Development of raw material management plan for ethanol industry in Thailand

Sriroth,K[2] ; V.Vichukit[1] ; E.Sarobol[1] ; K.Piyachomkwan[4] ; S.Wanlapatit[4] ; K.Amornitikul[3] ;
N.Termvejsayanon[4] and Boonrieng Lamchaiyaphum[3]

[1]*Department of Agronomy, Kasetsart University, Bangkok, Thailand*

[2]*Department of Biotechnology, Kasetsart University, Bangkok, Thailand*

[3]*Kasetsart Agricultural and Agro-Industrial Product Improvement Institute, Kasetsart University, Bangkok, Thailand*

[4]*Cassava and Starch Technology Research Unit, National Center for Genetic Engineering and Biotechnology, Bangkok, Thailand*

Summary

1. Introduction

Thailand as a world - leading agricultural country, has a strong capability to develop the ethanol industry since there are a plentitude of potential raw materials containing sugar and starch. Based on the planting acreage, rice has the highest of 60 million Rais and maize is the second with 8 million Rais. The planting area for cassava and sugar cane are alike, each owns about 7 million Rais. However, when considered the productivity, sugar cane has the highest production of 60 million tons following rice (26 million tons), cassava (18 million tons) while maize has the lowest production (4.5 million tons). To evaluate the potential raw material for ethanol production, the raw material cost is estimated by the price and conversion ratio (the amount of raw material used to produce 1 liter of anhydrous ethanol) of each substrate (Table 1). From the point of raw material cost, only cassava and molasses, by-product from cane sugar production, are most appropriate for ethanol production. As molasses is the by-product from cane sugar industry, the production plan of sugar cane for molasses production is included in this study.

2. Ethanol production from cassava

2.1 Current situation of cassava production

Cassava can be planted all year. Generally, two crops of cassava can be grown each year, i.e. raining (May – June) and after raining (October – November) seasons. The crop is able to grow with minimal inputs (fertilizers, herbicides, and insecticides), for a reasonable returning yield on infertile land where the cultivation of other crops is difficult unless considerable inputs are applied. Most of the planting area is in the North – Eastern (Table 2) including Nakhon Ratchasima,

Chaiyaphum, Kalasin, Khon Kaen and Buri Ram with total production of 7 million tons of roots in 2002. This North – Eastern region is, therefore, very suitable for ethanol plants with respect to raw material advantage.

Table 1 Productivity of sugar - or starch - containing agricultural materials and their estimated raw material costs for ethanol production.

Agricultural crops	Planting acreage (x 1,000 Rais)	Production (x 1,000 tons)	Ethanol conversion ratio (kg raw material / 1 liter of ethanol)	Average price of raw material (Baht / kg)	Raw material cost (Baht / 1 liter of ethanol)
Cassava roots	6,882	18,265	6.5	1.04	6.76
Cassava chips	-	-	2.5	2.50	6.25
Sugar cane	6,602	62,828	14.3	0.69	9.87
Molasses*	-	[3,000]	4.0	1.50	6.00
Rice	61,007	25,608	-	-	-
Broken rice**	-	-	2.7	6.00	16.20
Maize	7,866	4,461	2.7	4.16	11.23

* Around 5% of sugar cane production

** Around 10-20% of rice production

Table 2 Harvested area and production of cassava in each region of Thailand during 2000 – 2002.

Region	Harvested area (Million Rais)			Production (Million tons)		
	2000	2001	2002	2000	2001	2002
Northern	0.99	0.92	0.87	2.66	2.54	2.29
North – Eastern	4.03	3.61	3.31	10.47	9.82	8.79
Central / Eastern	2.03	2.01	1.98	5.92	6.01	5.77
Whole country	7.05	6.54	6.16	19.05	18.37	16.85

Current uses of cassava roots are classified by two major industries including starch and chip/pellet industry. The production capacity of starch industry, at present, accounts for 60% of total root consumption (Table 3).

Table 3 Industrial demand of cassava root as surveyed in 2002.

Type of industry	Number of factory	Demand of fresh cassava roots (million tons)	Ratio (%)
Starch	68	10.8	60
Chips	871	} 7.2	40
Pellets	63		

In the National Strategic Planning on sustainability development of cassava by all relating agencies, the goals of cassava production during 2002 – 2006 are:

- The planting acreage will not be more than 6.7 million Rais.
- The average productivity of the country will be increased to 4.0 tons / Rai.

By achieving this national strategic planning, the production of cassava roots will reach 26.8 million tons by 2006. This production can be abundant for ethanol production. The achievement of this plan is supported by these policies including

1) Root price policy: the minimum root price should be clearly specified, for example 1 Baht / kg, by Ministry of Commerce. The information about planting area and accurate forecast of root productivity should be available. Further, the cassava - planting farmers should register to the government and are encouraged to conduct contract farming with the ethanol plants.

2) Yield increasing policy: to improve the yield, there are several tasks to be implemented by relating agencies (Dept. of Agricultural Promotion, The Thai Tapioca Development Institute) including

- Development of good varieties and distribution of good varieties to farmers
- Soil conservation and fertilizer utilization
- Development of mechanization farming in planting, harvesting, and transpiration.

By economic analysis, ethanol production from cassava will not cause over demand to current industries since the starch industry will not grow rapidly and the chips/pellets industry begins declining. The domestic consumption structure of cassava can be illustrated as Figure 1. At the annual production of 20 million tons of fresh roots, there will be around 4 million tons of root surplus available for making 2.36 million liters of ethanol daily.

