Global Partnership of Asian Collages

Environment Economics Thesis

How Does the Transition to Organic Agriculture Affect the Environment and Economics: Based on Rice Cultivation in Taiwan

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When the first time we decided to participate in GPAC, we believed that it's a fun and easy task, but we totally underestimated this task. From the very beginning till now, we've made countless face-to-face or online discussions, meetings with Professor Wen, and visiting National Central Library. However, this training enables us to realize the ways to write a thesis and to do the research, and finding datas, enhancing the relationship between the our group members.

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ABSTRACT

Rice is the staple food and the dominant crop in Taiwan. But as the rice production decreases in recent decades, there is a need to find ways to save Taiwanese agriculture, one of which is organic cultivation.

This thesis mainly consists of literature review and analysis based on the data accessible. Chapter 1 states the problems faced and Chapter 2 provides the general knowledge about the development of organic agriculture in Taiwan. In chapter 3 we illustrate the reasons why organic rice production hasn't dominated the market is because the relatively higher production cost and the lack of knowledge about organic products among consumers. Chapter 4 shows the environmental improvement by transiting to organic cultivation: a reduction in the emission of greenhouse gases (primarily methane). Lastly, we give some suggestions on improving the development of organic agriculture: subsidies for the farmers provided by government, and a better-developed system of certification and regulations for organic agriculture.

Keywords: organic rice cultivation, paddy, global warming, greenhouse gas, government policy.

1.0 INTRODUCTION

1.1 Motivation & Problem Statement

Rice is a symbol of agriculture in Taiwan. It is the dominant crop, and a staple food source in Taiwan. But the production has declined over the decades, mainly because the strong economic growth leads to diet diversification and thus a decrease in rice consumption. Especially after Taiwan joined WTO, the comparatively higher production cost in Taiwan makes it even more difficult for domestic farmers, which we could see from the obvious drop in the amount of exported rice, and the rise in the amount of imported rice.

To save the rice industry in Taiwan, one of the ways is organic cultivation. Through the transition from conventional rice production to organic rice production, it will differentiate Taiwanese rice from the rice products of other countries. Furthermore, the environment will also benefit from the way of production. With the fast growth of world population and the decrease in arable lands, it is necessary to develop sustainable agriculture. Another important benefit that organic cultivation could bring us is the reduction in the emission of greenhouse gases, one of the major factors that leads to global warming. As we see the advantages organic cultivation could possibly brings, there is a need that we go organic.

2.0 LITERATURE REVIEW

2.1 The Definition of Organic Agriculture

The standard for organic agriculture varies from country to country. But the definition of organic agriculture is mostly similar. According to the FAO/WHO Codex Alimentarius Commission, organic agriculture is a holistic production management system which promotes and enhances agro-

ecosystem health, including biodiversity, biological cycles, and soil biological activity.[1] It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.

2.2 The Development of Organic Agriculture in Taiwan

Organic agriculture is a production system that sustains the health of soils, plants, and creatures. Ecological processes, biodiversity and cycles are adjusted to local conditions by organic agriculture. The development of organic rice industry is in really slow pace. As we can see from Table X, the harvested area of organic rice has increased gradually while the harvested area of conventional rice is decreasing. But still, as shown in Table I and II[2], until 2008, Taiwan's organic paddy field accounts for only 0.37% of the harvested area. Organic agriculture in Taiwan still needs some improvement. We are going to develop some methods to solve this problem in this paper.

Year	Total (ha.)
1996	61.5
1997	238
1998	302
1999	466
2000	596.27
2001	493.39
2002	609.04
2003	600
2004	743.67
2005	697.42
2006	704.02
2007	842.46
2008	949.43

Table I Harvested Area of Organic Rice in Taiwan

Year	Total (ha.)
1996	347762
1997	364212
1998	357687
1999	353065
2000	339601
2001	331619
2002	306840
2003	272124
2004	237015
2005	269023
2006	263188
2007	260116
2008	252292

Table II Harvested Area of Paddy in Taiwan

[1] FAO/ WHO Food Standards CODEX alimentarius. 1999. FAO/ WHO. www.codexalimentarius.net (accessed February 22, 2010)

[2] Agricultural and Food Agency, Council of Agriculture, Taiwan. 2009. Agricultural and Food Agency (accessed June 6)

