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Biofuel and food security in China and Japan

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ABSTRACT

The Chinese government is promoting the national biofuel program to deal with energy security and excessive grain stocks. The Japanese government is promoting a biofuel program to deal with climate change and energy security, and to promote rural development. This study is an economic analysis of the competition between biofuel and food, and the relationship between biofuel and food security in China and Japan. The definition of competition between biofuel and food can be divided into food and food-related demand, and agricultural production. This analysis shows that not only the feedstock of agricultural product-based biofuel, but also cellulose-based biofuel competes with food and food-related demand, and agricultural production in China and Japan. It is assumed that *non-food*-based biofuel and cellulosic-based biofuel do not have a serious impact on food security on a country and sub-country level in China and Japan, because the amount of feedstock used for non-food and cellulose-based biofuels is small. However, such use could have a negative impact on undernourished households in China. In its promotion of biofuel development, the Chinese government has to pay full attention to nutrition levels of households. In 2010, the Japanese government released draft sustainable criteria for biofuel, but did not cover food security in partner countries. Such criteria should consider food security in partner countries.

Contents

1. Introduction

To deal with energy security and excessive grain stocks, the Chinese government[2] strongly promoted the national biofuel

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[1] The views expressed in this document are those of author and do not reflect the official view of the FAO.

[2] It means central government.

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Table 1
Current bioethanol production.

Location	Company	Main feedstock	2009 Production (Estimated: 1000 l)	2010 Production Capacity (1000 l)	Supply location
Heilongjiang, Zhaodong	China Resources Alcohol Co.	Corn	240,730	253,400	Heilongjiang
Jilin, Jilin	Jilin Fuel Ethanol Co.	Corn	633,500	570,150	Jilin and Liaoning
Henan, Nanyang	Henan Tian Guan Fuel-Ethanol Co.	Wheat	561,281	570,150	Henan, Hubei (9 Cities) and Hebei (4Cities)
Anhui, Bengbu	Anhui BBCA Biochemical Co.	Corn	532,140	557,480	Anhui, Shandong (7 Cities), Jiangsu (5 Cities) and Hebei (2 Cities)
Guangxi	Guangxi COFCO Bioenegry Co.	Cassava	211,589	177,380	Guangxi
Total			2,179,240	2,128,560	

Data Source: USDA-FAS [28].
[a]Rice is partly used for bioethanol production in Heilongjiang.

program. The main feedstock is corn. However, the government is trying to diversify the production of bioethanol to include non-food feedstock. In terms of the Kyoto Protocol, the Japanese government was required to start a biofuel program. To ensure that the availability of domestic food sources are not affected, the feedstock for biofuel consists of byproducts, unused agricultural products, and cellulose. Since starting their biofuel programs, both the Chinese and Japanese governments have paid close attention to the relationship between biofuel and food security.

Several studies have examined China and Japan's biofuel programs and production. Wang et al. [33] examined the distribution and development of biofuel crops and the bioenergy industry in China. Chavez et al. [2] reviewed technical and policy developments in Chinese biofuel. Wang [34] reviewed non-food biofuel commercialization in China. Hu and Philips [10] assessed the technical evolution of the Chinese biofuel industry. Qiu et. al [22] reviewed Chinese biofuel policies and their current status. Huang et al. [11] examined how global biofuel production could impact poverty in China. Matsumoto et al. [19] reviewed biofuel initiatives and the future potential of biofuel in Japan. Koizumi [17] reviewed developments of, and perspectives towards, the Japanese biofuel program.

However, none of these studies has analyzed the competition between biofuel and food, and none of these studies has analyzed the relationship between biofuel and food security in China and Japan. This study is an economic analysis of the competition between biofuel and food, and the relationship that exists between biofuel and food security in China and Japan. The next section covers Chinese biofuel programs, while the third section covers the Japanese biofuel program. The fourth section covers the relationship between biofuel and food security; the fifth section is a discussion; and the last section provides a summary and conclusion.

2. Chinese biofuel policy and production

2.1. Background and biofuel policy

As a result of China's high economic growth, the number of cars in the country is increasing rapidly. From 1990 to 2008, the market for passenger cars grew from 0.51 to 9.38 million. The Chinese car market has overtaken that of Japan to become the second-largest car market in the world, with sales of 7.28 million vehicles in 2006. Chinese petroleum consumption increased from 164 million tons in 1990 to 553 million tons in 2008; and crude oil imports rose from 2.9 million tons in 1990 to 178.9 million tons in 2008 [21]. After the USA, China is the second-largest petroleum consumer in the world. Increasing oil consumption led China to become a net oil importer from 1994. However, a shortage of energy resources, including petroleum, has been a serious problem since the 1990s. Proved oil reserves in China amounted to only 1.2% of the total world proved oil reserves at the end of 2008 [1]. In addition, rising crude oil prices since 2003 have had a negative impact on Chinese energy markets, as well as on the energy markets of other countries.

