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Review

Role of Bioscience and Biotechnology through Green Revolution to Increase the Rice Production in Indonesia

Made Antara[a] and Made Sri Sumarniasih[b]

[a]Department of Agribusiness, Faculty of Agriculture, University of Udayana, Bali, Indonesia
[b]Department of Agroecotechnology, Faculty of Agriculture, University of Udayana, Bali, Indonesia

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Bioscience and biotechnology is one of the modern agriculture technologies has produced high yielding variety (HYVs) which is one of the five pillars of Green Revolution, aims to increase the production of food agriculture. Green Revolution that swept the world around the 1960s, particularly in Latin America are characterized by findings of corn and wheat superior varieties in Mexico and Soybean in Brasilia. In Asia especially in the IRRI-Philippines found superior rice IR-8, so the annual Philippine rice production increased drastically, which makes the Philippines rice exporter for the first time in the 20th century? India adopts and planting variety of IR-8 and managed to improve paddy agricultural products nearly doubled, which makes India one of the most successful producers of rice in the world. The implementation of Green Revolution in Indonesia by New Order through mass counseling program (*Bimas),* one efforts of the five farming management of this program is use of HYV- Superior Variety Resistant Brown Planthoppers of IR-26 and IR-36 in the 1980s, has increased significantly in rice production, this is evidence of the successful application of bioscience and biotechnology.

Keywords: Agriculture, Production, Bioscience, Bioscience, Green Revolution.

INTRODUCTION

In 1950-1960, the developing countries in Asia, Africa and Latin America suffer food shortage, because the population is growing, while the traditional agricultural conditions are not able to produce food in accordance with the needs of the population. Anon (2015) report that in Indian Agriculture condition pre-green revolution characterized by: Indian cereal grain supply dependent on Britain/trade, most cannot afford high trade prices, bengal Famine–1943 because trade difficulties cause rice shortage, news of difficulties lead to hoarding, raised prices, one million people die. When this phenomenon occurs, the Malthusian theory gets justification. Roberth Malthus in 1798 proposed a theory entitled *Essay on the Principle of Population*, the point that population growth will excel the growth of food

*Corresponding Author's Email: antara_unud@yahoo.com; madesris@gmail.com

production, unless there is a war, disease, natural disasters, and famine to lower human population. While Fujita (2005) report that the agricultural sector of British Colonial India, especially the crop sector, was totally stagnant or even a negative growth was recorded in the entire first half of the 20th century.

The phenomenon of food crisis that hit developing countries, and the desire to subvert the Malthusian theory, have encouraged the biosciencetist and biotechnologist which is generally origin from developed countries like the US, which is sponsored by the foundation renowned in the US such as the Ford Foundation and Rockefeler Foundation, held research in several food research centers, such as Brazil, Mexico, and the Philippines. It seems that the efforts that began in the 1960s pioneered by Norman orlaug, has been successful with the discovery of several varieties of rice, corn, soybeans and wheat, which are known as high-yielding variety (HYVs). For example in the Philippines through the rice research station at the International Rice Research Institute (IRRI) in Los Banos found IR8 rice which eventually spread to other Asian countries, such as Indonesia, India, Pakistan, Vientam, and Thailand.

According to FAO (in Hobbelink, 1988), in the future demand for food in developing countries will increase two-fold. Therefore, it is necessary to increase food production in the south, but not in the north. Nothing is more reasonable longer than utilizing bioscience and biotechnology to help boost food production in the Third World, to meet the food needs increased due to the increase of population. Therefore according Harijadi (1992), in fact, the development of bioscience and biotechnology research, particularly in industrialized countries, currently carry threat for developing countries more than a benefit. Even according to Prabowo (1981), the increase in food production has indeed occurred, especially in developed countries, but developing countries and the poor just the opposite. It seems there is a general consensus that although in some countries there is a surplus of food, food insecurity and hunger still occur in poor countries, and the food will still be a troubling issue in the upcoming time. Latest FAO figures (cited by Ruane and Sonnino, 2011) indicate that an estimated 925 million people are under nourished in 2010, representing almost 16% of the population in developing countries. Looking to the future, there are also major challenges ahead from the rapidly changing socio-economic environment (increasing world population and urbanisation, and dietary changes) and climate change.