2.3 The Advantage and Disadvantage of the Transition to Organic Cultivation

Organic agriculture substantially improve the quality of environment. By using the conventional farming system, it greatly increased the yield of crops; however, it also increased the rate of soil erosion[3] and the pesticide residues, which means that crops production under conventional system was higher than organic but this higher production is at the cost of health risk and also poses other hazards to flora and fauna.[4]

The global warming has become a big issue in recent years, the main reason is the tremendous emissions of green house gas, and agriculture is a major contributor to emission the methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2). On a global scale, agricultural land use in the 1990s has been responsible for approximately 15% of all GHG emissions. Surprisingly, organic agriculture can significantly reduce carbon dioxide emissions[5], through the promotion of aerobic microorganisms and high biological activity in soils, the oxidation of methane can be increased. Decrease in using agro-chemicals, such as pesticides and inorganic fertilizers, can effectively protect the environment, but the trade-off between adopting organic agriculture and conventional agriculture is still a paradox.

Research reveals that an investment of approximately $4 billion dollars in pesticide control saves approximately $16 billion in US crops, but this assessment is incomplete because there is no acceptable monetary value for a human life lost or for a cancer due to pesticides, equally difficult

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[3] John, Reganold, Lloyd, Elliott and Yvonne L. Unger. 1987. "Long-term effects of organic and conventional farming on soil erosion" Nature, 330(1): 370-372

[4] Rekha, Naik, R. Prasad. 2006. "Pesticide residue in organic and conventional food-risk nalysis." Chemical Health & Safety, 13(6): 12-19

[5] Johannes and Karl Müller-Sämann. 2004. "The Role of Organic Agriculture in Mitigating Climate Change." International Federation of Organic Agriculture Movements Working Papers May 2004

placing a monetary value on wildlife, invertebrates, microbes, food, or groundwater.[6] Using organic fertilizer can naturally fix and enrich nitrogen in the soil and also creates a healthy soil structure, but the Human Resource Cost is high because it takes more times tending to the soil, adding mulches, testing soil pH for nutrients, and buying composted manures to increase nitrogen levels; crops can easily absorbed inorganic fertilizer by the plant's roots, and this results in rapid growth, however lots of problem occurs, such as more pests and disease and harmful algal bloom.[7]

2.4 The Development of Organic Regulations

2.4.1 International Organic Regulations

The organic movement was first formed between 1950-1960, along with the establishment of International Federation of Organic Agriculture Movements (IFOAM), which is the first nongovernmental international organic agriculture organization. IFOAM formulated the IFOAM Basic Standards for Organic Production and Processing (IBS) in 1980. Although IBS is the first international organic regulations, most of the nations, including EU, US, Japan, haven't approved IBS as their national organic policies. We will address each nation's organic policies later. Food and Agriculture Organization (FAO) and World Health Organization (WHO) co-established the Codex Alimentarius Commission (CAC) in 1963 to construct a global food standards and regulations. In order to prevent false claims of organic food by the governments, CAC published "Guidelines for the Production, Processing, Marketing, and Labeling of Organically Produced Foods" in 1999[8]. According to this guideline, the legislative intent is to provide a guideline for the nations to formulate the organic regulations suited to each nation, but not to construct a internationally unanimous organic regulation, therefore, it is a non-mandatary, voluntary regulation.

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[6] David, Acquay, H. 1992. "Environmental and Economic Costs of Pesticide Use." Bioscience, 42(10): 750-760

[7] Chris Molnar, Go organic gardening. 2010. <http://goorganicgardening.com/garden-maintenance/organic-versus-conventional-gardening-fertilizer> (accessed February 22, 2010)

[8] CAC/GL 32. At http://www.codexalimentarius.net/download/standards/360/CXG_032e.pdf

2.4.2 National Organic Regulations

The organic agriculture started to grow since 1980s in Europe; however, the organic agriculture was considered as a social movement at the moment. It was until late 1980s and early 1990s, the consumers focused more on food safety and the environment protection, and because organic agriculture happened to have both features, the demand of organic food had skyrocketed. Yet, there were no clear regulations to define organic agriculture, which caused some confusions and misunderstandings to the consumers. For example, there were a lot of non-organic food being labeled as organic food, infringing the right of the the consumers and jeopardizing their health. In order to improve the situation, EU officials have formulated Council Regulation (EEC) 2092/91 of June 1991[9] on organic production of agricultural products and indication referring thereto on agricultural products and foodstuffs. This regulation is applicable to every EU nation members, each nation is forbidden to make the laws contradict to this regulation. However, considering the differences between each nations with their geography, social economy status, ECC 2092/91 is the lowest organic standard they have to follow.

