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Extended Summaries

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Country Report

Maize in Thailand

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Introduction

Thailand used to be one of major maize exporters to the world market. Since 1986, domestic consumption has been increasing due to the rapid growth of the feed industries. In 2013/2014, the Thai Feed Mill Association (TFMA) expects total feed demand to increase to approximately 16.3 million tons, up around 5 to 6 percent from 2012/2013. The total value chain, excluding employment, is approximately US $11,627 million. Domestic maize production was affected by variations in climatic conditions with frequent drought during flowering period. In addition, competing crops such as sugarcane and cassava sometimes replace maize when prices of maize gram are low.

The main reasons for Thailand's ability to maintain such high production is because the average yield has continuously increased due to the wide adoption of better technologies by Thai farmers. In order to meet the great domestic demands, Thailand has to make a significant increase in maize production. Raising the yield per unit of land area is a possible solution which can be done by increasing yield potential of maize varieties, using agricultural inputs appropriately and efficiently, improving cultural practices and reducing yield losses from both biotic and abiotic field losses from both biotic and abiotic factors.

Trends in area, production and productivity of maize

The maize growing area was stabilized at around 1.41 million hectares during the 1990s with total production of 3.98 million tons. Since the early 2000s, maize area has declined steadily to 1.19 million hectares with a total production of 4.259 million tons and an average yield of 3.56 tons ha^{-1}. Currently, the maize growing area is estimated at around 1.206 million hectares with total maize production of 5.063 million tons and average yield of 4.41 tons ha^{-1} in 2013 (Table l).

Table 1 Planted area, production and domestic utilization of maize in 2002-2013.

Year	Planted area (1,000 ha)	Production (1,000 tons)	Yield (t ha^{-1})	Domestic utilization (1,000 tons)
2002	1,179	4,259	3.56	4,259
2003	1,131	4,349	3.66	4,119
2004	1,163	4,341	3.69	3,545
2005	1,105	4,094	3.68	4,096
2006	1,025	3,918	3.88	3,842
2007	1,017	3,890	3.82	3,949
2008	1,071	4,249	3.97	4,335
2009	1,136	4,616	4.06	4,066
2010	1,197	4,861	3.91	4,834
2011	1,184	4,973	4.32	4,898
2012	1,205	4,948	4.33	4,670
2013	1,206	5,063	4.41	4,900

Sources: 1. Office of Agricultural Economics, Agricultural statistics of Thailand 2009 and 2013.
2. Office of Agricultural Economics, Thailand Foreign Agricultural Trade Statistics 2012.

The main maize-growing areas in the northern, northeast and central regions of Thailand have 0.757, 0.298 and 0.124 million hectares, which cover 64.23 percent, 25.28 percent and 10.49 percent of total areas, respectively. Soil in the northern and central regions is generally neutral to slightly alkaline. The major soil groups are reddish brown laterites and black soil type (Table 2). About 98 percent of maize production is on upland rainfall conditions with annual average rainfall of 1,100-1,200 mm. A bimodal rainfall distribution prevails in the major maize growing areas. The major growing season begins during May-June and harvesting is done in September-October. In this case, farmers produce other field crops such as sorghum, mungbean sunflower and groundnut as the second crop. In some areas where rain comes late, the maize growing season begins during July-August and harvesting is done in November-December. There are a few limited areas with planting of maize in the paddy fields after rice with irrigation from mid-November-December and harvesting during March-April.

Table 2 Characteristics of maize production zones in Thailand in 2013

	Production zone		
	North	Northeast	Central
Area, (M ha)	0.757	0.298	0.124
Total area (%)	64.24	25.28	10.48
Production (M t)	3.155	1.316	0.514
Yield (t ha^{-1})	4.162	4.410	4.164
Ecology	Tropical	Tropical	Tropical
Grain type	OYF, OYSF	OYF, OYSF	OYF, OYSF
Growing season	major	major/minor	major
Maturity (day)	110-120	110-120	110-120
Soil texture	loamy clay	sandy	loamy clay

Source : Office of Agricultural Economics, Agricultural statistics of Thailand, 2013
OYF = orang yellow flint; OYSF = orang yellow semi-flint

Types of maize under cultivation Thailand is located in latitude 5° N 40'-20°N30' and longitude 97°70'-105°45' E; thus, tropical background germplasm is more relevant. Most Thai farmer; prefer yellow kernel flint or semi-flint types with high yielding late maturity varieties (110-120 days).

