Chapter 8

Crops

The dominance of rice reflects both the natural environment of Thailand and the historical origins of its agriculture. Attempts to diversify have usually met with limited success until recent decades; the number of farms growing more than one kind of crop increased by only two percent and the area by five percent between 1978 and 1993, mainly in newly opened and unirrigated land. As diversification is conventionally associated with farmer risk aversion,[1] the Thai case suggests that wet rice is locally perceived as low risk. This has been the lesson of agricultural history for the Tai and Thai. Perhaps the main form of diversification in recent times has been income from off-farm labour.[2] Hence rice remains the leader in Thailand's ten leading primary crops, others being; sugar, maize, cassava, oil palm, coconut, soya bean, mung bean, garlic, and groundnuts. The estimated value of major crop products received by farmers in 1996 is presented in Table 8.1; rubber is omitted from most tables of farmer crops and in the case of Thailand masks its leading producer status with one-third of the world's production returning an export income of some seven billion baht in 1997.[3] Thailand also leads in canned pineapple production.

Major production areas are the irrigated and high-rainfall lowlands, mainly of the Central Plain and the South. The Northeast is affected by variable water regimes, and the North is highly productive, in its narrow river valleys. The northern highlands, once dominated by shifting cultivation[4] with reducing periods of forest

[1] Binswanger, H. and Siller, H. (1983)
[2] Paopongsakorn, Nipon (1995)
[3] FAO (1999)
[4] Zinke, P.J. et al (1978)

Table 8.1 *Estimated Value Received by Farmer from Principal Crop, 1996*[5]

Product	Value million baht	Product	Value million baht
1. Rice	123,317	11. Tobacco	2,027
2. Sugar cane	23,122	12. Groundnuts	1,639
3. Maize	17,815	13. Shallot	1,583
4. Cassava	12,840	14. Chilli	1,214
5. Oil Palm	5,430	15. Cotton	938
6. Coconut	4,700	16. Kenaf	780
7. Soya bean	3,120	17. Sorghum	619
8. Coffee	2,582	18. Sesame	587
9. Mung bean	2,533	19. Onion	412
10. Garlic	2,397	20. Kapok	371

fallow,[6] are tending towards perennial farming[7] based on minimal tillage[8] and leguminous trees such as *Gliricidia* and *Leucaena*[9] in socially sustainable systems.[10] Concerns that hilltribes preferred to grow opium eventually abated as it became clear that their primary concern was a means to obtain sufficient rice.[11]

The opening of new uplands to non-rice crops caused the proportion of cultivated area allocated to rice to decline from about 77 to 55 percent (Table 8.2) in the thirty years from 1961. Over this period, assisted by the emphasis on central planning, agricultural statistics have improved in accuracy and timeliness; such information as presented in the following three chapters is thus easily updated through the sources indicated.[12] Rice always comes first in Thailand.

[5] Office of Agricultural Economics (1998)
[6] Kyuma, K. and Pairintra, Chaitat (1983)
[7] Sanchez, P.A. et al (1982)
[8] Greenland, D. (1975)
[9] Falvey, L. (1982b)
[10] Grandstaff, T. (1980b)
[11] Grandstaff, T.B. (1979)
[12] Office of Agricultural Economics (1999)

***Table 8.2** Proportion of Rice Area by Season for each Region*[13]

Rice Crop	Year	Northeast	North	Central	South	Country
Wet Season	1961	30.49	14.58	25.23	6.12	76.43
	1970	28.95	13.78	17.84	4.59	65.16
	1980	27.80	12.36	11.95	4.01	56.12
	1985	26.35	11.79	11.09	3.27	52.51
	1991	27.49	11.23	9.44	2.78	50.94
Dry Season	1961	0.01	0.05	0.08	0.00	0.14
	1970	0.01	0.13	0.69	0.03	0.86
	1980	0.15	0.35	2.61	0.07	3.18
	1985	0	0.39	2.78	0.17	3.52
	1991	0.61	0.98	2.48	0.08	4.15

Rice

Possibly originating in the southwest Himalayas,[14] the first cultivation of rice may have been in southern China, Southeast Asia, or India and its first irrigation relatively recently in 780 BC.[15] Rice seed broadcasted into receding flood water areas was the earliest form of wet rice domestication[16] in Thailand, which was an early prehistoric site regardless of archaeological doubts.[17] Opportunistic harvesting had long given way to agriculture before Khmer and Tai times, although early Mon and Khmer influence[18] probably began the rice revolution of Thailand[19] by building on the agro-cities of the shallow and gentle floodplains. Khmer annual rice production of 38,000 ton of hulled rice[20] from some five million hectare[21] substantiated the region's potential. Migrating Tai wet rice cultivators[22] blended their unique *muang fai* irrigation with Khmer technology to control increasingly larger rivers until the flooding of the delta was controlled. Ayutthaya management of receding flood waters allowed rice exports to begin, notwithstanding views that rice was only for subsistence prior to the 1850s,[23] with entrepreneurial skills being

[13] Paopongsakorn, Nipon (1995)
[14] Vavilov, N.I. (1930)
[15] Grist, D.H. (1959)
[16] Wyatt, D.K. (1989)
[17] Yen D.E. (1977)
[18] Rogers P. (1996)
[19] van Beek S. (1995)
[20] Hall, K.R. (1992)
[21] van Liere, W.J. (1980)
[22] Kato, K. (1998)
[23] Poapongsakorn, Nipon (1995)

found in Chinese middlemen as rice expanded along small canals and contour barriers.[24] By the 1940s, *muang fai* had failed the demands of intensification and Green Revolutionary pressures finally persuaded government to implement a facsimile of the 1906 van der Heide plan to control flooding for an irrigation benefit,[25] thereby firmly orienting Thai rice production to the world market.