The organic certification system started in 1970s in USA. It was established by the nongovernmental organization, providing the guidelines to the organic producers and endorse their organic products, gained the trust from the public and facilitated the organic production. Based on the same reason, several States began to construct the organic certification system in the 1980s.[10] Yet, different standards and systems among States caused confusions to the consumers. To the producers, facing different standards and systems caused them to pay more production cost and transaction cost. Therefore, the Congress passed the Organic Food Production Act (OFPA) in 1990. This Act authorized the U.S. Department of Agriculture to formulate the National Organic Program

[9] Weseen (2003) At http://organic.usask.ca/reports/Organic%20Europe%20Oct%2013.pdf

[10] Greene and Kremen (2003) At http://www.ers.usda.goc/publications/aib780/aib780.pdf

(NOP). Before the application of NOP, the public could give comments to this program, and it was until 2002, the NOP became effective, stated that every organic-labeled food is regulated by NOP.

Japanese Ministry of Agriculture, Forestry and FIsheries (MAFF) published it's first organic regulation in 1992. Because it was a non-mandatory, voluntary regulation, the products labeled as organic were not necessary to comply with the regulation. On the other hand, the definition of organic product was confusing back then, while the products that didn't use or reduce the pesticides could be claimed as organic product. There were no clear definitions for the organic products, causing some misleads to the consumers.[11] As a result, MAFF revised the Law concerning Standardization and Proper Labeling of Agricultural and Forestry Production, Law No. 175 of 1950 (JAS), bringing in the organic production into it.

3.0 RESEARCH OBJECTIVES

3.1 Environmental Issue

The world has put much concern on the fact that the surface of the earth is getting warmer. IPCC used the IS92 emission scenarios to project mean temperature changes in year 2000. Climate models calculate that the global mean surface temperature could rise by about 1 to 4.5 centigrade by 2100. This is a serious problem, as we all know that climate change doesn't do much good to human beings and the other creatures on the earth. One of the reasons why the global keeps warming is the emission of GHG. Evans & Puckrin (2006) did a research on it. Their measurements showed that the greenhouse effect from trace gases in the atmosphere is real, and adds significantly to global warming. Although most of the increase in greenhouse gas concentrations is due to carbon dioxide (CO_2) emissions from fossil fuels, globally about one-third of the total human-induced

[11] FAO (2001) At http://www.fao.org/DOCREP/004/Y1669E/y1669e0b.htm#bm11

warming effect due to GHG comes from agriculture and land-use change.

Precisely, agricultural activities currently generate the largest share, 63 percent, of the world's anthropogenic non-carbon dioxide (non-CO_2) emissions (84 percent of nitrous oxide [N_2O] and 52 percent of methane[CH_4]), and make up roughly 15 percent of all anthropogenic GHG emissions.[12]

One thing very interesting about one of the GHGs, methane, is that of the man-made methane sources, rice cultivation accounts for 19% of the emission. This is because most rice in Asia and the rest of the world is grown in flooded paddy fields, the condition which would make the bacteria generate more methane. Such a big amount of emission is worth our attention, and that's also one of the reasons why we choose to focus on rice.

3.2 Market Domination

In Taiwanese rice market, conventional rice is still the main choice for most of the consumers. But organic rice cultivation can bring us so many benefits, why hasn't it dominated the market in Taiwan? We can analyze this problem through three aspects, which are producer, consumer and government`s policy.

3.2.1 Producer's Point of View

Through producer's point of view, we find that the transition to organic rice will lead to some facts which would make the farmers unwilling to transit from conventional cultivation to organic cultivation.

Table III shows after transiting from conventional to organic cultivation, the production quantity per

[12] U.S. Environmental Protection Agency (USEPA), 2006; Prentice et al., 2001

hectare decreases from 5,493 kg to 4,746 kg, because more nutrients and spaces are required for growing organic rice. Therefore, in the equivalent farm land area, farmers can grow more conventional rice than organic rice. The production cost also increases from 64,878 NTD/kg to 96,275 NTD/kg after the transition.[13] The main reason is that organic farming needs more labors to run the farm work. Besides the increase of wage for labors, high certification fee is another reason that raises the cost of planting organic rice.

Pest and weed control is another reason that hinders farmers from transition. Instead of using machine and pesticide, organic farming mainly relies on human labor in weeding and pest controlling. It not only increases production cost but also makes those works ineffective, causing the production quantity of organic rice unstable.