Maize research and development in Thailand is carried out by both public and private organizations. In the public sector, the staffs of the Department of Agriculture (DOA) and Kasetsart University (KU) are mainly involved. They devote 30 percent of their research effort to population improvement and 70 percent to hybrid development. In the private sector, m contrast, the main focus is on developing proprietary hybrids. These hybrids exhibit increasingly high yield potential, tolerance to biotic and abiotic stress, better grain quality and other desired traits.

The private seed businesses of major field crops were established in Thailand in 1978-81. Presently, there are five strong research and development seed business companies. Some companies invest in the seed business directly such as Monsanto (Cargill) Seeds, Pioneer Seeds, Syngenta Seeds and pacific Seeds, while some companies invest in the form of joint ventures together with Thai agricultural enterprises, such as Monsanto (DeKalb) from the USA with Charoen Pokapan (CP) group companies.

Utilization of maize hybrids in Thailand began in 1981; the total amount of hybrid seed was around 40 tons. The amount of hybrid seed sold from 1981 until 1985 doubled every year, was fairly stable, but decreased during 1986-1988. In 1989, the farmers used more hybrid seeds because of attractive grain price which have increased. Since the end of 1987 all seed companies have developed and released new generation hybrids in the form of three-way and double-crosses. In 1990s, single crosses played the most important role for yield improvement. Due to the excellent performance of single-cross hybrids and the hybrid promotion policy of the Department of Agriculture Extension (DOAE), hybrid seed increased rapidly from 8,940 tons in 1992 to 18,800 tons in 2001, and is estimated to be 23,175 tons in 2013, covering more than 98 percent of total maize growing area (Table 3).

Principal stress factors responsible for yield reduction in the maize growing zones

Maize crop losses may be caused by both abiotic and biotic stresses. Generally, abiotic or environmental stresses, particular drought stress, are observed almost every year in Thailand (Eskasingh et al. 2004). According to reports issued by the Office of Agricultural Economics, the maize area affected varied from 49,000 to 393,000 hectares or from 3 percent to 22 percent of the total growing area, particularly in the northeast region. The estimated value of losses is US $10 million to $80 million per year.

Table 3 Estimation amount of hybrid maize seed volumn and area planted during 1981-2013

Year		Amount (t)	Hybrid area (1000 ha)	% of Total maize area	
1981		40	2.80	0.14	TC,TWC,DC
1992	Hybrid Promotion policy	8,940	558.75	35.28	TWC, MSC, SC
2001		18,800	1,143.75	95.11	MSC, SC
2013		23,175	1,155.14	98.00	

Remark : Data modified from Suwantaradon, K., 2013
Estimation total maize seed demand = 23,648 tons/year
Average sowing rate of hybrid seed = 20 kg ha^{-1}

Thai farmers know the advantages of fertilizer use, but they still apply a small amount of fertilizer because it is quite expensive. The effect of fertilizers comes along with high soil moisture but rainfall unpredictable; so the benefit of fertilizer application is considered as high risk by smallholder farmers. Maize in some growing area also shows symptoms of nutrient deficiency. Area affected by low nitrogen stress is about 60 percent, mainly in the northeast.

Due to the expanding of feed industries and an urgent need for increasing maize to meet domestic demand, the cultivation of maize has increased in the paddy fields during the dry season after the first crop, particularly in the central and lower northern regions along the Chao Praya Plains, which covers nearly 300,000 hectares. Maize here is an upland crop; so yield loss due to excess water or waterlogging is extremely high.

Among the biotic stresses, downy mildew, primarily caused by *Peronsclerospora sorghi*, is the most serious pathogen affecting maize in Thailand. It may damage from young plant stage until flowering stage. Maize cannot be grown under such conditions with downy mildew resistance or chemical control. Currently, Southern Rust caused by *Puccinia polysora*, Charcoal stalk rots caused by *Macrophomina phaseolina*, Northern Corn Leaf Blight caused by *Exserohilum turcicum*, Southern Corn Leaf Blight caused by *Bipolaris maydis* and Maize Dwarf Mosaic caused by Maize Dwarf Mosaic Virus (MDMV) show economic losses in some areas in the north and northeast. Among the insect-pests, corn borer (*Ostrinia furnacalis*) is most important. It recently appeared in the north and central regions.