Some 90 percent of the world's rice is produced and consumed within Asia, mainly in the country of production. Consistently the world's largest exporter, Thailand is the sixth largest rice producing country behind populous Asian countries (Table 8.3). It has enjoyed an era of disruption in the other traditional exporting countries of Myanmar and Vietnam, when, at the same time, Green Revolution technologies have enabled once rice importing countries to become self-sufficient.[26]

Table 8.3 *Rice Production (Yield) for Selected Countries 1991 - 1995*[27]

Country	Production (ton) and Yield (kg/rai)				
	1991	**1992**	**1993**	**1994**	**1995**
World Total	**515,431 (561)**	**526,161 (570)**	**523,743 (578)**	**536,432 (590)**	**549,291 (591)**
Asia	**474,720 (575)**	**481,106 (586)**	**480,587) (592)**	**489,748 (603)**	**501,980 (604)**
China	186,086 (902)	188,255 (927)	179,977 (937)	178,031 (933)	187,192 (963)
India	110,591 (418)	109,001 (419)	118,464 (451)	121,997 (471)	122,372 (461)
Indonesia	44,688 (695)	48,240 (695)	48,181 (700)	46,641 9695)	49,860 (695)
Bangladesh	27,377 (428)	27,510 (432)	27,062 (441)	25,248 (408)	24,659 (397)
Vietnam	19,622 (498)	21,590 (533)	22,837 (557)	23,528 (570)	24,000 (582)
Thailand	*10,400 (361)*	*19,917 (348)*	*18,447 (348)*	*21,111 (376)*	*22,016 (387)*
Myanmar	13,199 (462)	14,837 (470)	16,760 (489)	18,195 (507)	20,109 (497)
Japan	12,005 (937)	13,216 (1,004)	9,793 (733)	14,976 (1,083)	12,625 (962)
Philippines	9,673 (452)	9,129 (457)	9,434 (448)	10,538 (456)	11,002 (425)
Korea, South	7,293 (966)	7,303 (1,010)	6,507 (917)	6,932 (1,006)	6,519 (989)
Pakistan	4,865 (371)	4,676 (379)	5,992 (438)	5,170 (392)	5,714 (437)
Nepal	3,223 (365)	2,585 (328)	3,493 (384)	2,928 (330)	2,906 (340)
Sri Lanka	2,389 (483)	2,340 (489)	2,570 (501)	2,684 (479)	2,685 (479)
Korea, North	4,420 (589)	2,439 (600)	2,300 (567)	2,500 (615)	2,580 (635)
Others	8,889 (351)	10,070 (383)	8,770 (352)	9,269 (389)	7,742 (362)

[24] Phongpaichit, Pasuk. and Baker, C. (1998)
[25] van Beek, S. (1995)
[26] Haanant, Juanjai et al (1987)
[27] Office of Agricultural Economics (1998)

Rice Policy

Thailand has been unique among less developed agricultural countries in its three implicit policies for agriculture of:

- maintaining low domestic prices for consumers
- minimising large fluctuations in domestic rice prices
- contributing significantly to government income.

The last separates Thailand from food deficit nations.[28]

Rice policy, as distinct from taxation, was not a focus of government until the 1950s. During the World War II, rice exports to Japan and a large unofficial trade[29] through Malaya confused statistics,[30] although Allied calculations that stocks totalled two million ton led to a 1946 war reparations demand[31] of 1.5 million tons through a period of high world prices.[32] Frequently renegotiated and managed through a specific office, the burden of producing free rice was transferred to growers, such that with reparation obligations met within two years, government maintained the policy. The differential between domestic and export prices became a major source of government revenue with the effective tax between 1947 and 1955 being about 30 percent; the approach was retained until recently to also subsidise domestic prices.[33]

Thai rice prices have thus been amongst the lowest in the region through such policies. This led to farmers being exposed to low world prices, for example in 1971, while consumers were protected through an export subsidy. Low government reserves precluded assistance to farmers although farmer price receipts rose with world prices at a rate above the consumer price index through the third and fourth plans (1972 - 1981). Rice contributed more than 11 percent of government revenues from 1955 to 1965, declining progressively to about two percent by 1975, about $40 million per year.[34]

[28] Brannon, R.H. (1978)
[29] Corden, W.M. (1967)
[30] Silcock, T.H. (1949)
[31] Silcock, T.H. (1970)
[32] Tarling, N. (1978)
[33] Rilston, R.A. (no date)
[34] Siamwalla, Ammar (1975)

Objections to the rice premium have included:

- taxing cash-poor farmers is inequitable
- farmers in the Northeast and the North produce glutinous rice which is not traded globally
- adoption of modern technologies is hampered by low farmer receipts
- rice policy should not be separate from a comprehensive agricultural pricing policy.[35]

Each objection was addressed through the late 1970s and 1980s, although policy revisions were then inseparable from the realisation that global agricultural prices would not remain high.

Rice Production Systems

Rice production systems vary by types of rice and region. Four types of *Oryza sativa* widely used in Thailand are:[36]

- **Wetland rice** (*Oryza sativa* var. *dura*) is often referred to as paddy, being produced in controlled flooded fields during the entire growing period and hence is restricted to the delta and valleys with developed irrigation systems. It supplies most of Thailand's export rice, although statistical aggregation with glutinous rice usually requires socio-cultural assumptions to estimate its total production.
- **Glutinous rice** (*Oryza sativa* var. *glutinousa),* also known as sticky rice, varies in grain colour and cooking characteristics from paddy. Its translucent colour in the uncooked state and sticky characteristics upon cooking readily distinguish it among informed consumers. Some ten percent of production is exported to neighbouring Tai-related groups, particularly in Lao-PDR, from the Northeast and North production areas. Production systems for glutinous rice are essentially similar to those for paddy.[37]
- **Upland rice** (*Oryza sativa* var. *montana)* is grown under shifting and permanent cultivation in the mountainous North and poorer upland regions of the Northeast. Entirely dependent on rainfall, it is a subsistence crop which is not considered of statistical importance in official surveys, which might explain false contentions that upland rice is unknown in Thailand.[38]

[35] Wright, J. (1977)
[36] Donner, W. (1978)
[37] Judd, L. (1964)
[38] de Datta, S.K. (1975)

- **Floating rice** (*Oryza sativa* var. *fluitans*) has been long grown in the region, being used earlier than the Mon-Khmer period. It is a type of wetland rice which can rapidly accelerate internodal growth in response to rising floodwaters up to two metres in depth by nutrient-uptake from water more than soil based roots. Low grain and very high stem yields, and modern water control works, have reduce its area to less than half the estimated five million rai (800,000 hectare) of the 1960s, now being used only in flood-prone areas of the Northeast.

Regional variations define much of Thai agriculture and rice. The Central Plain, the country's rice bowl, represents some 45 percent of the area under rice and more than half of total production and the bulk of rice exports, producing less than four percent of glutinous rice. The Northeast, with about 43 percent of total acreage, produces less than 30 percent of all rice from its poorer overall water and soil regimes, and a dietary preference for the lower yielding glutinous varieties. The South, with about seven percent of the rice area, produces some nine percent of production, mainly paddy, from small river valleys and coastal plains. The three main river inter-montain valleys of the North, Chiang Mai-Lampang, Chiang Rai-Lampang, and Phrae-Nan, with silty loam soils contribute more than ten percent of production from six percent of the national rice area, increasing with a shift away from glutinous varieties.[39]

Glutinous Rice

The long cultural and regional association with wet rice[40] includes effects from trading, migration, and market demand. Technologies and varieties of the North or Northeast reflect the southern China migration route of the Tai, while the Central Plain reflects Indian influence through the Mon-Khmer and other cultures of the Mekong delta region in its Bengal rice cultivation approaches, in common with the South.[41] Glutinous rice history provides interesting insights to Thai culture.