In China, the definition of alternative energy was expressly stated in the Five-Year Plan of 1982. In 2001, the promotion of biomass energy was expressly stated in the Five-Year Plan for the period 2001–2005. In June 2002, the Chinese government started to mandate the use of bioethanol blend gasoline in five cities in the Heilongjiang and Hernan province. In October 2004, the government introduced the compulsory use of a 10% blend of bioethanol to gasoline (E10) in all areas of Heilongjiang, Jilin, Liaoning, Hernan, and Anhui. The government has expanded the E10 program to 27 cities in Shandong, Jiangsu, Hebei, and Hubei since 2006.

2.2. Biofuel production

China, the third-largest bioethanol-producing country after the U.S. and Brazil [8], produced 2100 thousand kℓ of bioethanol in 2011. Corn and wheat comprise the major part of the feedstock for bioethanol. Bioethanol is produced from corn in Heilongjiang, Jilin, and Anhui, and from wheat in Hernan. In addition, bioethanol is produced from cassava in Guangxi. Currently, five bioethanol production plants in China (Table 1) have operating licenses from the government.

China also produces biodiesel for fuel use. There are four major plants in Fujiang, Jiangsu, Hebei, and Beijing. The country produced only 454 thousand kℓ of biodiesel in 2011 because of a lack of feedstock availability. The main feedstock for biodiesel is used cooking oil. Although Chinese mills prefer to produce biodiesel from vegetable oil, securing vegetable oil for biodiesel use can be difficult because China is a net importer of oilseed and vegetable oil. Procuring feedstock is a crucial problem for expanding biodiesel production in China.

The Chinese bioethanol production cost from corn is equivalent to 1.022 US$/ℓ[3], while the U.S. bioethanol production cost from corn is 0.492 US$/ℓ [7]. The cost of Chinese bioethanol production from cassava is equivalent to 0.882 US$/ℓ, while Thailand's bioethanol production cost from cassava is 0.300 US$/ℓ [7]. Thus, the cost of Chinese bioethanol production is much higher than that of the U.S. and Thailand. Because of high feedstock prices, it is necessary for all bioethanol producers to

[3] It is calculated that US$1 is equivalent to 6.57 yuan (2011.3).

receive government subsidies to cover operating losses. The average subsidy for fuel bioethanol production set by the government reached 1836 yuan/ton in 2005, 1625 yuan/ton in 2006, 1374 yuan/ton in 2007, and 1754 yuan/ton in 2008[4]. The average subsidy decreased gradually between 2005 and 2007. However, it increased from 2007 to 2008 because of high feedstock prices resulting from soaring international grain prices at that time. Since 2008, the government has implemented a flexible subsidy program for all five fuel bioethanol producers [28]. In addition, value-added tax (17%) on these plants has been removed [34], bioethanol has been made exempt from a 5% consumption tax, and approximately 100 yuan in profit is guaranteed for each stock on a preferential basis. All supporting benefits are directed toward state-owned enterprises, whereas only a few of them are accessible to private enterprises. Currently, five licenses have been issued in China. In some cases, the lack of supporting benefits is the main reason for the failure of private enterprise investment in biofuel plants [34].

2.3. Feedstock for biofuel production

Corn is the main feedstock for bioethanol production in China. Chinese corn consumption for feed and starch use has increased since 1990, and the domestic price of corn has also risen since December 2004. Chinese corn ending stocks decreased dramatically from 123,799 thousand tons in 1999/2000 to 36,602 thousand tons in 2006/07 [35]. When the government started to expand the corn-based bioethanol program, corn ending stocks were abundant and the government tried to manage the decrease in these stocks.

In China, the wholesale price of domestic corn increased from 1190 yuan/MT in February 2005 to 1547 yuan/MT in September 2006[5], because the changing ratio of domestic consumption was higher than that of production. Corn consumption for bioethanol was competing with corn consumption for feed, food, and processed food. As a result, on December 21, 2006, the National Development and Reform Commission (NDRC) started to regulate corn-based bioethanol expansion. This regulation allowed the current bioethanol production level in Heilongjiang and Jilin to be maintained, but limited further expansion of corn-based bioethanol production. This regulation applies to wheat-based bioethanol production as well.

