Maize: The Food, Feed, and Fuel

Samanhudi and Bambang Pujiasmanto

Faculty of Agriculture, Sebelas Maret University (UNS)
Jl. Ir. Sutami 36A, Surakarta 57126, Telp./Fax. +62 271 637457
E-mail: samanhudi@uns.ac.id, HP. +62 81329060000

ABSTRACT. Food needs always follow the trend of the population and are affected by the increase in per capita income and changes in consumption patterns. This is an indication that diversification is necessary to support the stabilization of food self-sufficiency. Corn is one crop that has long been held by the Indonesian food and still continues to serve as a food ingredient. Advances in technology processing, make corn into raw materials different types of food, beverages, and other key industrial materials. Currently serve corn as food, feed and alternative energy sources. As for food, the protein content of corn is higher than rice, making it suitable as a nutritious food. Based on the various results of the analysis showed that the protein content of corn has nearly matching sorghum and wheat and is higher than the rice flour. Demand for feed corn has continued to increase in line with the development of the poultry feed industry. Currently, most of the corn used for feed production and its use for food volume tends to decrease. Initially, much of this corn grown by local farmers and seed corn produced is relatively small, but has relatively high protein content. The development of hybrid corn technology in the past 10 years, prompting some farmers to plant hybrid corn, so corn is used for feed is a type of hybrid. Increasingly the lessen of fossil fuel reserve amounts in earth will result the happening of energy crisis in some states. This thing opens exploiting opportunity of crop as alternative energy source. Corn is potentially to be developed, because having wide adaptation, high productivity, needs slimmer relative input, resistant to pest and disease, and more tolerance to marginal land condition (drought, salinity, and acidity). Sees several of its excellences, corn are a real potential cereal crop to be developed as source of bioethanol in Indonesia, as well as food and feed.

Keywords: corn, food, feed, fuel.

Introduction

Food needs always follow the trend of the population and are affected by the increase in per capita income and changes in consumption patterns. This is an indication that diversification is necessary to support the stabilization of food self-sufficiency. Of these conditions can be met then it should be two things, namely the provision of food and processed food diversification (Saenong *et al.* 2002 in Sutanto 2012).

According Supit (2010), world corn production stagnant, especially those traded on the international market. Exporting countries to increase domestic consumption of corn, due in part converted into ethanol. The higher oil prices, more and more corn is converted into ethanol. Indeed, the world wants fuel derived from vegetable oils, so pollution is not getting worse. If more and more ethanol is produced from corn, the corn supply to the international market the less.

Indonesia's progress in the production of corn, is now being challenged because, although the production and productivity has increased fairly, users still complain about the difficulty of getting corn domestic corn. Technological advances in the cultivation of maize, the better, now in a one hectare can be produced dry corn of 10 tonnes in 1955, while the new is 2.8 t/ha. This progress needs to be utilized in order to meet the domestic corn supply domestic demand (Supit 2010).

Dry land and rainfed land belonging spacious and yet optimal use, the potential for planting corn. Technological advances in the cultivation of corn continues to increase, making the certainty of success is much higher than in previous years. The potential is vast land when planted with maize, would be a good source of income for farmers, since corn is still needed in large quantities, and if excessive can be easily exported. Under these conditions and with the price of a good corn today, corn is a commodity that is right for accelerated production by farmers in the countryside (Supit 2010).

As known, the corn has long been held by the Indonesian food and still continue to play as a food ingredient. Advances in technology processing, make the corn into various types of raw material food ingredients and other key industries, including food and alternative fuels. So now the corn is known as a food source (food), feed (feed), and fuel (fuel).

Corn as a Source of Food

Indonesia has a variety of local foods other than rice containing high carbohydrate. One of them is the corn, we may easily see. Corn is consumed by most people as a staple food, as people in Gorontalo, NTT, and some areas in East Java.

Unfortunately, the level of corn consumption in the family decreases because most people consume rice as a staple food. Later, the higher the level of rice consumption because the population is increasing.

The condition is getting worse with the wrong outlook on most people associate eating corn with poverty. As a result, even more distanced maize in the diet of the family. Though corn contains nutrients needed for health.