Glutinous rice is a peculiarly Tai phenomenon. Today it is synonymous with subsistence production with some cross-Tai group trading, and possibly, an embryonic boutique market. Its different cooking, eating, and taste qualities separate

[39] Chomcalow, N. (1993)
[40] Kato, K. (1998)
[41] Watabe, T. (1978)

sticky rice eaters from others in terms of kitchen, meal, and snacking behaviour. Cohering at temperatures as low as 72°C which produce no change in non-glutinous varieties,[42] sticky rices exhibit different amylose:amylopectin ratios, and contain four to five percent of dextrose in their endosperm compared to very low levels in non-glutinous varieties.[43]

Glutinous rice growing is today a cultural preference, not an indication of environmental variation. It covers an estimated one-half million square kilometre[44]

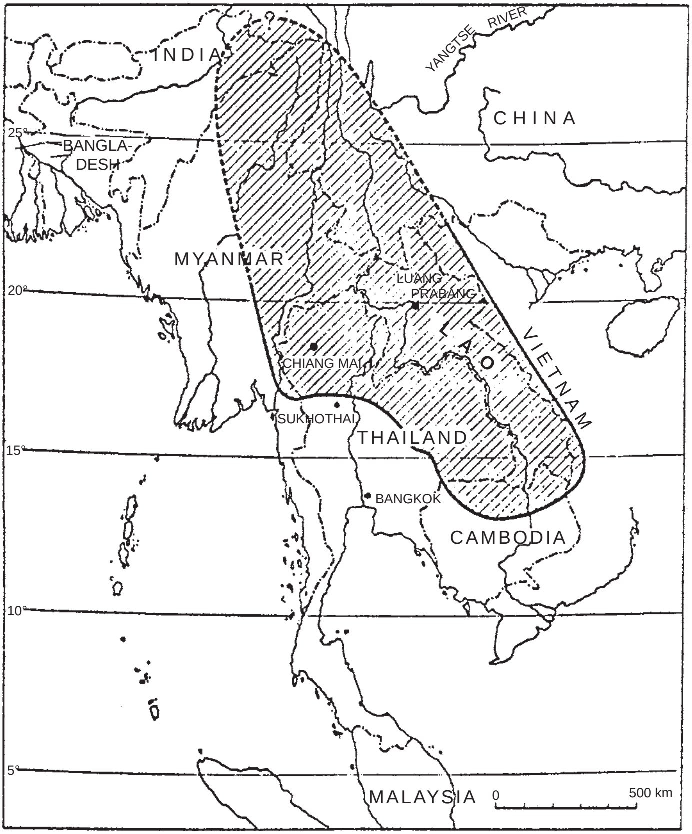

Figure 8.1 *The Glutinous Rice Zone of South East Asia*[45]

[42] Chandraratna, M.F. (1964)
[43] Chang T.T. and Bardenas, E. (1965)
[44] Watabe, T. (1967)
[45] Watabe, T. (1967)

across several ethnic groups, the majority of which are of Tai origin and all of which have some Tai association (Figure 8.1). Originating as a short growing season variety suited to low rainfall regimes and light soils with minimal water control, and being a recessive mutant which can only be differentiated at harvest, suggests that glutinous varieties were selected from non-glutinous varieties.

Large scale adoption of non-glutinous varieties in response to market demand during the Ayutthaya and, in particular the Bangkok, period was consolidated through controlling of water environments to favour the, originally, longer growing season non-glutinous varieties.[46] The recent nature of the change to non-glutinous varieties with incidental changes in diets, is indicated from the, now export oriented Chiang Mai valley, which in 1974 grew glutinous varieties on more than 80 percent of the rice area.[47] Genetic modification of non-glutinous varieties led to their yield capacities exceeding those of glutinous varieties, thereby ensuring their commercial dominance.

Variations in photoperiodicity,[48] photosynthetic and temperature responses, water regime requirements, grain production characteristics, suitability for harvest, and a range of other factors were considered in breeding new non-glutinous varieties. These produced the high-yielding varieties of the Green Revolution emanating from programs of the International Rice Research Institute.[49] Their development caused the apparent cyclical movement between broadcasting and transplanting techniques in Thailand's delta region. With the advent of rice mono-culture in the delta, the preferred transplanting of rice seedlings shifted to broadcasting, to cover the larger areas available.[50] Progressive intensification of rice production with the advent of high yielding varieties favoured re-introduction of seedling transplantation to allow double cropping and efficient water management. The less labour intensive broadcast sowing required growing periods of up to nine months.[51] By the 1970s, 80 percent of the rice area was transplanted.[52]

[46] Golomb, L. (1972)
[47] Tanabe, S. (1994a)
[48] Tanaka, A. et al (1966)
[49] IRRI, (1995)
[50] Tanabe, S. (1978)
[51] Kulthong Kham, S. et al (1964)
[52] Donner, W. (1978)

Rice Breeding

Thousands of rice varieties chosen over millennia were once cultivated from India across southern China and through Southeast Asia when communities remained relatively separated. With migration, knowledge of varietal suitabilities to sites led to sharing of genetic material such that as recently as the eighteenth century some 300 varieties were in use in the Red River delta region of Vietnam.[53] By 1991, such traditional varieties represent only about two percent of the planted area in Thailand and projected reductions in subsistence farmer numbers would exacerbate the trend of genetic uniformity.[54] Modern rice breeding in Thailand began around 1907 at the Thanyaburi research station; production of longer grains to suit the domestic market led to some notoriety at the 1933 World Grain Exhibition Conference in Canada. However, until the 1950s, rice yields remained low, averaging 250 kilogram per rai (1.6 ton per hectare). Foreign and Thai breeders of the 1950s used pure line breeding until hybridisation was introduced from India, although this work was soon overshadowed by the IR8 variety developed through the International Rice Research Institute.