Instead of expanding corn-based bioethanol production, the Chinese government wants to diversify bioethanol production, with increasing emphasis on Cassava as a feedstock. In 2009, cassava-based bioethanol production was 211,589 kℓ. Guangxi, Guangdong, Hainan, Fujian, Yunnan, Hunan, Sichuan, Guizhou, Jiangxi, and nine other provinces are suitable for cassava growth. In 2009, total output of cassava in China was 4.5 million tons [30]. Cassava-based bioethanol plants are operating in the Guangxi Zhaung Autonomous Region in Southern China. In addition to these crops, bioethanol production from sweet sorghum, crop stalk and straw, sugarcane, sweet potatoes, sugar beet, woody biomass, and others is at an experimental stage.

2.4. Future developments of the Chinese biofuel program

In January 2006, the Chinese government enacted the "Renewable Energy Law" to promote renewable energy utilization and production. The government's biomass energy policy is divided into four categories: biofuel, rural biomass, biogas, and bioelectricity. The NDRC provided a mid- to long-term plan for renewable energy in September 2007. The plan indicated that in 2020, bioethanol from non-food grade would be 10 million tons and that biodiesel production would be 2 million tons. The Chinese government will promote the expansion of biofuel production from non-food grade feedstock in the future, and will encourage the use of agricultural resources that can be grown in marginal
land.

In future, China will have to diversify feedstock for biofuel production. China has switched from grain-based biofuel to non-food grade biofuel production, using feedstock such as sweet sorghum and cassava. However, biofuel levels from these non-food resources are still being determined in a pilot scale project at present, and it is difficult to expand bioethanol production from cassava and sweet sorghum, because of the difficulty in procuring feedstock. In addition, China is exploring second-generation biofuel production from corn stalk and algae. Currently, high enzyme cost is one of the problems in expanding cellulose-based bioethanol production. While Chinese R&D for second-generation biofuel production has just begun, it will be active in the future[6].

3. Japanese biofuel policy and production

3.1. Background and biofuel policy

The Japanese government started its biofuel programs under the Kyoto Protocol. In terms of the protocol, Japan committed to cutting its 1990 greenhouse gas emissions by 6% before the end of the first commitment period (2008–2012). Since 2003, the government has been promoting bioethanol production and its use for automobiles. In March 2000, the Japanese bioethanol production level was estimated at 13,000 kℓ [20]. Sugarcane molasses, surplus sugar beets, substandard wheat, nonfood rice, rice and wheat straw, and other materials are used for bioethanol production. To promote bioethanol production and utilization, a tax break for bioethanol production and utilization was also established in 2008. First, a 50% reduction in the fixed-assets tax for biofuel manufacturing facilities was applied for three years. Second, a tax reduction was established for the portion of bioethanol in bioethanol-blended gasoline[7]. The municipal government and non-governmental organizations are promoting the production of biodiesel from used vegetable oil blended with diesel for use by public buses, official cars, and municipal garbage trucks. As of March 2010, the total amount of biodiesel production was estimated at 13,000 kℓ [20].

3.2. Cost of bioethanol production and securing feedstock

The domestic costs of bioethanol are much higher than those of gasoline and imported bioethanol because of expensive land usage[8]. These price differences present crucial challenges to the goal of expanding biofuel production in Japan. At present, bioethanol producers are reliant on subsidies, without which they cannot operate their production facilities. Reducing the cost of producing bioethanol is the key to increasing its domestic production, but it will be difficult to reduce the cost of domestic

[4] This bioethanol cost is estimated from USDA-FAS [27].

[5] This was derived from the Institute of Agricultural Economics, Chinese Academy of Agricultural Science (2007.10).

[6] For detailed information for China, please refer to Koizumi [16].

[7] In the case of 3% bioethanol blended in gasoline, 1.6JPY/ℓ is tax exempt.

[8] The bioethanol price (including feedstock cost, processing cost, and gasoline tax) made from molasses was 142.6 JPY/ℓ and that from non-food grade wheat was 150.2 JPY/ℓ. However, the wholesale gasoline price was 113.4 JPY/ℓ and that of bioethanol-blended gasoline derived from Brazilian bioethanol was 127.3 JPY/ℓ. For detailed information, please refer to Koizumi [16].

Table 2
Biofuel use in China.

	Unit	2006	2007	2008	2009	2010	2011
Corn use ratio (1)/(2)	%	2.2%	2.1%	2.4%	2.4%	2.2%	2.3%
Corn use for bioethanol (1)	1000MT	3200	3200	3700	4000	3900	4284
Domestic corn consumption (2)	1000MT	145,000	150,000	153,000	165,000	180,000	188,000
Wheat use ratio (3)/(4)	%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%
Wheat use for bioethanol (3)	1000MT	1050	1050	1050	1050	1050	1050
Domestic wheat consumption (4)	1000MT	102,000	106,000	105,500	107,000	110,500	120,500
Cassaca use ratio (5)/(6)	%	–	–	7.7%	10.4%	8.4%	–
Casssava use for bioethanol (5)	1000MT	0	0	340	470	392	336
Domestic cassava productuion (6)	1000MT	4313	4362	4409	4506	4684	–

[a]Corn, wheat and cassava used for bioethanol is derived from USDA-FAS [30]. Domestic corn and wheat consumption are derived from USDA-FAS [32].
[b]Domestic cassava production is derived from FAO [5]. Domestic cassava production is alternative for cassava consumption.

bioethanol to the level of gasoline prices and imported bioethanol prices in a short period.