Corn cereals in the group, and is one of the world's important food other than wheat and rice. Color, texture and flavor is determined by the nature of the ears of corn and the outer layers of the grains forming the color variations ranging from white, yellow, orange, bright red, blood red, purple, to purple-black, and the sweetness and texture of sticky rice on corn.

Residents of some areas in Indonesia, such as Gorontalo and East Nusa Tenggara using corn as a staple food. Similarly, people in Madura. For residents in Central and South America, corn is the main source of carbohydrates. In the United States, corn into alternative food sources. Evidently, ears of corn can also be processed to take oil, made of flour corn (maize), sugar corn, and drinks.

According Soegiharto (2011), ears of corn contains a lot of carbohydrates, reaching 80% of the grain dry matter. Carbohydrate content in the corn is lower than rice. For every 100 g of corn (pipil, minced) contain 361 to 366 calories. However, corn fiber and carotenoids were higher than rice. Carotene is a substance that is important in the formation of vitamin A. Yellow corn grain contains more protein and vitamin A.

Corn starch is generally a mixture of glucose (amylose) and glutinous substance (amylopectin). In the more sweet corn sugar substances. Glutinous corn contain more amylopectin so it feels like sticky chewy. Indirectly mother's knowledge of nutrition will affect the nutritional status of young children, because the mothers knowledge to care for and meet the nutritional needs of children. With the knowledge of good nutrition, insufficient capital to ensure the nutritional needs of the child. It is very important to ensure the growth and development of optimal early childhood.

Benefits of corn as food substitution is very much his role. Some food products from corn that has been common in Central Java is the rice and corn marning. In the development of corn can be made into corn crackers, various pastries, tortillas, grits, and so on. Processed products made from corn that has been successfully tested and developed is the manufacture of corn crackers and pastries (pastry syringe) as a home industry farmers (Sutanto 2012).

To provide quality nutrition, domestic corn production is needed now, because the dependence on imports will be more volatile and the price of corn imports will also be more expensive. On the other hand, corn can be produced in Indonesia with a highly competitive and require application of appropriate technology.

High corn demand mainly driven by the need to produce animal feed, and lately the higher demand for corn to be processed into ethanol (fuel) and the need for other industries. Utilization of corn which was originally to direct food, has now turned into a commodity industry (Supit 2010).

Corn as a Source of Feed

According Krisnamurthi (2010), in the province of corn used as a local food source community, more than 50% of corn production is used for consumption, and the remaining 10% processed for animal feed. Aside from being a source of carbohydrate, corn is also used as animal feed (forage and cob). In addition to food and feed, corn kernels can be extracted as oil and made flour (cornstarch), as well as industrial raw materials (wheat grain or flour cob).

The main cause of the increasing need for domestic corn is the animal feed industry in the country which was originally (in 1973) production is only 34,050 tons per year of poultry feed, in 1994 has grown to 5,681,989 tons per year of employment with 17,061 people, and reach embedded investment rate of Rp 460 billion (Industry, 1994 in Krisnamurthi 2010).

With productivity figures attached deficit is still around 1.1 million tons of the raw material. Conditions that shows how much potential domestic market for corn. To meet the raw material needs of the animal feed industry, business importing raw materials from other countries, like the United States and China. The reason, the domestic maize products can not meet their needs. Besides maize import better quality and supply side and demand side is more assured. While the domestic supply of corn available only in certain seasons, in addition to the competition between users for

food such as corn, rice, corn and other food industry made from corn (Mahar 2010).

Data biggest national maize consumption from 2005 to 2009 is to feed mainly poultry feed which is about 3.53 million tons in 2005 and reached 4.54 million tons in 2009. For consumption as food (direct consumption) is only 0.865 million tons in 2005 and reached 0.99 million tons in 2009. Starting in 2007, we had a surplus of corn dry, even in the year 2009 our surplus maize te-lah reached 1.979 million tons (Krisnamurthi, 2010). Surplus can actually be processed foodstuffs potential through flour products as a substitute for wheat or grain imports so we can be decreased.