Discerning Thai palates deemed IR8 as poor, causing its slow acceptance until it was crossed with a native variety, *Luang Thong*, to produce two palatable photoperiod-insensitive varieties. Further, glutinous and non-glutinous varieties were developed through the Thai Rice Research Institute for major rice production environments and dry season cropping. By the 1990s, 27 lowland rice varieties were being recommended, nine of which had been produced through hybridisation, three through mutation breeding and 15 through pure line selection, with 19 being non-glutinous varieties and 21 being photoperiod insensitive. Five floating rice and three upland rice varieties were also produced, of which four were pure line selections for floating rice, three were non-glutinous varieties, and all were photoperiod insensitive, as was the single hybridisation produced variety of floating rice. Upland rice selections were based on pure lines, two of which were non-glutinous and all photoperiod insensitive. High demand rices such as Basmati were also imported from India and Pakistan.[55]

[53] Steinberg, D. J. (1987)
[54] Choice, W. (1995)
[55] Setboonsarng, Suthad et al (1988)

Rice Husbandry

During the 1960s, the relative labour inputs (Table 8.4) for three Thai rice cultivation systems indicated that the high inputs of transplanting produced lower outputs than broadcasting, thereby confirming that transplanting was used for other reasons other than saving of labour. Broadcasting dominated from 1890 to 1935 when transplanting assuming importance. Shifting cultivation remained important throughout in some areas, although in major rice production areas was only of significance to the mid-nineteenth century.[56]

Table 8.4 *Labour: Harvest Output Comparisons for Rice Production Systems*[57]

System	Labour (days/ton)	Output	Output:Input
Shifting	245	2.5	9
Broadcast	301	6.2	20
Transplanting	430	5.4	12

The intensive work schedule for wet rice production follows the phases of:[58]

- pre-crop preparation of nursery beds, watering facilities, ploughing and harrowing equipment, cleaning of paddies, repair of bungs and purchase of inputs
- nursery tending under semi-flooded conditions with supplemental watering, weeding and culling[59]
- ploughing and harrowing of paddy fields with traditional animal-powered wooden ploughs or two- or four-wheeled tractors, puddling of the paddy in cases where buffalo are used for draught, harrowing with wooden or modern implements followed by levelling with a simple grader
- cleaning of the paddy field in situations where ploughing and harrowing has been shallow or hurried and remaining weeds necessitate hand weeding
- preparing seedlings for transplanting by hand pulling from the nursery, shaking off excess mud, and trimming shoots from their 60 - 70 centimetre to about 40

[56] Hanks, L.M. (1972)
[57] Hanks, L.M. (1972)
[58] Calavan, M.M. (1977)
[59] Watabe, T. (1967)

centimetre to facilitate transplanting, minimise evapotransporation, and to inhibit excessive tilling and vegetative production

- transplanting as a communal activity performed by hand planting rows while walking back to the next planting position to achieve an average spacing of about 15 - 30 centimetre with up to six plants per site
- weeding by hand or through herbicide spray once or twice within the first month, although in some cases not at all, to control aquatic species of *Cyperacia* and *Graminae*
- irrigation is largely determined by the projected release of dam waters which has formed the basis for scheduling other activities; with the arrival of water sufficient to flood the paddy, management is largely limited to maintenance of the flooded regime through pumping in marginal areas and weeding, and upon maturity, draining the paddy and allowing rice to dry
- harvesting of mature plants by grasping the tops of several together, cutting the stalks about 25 - 30 centimetre above ground level with a short, curved sickle and laying cut stalks to dry in the sun for two to three days, except in the South where a small curved knife is used to harvest only the head of the rice plant
- threshing of bundles of dried rice stalks either by hand using a bamboo or wooden and rope tool to hold bundles which are beaten against the inside of the *khu* harvest basket, or by utilisation of small motorised threshing machines
- storing of threshed rice in farm storage bins possibly after further drying, or bagging for sale to rice mills.

The relationship between rice production and area has been reasonably stable, notwithstanding an increase in double cropping with the development of irrigation facilities in the past three to four decades.[60] The expansion of planted area over the period 1988 - 1997 (Table 8.5) by some 10 percent was associated with a production increase of approximately 22 percent as a result of a yield increase of 20 percent which, with an increase in farm price of 44 percent led to an increase in farm value of 70 percent, reflecting some redress of low returns in rural areas during the previous decade.

[60] Office of Agricultural Economics (1998)

Table 8.5 *Total (First and Second Crop) Rice Area, Production, Yield, Farm price and Value, 1988 - 1997*[61]

Crop Year	**Planted area** '000 rai	**Production** '000 ton	**Yield** kg/rai	**Farm Price** baht/ton	**Farm Value** million baht
1988	58,888	18,428	322	3,946	70,874
1989	64,677	21,263	343	3,980	84,626
1990	64,439	20,601	334	3,629	74,761
1991	61,910	17,193	313	3,608	62,032
1992	59,671	20,400	361	3,808	77,683
1993	60,453	19,917	348	3,286	65,447
1994	59,251	18,447	348	3,727	68,752
1995	60,677	21,111	376	3,857	81,425
1996	63,353	22,016	387	4,764	104,884
1997	63,728	22,332	386	5,522	123,317

Variations in rice yields with rainfall and temperature have been made manageable with irrigation in many areas, although irrigation water availability, competitive water regimes for other crops, and drought in rainfed and partially irrigated rice areas continue to affect production. A critical period remains that of the early wet season when rice is planted before monsoon rains replace intermittent thunderstorms.[62] Reliable access to water will determine the future of Thai rice and allow application of known technologies which can increase yields by two to four times current levels. This may well occur regardless of government intent as tradition continues to give way to commerce. Commercial production has already impacted on the disadvantaged Northeast where it was not predicted, as indicated by a relationship between rice plantings and price,[63] which would not be expected if the traditional glutinous varieties were the majority crop.

Notwithstanding the substitution of other crops for rice, whether as a result of farmer initiatives, government diversification policies, declines in domestic rice consumption, or depressed global prices, rice will remain critical to Thai agriculture. Large infrastructral investments, including irrigation systems, are more suited to rice than other crops and have decades of service left at marginal cost. Global demand for cereals remains high. The Thai environment and culture continue

[61] Office of Agricultural Economics (1998)
[62] Tartasarthy, N. (1971)
[63] Rogers, K.D. and Itharattana, Prasit (1982)

to favour rice production above other crops, and current production systems allow scope for large yield increases and possibly sustainable innovations as a benefit of relatively low current yields. Unrealised potential to patent research outcomes in rice production and high value processing could consolidate Thailand's historical leadership in international rice production, although ownership of such genetic material may have already left Thailand.[64]

Maize

Introduced more than four hundred years ago by Portuguese traders, the suitability of maize to the Thai agricultural environment led to widespread planting as a minor domestic industry. Introduction in the 1920s of flint and dent varieties suitable for poultry feeding by Prince Sitiporn Krisdakorn[65] provided a fillip until, after World War II, maize rapidly became an export crop;[66] domestically consumed maize was thenceforth treated as a miscellaneous vegetable despite rising use as a livestock feed.[67] Now Thailand's third largest export income earning crop after rice and rubber, maize has shared Green Revolution advances including Thai-based breeding successes. Thailand ranks as about the sixteenth largest producer of maize in world terms (Table 8.6).[68]

Table 8.6 *Selected Maize Areas, Production and Yields, 1991 - 1995*[69]