At present, ten bioethanol production facilities are operating, and it is difficult for most of them to expand their production levels dramatically because of limited feedstock. Japan is a net food-importing country. There is strong critical debate that food-based biofuel production may affect domestic food availability in Japan. The Japanese government therefore selects the feedstock of biofuel from by-products and unused agricultural products, so as not to have a negative impact on domestic food availability. In order to increase the volume of domestically produced bioethanol in Japan, it is necessary to produce biofuel using cellulose materials and unused resources.

3.3. *R&D for second-generation biofuel production and sustainability criteria for biofuel*

The most crucial factor in expanding biofuel production is technological innovations. Technologies have been developed to manufacture bioethanol more efficiently from nonfood resources, such as woody biomass, rice straws, and energy crops. Japanese research institutes are also working on increasing the efficiency of cellulose-based bioethanol production[9]. Some Japanese universities and private companies are researching the production of biodiesel from algae, such as *pseudochoricystis ellipsdoidea* and *Botryococcus braunii*, for automobile fuel and jet fuel.

Some domestic research institutes, universities, and private companies that are researching biofuel production, plan to utilize their advanced technologies not only for domestic production, but also for international production in Asia. Therefore, these researches can contribute to increasing second-generation biofuel production in Asia.

The Sophisticated Methods of Energy Supply Structures Law, enacted in July 2009, requires petroleum and gas enterprises to use biofuel and biogas. The government established a study panel to discuss the introduction of sustainable biofuel in 2009, and the panel released intermediate sustainable draft criteria for biofuel in March 2010. Biofuel should eliminate 50% of GHG, compared to gasoline or diesel. This is the main criterion. At present, most domestic biofuel production does not satisfy the draft criteria (50% GHG reduction), with the exception of waste woods and sugar beet for bioethanol use[10]. The panel recognized that the biofuel industry was not yet mature enough to apply these criteria to current biofuel production, so it would be necessary to examine the criteria for these LCA (Life Cycle Assessment) analyses, whenever bioethanol-related technological developments occur. The Japanese government has to establish sustainable criteria for biofuel that determine the limitations of GHG emission, and pay close attention to biodiversity and social consequences. The sustainable criteria could be a good model for other countries, especially in Asia, but further research and dialogue with these countries will be required[11].

4. The relationship between biofuel and food security

4.1. *Competition between biofuel and food*

One of the most crucial problems for increasing biofuel production is competition for resources with food and food-related use. There were many debates when food price hikes occurred all over the world between 2007 and 2008. The biofuel impact on food prices was discussed at the Food and Agricultural Organization's (FAO) High-Level Conference on World Food Security in June 2008. It was also discussed at the G8 Hokkaido Toyako summit in July 2008. The G8 Leaders' Statement on global food security was published during the G8 summit.

The definition of competition between biofuel and food can be divided into two dimensions. The first dimension is competition with food and food-related demand. The second dimension is competition with the agricultural resources (Table 2). When biofuel demand increases, feedstock demand will also increase. At present, the main feedstock of biofuel all over the world is agricultural produce. This means biofuel demand competes with food and food-related demand. Bioethanol use accounted for 45.9% of total U.S. domestic corn consumption in 2011/12 [26]. In the case of Brazil, the world's second-biggest bioethanol producer, more than half of the sugarcane has been used for bioethanol use since 1990. In 2010/11, 55.2% of sugarcane production[12] was used for bioethanol production [29]. In EU27, 68.1% of rapeseed oil consumption was used for biodiesel in 2011/12 [31]. Bioethanol use accounts for 14.2% of the world's total consumption of corn and 17.4% of total sugarcane production. Biodiesel accounted for

[9] In 2006, the Research Institute of Innovation Technology for the Earth (RITE) and Honda R&D Co., Ltd. developed the *RITE strain*, which substantially reduces the harmful influence of fermentation inhibitors. RITE is also developing high STY (Space Time Yield), which promotes productivity in a unit of reaction volume per hour and simultaneous utilization of C6 and C5 sugars.