	Conventional Rice	Organic Rice	Difference
Production Quantity (kg/ha)	5,493	4,746	Decrease 13.59%
Production Cost (NTD/kg)	64,878	96,275	Increase 48%

Table III Differences in Two Production Methods

3.2.2 Consumer's Point of View

In Taiwan, nearly 63% of organic products have higher price than conventional ones. For organic rice, they have 30% to 100% higher price than the conventional rice[14]. Based on this result, we believe that organic rice have premium price. In Taiwanese market, there are two groups of customers: price-sensitive consumers and quality-sensitive consumers. The transition from conventional to organic rice cultivation causes different effect on both two groups.

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[13] 有機米產銷現況與展望, 行政院農委會中部辦公室, 林銘州、林鈴娜、李蒼郎

[14] Organic farming for sustainable agriculture in Asia with special reference to Taiwan experience, Sung-Ching Hsieh, 2005/9/1, http://www.agnet.org/library/eb/558/

To price-sensitive consumers, if farmers apply the transition, the variety of cheap rice, which refers to conventional rice, will decrease. Due to the transition, the quantity of cheap rice will also decrease and lead to the rise of price. Therefore, for price-sensitive consumers, it'll be a worse off situation.

To quality-sensitive consumers, after the transition, the quality of rice will be improved because organic rice is high quality rice. Also, quality-sensitive consumers can have more choices when buying high quality rice. So, for quality-sensitive consumers, it'll be a better off situation.

Through E-ICP[15], moreover, we found that flavor is the chief consideration when 62% of the consumers choose to buy organic rice, while only 7% of the consumers make the purchase because the rice is organic produced.

Due to this consumer behavior, organic rice have great difficulty to enter and dominate the market. To solve this problem, we believe there are two ways. First, the producer should try to lower the price of the organic rice, which can be done by many ways. For example, the government can subsidize on the transition or lower the certification fees. Second, the government should help in promoting organic rice and educate the consumers, letting them know how organic products benefit health and the environment.

[15] 東方線上 ISURVEY. 2009. Eastern Online Co., Ltd. (accessed June 6).

4.0 CONCLUSION

4.1 Suggested Policies

After we addressed the difficulties that the organic rice is facing, we here now propose some possible organic policies to the Taiwanese government.

(1) Differentiate the certification fees according to the scales of farming.

No matter what scales of the farming, they all pay the same amount of certification fees, 36,500 TWD[16], for Taiwanese farmers. This seems not fair for some small-scale farmers. We try to adapt one feature from USA. The organic regulation stated that if the yearly output value is lower than 5,000 US Dollars for specific small-scale farmers, they don't have to pay for the certification fees, but just to get a simple qualification. The limitation is that their product can only be sold in their farms. By adapting this similar policy, it will relieve the cost pressure from some small-scale farmers in Taiwan.

(2) Subsidize the organic farming.

It is without a question that by subsidizing the organic farming will boost the industry. One example from Austria is that the government subsidize 327 Euro per Ha. to organic farming. The outcome was effective instantly when they started the policy in 1999: the organic farming area grew 6% over 5 years.[17] Providing subsidies to organic farming in Taiwan will give more incentives to the farmers.

(3) Widen the limitation on pesticide residue.

As we addressed in the previous chapter, Taiwan has the most strict standard towards pesticide residue. It seems like Taiwanese government has mistaken the nature of organic farming: to improve the environment and sustain the land fertility, some contaminations that have already in the

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[16] 有機農糧產品驗證收費數額核定標準, http://www.afa.gov.tw/Public/organicAgriculture/20095271035497055.pdf (accessed June, 2010)

[17] A Study on the Regulations and Policies of Organic Agriculture, Kai-Hsiang Liu, 2007, P. 238

land are unavoidable. Therefore, it is unreasonable to ask for 0% of pesticide residue. By widening the limitation, more farmers will be willing to invest in the organic farming.

(4) Educate the consumers about organic products.

According to E-ICP, only 7% of Taiwanese consumers would buy organic rice, demonstrating that educating the consumers is the very first step of booming the organic rice market. How to educate the consumers is out of the scope of this thesis.