The major breakthroughs in yield potential that kick started the Green Revolution in the late 1960s came from conventional plant breeding approaches, which is a branch of bioscience and biotechnology.Crossing plants with different genetic backgrounds and selecting from among the progeny individual plants with desirable characteristics, repeated over several cycles/generations, led to plants/varieties with improved characteristics such as higher yields, improved disease resistance, improved nutritional quality, etc. The yield potential for the major cereals has continued to rise at a steady rate after the initial dramatic shifts in the 1960s for rice and wheat. For example, yield potential in irrigated wheat has been rising at the rate of 1 percent per year over the past three decades, an increase of around 100 kilograms per hectare per year (Pingali and Raney, 2015).

Hobbelink (1988) stated that bioscience and biotechnology as a technology is not new goods. It has been there since thousands of years ago, since the man knew how to make wine, beer, cheese or bread. The Egyptians have used bioscience and biotechnology to make beer two thousand years before the birth of Jesus Christ. The basic principle of these efforts are mostly the same. Some basic ingredients exposure to certain microorganisms that would transform the basic ingredients (wine, barley, milk, or wheat) into the desired product (drink of wine, beer, cheese or bread). The new biotechnologies often also based on the same principles. The main differences between old method and the new one is on the extent to which the processes in the bioscience and biotechnology that can be influenced and controlled. In modern agricultural, bioscience and biotechnology, it is done through two ways become the main pillar: tissue culture techniques and recombinant DNA (r- DNA), both of which were created and developed in the last decade.

The application of the green revolution in Indonesia has only begun since the New Order Government of 1969, marked by the application of the mass counseling program (*Bimas*) for rice farming, which contains a package of five farms, one of which is the application of HYV that is IR-26 rice which for the first time was imported from the International Rice Research Institute (IRRI), Philippines. The following years the application of *Bimas* intensified and expanded throughout in over all Indonesia, so that Indonesia's rice production is increasingly year by year.

The purpose of writing this paper is to identify the role of bioscience and biotechnology through Green Revolution to increase the agricultural production in Indonesia.

GREEN REVOLUTION AND GENE REVOLUTION

1. Green Revolution

The term "Green Revolution" was first used in 1968 by former US Agency for International Development (USAID) director William Gaud, who noted the spread of the new technologies: "These and other developments in the field of agriculture contain the makings of a new revolution. It is not a violent Red Revolution like that of the Soviets, nor is it a White Revolution like that of the Shah of Iran. I call it the Green Revolution". Borlaug (2011) said "It started in the 1940s when I joined a new program, funded by the Rockefeller Foundation, aimed at assisting poor farmers in Mexico to increase their wheat production. We spent nearly 20 years breeding high-yield dwarf wheat that resisted a variety of plant pests and diseases and yielded two to three times more grain than traditional varieties". Borlaug further said that the Green Revolution began in the 1940s in the croplands of Mexico and its spirit must continue into this century because many countries continue to have food shortages, global overpopulation threatens adequate food supplies, and new technologies can help increase food production.

The Green Revolution is informal designation that is used to describe the fundamental changes in the use of agricultural cultivation technology that began in the 1960s and 1980s in many developing countries, especially in Asia. Real results is the achievement of self-sufficiency a number of foodstuffs in some countries that previously were always shortage of food supplies (basic), such as India, Bangladesh, China, Vietnam, Thailand, and Indonesia, to name a few countries. The initiatives, led by Norman Borlaug, the "Father of the Green Revolution," who received the Nobel Peace Prize in 1970 (Wikipedia, 2016). While Briney (2015) state that the term Green Revolution refers to the renovation of agricultural practices beginning in Mexico in the 1940s, spread worldwide in the 1950s and 1960s like Asia, and Africa, and success increase agricultural products, and significantly increasing the amount of calories produced per acre of agriculture.

The Green Revolution based on five important pillars: water supply through irrigation systems, optimal use of chemical fertilizers, pesticides application in accordance with the level of pest attacks, and the use of high yielding varieties (HYVs) as quality planting material, and improvement of cultivation. Through the application of these non-traditional technology, increased crop yields and enable cultivation doubled three times a year for rice in certain places, something that previously was not possible.

New technological developments that are components of the Green Revolution include the production of new wheat cultivars, corn, wheat, and rice commonly referred to as HYVs or "superior varieties". HYV has a higher nitrogen absorption potential than other varieties. Because cereals that absorb additional nitrogen will usually fall before the harvest. The genes that have been grouped into their genome have been bred into Japanese dwarf wheat cultivars (Norin 10 wheat), which are sent to Washington, D.C. By Cecil Salmon, was instrumental in developing the Green Revolution grain cultivar. IR8 is the first widely planted HYV rice produced by IRRI, created through crossbreeding between Indonesian varieties named "Peta" and Chinese varieties called "Dee-geo-woo-gen" (Pingali and Raney, 2015).