[10] As examples, bioethanol made from sugar beet can eliminate 27% of GHG and that from non-food grade wheat can eliminate 46% of GHG, compared to gasoline. In the case of Brazil, the panel said that bioethanol production from existing cropland could eliminate more than 60% of GHG emissions. This means that Brazilian bioethanol production from existing cropland can pass the draft criteria. The panel also reported that bioethanol production from converted pasture land could increase GHG emissions 8% over those of gasoline.

(*footnote continued*)

[11] For more information, please refer to Koizumi [16].

[12] There are no statistics for sugarcane demand in Brazil. Instead of sugarcane consumption, its production was applied in this part.

27.2% of the world's total demand for rapeseed oil and 11.9% of the world's total soybean oil demand[13]. The more biofuel demand increases, the more the demand increases for agricultural feedstock. The demand for biofuel, therefore, competes with food use, feed use, and processed food and this competition can have a direct impact on national food consumption. This competition in agricultural commodity demand for feed use, which is prevalent domestically and internationally, can have negative impacts on the livestock sectors. For food importing countries, this is crucial concern. In addition to this, each competition can be divided into direct and indirect competition. Indirect competition can cause substitution effects to alternative commodities; for example, the soybean oil price increase can stimulate increases in the prices of other vegetable oils.

The competition in the agricultural resources means competition in land and water use, fertilizer use, pesticide use, agricultural machinery use, labor use, capital use, and others. In this dimension, the competition for land use is the most crucial problem, especially in the USA and Brazil. In the case of the U.S., the more bioethanol demand increases, the more the corn price increases. Corn and soybean are competing for planting mainly in the Mid-west area. As a result, the area harvested for soybeans in the U.S. could decrease, particularly in the Mid-west area. In the case of Indonesia and Malaysia, demand for biofuels is already leading to more deforestation in Indonesia and Malaysia, and that 20% of the EU's biofuel expected to be supplied by these two countries [9]. In the case of Brazil, the area for sugarcane cultivation has expanded as a result of increasing bioethanol demand. Sugarcane is competing for land with other crops such as coffee beans, oranges, cotton, rice, and others. This competition is causing changes in land use patterns, especially in Sao Paulo state (*direct land use change*). In addition, such competition can cause *indirect land use change*[14] to other areas. Such competition can be divided into direct and indirect competition.

As stated above, the competition between biofuel and food should be divided into food and food-related demand and the agricultural resources. Demand should be divided into domestic and international demand. The most crucial issue is that competition should be divided into direct and indirect competition. The feedstock of first-generation biofuel competes with agricultural commodities and agricultural production. The feedstock of second-generation biofuel, such as rice and wheat straw, competes with feed use. *Jatropha curcas* can be grown in marginal land in Latin America, Asia, and Africa. However, it can compete with agricultural production for other crops and livestock, if it can be grown in arable land. In addition to this, growing and harvesting *Jatropha carcass* competes by using resources such as water, agricultural machinery, fertilizers, pesticides, labor, capital, and others. Thus, the feedstock of cellulose-based biofuel can compete with food and food-related demand, and agricultural production

4.2. Biofuel and food security in China

Energy security was the main driver behind the promotion of China's biofuel program. When the Chinese government started the biofuel program in 2002, it expected that considered that it would not have a negative impact on food security at a national level. During the first stage of biofuel development, the government limited the types of agricultural products that could be used as feedstock for bioethanol to mitigate the impact on the agricultural market. The government prohibited the use of normal corn, traditionally used for feed, food, and other industrial materials[15], as a feedstock for bioethanol. Inferior corn[16] for bioethanol could be used from reserved stocks after a period of two to three years. The supply of this inferior corn and wheat has been decreasing since 2001 because of decreasing production. In addition, the Chinese government has promoted effective food marketing systems and tried to reduce these inferior agricultural foods since 2001. In the mid 2000s, there was not enough inferior corn to meet bioethanol demand in China. All the bioethanol facilities in Heilongjiang and Jilin used normal corn as a feedstock for the production of bioethanol, because they could not get enough inferior corn to produce bioethanol. The government had to change its policies to allow the use normal corn for bioethanol production. However, this policy change could increase corn demand for bioethanol production and the national domestic price of corn in the future ([13] and [14]).

The use of corn for bioethanol increased after that and the corn supply and demand situation in China changed to become tight from 2002 to 2006. Corn consumption for bioethanol was competing with corn consumption for feed, food, and processed food. In December 2006, the NDRC started to regulate corn-based bioethanol expansion. This regulation allowed the current bioethanol production level in Heilongjiang and Jilin, but limited further expansion of corn-based bioethanol production. This regulation will also be applied to wheat-based bioethanol production. To encourage the development of non-cereal based bioethanol, this policy announcement also makes it clear that any new bioethanol production based on cereal crops will not be supported or subsidized [22]. This regulation can be evaluated as an adequate policy measure to regulate bioethanol production from corn and wheat. Without this regulation, the international corn price could have been much higher than the real prevailing price from 2006 to 2008, and damaged food security for China and food-importing developing countries.

