

# Fuel ethanol program in Thailand: Potential supply, impacts, and implications for the CDM



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# Outlines

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# Introduction

- Assessment of ethanol programs being implemented in developing countries including quantification of the impacts and costs of achieving the programs' targets could be of interest for further development of biofuel policy as well as the CDM
- Among developing countries in Asia, Thailand currently has one of the strongest fuel ethanol growth rates. The country is targeting molasse and cassava for ethanol production and is supporting the use of fuel ethanol in order to reduce dependency on imported oil and the consequent loss of foreign currency as well as to stabilize the agricultural sector
- The country has set 2 ambitious targets for its fuel ethanol program
  - Replacing all octane-95 gasoline with octane-95 gasohol containing 10% ethanol by volume (E10) by 2007
  - Replacing octane-91 gasoline with gasohol (E10) by 2011

# Purposes of the study

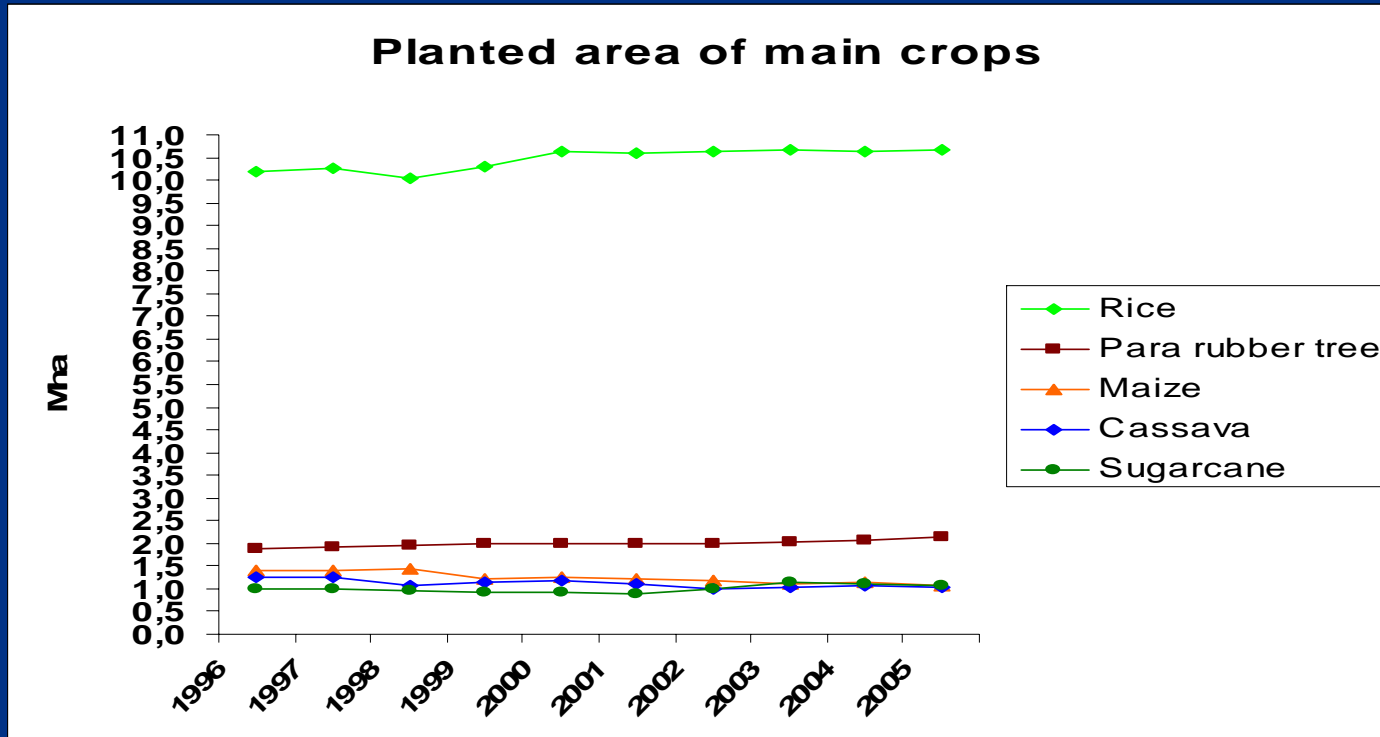
1. To estimate the potential supply of ethanol produced from molasse and cassava in Thailand
2. To quantify the impact of achieving the ethanol program targets on 1) self-sufficiency rates for crude oil (energy) and cassava (food) 2) trade, and 3) CO<sub>2</sub> emissions
3. To estimate the cost of fuel substitution and the cost of implementing the program