Viewing the history of the origin of corn, which comes from the dried, then we need not fear the threat of excessive drought due to global warming, the important thing we want to begin to eat the corn. The areas where rice plants were less successful in conditions of shortage of water, we can divert its use for corn is not only to meet the needs of poultry feed, but corn for food and its biomass for ruminants feed. Target dried corn production in 2010 was 19,764,280 tons and will increase steadily until 2014 which will reach 28,924,041 tons, or an average climbed 10.02% per annum (Deptan 2009 in Krisnamurthi 2010).

The use of corn as feed is not only limited to the seeds, but also waste. Waste corn plant can be used for feed, especially for ruminants because of the high fiber content. Corn straw is an important feed ingredient for cattle when grass is difficult to obtain, especially in the dry season. Corn straw is preserved by sun drying produces hay and stored by farmers for cattle feed supplies during the dry season. With growing fattening beef imports or development of the dairy industry, the entire plant can be used as feed corn. Corn is grown specifically to replace the grass. Plant corn at a certain age, especially when the grain begins to grow, has a high nutritional value for cattle (Tangendjaja and Vienna 2007).

There are several kinds of waste corn and corn-based industrial byproducts. In Indonesia, the term known locally for several sewage plants and industrial corn.

- Tebon corn, the whole plant, including stems, leaves, and fruit of young corn chopped and given directly to livestock. Farmers who only produce corn tebon usually work with rancher. Farmers just plant corn as a forage crop and at a certain age are trimmed and chopped to give to livestock. Chopped corn silage were also made.
- Straw corn / stover, namely the corn stalks and leaves are allowed to dry in the fields and harvested in the cob picked. Corn straw as is commonly found in areas producing seed or feed corn for industrial use.
- Corn rind, usually discarded. Skin sweet corn silage because of the potential to be quite high in sugar.
- Cob corn / corncob, which is part of the fruit after seed corn separated.

With the greatest proportion of waste corn is corn stalks (stover) with in vitro digestibility of dry weight low. Corn husk is a waste with the smallest proportion but has a higher digestibility than other wastes (Table 1). Similar data reported by Anggraeny *et al.* (2006), waste from the corn stalk ranged from 55.4 to 62.3%, from 22.6 to 27.4% of the leaf, and from 11.9 to 16.4% of the skin (klobot).

Corn processing industry generally associated milling process, which can be grouped into two, namely the processing industry with a dry milling and wet. In Indonesia, the corn processing industry is still running with the system generally dry grinding. The process is simple milling, primarily intended to produce corn grit is used for the manufacture of snack (snack) is growing rapidly these days. This corn milling byproducts form Homini (hominy) also called empok, is the result of comminution traditional corn to produce corn rice (Tangendjaja and Vienna 2007).

At the dry milling process, corn husks can also be separated, including other factions, either smooth or partially dirt institutions and endosperm. This byproduct called tumpi which have relatively high crude fiber content and can be used to feed ruminants.

Unlike the dry milling, wet milling is done because corn fractionation performed using water or solvent wet. Generally, wet milling is intended to produce corn starch. Corn that has been cleared will be process of fractionation to separate the chemical components of corn. Corn will be separated from the institution (germ) using water immersion steep water (fluids used in wet grinding and can be reused). Once separated institutions, then having the rest of the corn milling, filtration, and centrifugation to separate corn

Table 1. The proportion of the corn crop waste, crude protein content and digestibility value of dry weight.

Waste corn	Moisture content	Waste proportion (% dry weight)	Rough protein (%)	Digestibility of dry weight *in vitro* (%)
Rod	70-75	50	3.7	51
Leaf	20-25	20	7.0	58
Cob	50-55	20	2.8	60
Corn husk	45-50	10	2.8	68

Sources: McCutcheon dan Samples (2002) in Tangendjaja and Wina (2007).