The Green Revolution refers to a set of research and development of technology transfer initiatives occurring between the 1930s and the late 1960s (with prequels in the work of the agrarian geneticist Nazareno Strampelli in the 1920s and 1930s), that increased agricultural production worldwide, particularly in the developing world, beginning most markedly in the late 1960s. The initiatives resulted in the adoption of new technologies, including: new high-yielding varieties (HYVs) of cereals, especially dwarf wheats and rices, in association with chemical fertilizers and agro-chemicals, and with controlled water-supply (usually involving irrigation) and new methods of cultivation, including mechanization. All of these together were seen as a 'package of practices' to supersede 'traditional' technology and to be adopted as a whole (Wikipedia, 2016). According to Conway (2006) the President The Rockefeller Foundation, the first Green Revolution offered farmers new crop varieties that allowed them to improve their agricultural yields -- to grow much more wheat and rice per acre.

Beyond the Green Revolution (http://www.fao.org/FOCUS/E/SpeclPr/SPro07-e.htm)
FAO's Special Program aims at increasing food production in higher-potential areas in LDC countries. Farmers can benefit from access to the remarkable advances in agricultural science that the world has seen during the last 30 years.These advances include:

1) The use of improved genetic materal for crops and animals
2) Better farming practices including increased use of inorganic and organic fertilizers to improve soil fertility
3) Integrated Pest Management to reduce yield losses in ways less harmful to the environment than past chemical controls
4) Improved use of irrigation water to optimize water use and minimize risk of salinization and waterlogging

5) Appropriate mechanization to reduce labour shortages during critical periods in the cropping season.

2. Gene Revolution

According Pingali and Raney (2005), the past four decades have seen two waves of agricultural technology development and diffusion to developing countries. The first wave is the Green Revolution in which an explicit strategy for technology development and diffusion targeting poor farmers in poor countries made improved germplasm freely available as a public good. The second is the Gene Revolution in which a global and largely private agricultural research system is creating improved agricultural technologies that flow to developing countries primarily through market transactions. The Green Revolution strategy for food crop productivity growth was based on the premise that, given appropriate institutional mechanisms, technology spillovers across political and agro-climatic boundaries can be captured. A number of significant asymmetries exist between developed and developing, e.g.: agricultural systems, market institutions and research and regulatory capacity. These asymmetries raise doubts as to whether the Gene Revolution has the same capacity to generate spillover benefits for the poor. A strong public sector – working cooperatively with the private sector – is essential to ensure that the poor benefit from the Gene Revolution.

The Green Revolution was responsible for an extraordinary period of growth in food crop productivity in the developing world over the last forty years. Productivity growth has been significant for rice in Asia, wheat in irrigated and favorable production environments worldwide and maize in Mesoamerica and selected parts of Africa and Asia. A combination of high rates of investment in crop research, infrastructure and market development, and appropriate policy support fueled this land productivity. These elements of a Green Revolution strategy improved productivity growth despite increasing land scarcity and high land values (Pingali and Raney, 2015).

Over the past decade the locus of agricultural research and development has shifted dramatically from the public to the private multinational sector. Three interrelated forces are transforming the system for supplying improved agricultural technologies to the world's farmers. The first is the strengthened and evolving environment for protecting intellectual property in plant innovations. The second is the rapid pace of discovery and growth in importance of molecular biology and genetic engineering. Finally, agricultural input and output trade is becoming more open in nearly all countries. These developments have created a powerful new set of incentives for private research investment, altering the structure of the public/private agricultural research endeavor, particularly with respect to crop improvement (Pingali and Traxler, 2002 cited by Pingali and Raney, 2015).

Developing countries are facing increasing transactions costs in access to and use of technologies generated by the multinational sector. Existing international networks for sharing technologies across countries and thereby maximizing spillover benefits are becoming increasingly threatened. The urgent need today is for a system of technology flows which preserves the incentives for private sector innovation while at the same time meeting the needs of poor farmers in the developing world.