Corn used for bioethanol production was 4284 thousand MT in 2011 (Table 3). The corn use ratio in domestic corn consumption was 2.3% in 2011. The wheat use ratio in domestic wheat consumption was 0.9% in 2011. The cassava used for bioethanol production was 392 thousand MT in 2010. The cassava use ratio in domestic cassava production was 8.4% in 2010. The use ratio of cassava is much higher than the use ratio of corn and wheat. The government regulates the amount of corn and wheat used for bioethanol production, but does not regulate the amount of cassava used for bioethanol production. Cassava production is competing with feed use and for the agricultural resources, such as land and water use.

The Chinese government has tried to diversify bioethanol production by using cassava and sweet potato, sweet sorghum, and other crops. The use of sweet potato competes mainly with food use, but it can also compete for agricultural resources. Sweet sorghum competes mainly with feed use and for agricultural resources. Sweet sorghum is planted on marginal land in the Northeast area. Marginal land is ecologically fragile, and negative environmental impacts associated with the expansion of non-grain biofuel feedstock on this land will be inevitable [35]. These are water shortage areas. Growing sweet sorghum not only reduces water availability for agricultural use, but also for other uses in the region. The feedstock of second-generation biofuel such as crop stalks and

[13] As for the corn, rapeseed oil data is 2009/10 [15], sugarcane data is 2007/08 [15], and soybean oil data is 2011/12 [18].

[14] Indirect land use change is that natural ecosystems elsewhere might be converted to croplands to replace crops (either animal feed or food) that are lost due to biofuel production [12].

[15] Other industrial feedstock is used for adhesives, gummed tape, polished goods, and other products.

[16] Inferior corn is unsuitable for food use and is delivered from reserved stock to the market after a two-to-three-year reserve period.

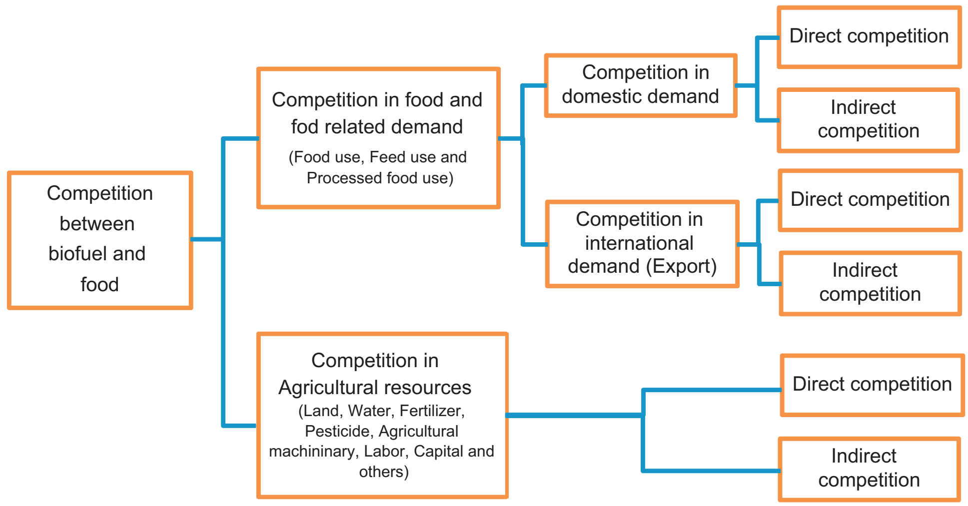

Fig. 1. The concept of competition between biofuel and food.

straw compete strictly with feed use. *Non-food* feedstock competes with food and food-related demand and agricultural production in China. It can also impact food availability at national level.

4.3. Biofuel and food security in Japan

From the beginning of 2007 to mid 2008, international corn, wheat, rice, soybeans, and other commodity prices were at an historically high level. A number of factors (the escalating crude oil price, the rapid expansion of biofuel production, devaluation of the dollar, adverse weather, and others[17]) contributed to the tight market conditions that set the stage for the sharp increase in food commodity prices since 2002 [25]. There was a critical argument that global food-based biofuel may have a negative impact on domestic and world food availability. Many international symposiums and seminars were organized to discuss agricultural commodity price hikes in Japan at that time. The Japanese government led the discussion for the *G8 Leaders Statement on global food security* in July 2008. Japan is a net food-importing country and the largest food- importing country in the world. The Japanese government was concerned about the impact of biofuel on food security. However, the government's concern was quite different from those of China and other countries. Japan is a developed country and there are few undernourished people in the country. The definition of Japanese food security is different from the FAO and other countries.