## Potential supply of ethanol from molasse and cassava (1)

	2000	2001	2002	2003	2004	2005	Avg.
<b>Fresh cassava production (Mton)</b>	19.1	18.4	16.9	19.7	21.4	17.0	18.8
• Domestic uses	4.4	4.4	4.4	4.4	4.4	4.5	4.4
• Uses for export (Mton of fresh cassava)	14.7	14.0	12.5	15.3	17.0	12.4	14.3
• Production of cassava product for export (Mton)	4.7	6.0	4.2	5.4	7.0	5.0	5.4
<b>Sugarcane production (Mton)</b>	54.1	49.6	60.0	74.3	65.0	49.6	58.8
<b>1. Sugar production (Mton of sugar)</b>	5.8	5.4	6.5	7.3	7.0	5.2	6.2
1.1 Domestic use	1.8	1.9	2.0	1.9	1.9	2.0	1.9
1.2 Export	4.1	3.3	4.0	5.1	4.6	3.0	4.0
<b>2. Molasse production (Mton of molasse)</b>	2.4	2.3	2.8	3.5	3.0	2.3	2.7
2.1 Domestic use	1.4	0.9	1.4	2.2	1.5	1.1	1.4
2.2 Export	1.0	1.4	1.4	1.3	1.5	1.2	1.3

A decrease in the export of molasse by 50% and cassava product by 30% would allow for production of 930 Mlitre of ethanol in 2011

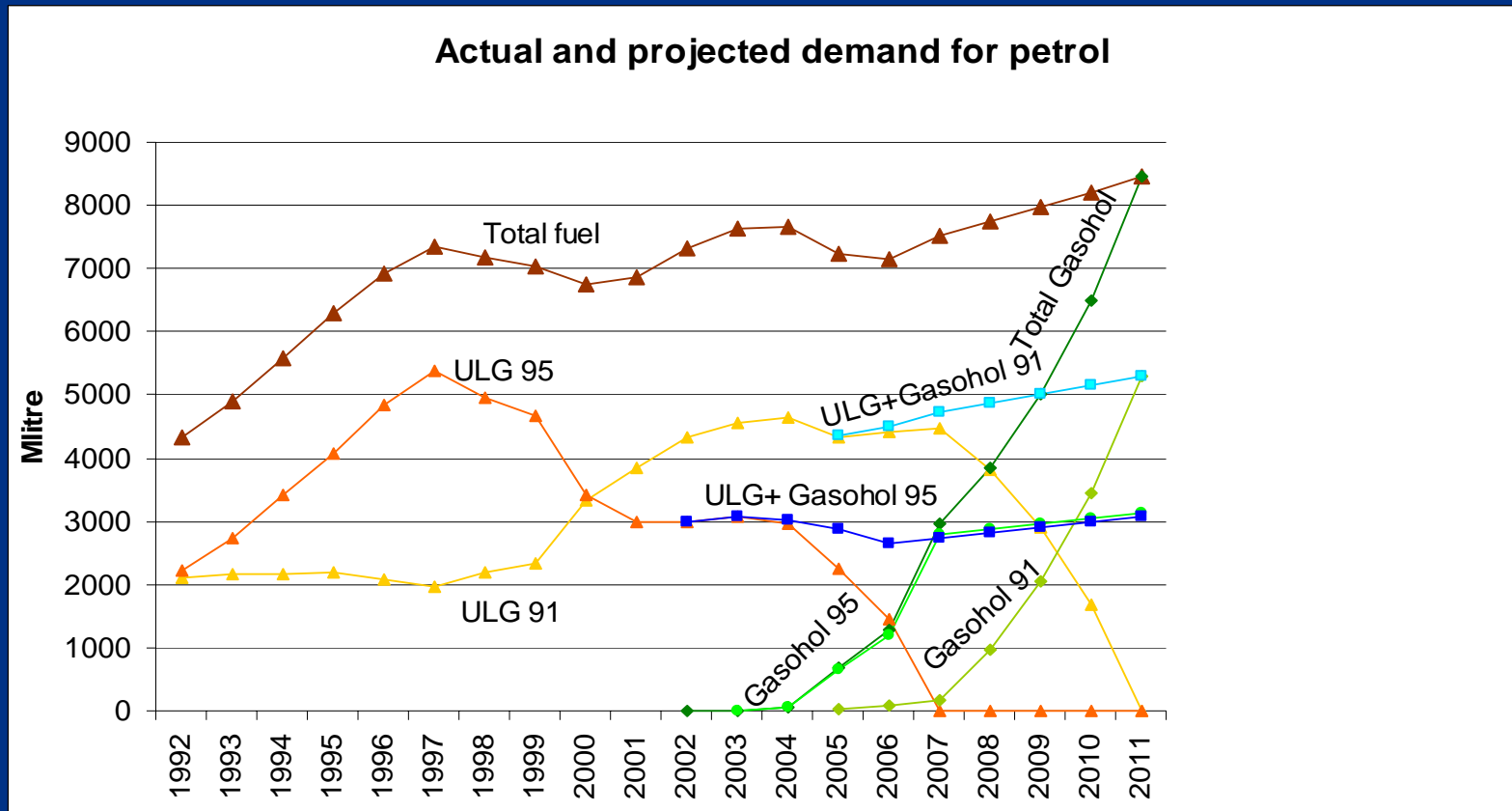
# Potential supply of ethanol from molasse and cassava (2)