Country	**Production** '000 rai					**Area** '000 rai	**Yield** kg/rai
	1991	**1992**	**1993**	**1994**	**1995**	**1995**	**1995**
World Total	**478,414**	**520,968**	**465,585**	**566,698**	**508,100**	**835,572**	**608**
Asia	**131,187**	**131,346**	**136,628**	**134,249**	**148,982**	**254,940**	**584**
China	99,094	95,722	103,050	99,622	112,331	142,819	787
India	7,983	10,202	9,480	9,490	9,800	37,500	261
Indonesia	6,256	7,995	6,460	6,869	8,223	22,794	361
Philippines	4,655	4,559	4,798	4,519	4,161	16,888	246
Thailand	*3,793*	*3,672*	*3,328*	*3,965*	*4,154*	*7,896*	*526*

[64] Rerkasem, Benjawan. (1999)
[65] Paopongsakorn, Nipon (1995)
[66] SEARCA (1975)
[67] Ministry of Agriculture (1950)
[68] FAO (1995a)
[69] Office of Agricultural Economics (1998)

Maize production expanded at an average of 22 percent per annum from the 1950s to the early 1970s[70] as part of a rise from pre-World War II annual production of 5,000 ton to more than one million ton by 1965. Together with USA assistance, government programs in the Northeast built on the apparent suitability of its relatively drier climate for maize production.[71] Successful expansion occurred in the Northeast in conjunction with a second promoted crop, kenaf,[72] although subsequently maize expanded rapidly beyond the Northeast while kenaf did not. Statistical shifts in maize production from the Northeast to the Central region are confounded by some southern Northeast provinces where maize is grown being re-categorised as Central, with the result that only one Northeast province was shown as a major maize producer in 1971; hence maize production is considered highest in the Central region.[73] These northern Central provinces are more accessible to the Bangkok port, and were some of the last frontier areas which once separated the Northeast plateau from the Central Plain. Their high fertility and reasonably reliable rainfall also met criteria for larger farm sizes.

Domestic consumption of maize as seed and livestock feed increased annually by 14 percent through the late 1960s as livestock feedmills and agribusiness expansion began, continuing through the 1970s. Some 2.3 million ton was exported in 1974 in a stable price environment as Japan, in particular, enhanced its own lifestyle through feedlot and other animal product consumption.[74] As a newly expanded crop, maize escaped the historic premiums, price policies, and monopolistic trading of rice, and was consequently served by Chinese-Thai middlemen provision of credit, technical advice, collection, and marketing. Middlemen developed storage, shelling, drying, cleaning, and fumigation facilities to consolidate maize for transport to ports.[75] Japan remained a most important market until the early 1970s with Japan, Taiwan, Hong Kong, Singapore, and Malaysia taking 90 percent of Thailand's exports; Taiwan became the principal market in 1974 accounting for 20 percent of the exports.

[70] Onchan, Tongroj et al (1975)
[71] Brown, L.R. (1963)
[72] World Bank (1959c)
[73] Gajewski, P. (1965)
[74] Silcock, T.H. (1970)
[75] Onchan, Tongroj et al (1975)

Despite statistical inaccuracies,[76] maize production for export overshadowed increases in production of sweet corn for domestic consumption. Sweet corn varieties, particularly baby sweet corn, increased through the 1980s for the export oriented canning industry. The areas, production, yields, farm price and value for maize over the decade 1987 to 1997 are presented in Table 8.7. Through this period, the area planted has varied between years showing an overall decline, while yield and price have tended upwards, with the consequence that farm value has risen by an average of almost 12 percent per annum. In regional terms, the North followed by the Northeast, represent the current major areas of planting with production being greatest from the North and the Central Plain, thereby reflecting the lower average yields of the Northeast; for example, in 1996 - 1997, the Northeast averaged 482 kg per rai compared to 608 kg per rai for the Central Plains and a national average of 552 kg per rai.[77]

Table 8.7 *Maize: Area, Production, Yield and Farm Price and Value, 1997 - 1996*[78]

Crop Year	**Area** '000 rai	**Production** '000 ton	**Yield** kg/rai	**Farm Price** baht/kg	**Farm Value** million baht
1987/88	10,941	2,781	328	2.52	7,008
1988/89	11,471	4,675	419	2.62	12,248
1989/90	11,166	4,393	411	2.92	12,827
1990/91	10,910	3,722	385	2.44	9,081
1991/92	9,219	3,793	434	2.75	10,430
1992/93	9,446	3,672	475	2.72	9,987
1993/94	8,370	3,328	437	2.81	9,351
1994/95	8,829	3,965	470	2.92	11,577
1995/96	8,346	4,155	526	4.05	16,827
1996/97	8,665	4,533	552	3.93	17,814

Rapid expansion of the maize industry was due to: malaria control; transportation improvements; Japanese market expansion; externalities of the rice export tax; low population to land ratios; Guatemala varieties and associated breeding; local adaptive research, and trade policy and agreements.[79]

[76] Silcock, T.H. (1970)
[77] Office of Agricultural Economics (1998)
[78] Office of Agricultural Economics (1998)
[79] Onchan, Tongroj et al (1975)

The malaria control program of the 1950s allowed penetration of hitherto uninhabitable upland areas for logging and agricultural expansion.[80] At the same time, assistance from the USA to build highways through the Northeast to Bangkok facilitated movement of agricultural inputs and product.[81] Farmers responded by planting maize rather than rice as a cash crop in rainfed areas, as they avoided the substantial government tax on rice.

Pre-Green Revolution maize varieties suited Thailand. Subsequent Green Revolution research introduced the Guatemala variety[82] which local adaptive research improved.[83] Otherwise known as cultivar C-110 Tiquisati Yellow Flint, the Guatemala variety was subject to broadly based mass selection for quantity and quality in a national Thai breeding program, and with subsequent refining, emerged in 1969 as a Thai variety known as Praputthabat Number 5. Useful until infestations by downy mildew (Peronosclerospora sorghi) demonstrated the superiority of another cultivar being developed at the same time, Praputthabat, on which more than 95 percent of exported corn had relied in the early 1960s,[84] gave way to Suwan 1.[85] The Rockefeller Foundation-assisted research also demonstrated the benefits of ongoing agricultural research in a manner uncommon in Thai agricultural support services. It was extended beyond breeding to agronomic practices, in particular time and method of planting, seed bed preparation, and weed control practice. Consolidation of the research program led to The National Corn and Sorghum Research and Training Program being initiated in 1965 as a joint activity of Kasetsart University, the Ministry of Agriculture, the United States Overseas Mission, and the Rockefeller Foundation.[86]

Export agreements for maize aimed to secure markets and prices from 1959, although inability to deliver contracted production in short-fall years and opportunistic seeking of higher priced markets in surplus years, voided contracts. Government re-licensing of exporters led to annual government to government