Table 2. Amino acid content of corn and corn byproducts wetmilling process

Parameter	Corn	Corn gluten meal	Gluten meal	Germ meal	Steep liquor
Protein (% DM)	9.3	23.8	6.5	25.1	46.0
Amino acids (%)					
Lysine	0.29	0.70	1.13	1.0	1.6
Methionine	0.19	0.39	1.59	0.7	1.0
Cystine	0.21	0.51	1.21	0.44	1.6
Tritofan	0.07	0.08	0.34	0.22	0.1
Threonine	0.33	0.81	2.31	1.2	1.8
Isoleucine	0.31	0.74	2.76	0.8	1.4
Leucine	1.11	2.18	11.32	2.0	4.0
Phenylalanine	0.44	0.84	4.27	1.0	1.6
Tyrosine	0.28	0.64	3.61	0.8	1.0
Valin	0.44	1.12	3.10	1.3	2.4
Histidine	0.26	0.74	1.42	0.8	1.4
Arginine	0.42	1.16	2.14	1.4	2.2
Glycine	0.27	1.1	1.86	1.22	2.2
Serin	0.42	0.89	3.29	1.1	2.0
Alanine	0.78	1.7	5.8	1.6	3.6
Aspartic acid	0.68	1.3	4.0	1.6	2.8
Glutamic acid	1.77	3.7	15.3	3.6	7.0
Proline	0.84	1.9	6.1	1.4	4.0

Sources: McCutcheon dan Samples (2002) in Tangendjaja and Wina (2007).

starch grains from other materials such as protein and fiber. Corn starch was further purified and dried for sale as a food ingredient known as cornstarch for the cake or other snacks.

The chemical composition of corn milling byproducts industry was wet method presented in Table 2. One of the reasons the use of byproduct corn for feed is the content of protein and fiber. Byproduct High-fiber as the CGF or corn germ meal, can be used to feed cattle, goats, sheep, pigs or pig pregnant adults. Materials that have low fiber and high protein can be used for poultry feed (Tangendjaja and Vienna 2007).

Corn Production by Country in 1000 MT

Rank	Country	Production (1000 MT)
1	United States	328,033.00
2	China	178,000.00
3	EU-27	60,093.00
4	Brazil	57,000.00
5	Argentina	26,000.00
6	Mexico	24,000.00
7	India	21,000.00
8	Ukraine	16,500.00
9	South Africa	12,500.00
10	Canada	11,000.00
11	Nigeria	8,700.00
12	Indonesia	8,100.00
13	Philippines	7,200.00
14	Serbia	7,000.00
15	Egypt	5,900.00

Sources: United States Department of Agriculture 2011.

Corn as a Source of Fuel

Lately a lot of talk about the “energy crisis” and the limited reserves of fossil fuels in the world by population increase and rising energy demand per person. Distribution of fossil energy reserves are not evenly distributed, coupled with political factors and economic causes of complex forecasting difficult. Ethanol is mostly produced as a substitute for alternative fuels. The use of alcohol as a motor fuel researched and implemented in the USA and Brazil since the fossil fuel crisis in both countries in the 1970s.

In the past 10 years in the United States has expanded the use of corn for ethanol or biofuels. Rising oil prices pushed the U.S. government to utilize other sources of renewable energy (renewable). There are two types of biofuels are developed, namely biodiesel derived from soybean oil to replace petroleum diesel, and ethanol derived from corn fermentation process. The process of making ethanol from corn are grouped into the dry milling process combined with the fermentation process to convert corn starch into ethanol (Tangendjaja and Vienna 2007).

Many uses of corn, ranging as human food and livestock consumption, to the bioethanol demand for corn to make the world continues to increase while the supply is difficult and prone to further expand the influence of the weather. For the future, the world corn prices will continue to rise (Tabel 3).

The effect of price movements is most factors derived from corn producing states on the product itself. Currently leading producer of the world is the United States corn produces nearly 40% of world corn production, while China accounted for 20% of world production.

Corn Agribusiness Opportunities and Challenges

Corn crop in Indonesia generally on dry land, wavy, and has no irrigation facilities. Land in rainfed lowland maize cultivation potential, because if lack of water, shallow ground water can be used to irrigate crops. On flat land that can be used machinery for land preparation, planting, maintenance and harvesting crops, as well as improving the quality of work, speed work, and increase the productivity of land and labor (Supit 2010).

