricultural development, but some of it ended in scientific publications. It needs a sustainable program and integrated with the government plans.
- The best linkage of the wisdom farmers and the technology platform would produce information-oriented fields and information-added products that encourage multi-functions of agriculture creating new value-chains in the agro-production-consumption system (Shibusawa, 2003).
- If technology is needed they should be used to complement the traditional methods for enhancing productivity and quality, rather than to replace the local conventional methods (Griepentorg and Blackmore, 2004).
- The improvement of farmers' management skill through the accumulation of data and information is an important aspect of PA system and it has been integrated into the development and dissemination of rice integrated crop management in a number of developing countries (Tran and Nguyen, 2006).

PA approach in Indonesia (study case at Magelang, Central of Java)

- Implement PA using a learning media that fit to local wisdom so-called the Centre of Farmer Learning Activities (CFLA).
- It is related with the government program, Field School for Integrated Crop Management, an extension method of agricultural technology dissemination that has been considered as the most effective one, and the best approach to accelerating farmers' understanding and adoption process.
- CFLA try to motivate the farmers in improving their knowledge of PA and build environmental friendly farming communities by involving them in the PA research in their farm.
- In CFLA, the groups manage some extension activities used learning by doing method, focused on managerial capacity development, leadership and entrepreneurship, and create innovative farmers.

- Technically, information dissemination program on the lower level (village) has been performed effectively by the existence of farming group institution.
- The traditional ways of socialization such as agricultural extension program need to be improved with technical assistance and facilitation to access information and technology.
- Farmers should be encouraged by fostering their knowledge in order to prepare them as modern agricultural actors in the 21st century.
- Learning activity, networking, or marketing can be performed in the community-based form as an interaction activity in the agricultural institution.
- Agricultural extension actors and farmers must be empowered with ICT understanding so that they can access necessary information fast, accurately, and efficiently for the decision making on agricultural activity management.
- Implementation of PA should be supported by development and renovation of infrastructures as well as establishment of credit scheme to enable farmers to adopt modern technology.

Conclusions

- The PA development cannot be separated from the advance of technology which is dynamic in accordance with the dynamic of environment and market demand.
- The implementation of PA is still partial because of lack of coordination between institutions and the need of strategic road map and complete planning for long term.
- Rapid advance in the technology of remote sensing, GIS, ICT, and DSS at the present time is a positive stimulation for the implementation of PA in Indonesia.
- It is expected that the symbiosis of roles between researchers/ innovators from universities, policy planner from the government, facilitators from agricultural industries, and farmers as the agricultural actors becomes synchronic and more focused to achieve a sustainable agricultural development.