4.2 Environmental Improvement

In the past decades, Taiwan's agriculture depended very much on the use of pesticides and chemical fertilizers. However, it is time now to realize the harmful effects of chemicals on environment. Before we continue, let's check out the trends in conventional rice paddy fields in Taiwan. Firstly, we collected the information from Taiwan Agriculture Year book (1990- 2008) and realized that in recent years conventional rice paddy fields' area is decreasing. From 1990 to 2009 it decreased by 50% (from 454,266 ha. in 1990 to 228,299 ha. in 2009), we have used a forecasting method "TREND" to predict its future behavior, and found that by 2016 it will decrease by 32% more to compare with the area in 2009 (from 228,299 ha. in 2009 to 154,878 ha. in 2016). Such a big difference can be raised by changes in consumptions and eating habits of consumers, dangerous decrease of agricultural land is another reason of it.

Secondly, we collected the data about methane emissions from conventional rice paddy fields in Taiwan during 1990-2006 (Yang, 2009) and then divided it by the area of Taiwanese paddy fields, so we found that the methane emissions from conventional rice paddy fields in Taiwan during 1990-2006 estimated in tons per hectare have a tendency to decrease (Figure I). We also used

TREND method to forecast future behavior of methane emissions, which showed continuous reduction of CH4.[18]

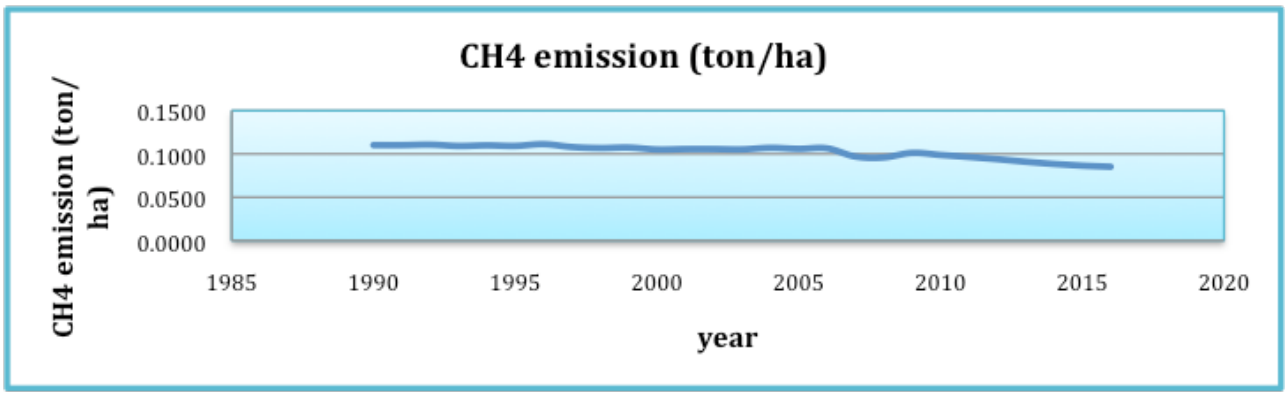

Figure I

Taiwanese rice planting is special comparing with Japan. There is only one crop season in Japan, while there are two crop seasons in Taiwan. The first crop season is cultivated in February and harvested in July, and the second crop season is cultivated in August and harvested in December (Yang, 2009). Using the data about Taiwanese Conventional paddy fields area for each crop (Taiwan Agriculture Yearbook, 2007) and the methane emission from each crop separately, we calculated the methane emissions for each crop and found that emission of methane during the second crop was 2.35 times bigger in 1990 (total methane emissions were 14,980 and 35,208 tons at first and second crop seasons respectively); however, by the year 2006 the difference has been significantly reduced to the 1.78 times (total methane emissions decreased to 10,087 and 17,942 tons at first and second crop seasons respectively, as in Figure II). Though the distinction is reduced, still what is the reason for such a great difference in the amount of methane emissions between the first and second crop during the years? The answer is positive linear correlation between the temperature during the transplanting stages of rice cultivation. It is important to notice that the temperature has to be estimated exactly during first few weeks when the rice have been

[18] Yang, Shang-Shung. 2009. "Estimation of methane and nitrous oxide emissions from paddy fields in Taiwan." *Renewable energy 34,* January, 20, 1916-1922

grounded. If we compare the average temperature during the whole first and second crops, we will not find any significant difference, only the difference between average temperatures of transplanting stages is evident: in the first crop season is 16-24 °C and in the second one is 21-28°C (Yang, 2009). So the greater the temperature during the transplanting stage is, the greater methane emission would be. Actually, because of the greenhouse effect and increasing temperatures in winters, the emission of CH4 from the first crop season is increasing in recent years, and according to our forecast it will continue to increase (as in Figure II).