ROLE OF BIOSCIENCE AND BIOTECHNOLOGY

1. Bioscience and Biotechnology to Increase the Agriculture Production

The role of bioscience and biotechnology (bb) through green revolution to increase the agricultural production presented in the form of a diagram at figure 1. In the diagram (figure 1) can be seen that bioscience produce biotechnology or biotechnology is applied of bioscience (identical with: technology is applied of science). Biotechnology has multiple branches/fields, one of which is genetic engineering. Genetic engineering can produce an important product that is high yielding variety (HYVs). So it can be said HYV is the product of Bioscience and Biotechnology, one of the five component of the green revolution to increase the agriculture production. HYV in Brazsil in the form of Soybean HYVs, in Asia in the form of Rice HYVs, and in Mexico in the form of Maize HYVs.

2. Role uf Bioscience and Biotechnology through the Green Revolution in other Parts of the World

Through seriously and continuously research for decades by researchers of bioscience and biotechnology, it was found HYVs in rice, corn, and wheat., all of whom are in the food crops of the most basic human needs. HYVs in the practice of planting is very responsive to the use of chemical fertilizers, irrigation water supply, new methods of cultivation, and the need for pests and diseases control. Finally five components, namely, HYVs, chemical fertilizer, irrigation water, new cultivation methods, and pest control to become one package said 'modern agricultural technology'. The distribution and planting of HYVs to worldwide that accompanied by other components known as the Green Revolution. Within 20 years, the development of the Green Revolution is able to increase the production of rice in some countries like Philippines, Indonesia, India, Vietnam, and Africa, production of maize and wheat 100-150% in Mexico compared to before of the Green Revolution (Table 1),