The 1996 World Food Summit adopted a more complex definition and refined it in the world Summit on Food Security in 2009: Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to mees their dietary need and food preferences for an active and healthy life [6].

On the other hand, Japanese food security was defined as: preparation for ensuring food supply measure and swift action in case that food supply has a negative effect from unexpected factors. In short, Japanese food security emphasized food availability[18]. At that time, the Consumer Price Index (CPI) of food in Japan increased by 2.6%, which was higher than the total index (1.4%) in 2008 (Fig. 1). Household expenditure for food decreased by 1.7%, whereas the total index decreased by 1.9% in 2008. However, the household expenditure index has shown a decreasing trend since 2002. These figures do not clearly show that increasing the food price had an impact on food expenditures at national level in Japan from 2007 to 2008. The food price hike during that period did not damage Japanese national food security significantly, because Japanese people have higher incomes[19] than other countries Fig. 2.

Molasses is by-product of sugar production. The use of molasses for bioethanol does not compete with food use, but it can compete with processed food use. Surplus sugar beets and substandard wheat do not compete with food and food-related demand, and for agricultural resources allocation. However, they can compete with feed use. Non-food rice can compete with feed use. Rice straw and wheat straw, the feedstock of second-generation biofuel in Japan, can compete with feed use. Thus, some of the feedstock of biofuel can compete with food and food-related demand, and for agricultural resources. Competition may have a negative impact on Japanese food security; however, this impact is quite small as Japanese biofuel production is at a very low level at present.

5. Discussion—Biofuel and food security in China and Japan

The State of Food and Agriculture 2008 reported that rapid growing demand for biofuel feedstock has contributed to higher food prices, which pose an immediate threat to the food security of poor net food buyers (in value terms) in both urban and rural areas. In the long term, expanded demand and increased prices for agricultural commodities may represent opportunities for agricultural and rural development [3].

In China, it is assumed that this *non-food* based biofuel production and cellulosic-based biofuel cannot have a serious impact on food security at a country and sub-country level, because

[17] Slowing growth in agricultural production, declining demand for stocks of food commodities, escalating crude oil prices, the rapid expansion of biofuel production, dollar devaluation, large foreign exchange reserves, adverse weather, aggressive purchases by importers, export policies, and import policies.

[18] Calorie-based food self-sufficiency is used as the indicator of national food security. The FAO insisted that food security and food self sufficiency are different concepts and are often at odds with one another. Self-sufficiency policies that distort market signals using protectionist strategies, such as import bans, have high social costs given their distributional effects. They place food self-sufficiency at variance with the goals of food security and poverty reduction. But, by improving agricultural productivity and domestic competitiveness, imports are likely to be deterred, and consequently, higher levels of self-sufficiency will be compatible with food security and poverty reduction [4].

[19] Sen defined it entitlement [23].

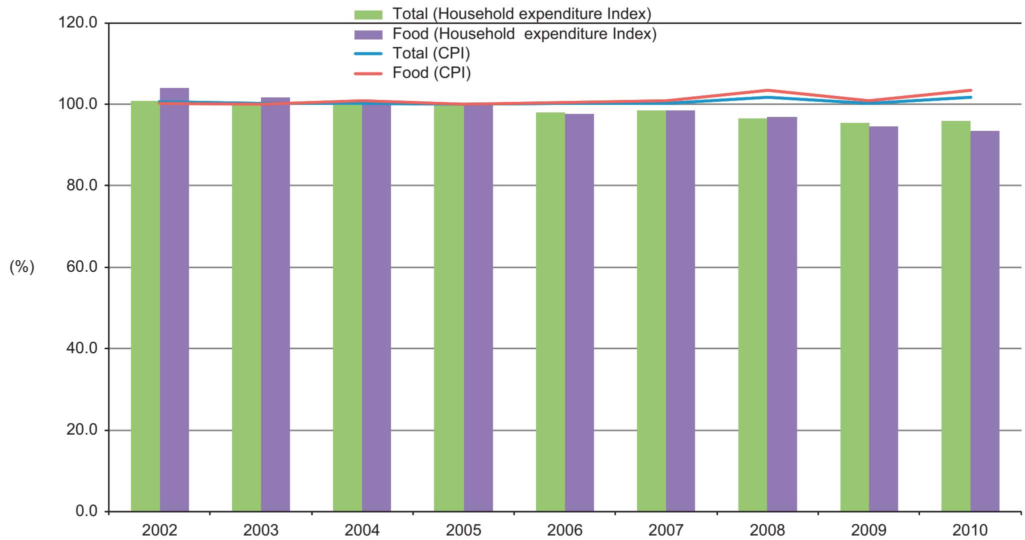

Fig. 2. Japanese CPI and Household expenditure Index.
Data source: Statistic Bureau, Ministry of Internal Affairs and Communication [24]