Given land outside Java is still available quite extensive, including an opened and optimal utilization, should be directed to the program of modernization and mechanization, resulting in a large increase in corn production and fast. Providing the necessary infrastructure (should be by the Government), so that farmers can cultivate corn and investors more efficient and competitive against products from countries exporters of maize (Supit 2010).

Related to the modernization and mechanization of the cultivation of corn, the pattern of development partnership between broad-scale entrepreneurs and farmers is the right choice. The partnership between farmers and entrepreneurs can be in various forms of mutual benefit, such as crop management partnership, partnership in service use the company's machines in the cultivation of crops. With the employment of facilities that can be utilized by farmers, the working capacity and maize cultivation area becomes higher and wider. The use of tools and machines accelerate activity and higher accuracy (Supit 2010).

Manual labor availability in rural areas is increasingly scarce, because non-agricultural wage employment more attractive to young workers because of work in the room more comfortable than working in the open field. Cultivation activities can actually be transferred to the working tools and machines, while the processing activities and a series of related activities can absorb a lot of manual labor. In general, wages in processing activities can be higher than the wages of labor in cultivation (Supit 2010).

Lots of information about the business partnership is not considered a success as a result of the lack of provisions and the agreement of both parties working together. This can be addressed by involving the local government as a facilitator for those who are partnered. Many examples of successful partnerships for the provision and understanding can be built from scratch. The company works on a vast scale and involve farmers as farmers can be more efficient, especially in the provision of inputs, crop management, and transportation outcomes. Thus, it can have a higher competitiveness against similar products imported (Supit 2010).

According Tjionger (2012), some of the challenges and issues that need attention in exploiting the opportunity of increased corn production is still wide open are:

1. Lack of capital facilities owned by farmers and supported by the lack of entrepreneurial spirit in themselves farmers.
2. Lack of knowledge of the technology at the farm level as well as the cultivation of the diimpliksikan pascapanennya with the still widespread use of local seeds and derivatives are still great.
3. Marketing of a major issue that caused farmers hesitate in implementing capital intensive intensification program. Marketing is not as obvious as the low prices received by farmers due to incompatibility corn harvest and produced by the animal feed industry standards is a very serious problem. Usually the standard discrepancy is due to harvest falls in the high rainfall resulting in high moisture corn.
4. Until now there has been interwoven system of sustainable partnerships between businesses with farmers as farmers with media partners, as well as the media partners to the animal feed industry as well as between farmers and the seed industry. Lack of clarity (transparency) of the mechanisms that run partnership which sometimes detrimental to the farmers' cause a lot of trauma that farmers partnership itself becomes difficult to develop.
5. The unavailability of the dryer (dryer) in the location of production centers. Generally the collectors that have the dryer located in the provincial capital thus extending the marketing chain.

To answer some of the challenges mentioned above have fostered a climate of cooperation transparent and mutually beneficial relationship between farmers, seed producers, traders, and entrepreneurs fodder. Climate so that cooperation can be sustained it is necessary to the development of agri-system partnerships and mutually benefit from each other. The system must be supported by a partnership with management / good management by each subsystem elements such as inputs (seed and fertilizer procurement and pesticides), subsystem farming, post-

harvest subsystem (agro) and marketing subsystem (Tjionger'S 2012).

Conclusions

Indonesia has abundant natural resources and appropriate for the development of large scale corn. Meanwhile, corn is one commodity that has more advantages, especially its ability to grow in dryland maize cultivation and technologies already available. Taking into account the condition of the farmers, and corn have advantages on dry land, it should be positioned as a commodity corn farmers a reliable source of income, through both government policy and the national and regional. The need for domestic corn demand will continue to increase following the consumer and if not met, then the user will import corn. To accelerate the expansion of corn acreage in the country, private companies need to be invited to build a corn plantation. The involvement of private companies will further strengthen the domestic corn production. Corn will be increasingly important in the national economy, therefore Indonesia must speed up the dissemination of advanced technologies to be adopted by corn growers. In order to raise awareness in order to improve production and quality of maize at the farm level, counseling activities and the improvement of facilities and infrastructure that support should continue to be encouraged. Including one is to embed the principle that the trend was more interested in the animal feed industry with raw materials derived from corn because more fresh local produce in order to motivate them to increase production.

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