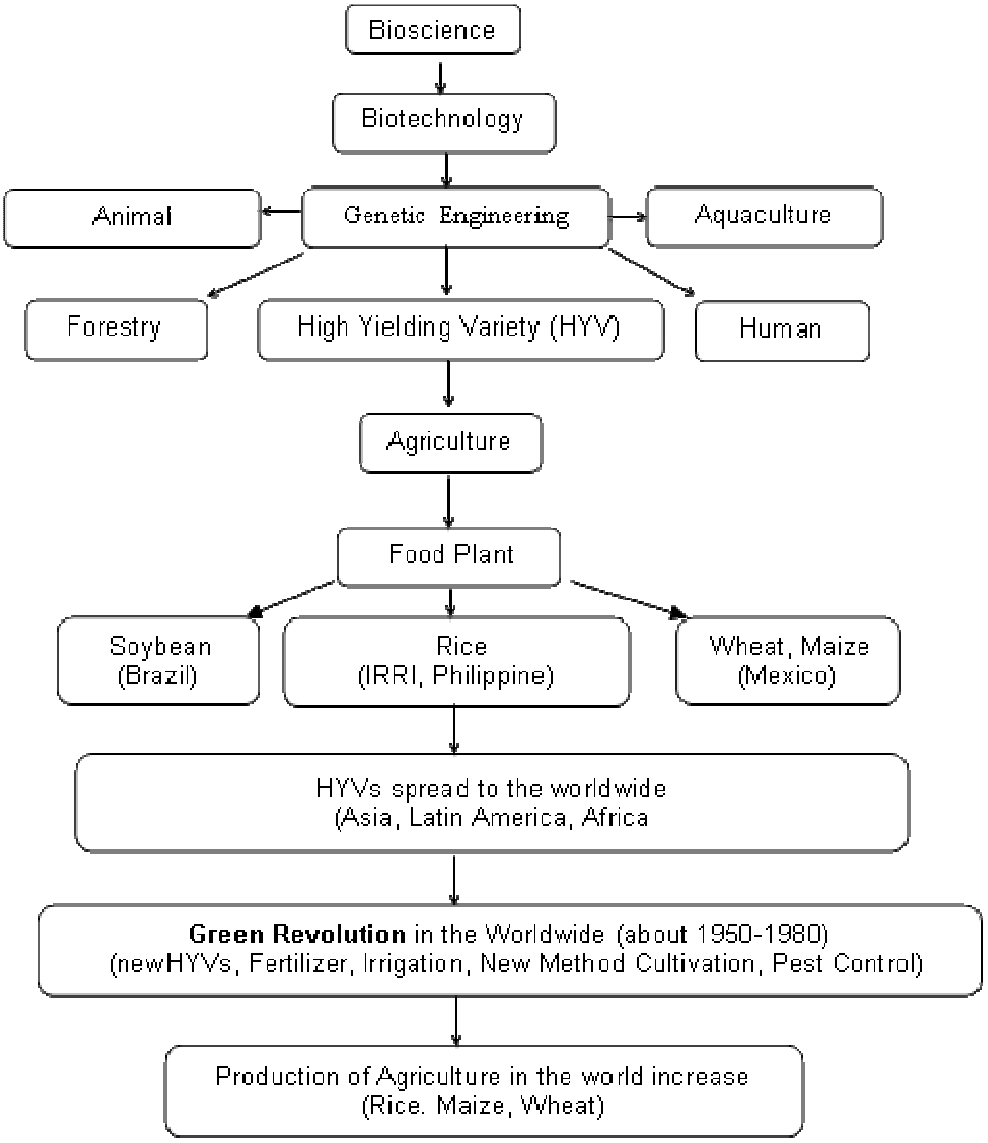

Figure 1: Diagram Role of Bioscience and Biotechnology through Green Revolution to Increase the Agriculture Production

so as to overcome the world food shortage. Even Othman and Bhassu (2011) confirms that The Green Revolution brought spectacular yield gains to many crops in many parts of the developing world.

3. Role uf Bioscience and Biotechnology through the Green Revolution in Indonesia

Food problems in Indonesia According Mulyono (1981) have appeared since 1655 which is a very dry year, up Sunan Amangkurat I (1645-1677) when it banned the

Table 1: Impact of Implementation the Bioscience and Biotechnology through the Green Revolution to Increase of the Agricultural Production

No	Country	Plant	Increase of Production
1	Mexico	Wheat	Dominating wheat production as early as 1951 (70%), 1965 (80%), and 1968 (90%)(Wikipedia, 2016).
		Maize	Mexican government founded the International Maize and Wheat Improvement Center (CIMMYT), which became a base for international agricultural research (Wikipedia, 2016).
2	Brazil	Soybean	Brazil has become the world's second biggest soybean exporter and, thanks to the boom in animal feed production, Brazil is now the biggest exporter of beef and poultry in the world (Wikipedia, 2016).
3	Philippines	Rice IR 8	Produced substantially higher yields than the traditional cultivars. Annual rice production in the Philippines increased from 3.7 to 7.7 million tons in two decades. The switch to IR8 rice made the Philippines a rice exporter for the first time in the 20th century (Wikipedia, 2016).
4	India	Rice	• In the 1960s, rice yields in India were about 2 tons per hectare; by the mid-1990s, they had risen to 6 tons per hectare. India soon adopted IR8, yielded about 5 tons per hectare with no fertilizer, and almost 10 tons per hectare under optimal conditions. This was 10 times the yield of traditional rice.IR8 was a success throughout Asia, and dubbed the "Miracle Rice". IR8 was also developed into Semi-dwarf IR36 (Wikipedia, 2016). • India's production was 20 million tons in 1970, up from 12.3 million 1965 (Borlaug, 2002).
5	Pakistan	Rice	Pakistan produced 8.4 million tons in 1970, up from 4.6 million in 1965 (Borlaug, 2002).
5	Africa	Rice	• There have been numerous attempts to introduce the successful concepts from the Mexican and Indian projects into Africa. • These programs have generally been less successful. Reasons cited include widespread corruption, insecurity, a lack of infrastructure, and a general lack of will on the part of the governments. • A recent program in western Africa is attempting to introduce a new high-yielding 'family' of rice varieties known as "New Rice for Africa" (NERICA). NERICA varieties yield about 30% more rice under normal conditions, and can double yields with small amounts of fertilizer and very basic irrigation (Wikipedia, 2016; Otsuka and Yamano, 2005).
6	Vietnam	Rice	• Green Revolution in Vietnam started when IR8 introduced into South Vietnam in May 1966 by Long Dinh Rice Research Station • Agriculture production increase from yield of 2 tons per hectare (yield traditional variety) to become 4 tons per hectare (IR8)(Thi Ut and Kajisa. (2006).)
7	Indonesia	Rice Variety of IR 8, IR 26, IR 36	• Before the Green Revolution, rice productivity was 1-2 tons per hectare, and after Green Revolution (implementation of modern inputs and new technological production→(call: five farming management) has increased rice productivity to 2-4 tons per hectare. Attainment of rice self-sufficiency at a national level in 1984. • In the span of 1969 to 1988, rice production increased by an average 4.5% per year. (Simatupang and Rusastra, 2015)

export of rice. In the reign of the Dutch colonists also frequent food crisis marked by fluctuations in production and the need to import rice from Saigon. To solve the food problem, the Dutch government then established the Fonds Middelen Sticking het Voedings (VMF) in charge of buying, selling and holding his food supplies (in this case rice) and was born stock first policy. So, it's common if at any time Indonesia faced with food shortages, because long ago Indonesia are facing food problems. Even in the future Indonesia will be facing serious food insecurity problem and if the agricultural sector is not dealt seriously. The proof, in early 2008 Indonesia deficits types of main crops, namely rice, soybeans sugar, soybean meal, corn, beef, wheat as raw material for flour.