[80] Behrman, J.R. (1968)
[81] Chaiyong, Chuchart et al (1962)
[82] Silcock, T.H. (1970)
[83] Wagner, M.M. (1969)
[84] Breitenback, C.A. (1964)
[85] Poapongsakorn, Nipon (1995)
[86] SEARCA (1975)

agreements with Japan from 1966[87] with similar agreements being made subsequently with Taiwan.[88] Government issuance of several licences with small export quotas led to high costs per exported ton,[89] which entrepreneurial pooling of export licenses by Chinese-Thai traders overcame. By the mid-1970s, optimistic assumptions by planners of continued maize expansion would have required increased research allocations and an unprecedented level of cross-departmental coordination. In the event, yield targets were not met; an unsurprising outcome to scientists observing the declining fertility of the newly cleared soils under the high nutrient demands of maize.[90] Hence, maize area has contracted from more than 11 million rai to something around 8 million rai in the most recent ten years.[91] For 1999, Thai maize exports were 68,381 ton against imports of 120,675 ton.[92]

Environmental concerns from the 1970s noted the changing ecology of upland areas, bio-diversity loss with widespread clearing, rapid soil fertility decline, and rapid depletion of soil organic matter, and linked these to declining yields which led to an unintended outcome of further clearing of virgin forest. Rotational planting of a legume crop to contribute some nitrogen for a subsequent maize crop[93] has been adopted in some areas, although the higher environmental cost approach of high nitrogen fertilisers inputs has become the norm.

Mung Bean

Mung bean area expanded rapidly through the late 1950s to the 1970s finding ready market outlets as bean sprouts, gelatin, and vermicelli. By the 1970s, around 70 percent of the four upper Central provinces were planted with mung bean while in the Northeast, its early introduction was soon supplanted by the more suitable kenaf.[94] Approximately two-thirds of the expansion of the crop occurred in Nakhon Sawan Province in association with transport improvements and immigration.[95] The rapid adoption of the crop indicates the advantage of

---

[87]Houck, J. (1972)
[88] Tongpan, Sopein (1971)
[89] Fedderson, P. (1972)
[90] Sato, T. (1966)
[91] Office of Agricultural Economics (1998)
[92] Customs Department figures
[93] Donner, W. (1978)
[94] Donner, W. (1978)
[95] Silcock, T.H. (1970)

mung bean in two ways; it received no specific government promotion, and there was no recorded decrease in yield with expansion into new areas.

Early figures concerning mung bean production in Thailand are confused by their categorisation as peas. It would appear that in 1950 there was approximately 256,000 rai (41,000 hectare) producing some 32,000 ton, which by 1960 had risen to 325,000 rai (52,000 hectare) and 60,000 ton, and by 1970 to 1.5 million rai (240,000 hectare) and nearly 150,000 ton. Yields have been generally highest in the North and lowest in the South.[96]

Table 8.8 *Dry Bean Areas, Production and Yield in 1995*[97]

Country	Area '000 rai					Production '000 ton	Yield kg/rai
	1991	**1992**	**1993**	**1994**	**1995**	**1995**	**1995**
World Total	**165,130**	**153,657**	**156,248**	**169,219**	**169,736**	**17,851**	**105**
Asia	**84,012**	**81,312**	**87,503**	**88,406**	**90,305**	**8,377**	**93**
India	60,269	57,825	61,500	61,500	61,500	4,140	57
China	8,800	7,544	8,788	8,788	8,788	1,811	206
Myanmar	3,313	4,656	6,281	7,600	9,013	966	107
Indonesia	2,250	2,500	2,438	1,825	2,144	308	144
Thailand	*2,610*	*2,189*	*1,966*	*2,094*	*2,080*	*234*	*113*
Turkey	1,113	1,044	1,013	1,019	1,094	225	206
Iran	969	988	706	681	688	150	218

Thailand produces less than two percent of the world's dry bean product and nearly three percent of that produced in Asia, which represents nearly 50 percent of world production (Table 8.8). Areas of production indicate a marginal rise followed by a general decline over the period 1987 - 1996 which is reflected in production levels as yields have remained relatively static. The North represents some 78 percent of the planted area in recent years, some 80 percent of production with an average yield of the prior four years of 118 kg per rai compared to 113 kg for the Central plain, 104 kg for the Northeast, and 97 kg for the South.[98] Areas, yields, and values for mung bean from 1988 to 1997 are presented in Table 8.9.

[96] Donner, W. (1978)
[97] FAO (1995b)
[98] Office of Agricultural Economics (1998)

Table 8.9 *Mung Bean Area, Yield, Farm Price and Value, 1988 - 1997*[99]

Crop Year	Area '000 rai	Production '000 ton	Yield kg/rai	Farm Price baht/kg	Farm Value million baht
1988	2,900	267	98	8.41	2,245.5
1989	2,964	333	115	8.67	2,887.1
1990	3,205	356	115	6.24	2,221.4
1991	2,808	303	113	6.70	2,030.1
1992	2.754	304	117	10.90	3,313.6
1993	2,404	261	119	9.23	2,409.0
1994	2,147	231	118	9.44	2,180.6
1995	2,267	256	122	9.72	2,488.3
1996	2,197	234	113	11.88	2,780.0
1997	1,978	218	115	11.62	2,533.2

Cassava

Thailand's uniquely low human consumption sets it apart from other major cassava producers; even in otherwise similar Indonesia it forms a component of upland diets.[100] Thailand's cassava is mainly destined for animal feeds, starch,

Table 8.10 *Cassava Areas, Production and Yields in 1995*[101]

Country	1995		
	Area '000 rai	Production '000 ton	Yield kg/rai
World Total	**101,183**	**161,830**	**1,599**
Asia	**22,389**	**46,411**	**2,073**
Thailand	*7,782*	*16,217*	*2,084*
Indonesia	7,913	15,438	1,951
India	1,594	6,000	3,764
China	1,438	3,501	2,435
Vietnam	1,756	2,497	1,422
Philippines	1,344	1,870	1,391
Malaysia	263	440	1,673
Africa	61,750	82,776	1,341

[99] Office of Agricultural Economics (1998)
[100] Falcon, W.P., Jones, W.O., and Pearson, S.R. (1984)
[101] FAO (1995a)

and other food components. Ranking first among Asian countries and around equal third largest producer with Zaire, behind Brazil and Nigeria (Table 8.10), Thailand's benefits from this crop are linked to; the past three decades' export orientation policies, upland crop expansion, environmental degradation, and rural poverty.