• An increase in the area of cassava by 0.5 Mha, replacing maize, and an increase in cassava yield by 20% would allow for production of 2,540 Mlitre of ethanol in 2011

• Meeting the target of replacing all gasoline grades with gasohol in 2011 requires less than 1 billion litres of ethanol, just 25% of the total estimated potential ethanol supply (3,500 Mlitre)

# Assumptions on the demand for petrol



- Octane-91 fuel and octane-95 fuel will increase by 3% per year during 2007-2011
- No demand for ULG 95 in 2007 and ULG 91 in 2011 according to the targets
- Total gasohol demand will increase by 30% per year during 2007-2011
- Total fuel demand is adjusted for gasohol' 2% lower fuel efficiency

## Assumptions on the reduction in the demand for MTBE and crude oil and CO<sub>2</sub> emissions

- ULG 95 contains 5% MTBE by volume
- The amount of crude oil replaced by ethanol is based on energy content (1 litre ethanol corresponds to 0.6 litre crude oil)
- Fuel efficiency of gasohol (E10) is 2% lower than that of gasoline
- Total life cycle CO<sub>2</sub> emission factor for gasoline is 2.5 kg CO<sub>2</sub>/litre
- The emissions factor for ethanol produced from molasses and cassava in Thailand is considered negligible at this stage

## Assumptions on ethanol and feedstock supply

	2004*	2005*	2006 (Jan-Aug)*	2006	2007	2008	2009	2010	2011
<u>Total ethanol demand (MI)</u>	6	68**	84**	128	296	385	500	650	845
Ethanol from molasses	6	53	66	98	156	156	156	156	156
Ethanol from fresh cassava	-	-	11	23	140	229	344	494	689
<u>Feedstock supply (Mton)</u>									
Molasses	0.02	0.26	0.3	0.4	0.6	0.6	0.6	0.6	0.6
Fresh cassava	-	-	0.05	0.1	0.8	1.3	1.9	2.7	3.8

\* Actual data

\*\*Thailand imported 15.4 and 7.1 Mlitre ethanol in 2005 and 2006, respectively

- During 2007-2011, molasse is first used to supply the demand for ethanol and additional demand will be met with fresh cassava
- Export of molasses can be reduced to 50% of its average value during 2000-2005
- During 2006-2007, the area used for cassava is kept constant at the average 2000-2005 level and ethanol demand from cassava is only met by reducing the export of cassava chips
- From 2008-2011, 50% of the annual ethanol demand from cassava can be fulfilled by cassava area expansion, replacing maize and the remaining 50% is met by reducing the export of cassava chips
- Export of cassava chips can be reduced to 30% of the average value during 2000-2005