the amount of feedstock used for non-food and cellulose-based biofuel is small. However, it could have a negative impact on undernourished households. Ten percent of China's population was undernourished in 2006–2008 [4]. Rising food commodity prices tend to negatively affect lower income consumers more than higher income consumers. Lower income consumers spend a large share of their income on food, and staple food commodities account for a larger share of food expenditures in low-income families [25], and therefore undernourished households are more vulnerable than high- and middle-class households. The government of China has to ensure not only food availability, but also food that is nutritious for different household levels. Huang et al. [11] found that there were positive benefits for the poor, especially in the northern regions of China, if there was poor access to land and they earned a major share of their income from agriculture. Chinese biofuel production may become a new agricultural investment to promote rural development and to increase income in poor areas. However, it is uncertain whether Chinese market opportunities can overcome existing social and institutional barriers to equitable growth[20].

In Japan, it is assumed that current biofuel production from byproducts, unused agricultural products, and soft cellulose will not have a serious impact on Japanese food security at a country and sub-country level, because the amount of feedstock use is small. The competition between biofuel and food does not always have negative impacts on Japanese food security. Agricultural commodity price increases caused by competition can offer good opportunities to increase farm income and promote rural development. After the earthquake and tsunami disasters in March 2011, one of the priority policy tasks in Japan was to revitalize the economies of disaster-stricken areas in the northeast region (Fukushima, Iwate, and the Miyagi prefectures). The severe effects of the radiation leakage accident caused by the disaster are still being felt by the Japanese economy and society. Following the disaster, there was a crucial debate on whether Japan should abandon nuclear energy or not, and whether Japan should increase its renewable energy supply ratio. Energy security therefore became a national concern after the disaster in Japan, and renewable energy, including biofuel production, is expected to mitigate energy security problems and stimulate rural development, especially in the disaster area. To promote renewable energy, the government has to invest not only in biofuel production and consumption, but also in the infrastructure for biofuel distribution.

Japan is importing biofuel from other countries. Japan is importing 564 thousand kℓ in 2011 [8]. In addition, some Japanese companies, agencies, and institutes plan to increase biofuel production in Indonesia, Malaysia, and Botswana. When they promote biofuel development in other countries and increase biofuel imports, they have to pay full attention to concerns about food security in the partner country. The crucial point is that the definitions of food security in the partner countries are different from the definitions of Japanese food security. Japan does not cover undernourishment in the definition of its food security. The Ministry of Economy, Trade and Industry (METI) has released draft sustainable criteria for oil refiners, who have to ensure they do not negatively impact the food price when they derive biofuels from overseas. However, the current criteria are not strong enough to present negative effects on the food security in partner countries. If Japan plans to expand its biofuel development program and import from overseas in the future, the government's criteria should pay full attention to the impact on food security, including the malnutrition level, in partner countries. However, the draft criteria do not cover the food security impact of biofuel in partner countries.

6. Conclusion

This study is an economic analysis of the competition between biofuel and food, and the relationship between biofuel and food security in China and Japan. The analysis shows that not only the feedstock of agricultural product-based biofuel, but also cellulose-based biofuel can compete with food and food-related demand, and for agricultural resources. It is assumed *non-food*-based biofuel production and cellulosic-based biofuel cannot have a serious impact on food security on a country and sub-country level in China and Japan, as the feedstock use in those countries is small. However, it could have negative impact on undernourished

[20] Market opportunities can overcome existing social and institutional barriers to equitable growth with exclusion factors such as gender, ethnicity, and political powerlessness [3].

households. Undernourished households are more vulnerable than high- and middle-class households. The government of China has to ensure not only food availability, but also an appropriate level of nutrition across all household levels. The Japanese government released draft sustainable criteria for biofuel in 2010. The criteria covered food availability in Japan, rather than the general concept of food security did not cover food security in partner countries. The criteria should pay full attention to food security in partner countries if Japan plans to expand its biofuel development to other developing countries.

The biofuel programs in China and Japan can promote agricultural and rural development, and reduce GHG. In contrast to this, biofuel can have a negative impact on food security and environment. The governments of China and Japan have a common concern for the relationship between biofuel and food security. China and Japan have a close economic relationship. The Chinese biofuel policy and food security can impact Japan's food security. The Japanese government should pay full attention to the Chinese biofuel program and food security. This study focuses on biofuel and food security in China and Japan. The future direction of the study is to examine how biofuel policies and markets can impact food security in both countries, using an econometric model. Future studies also need to further analyze biofuel impacts, energy security, GHG reduction, biodiversity, and the effect on society in both countries.

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