Based on data published by Ricepedia (2016), before the Green Revolution in the era of the old order (1961-1968) and agriculture in Indonesia is still traditional, the rice productivity was 1-2 tons per hectare. However after Green Revolution in the era new order under the President of Republic of Indoneeia, General (ret) Soeharto (1969-1997) when implemented the modern inputs and new technological production (call: five farming management) has increased rice productivity to 2-4 tons per hectare, even in the reformation order (1998-2014) when the Indonesian agriculture entered the transition period, rice productivity reached 4-5 tons per hectare (Table 2) and chart of area, production, and productivity of rice in Indonesia 1961-2014 presented at Figure . This fact proves that the bioscience and biotechnology through the branch of genetic engineering science that has created HYVs on food crops, which HYVs become a major component in the package of modern agricultural technology that drive the green revolution, has been able to increase production and productivity of rice in Indonesia doubled compared with the Green Revolution before it is applied. According to Sohel Azad and Akter Hossan (2004), Biotechnology and Green Revolution are interrelated issues. The Green Revolution is attributed to Biotechnology. The Green Revolution was an effort to reduce hunger through the improvement of agricultural crops in developing countries. The revolution has been engineered through the introduction of agricultural biotechnology that ensured scientifically bred, high yielding rice, wheat, and maize varieties in developing countries during the 40`s, 50`s and 60`s. Among the various dimensions of biotechnology, agricultural biotechnology is by degrees getting special attention of the governments of the developing nations particularly third world and fourth world with the extension of green revolution. However, according to Ruane and Sonnino (2011), agricultural biotechnologies to increase productivity and conserve natural resources. McDade (2002) reviewed the book "Biotechnology in Agriculture: Good or Bad ?, written by Daniel Charles (2001). Perseus Publishing, Cambridge, MA, concludes that biotechnology in agriculture is good, as it can increase food production, despite the excesses of seed industry capitalist companies. McGloughlin (1999) stated that ten reasons why biotechnology will be important to the developing world, namely (1) The argument that hunger is a complex socioeconomic phenomenon, tied to lack of resources to grow or buy food, is correct; (2) The assertion that most innovations in biotechnology are *not* need driven is incorrect; (3) The argument that the integration of chemical pesticides and seed-use has led to lower returns for farmers is incorrect; (4) The assertion that "genetically engineered seeds do not increase the yield of crops" is misleading; (5) The assertion that "there are potential risks of eating (bioengineered) foods" is alarmist; (6) The argument that the new bioengineered varieties will fail, as pests develop resistance to the natural Bt-toxins produced by these varieties because they violate the basic principles of integrated pest management (IPM), is misleading; (7) The argument that biotechnology crops have been commercialized without proper testing while posing risks to human health and the environment is incorrect; (8) Many of Altieri and Rosset's "unanswered ecological questions regarding the impact of transgenic crops" are not unanswered; (9) Altieri and Rosset misrepresent the position of CGIAR and their research direction; (10) Altieri and Rosset extend their artificial dichotomy further to pass judgement on what kind of agriculture we should have.

Indonesian successful to increase rice production, because New Order Government are well aware that the food has a strategic and political position. Therefore, measures to increase rice production since 1969 continues to be encouraged through the Green Revolution and has demonstrated success so amazing that achieved self-sufficiency in rice in 1984, and changes the status of Indonesia from a country largest rice importer in the world in 1970s to country self-sufficiency of rice. In the span of 1969 to 1988, rice production increased by an average 4.5% per year. This success is a result of policies that emphasize the use of new technologies, irrigation infrastructure investments such as construction of dams, reservoirs, irrigation canals to farmers' fields and village roads, as well as the prices of grain and fertilizer that benefits for farmers. The use of high yielding varieties (HYVs), fertilizers, extension to farmers and improved water management irgasi are key factors in increasing rice production. Five component green revolution in Indonesia said five farming management (*panca usahatani*) incoporated in mass counseling program (*bimbingan masal, Bimas*) included agriculture extension activity.