# Assumptions on prices

40 Baht: 1 USD

	2004*	2005*	2006 (Jan-Aug)*	2006	2007	2008	2009	2010	2011
<b><u>Fuel prices (Baht/litre)</u></b>									
<b>ULG 95 (up 10%/yr)</b>	12.35	16.26	19.06	19.06	20.97	23.06	25.37	27.91	30.70
<b>ULG 91 (0.5 Baht/l lower than ULG95)</b>	11.81	15.75	18.56	18.56	20.47	22.56	24.87	27.41	30.20
<b>Ethanol (up 9%/yr)</b>	12.75	18.50	24.00	24.00	25.20	26.46	27.78	29.17	30.63
<b><u>Export Prices (USD/ton)</u></b>									
<b>Molasses (up 13%/yr)</b>	28	56	82	82	93	105	118	134	151
<b>Cassava chips (up 3%/yr)</b>	77	108	102	102	105	108	111	115	118
<b>Maize (up 3%/yr)</b>	143	145	NA	149	154	158	163	168	173
<b><u>Import Prices (USD/Barrel)</u></b>									
<b>MTBE (up 5%/yr)</b>	48	65	NA	80	84	88	93	97	102
<b>Crude oil Dubai (up 5%/yr)</b>	34	49	65	65	68	72	75	79	83

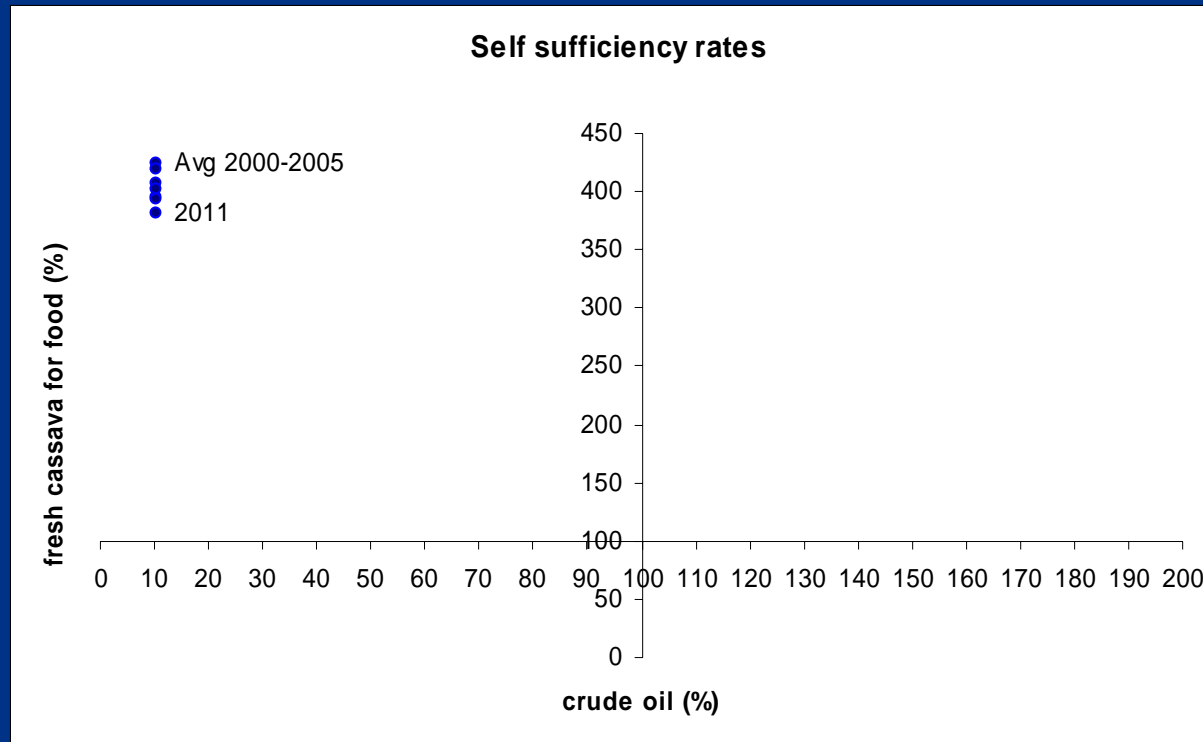
- Import prices of crude oil and MTBE as well as ex-refinery price of ULG 95 (price before taxes and marketing margin) each are set to increase by 5 and 10% per year
- Projected prices of molasse, cassava chips, maize are based on the historical prices change during 1998-2006
- Projected ethanol price is based on the historical price change of molasse and fresh cassava during 1998-2006 and an assumption that the feedstock prices account for 60 and 65% of the ethanol price