First introduced to Asia by the Portuguese, cassava was adopted in Indonesia prior to its introduction through Singapore to Thailand around 1845.[102] Initially used as a dessert, the 1955 introduction of a starchy variety from Malaysia by Chinese expanded production marginally through intercropping with rubber.[103] Its first expansion appears to have been in Chonburi Province which has the only recorded planting in the immediate post-World War II years, possibly as a outcome of wartime industrialisation. Introduction of a different variety to the Pimai District of Nakorn Rachasima Province in 1961 led to rapidly adoption in all provinces of the Northeast.[104] Areas of planting in 1956 were recorded as 245,000 rai and in 1965 as 637,000 rai.[105]

The introduction of the *Manihot esculenta* bitter variety, transformed upland Thailand. Initially the industry was based on the export of dried cassava chips until the late 1960s when pelletising was introduced.[106] The EEC proved a reliable market where domestic corn was maintained at a price 40 percent higher than that of the imported cassava,[107] so Thai production areas reflected negotiated EEC import quotas. The ability of cassava to continue to produce a harvestable yield under conditions of low soil fertility and variable rainfall was complemented by its ease of planting into new areas, flexibility in harvest time, ready marketability, low requirements for management, and associated credit and advance purchase schemes through local middlemen. Never officially promoted by government,[108] it has times been the subject of attempts at reducing planted areas to minimise environmental degradation.

---

[102] Poapongsakorn, Nipon (1995)
[103] McFadyean, A. (1944)
[104] Poapongsakorn, Nipon (1995)
[105] Ministry of Agriculture (1958) and (1965)
[106] Donner, W. (1978)
[107] Ajanant, Juanjai et al (1987)
[108] Silcock, T.H. (1970)

The efficient nutrient extracting capabilities of cassava allow its use on areas depleted by other crops, with the result that cassava is sometimes mistakenly assumed to have caused the major degradation. On most upland soils of the Northeast, three consecutive crops of cassava are said to preclude any other crop being grown without fertiliser and organic matter inputs. Thailand's comparative advantage in transportation to ports and the EEC to gain a three-fold price advantage over other cassava producing countries[119] highlights a need for balanced agricultural development, such as applying windfall profits from this market to development of sustainable farming systems in poverty areas[110] where cassava is the main crop.

Cassava areas, production, yield and farm price and value over the past decade are presented in Table 8.11. A general decline in area planted and production is evident while yields have remained relatively constant and farm prices and value have varied according to export market contracts. The major region of planting has remained the Northeast with some 4.7 million rai in 1997 representing 60 percent of the total area, with some 25 percent in the Central Plains and 15 percent in the North; production follows similar proportions of 58, 19, and 12 respectively.

Table 8.11 *Cassava Area, Production, Yield, Farm Price and Value 1998 - 1997*[111]

Year	**Area** '000 rai	**Production** '000 ton	**Yield** kg/rai	**Farm Value** baht/kg	**Farm Price** million baht
1988	9,668	22,307	2,307	0.60	13,384
1989	9,957	24,264	2,437	0.54	13,102
1990	9,297	20,701	2,227	0.64	13,248
1991	8,960	19,705	2,199	0.83	16,355
1992	9,066	20,356	2,245	0.77	15,674
1993	8,998	20,203	2,248	0.66	13,334
1994	8,642	19,091	2,209	0.58	11,072
1995	7,782	16,217	2,084	1.15	18,649
1996	7,676	17,388	2,265	0.98	17,040
1997	7,690	18,084	2,352	0.71	12,389

[109] Siamwalla, Ammar (1991)
[110] Kaosaard, Mingsarn and Rerkasem, Benjawan (1999)
[111] Office of Agricultural Economics (1998)

Sugar

A traditional crop of Thailand, sugar cane production and sugar manufacture have enjoyed periods of great confidence, foreign investment, government protection, and oligopoly. Notwithstanding such influence, the industry remains one which has failed to fulfil its potential. Against the very large world producers of Brazil and India which can produce more than 300,000 and 250,000 ton per year respectively, Thailand ranks as a medium level producer of something more than 50,000 ton per year at the present time, behind China.[112] Table 8.12 presents 1995 world areas, production, and yield for sugar.

***Table 8.12** Sugar Cane Areas, Production and Yields for 1995/96*[112]

Country	Area 000 rai	Production '000 ton	Yield kg/rai
World Total	**114,869**	**1,155,370**	**10,058**
Asia	**51,725**	**518,082**	**10,016**
India	23,438	259,490	11,071
China	7,425	70,924	9,552
Thailand	*6,156*	*57,974*	*9,417*
Pakistan	6,306	47,168	7,480
Indonesia	2,531	30,272	11,960
Philippines	2,406	25,700	10,682
Vietnam	1,031	8,200	7,953

Sugar cane production expanded rapidly during the nineteenth century, particularly after Bowring predicted that it would become the major export of the country, stimulating successive investments which failed to yield to expectations. The 1867 formation of the Indo-Siam Sugar Company with a 625,000 rai (10,000 hectare) concession never met expected yields of cane or crystalline sugar.[113] Some thirty other registered factories of that time, each employing between 200 and 300 persons,[114] as well as larger ventures, suffered when floods ruined new sugar cane areas rendering growers unable to repay advances. The introduction of steam

[112] FAO (1995a)
[113] Thomson, V. (1967)
[114] Ingram, J.C. (1971)

ploughs to open up new lands more cost effectively than manual labour, experienced a similar fate[115]. Statistics from this period until the immediate post-World War II period are unreliable.[116]

By 1950, the industry had evolved into one with fifteen private and two government sugar factories which was to rise to a total of 48 by 1960, falling subsequently to 31 by 1970. Expansion and contraction associated with speculation and poor policies marked the industry; cane areas were some 337,500 rai (54,000 hectare) in 1950, one million rai (160,000 hectare) in 1960 and some 1.3 million rai (205,000 hectare) by 1970. From 1950 to 1970 production rose from 839,000 ton to 6.6 million ton and export increased from 3,750 ton to 168,000 ton. The combination of protection, periodic inefficiencies in management, and reliance on outdated grower-factory relationships has enabled the industry to make Thailand self-sufficient in sugar with exports, subsidized by growers, a modest achievement.

Sugar was an import to Thailand until the 1960s when exports began with government aid and expansion to an industry four times larger than it might otherwise have been.[117] A ban on imports and imposition of a levy on internationally traded sugar fostered exports[118] and produced a short-lived boom until international sugar prices fell.[119] Unregulated monopolistic behaviour allowed periodic exploitation of cane growers. From the mid-1960s, a geographical rationalisation of the industry occurred with the use of introduced cane varieties, some from Taiwan, increased efficiency of sugar extraction through improved delivery and receiving processes, and improved production through agronomic practices such as ratoon management and fertiliser application.[120] A shift away from the traditional centre of Chonburi is attributed to the greater productivity possible from the central plain provinces of Ratchaburi, Kanchanaburi, and Prachuap Khiri Kan.[121] It may also have been associated with land control and lobby.