Effective extension activities became the determining factor of the success of improvements in rice productivity. Before the Green Revolution, rice productivity was 1-2 tons per hectare. Implementation of modern inputs and new technological production has increased rice productivity to

Table 2: Rice Area, Rice Production, and Rice Productivity in Indonesia

Tear	Rice Area (000 ha)	Rice Production (000 ton)	Productivity (ton/ha)	Information
1	2	3	4	5
1961	6,857.00	12,084.00	1.76	Old Order ↓ Traditional Agriculture
1962	7,283.00	13,004.00	1.79	
1963	6,731.00	11,595.00	1.72	
1964	6,980.00	12,306.00	1.76	
1965	7,327.00	12,975.00	1.77	
1966	7,691.00	13,650.00	1.77	
1967	7,516.00	13,222.00	1.76	
1968	8,020.77	17,162.80	2.14	
1969	**8,013.62**	**18,020.20**	**2.25**	New Order ↓ Green Revolution (Five component green revolution in Indonesia said five farming management (*panca usahatani*) incoporated in mass counseling program (*bimbingan masal, Bimas*) included agriculture extension activity
1970	8,135.08	19,331.00	2.38	
1971	8,324.32	20,190.00	2.43	
1972	7,897.64	19,393.60	2.46	
1973	8,403.60	21,489.50	2.56	
1974	8,508.60	22,473.01	2.64	
1975	8,495.10	22,339.20	2.63	
1976	8,368.76	23,300.94	2.78	
1977	8,359.57	23,347.14	2.79	
1978	8,929.17	25,771.60	2.89	
1979	8,803.56	26,282.66	2.99	
1980	9,005.06	29,651.90	3.29	
1981	9,381.84	32,774.18	3.49	
1982	8,988.46	33,583.70	3.74	
1983	9,162.47	35,303.01	3.85	
1984	**9,763.58**	**38,136.45**	**3.91**	
1985	9,902.29	39,032.94	3.94	
1986	9,988.45	39,726.77	3.98	
1987	9,922.59	40,078.19	4.04	
1988	10,138.16	41,676.18	4.11	
1989	10,531.21	44,725.58	4.25	
1990	10,502.36	45,178.75	4.30	
1991	10,281.52	44,688.24	4.35	
1992	11,103.32	48,240.01	4.34	
1993	11,012.78	48,181.09	4.38	
1994	10,733.80	46,641.50	4.35	
1995	11,438.76	49,744.14	4.35	
1996	11,569.73	51,101.50	4.42	

Table 2: Continue

1997	**11,140.59**	**49,377.06**	**4.43**	
1998	11,730.20	49,236.70	4.20	Reformation Order ↓ Transition Agriculture
1999	11,963.20	50,866.39	4.25	
2000	11,793.00	51,898.00	4.40	
2001	11,500.00	50,460.80	4.39	
2002	11,521.17	51,489.70	4.47	
2003	11,477.36	52,137.60	4.54	
2004	11,922.97	54,088.47	4.54	
2005	11,839.06	54,151.10	4.57	
2006	11,786.43	54,454.94	4.62	
2007	12,147.64	57,157.44	4.71	
2008	12,309.16	60,251.07	4.89	
2009	12,883.58	64,398.89	5.00	
2010	13,253.45	66,469.39	5.02	
2011	13,203.64	65,756.90	4.98	
2012	13,445.52	69,056.13	5.14	
2013	13,835.25	71,279.71	5.15	
2014	13,797.31	70,846.46	5.13	

Sources: Rice Pedia, the onlie authority on rice. Basic Statistic of Indonesia (http://ricepedia.org/indonesia)