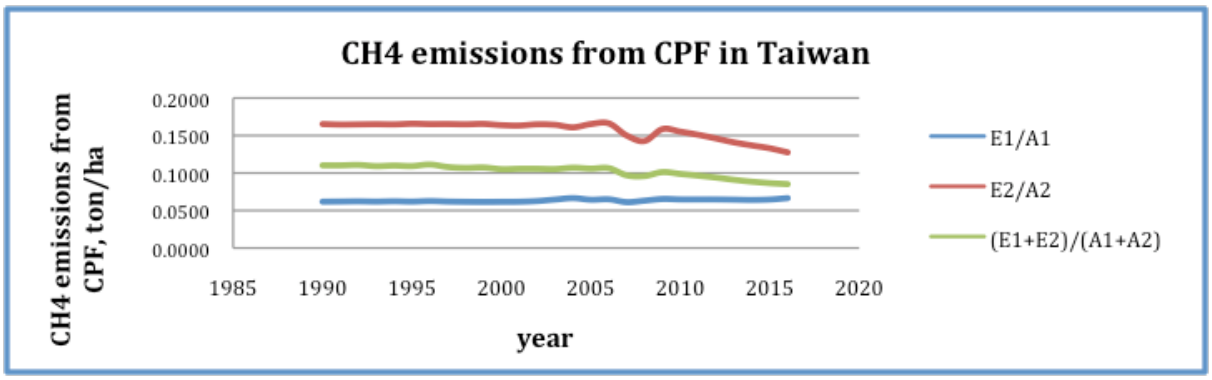

Figure II

During our research we obtained very valuable information, which is based on Japanese example of switch from conventional production of rice into organic production. As noted in Hokazono (2009) the GHG emissions for conventional farming had the highest level because of the large amount of chemical fertilizers used, besides the reduction in the amount of emissions from conventional and organic paddy fields stays for 10%".[19] So, due to trends in Taiwanese Paddy fields that were mentioned above (two-crop seasoning) and Japanese experience, we suggest that the first change from Conventional rice planting to Organic one should be made during the second crop, by that we firstly decrease the amount of methane emission by 10% during the second crop season and it

[19] Hokazono S., Hayashi K. and Sato M. 2009. "Potentialities of organic and sustainable rice production in Japan from a life cycle perspective." *National Agricultural Research Center, National Agriculture and Food Research Organization*, 257–262

simultaneously will decrease the total emission of methane during two crops together by 6.3% (Figure III).

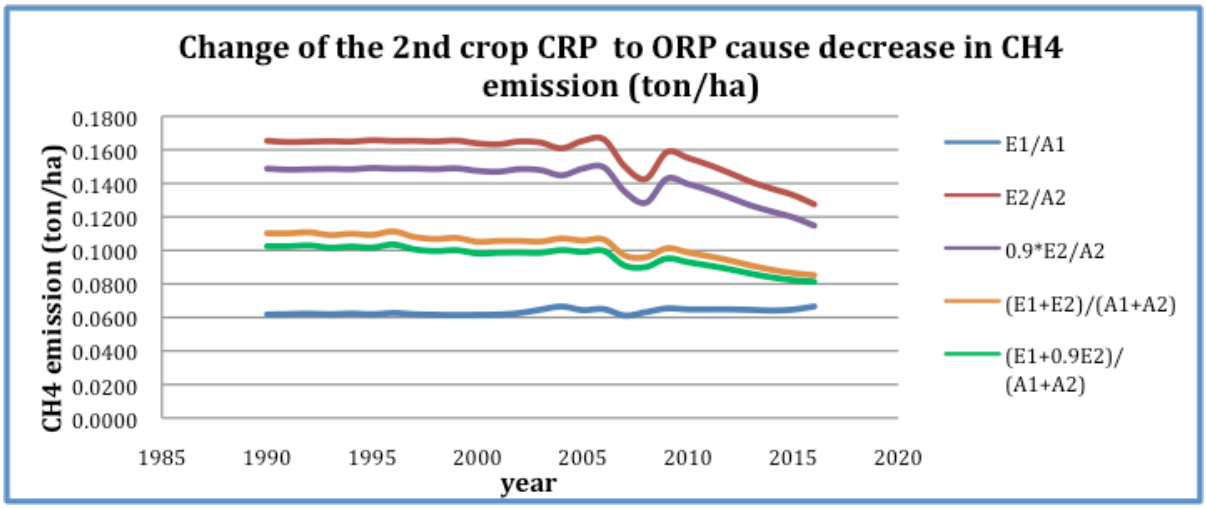

Figure III

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