Germplasm collection characterization, conservation and documentation

The average yield of maize increased in the 1950s and 1960s because DOA released C-110 (Tiguisate Golden Lint), an open pollinated variety under the name of 'Guatemala' in 1954. Then it was improved by using controlled mass selection and was distributed to farmers as the Praputtabat varieties (e.g., PBI and PBS) during 1961-75. Because the PB varieties were susceptible to downy mildew caused by *Peronosclerospora sorghi*, these were replaced by resistant varieties, namely Thai DMR-6 in 1972. Many accessions of maize germplasm have been introduced to Thailand since the beginning of the breeding program in 1960s. The Rockefeller Foundation's Inter Asian Corn Program brought in tropical germplasm from Mexico, Central America, the Caribbean and Brazil. The Suwan germplasm complexes were originally developed by crossing Thai Composite #1, a synthetic, with 36 varieties from Mexico, Central America and the Caribbean with several germplasm sources of downy mildew resistance from the Philippines (Sriwatanaponse et al., 1993).

Several breeding system have been employed in the development of new varieties such as controlled mass selection, S1 & S2 recurrent selection, reciprocal recurrent selection, half sib and full sib family selection. Other breeding systems employed include pedigree and backcross selection, top cross using the

latest cycle of Suwan 1, Suwan 3 and Suwan 5, Nakhon Sawan 1, Population 28, and also testcross using the promising inbreds or hybrids as testers. To obtain more reliable information, data has been collected over years, seasons and locations. Evaluations of varieties have been initially done at research stations/centers. Promising materials have been tested in multi-location trails in farmers' fields in maize growing areas.

Since 1975, several open-pollinated varieties (OPVs) have been released such as Suwan 1(1975); Suwan 2 (1979); Suwan 3 (1987); Nakhon Sawan 1 (1989); and Suwan 5 (1993). These varieties have shown excellent Performance with downy mildew resistance. Their Yielding ability ranges from 4.5-6.5 ton ha^{-1}. A Kasetsart University program has continuously released inbred lines (Ki 1 to Ki 45) and several hybrids with three way crosses and single crosses such as Suwan 2301 in 1982, Suwan 2602 in 1986, Suwan 3101 in 1991, Suwan 3601 in 1993, Suwan 3851 in 1998 and Suwan 4452 in 2003 which yielded 7.5-8.5 ton ha^{-1}. The Department Of Agriculture released inbred lines Nakhon Sawan1, Nakhon Sawan2, Tak Fa1, Tak Fa2 and Tak Fa 3. Several high-yielding hybrids with downy mildew resistance were released such as Nakhon Sawan 72 in 2001, Nakhon Sawan 2 in 2005 and Nakhon Sawan 3 in 2009, respectively. Their yielding ability ranges from 7.0-8.8 ton ha^{-1}.

Acreages planted with improved varieties

Thailand has been among the Asian countries with the highest proportion of farmers using improved maize germplasm. The estimate of hybrid seed used was about 98 percent of total maize growing area and the remaining 2 percent using OPVs, as of 2013 (Table 3). The public sector supplies a small amount of seed volume. The private sector, in contrast, is the mayor supplier of hybrid seeds. Much of private sector research, however, depends heavily on public sector maize germplasm, especially stress-tolerant materials (Table 4).

Table 4 Commercial hybrid maize available for sale in 2013-14

Organization	Hybrid			OPV
Charoen Seeds (C.P.)	CP888	CP888 New	CP888 Super	
	KKK Super	CP801	CP301	
	CP101	CP201	CP888 3G	
Monsanto Seeds	Mon919	Mon979	DK9901	
	DK9955	DK6919	DK7979	
	DK6818			
Pacific Seeds	PAC999 Super	PAC339	PAC777	
	PAC558	PAC559		
Syngenta Seeds	NK20	NK48	NK58	
	NK6346	NK6385	S7328	
	S6248	S7259	NK40	
Pioneer Hi-Bred	30B80	30K95	30Y87	
	30T60	P4199	P4296	
	P4546	P4311	P4181	
	P4554	P4472		
Seed Asia	TF222	SA333	SA501	
	SA399	SA326	SA282	
	SA336			
Kasetsart University	Suwan 4452			Suwan 5
Department of Agriculture	Nakhon Sawan 2			Nakhon Sawan 1
	Nakhon Sawan 3			

OPV = Open–Pollinated Variety

Maize marketing, commercialization and trade

In 2013/14 maize production is increased to 4.9 million metric tons due to better-than-expected average yields and acreage expansion of the off-season maize crop. The average maize yield is estimated to be 4.41 ton ha^{-1} compare to 4.33 ton ha^{-1} in 2012/2013 due to favorable weather conditions. Farmers also replaced the planting of the off-season rice crops with maize due to the limited water supplies in the irrigated areas of the northern and central plain regions; A maize crop usually uses 40 to 50 percent less water than a rice crop. In addition, the government decision to scale back the MY 2013/14 rice pledging program and payment delays encouraged some farmers to switch to planting maize.