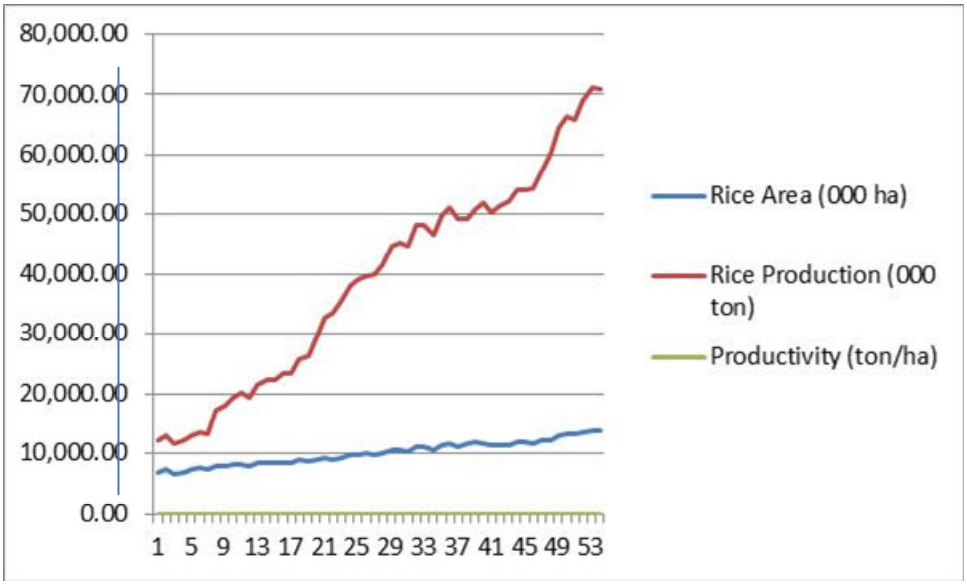

Figure 2: Area, Production, and Productivity of Rice in Indonesia 1961-2014
(Sources: Processed from data in table 1)

2-4 tons per hectare. Attainment of rice self sufficiency at a national level in 1984, which has been regarded as very important event in national agricultural history, can not be separated from the full implementation of institutionalized and systematic agricultural extension. But times changed and agriculture slipped on the list of national priorities. A

new paradigm of industrial development based on agriculture became inappropriate. New industries generally had no relationship with the agricultural sector. Consequently, agricultural development stagnated (Subejo, 2009)..

In spite of its shortcomings, it must be recognized that President of Soeharto, the New Order leader until 30 years, is the President of Indonesia, which has the most obsession and commitment to build a national rice agribusiness and to implement consistently and continuously. During the period 1968-1998, the national rice policy aimed to achieve three principal, namely: (1) establish a national food security, (2) spur economic growth and improve the economic stability (inflation) national and (3) increase the income of farmers (Simatupang and Rusastra, 2015).

While agricultural output increased as a result of the Green Revolution, the energy input to produce a crop has increased faster that the ratio of crops produced to energy input has decreased over time. Green Revolution techniques also heavily rely on chemical fertilizers, pesticides and herbicides and rely on machines, which as of 2014 rely on or are derived from crude oil, making agriculture increasingly reliant on crude oil extraction. Proponents of the Peak Oil theory fear that a future decline in oil and gas production would lead to a decline in food production or even a Malthusian catastrophe.

Briefly the positive impact of applied of bioscience and biotechnology through the Green Revolution in Indonesia namely: (1) Increased crop productivity; (2) Increased food production led to the primary needs of the industrial society become fulfilled; (3) Indonesia achieved self-sufficiency in rice; and (4) The quality of food crops is increasing.

CONCLUSION DAN SUGESTION

1. Conclusion

1. Agricultural development is dimension plural namely the efforts to enhance the institutional capacity of agriculture, improving the quality of human resources of agriculture, to increase the land productivity, and ultimately, its main purpose is to increase agricultural products through the application of modern technology, namely mechanical technology, chemical technology, and biological technology (bioscience and biotechnology).

2. Bioscience and biotechnology (biotechnology is applied of bioscience) is one of the modern technologies through Green Revolution can increase the agricultural production. Green Revolution that swept the world around the 1960s, particularly in Latin America are characterized by findings of corn and wheat superior varieties in Mexico and Soybean in Brasilia. In Asia especially in the IRRI-Philippines found superior rice IR-8, so the annual Philippine rice production increased drastically, which makes the Philippines rice exporter for the first time in the 20th century. India adopts and planting variety of IR-8 and managed to improve paddy agricultural products nearly doubled, which makes India one of the most successful producers of rice in the world. This is proof of the successful application of bioscience and biotechnology (manipulation of plant genes) in agriculture.

3. The implementation of Green Revolution in Indonesia by New Order (*OrdeBaru*) through the mass counseling program (*program bimbingan masal*, *Bimas),* one efforts of the five of farming management of this program is use of High Yielding Variety (HYV)-Superior Variety of Resistant leafhoppers of IR 26 and IR 36 in the 1980s, has increased significantly in rice production since 1961 until 2014, this is evidence of the successful application of bioscience and biotechnology.

2. Suggestion

1. Looking ahead, the world population is increasing the need of foodstuffs increasingly faced with increasingly narrow agricultural land, it answer is to increase the production of various agricultural products through the application of innovation in bioscience and biotechnology.

2. Although there are criticism toward Bioscience and biotechnology products, the Biosciencetist and biotechnologist keep working and research, because your work is needed to overcome the food crisis now and in the future.

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