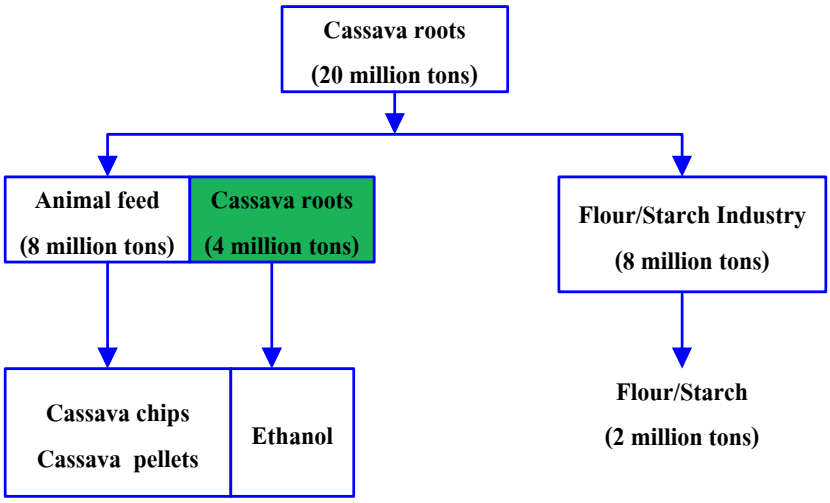

Figure 1 Structure of cassava consumption in current market.

2.2 Environmental impact of using cassava in ethanol industry

Use of cassava in ethanol industry will have little impact on environment. The yield will be increased by improvement of farm management with preserved existing planting area. Therefore, the national forest will be reserved.

3. Ethanol production from sugar cane

3.1 Current situation of sugar cane production

The total production of sugar cane is about 60 million tons with total planting acreage of 6 million Rais, mostly in the North – Eastern region (Table 4). The canes are usually planted at the beginning or rainy season (October – December).

Table 4 Planting area, production and yield of sugar cane in each region of Thailand in 2002/2003

Region	Planting area (Rais)	Production (tons)	Average yield (tons / Rai)
Northern	1,229,045	11,437,727	9,306
Central	2,178,777	20,641,174	9,474
Eastern	375,696	3,367,826	8,964
North – Eastern	2,507,520	24,133,897	9,625
Whole country	6,291,038	59,580,624	9,471

The cane purchasing system in Thailand is the profit - sharing system between farmers and industrial sectors at the ratio of 70 : 30. The profit is based on 3 classes of sugar including:

Quota “A” – cane sugars for domestic consumption

Quota “B” – Raw sugars for export by Thai Cane and Sugar Co., Ltd.

Quota “C” – White sugars and raw sugars for export

There are two prices (primary and final price) of sugar cane for purchasing in the sugar industry which is depending on the world sugar price.

- *The primary price* is the price of sugar cane announced by October before milling season. This price is estimated from the amount of milling cane and produced cane sugar.

- *The final price* is the real calculated price at the end of milling in the next October.

Molasses as by-product of sugar industry is also a good raw material for ethanol production. To use molasses in ethanol industry without interfering other industries, cane production should be increased by 15 million tons. At a total production of 75 million tons cane, 3.75 tons of molasses can be obtained (around 5% of cane is molasses). Only 1.5 tons of molasses is needed for domestic uses and the rest can be supplied to ethanol industry. To ensure that productivity of sugar cane (75 million tons per year), there should be well-developed production plans including:

- Increasing the irrigation area: the canes in irrigation areas provide higher yields, however, at present, only less than 1% of total planting area is irrigated.

- Development of new varieties: there are a few varieties of sugar cane currently used by farmers which have similar harvesting times. Therefore, the cane can be harvested only in a certain period.

- Promotion of cane plantation: there are several techniques that should be managed to improve the planting efficiency including farmer registration, mechanized farming, etc.

- Policy of cane purchasing system: in case that the ethanol plant can directly mill the cane, especially low-quality canes for sugar industry, the purchasing of cane should be based on the amount of total sugar, instead of CCS (Commercial Cane Sugar).

3.2 Impact of using molasses in ethanol industry

- The ethanol production of ethanol from molasses will not cause any impact on cane and sugar industry when the production of molasses is more than 3 million tons per annum.

- The planting of cane can have impact on cassava plantation since both crops are planted in the same region. This impact can be minimized by price stability of both crops.

- Some existing environmental impacts from cane transportation and green-house effect from cane burning should be properly handled.

4. Recommendation

When considered the raw material supply, cassava is recommended to be the most suitable raw material for ethanol production. The crop can be planted all year round with minimal inputs in infertile land where the cultivation of other crops is difficult and costly. Further, Thailand also has conducted continuous research and development on variety improvement and planting efficiency.

An average cassava yield is, therefore, expected to be higher. At the production capacity of 20 million tons of root, the total consumption is about 16 million tons (50% for starch industry and the others for chips/pellets industry). The surplus of 4 million tons of roots is available for feed and ethanol industry.

The use of sugar cane for ethanol industry is still troublesome because of the over capacity of sugar industry (sugar cane production and sugar industry capacity of 60 and 75 million tons, respectively). The harvesting season of sugar cane lasts only a short period (6 months), therefore, the cane cannot be stocked for the whole year production. Moreover, there are two prices of cane purchasing system, but the raw material cost of ethanol production should be specified. However, molasses, by-product from sugar industry, is capable of using in ethanol industry without disturbing cane and sugar industry. To produce ethanol from molasses, this plant should consider an annex factory model (ethanol production connected to sugar factory) to share energy facilities with sugar industry to minimize production cost.

Acknowledgement.
This research was supported by the office of the National Ethanol Committee, Ministry of Industry. (2003)