Thailand used to be one of major maize grain exporters to the world market. Since 1986, domestic consumption has been increasing due to the fast growth of the feed industry. According to the TFMA, total feed demand in 2013 decreased to 15.5 million metric tons; due to lower-than-expected poultry feed demand caused by the liquidity problem of one of Thailand's largest poultry processors. The company, which accounts for around 20 percent of total chicken meat production in the country, reportedly downsized its production capacity to only around 5 percent of total chicken meat production.

According to the Board of Trade of Thailand, maize exports in 2012/2013 increased to around 0.8 million metric tons, which increased significantly from 2012/2013 due to the government's export subsidies. Maize traders who participated in the domestic support program were encouraged by the government to export their maize and received a US $60/ton compensation to make up for the difference between the intervention and market prices. Basically, the government's policy encouraged traders to export their maize to prop up domestic prices.

Successful Public-Private Partnerships in maize R&D

Multi-location hybrid maize yield trials

The success of Thailand's maize production is based on the success in developing hybrid maize seed industry. New hybrids are continually being developed and introduced to the market by both private and public sectors. The multi-location cooperative hybrid maize yield trials have been conducted for 30 years by Kasetsart University in cooperation with Department of Agriculture, Chiang Mai University, Maejo University and the private sector. The objective IS to evaluate and compare maize hybrids available in Thailand. Each organization, except Chiang Mai University and Maejo University, submitted two hybrids each for the annual trials. Another four hybrids with high yields in previous trials were used as standard checks for yield comparison.

Maize breeders from the public and private sectors have the opportunity to discuss, share experiences, working procedures, management and problem solving through the working season. At the end of each year's programme, Kasetsart University organizes a meeting to present results at the National Corn and Sorghum Research Center (Suwan Farm). As a result, superior hybrids are developed with traits specifically targeted for increased performance in Thailand. This encourages higher incomes to the farmers through higher yields and increased tolerance to biotic and abiotic stresses. Many hybrids tested in the trials have been commercialized and introduced to the market.

Maize seed village

Fanners generally tend not to invest more on seed purchasing for maize cultivation mainly due to an increase of seed price, risk from climate change and seed storage. In this regard, the DOA in cooperation with farmer organizations and local companies established "Maize Seed Village" in order to ensure seed sufficiency among farmers, thus saving cost of seed purchasing. When the program began, Nakhon Sawan Field Crops Research Center (NSFCRC) prepared demonstration trials both in NSFCRC and farmer's fields. Groups of farmers and participants from farmer organizations and local companies were invited to visit and to select preference hybrids. Nakhon Sawan3 (NS3), a high-yielding and drought-tolerant hybrid was selected and released by DOA in 2009. Then, the technology of hybrid seed production of NS3 was transferred to those who were willing to produce seed. In 2013-2014, farmers, farmer organizations and local companies joined the project and continuously produced drought-tolerant hybrid seeds. NSFCRC provided sufficient among of parental inbred seeds, 9,120 kg of Tak Fa1 (female parent) and 3,502 kg of Tak Fa3 (male parent) to farmers, fanner organization and local companies without a royalty fee. The farmers planted inbred seed as recommended (female:rnale=4:l). Officers of NSFCRC continuously inspected the fields and advised farmers throughout the production process. The farmers and staff from farmer organizations and local companies have an opportunity to discuss and to share experience among their and officers. By the end of 2014, an estimated 800 tons of NS3 hybrid seed was produced by the farmers, farmer organizations and local companies.

Key enabling technologies that are presently limiting growth of maize in country

Currently, Thailand does not permit any commercialization, importation, transit and exportation of GMO crops, except for research purposes at the laboratory and greenhouse levels, although GM maize grain and its processed food products are permitted.

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