# Results: trade gain and loss (MUSD)

Year	Trade gain (Case 5%)		Trade gain (Case 10%)		Trade loss			Net trade gain (Case 5%)	Net trade gain (Case 10%)
	Crude oil	MTBE	Crude oil	MTBE	Molasses	Cassava chips	Maize		
2005	7	14	7	14	11	0	0	3*	3*
2006	17	31	17	31	29	6	0	10*	10*
2007	41	35	42	79	56	39	0	21	27
2008	64	85	71	94	63	33	21	34	48
2009	98	97	113	111	71	51	32	41	70
2010	147	110	177	132	80	75	47	54	107
2011	214	125	270	157	91	108	68	72	161

The net trade gain during 2007-2011 is only 0.2-1 % of the value of the net import of crude oil in 2005

# Results: self-sufficiency rates



- The self-sufficiency rate for fresh cassava (the ratio of total production of cassava for food purposes to domestic consumption) goes from 419% in 2006 down to 381% in 2011
- The self-sufficiency rate for crude oil (the ratio of total supply of crude oil to domestic consumption) is only marginally affected, increasing from 10.2 to 10.3%

## Results: CO<sub>2</sub> reduction, the cost of fuel substitution and the cost of implementing the program

	Ethanol demand (Mlitre)	CO <sub>2</sub> reduction (Mton)	Total cost of fuel substitution (MUSD)*		Cost of fuel substitution (USD/tonCO <sub>2</sub> )		Total cost of program** (MUSD)		Cost of program (USD/tonCO <sub>2</sub> )	
			5%	10%	5%	10%	5%	10%	5%	10%
<b>2004</b>	6	0.01	NA		NA		1		87	
<b>2005</b>	67	0.14	2		12		31		227	
<b>2006 (Jan-Aug)</b>	84	0.17	10		62		50		294	
			<b>5%</b>	<b>10%</b>	<b>5%</b>	<b>10%</b>	<b>5%</b>	<b>10%</b>	<b>5%</b>	<b>10%</b>
<b>2006</b>	128	0.26	16	16	62	62	80	80	312	312
<b>2007</b>	296	0.59	45	38	76	64	193	186	326	314
<b>2008</b>	385	0.77	68	49	89	63	261	241	338	313
<b>2009</b>	500	1.00	99	57	98	57	349	307	348	307
<b>2010</b>	650	1.30	138	61	106	47	463	386	355	296
<b>2011</b>	845	1.69	189	55	112	32	612	477	361	282

\*The cost of fuel substitution is the difference between the ex-refinery prices of gasohol and gasoline

\*\*The government provides tax subsidies to make the price of gasohol at the pump 1.5 Baht/l less than gasoline (incl. the reduction of excise and municipal tax and tax collected for the Oil Fund and the Energy Conservation Fund for ethanol blended in the gasoline, as well as tax exemption for ethanol production)

# Conclusions

- Thailand's resource provides a large potential supply of ethanol for domestic consumption and export
- Achieving the government targets for ethanol leads to a small improvement in trade balance and energy security and only has a modest impact on CO<sub>2</sub> emissions
- To serve its purpose, the program's targets need to be enhanced
- The fuel substitution cost is low compared to European estimates and could offer a cost-effective option for CO<sub>2</sub> reduction through the CDM
- However, the cost of implementing the program is much higher than the fuel substitution cost, because of the lower price of gasohol set by the government

# Policy implications

- Thailand's agricultural sector should be able to accommodate the present level of program ambition
- But with much higher targets, the sustainability dimension, including local socioeconomic and ecological impacts due to land use changes but possibly also national food security, warrants careful consideration, especially if ambitious targets coincide with large and rising ethanol import demands in several world regions