115 Donner, W. (1978)
116 Gajewski, P. (1965)
117 Siamwalla, Ammar and Setboonsarng, Suthad (1989)
118 Corden, W.M. (1967)
119 Silcock, T.H. (1970)
120 Ministry of Agriculture (1961)
121 Wu, H.S. (1967)

Areas, production, yield, and farm price and value for sugar cane over the recent decade are presented in Table 8.13. A 72 percent increase in planted area has produced a 107 percent increase in cane from a 21 percent increase in yield which, with a 25 percent increase in the price paid per ton, has increased the farm value of sugar cane by some 159 percent over the period 1988 - 1997. The main production areas have been the Central Plain with 44 percent of the area and 45 percent of production, and the Northeast with 32 percent of the area and 30 percent of production.[122]

Table 8.13 *Sugar cane: Area, Production, and Farm Value, 1988 - 1997*[123]

Crop Year	Area '000 rai	Production '000 ton	Yield kg/rai	Farm Price baht/kg	Farm Value million baht
1988	3,664	27,191	7,624	328	8,918
1989	4133	36,668	8,896	331	12,137
1990	4,298	33,561	7,823	402	13,491
1991	4,929	40,661	8,314	460	18,704
1992	5,791	47,480	8,288	336	15,953
1993	6,267	39,827	6,426	359	14,297
1994	5,355	37,823	7,569	468	17,701
1995	5,887	50,597	8,774	435	22,009
1996	6,279	57,974	9,417	386	22,378
1997	6,314	56,394	9,205	410	23,121

The extraction of sugar from the palmyra and coconut palm trees continued throughout the rises and falls of the commercial cane sugar industry, supplying local consumption in specialist and village markets.[124]

Coconut

Distinct from sugar cane, maize, and cassava, coconut is a traditional part of the Thai diet. Tending of coconut palms, albeit a minor management task, was part of the agricultural occupation of Thai farmers across the whole country until the nineteenth century attack of the black beetle (*Oryctes rhinoceros*) and red

[122] Office of Agricultural Economics (1998)
[123] Office of Agricultural Economics (1998)
[124] Donner, W. (1978)

weevil (*Thynochophora*) which effectively eliminated intensive coconut production from the Northeast and Central Plains. The preeminence of southern Thailand has continued even with the introduction of new varieties and technologies to all regions of Thailand. In 1963, 44 percent of the some 34 million coconut trees were said to be in the South, a figure which fell to 41 percent in 1967 when the South produced 51 percent of the country's production.[125] For the period 1950 - 1970, the area planted to coconuts quadrupled, the number of trees increased by 3.5 times with the consequence that statistics for the bearing trees and production per bearing tree fell, reflecting the higher proportion of young stands.

Coconut production in Thailand failed to develop as a major export industry during the colonial period while its neighbours benefited from these markets. Thai production through the 1960s was estimated to be similar to that of Malaysia which exported seven times as much copra; from such observations came the conclusion that the Thai diet contains a higher proportion of coconut than similarly populated peer producers, thereby precluding large scale export of some coconut products.[126] Until recent decades, about half of the fat component of the Thai diet may have derived from coconuts, representing an annual consumption of around 18 coconuts per person.[127] Sweet juice continues to be extracted from the unopened coconut flower into a bamboo tube to produce fresh coconut sugar and illicit toddy.

Products of the coconut palm include: oil from the endocarp traditionally used for cooking and lighting and, in recent decades, for soap making, margarine and lubricants; the husk or pericarp which, after soaking in water for 15 to 20 days, can be made into mats, brushes, matting, mattresses, and coarse ropes; and commercial copra which is the coconut oil derived from large kernels. Thai copra of the 1960s yielded around 66 percent oil. In Thailand, coir mattress fibre and rope were produced by two factories with a capacity of around 3,000 ton per year during the 1960s.[128] Indicative export figures for 1955 reveal export incomes of some 28,000, 541,000, and 8,800,000 baht for nuts, copra, and copra cakes respectively.[129]

[125] Donner, W. (1978)
[126] Anonymous (1971)
[127] Donner, W. (1978)
[128] Donner, W. (1978)
[129] Ministry of Agriculture (1961)

With the introduction of early maturing small and dwarf varieties, lower harvesting labour requirements and higher production, paved the way to a commercial industry for copra production, supported by research into the control of insect pests. The utility of coconut palms in stabilising and reclaiming low lying areas, even adjacent to the sea, has allowed a, sometimes temporary, increase in planting. The areas, production, yield, and farm prices and value for coconuts for the years 1987 - 1996 are presented in Table 8.14.

Table 8.14 *Coconut Areas, Production, Yields, Farm Price and Value, 1987 - 1996*[130]

Year	**Planted Area** '000 rai	**Production** '000 ton	**Yield** kg/rai	**Farm Price** baht/ton	**Farm Value** million baht
1987	2,545	1,311	632	2,072	2,715
1988	2,490	1,378	654	2,736	3,769
1989	2,481	1,437	656	1,816	2,608
1990	2,455	1,426	659	1,968	2,807
1991	2,432	1,379	655	2,600	3,584
1992	2,427	1,411	671	2,704	3,815
1993	2,384	1,435	678	2,704	3,880
1994	2,362	1,413	678	2,208	3,119
1995	2,351	1,419	680	3,312	4,699

Rubber

Thailand is the world's largest producer and exporter of natural rubber (Table 8.15). Unlike rice, it is an industrial crop and has developed from private initiatives in the first instance followed by coordinated government responses and skilful international negotiation involving both government and the private sector.

[130] Office of Agricultural Economics (1998)

Table 8.15 *Major Rubber Producing and Exporting Countries (ton)* [131]

	Production	Exports
World	**6,696,771**	n.a.
China	451,970	321
India	542,000	1,673
Indonesia	1,586,744	21,352
Malaysia	971,100	119,600
Philippines	197,160	n.a.
Sri Lanka	105,783	107
Thailand	*2,168,720*	*231,035*
Vietnam	186,500	n.a.

Rubber is said to have first been introduced to the southern province of Trang in 1901 by the Chinese-Thai nobleman Kaw Sin Bee na Ranong[132] and developed into an industry around 1918.[133] This probably reflects Chinese planters from Malayasia producing rubber in Thailand to circumvent the Stevenson restriction scheme, and as part of a general Chinese expansion out of Malaysia. Under the protection of the King Chulalongkorn,[134] Chinese-Thai entrepreneurs created an industry in provinces contiguous with Malaysia and populated by Malay speaking persons, possibly reflecting familiarity in working with these communities. From the 1930s, the majority of growers were Malay speakers and traders were Chinese speakers with local control over the industry which was interpreted periodically as illegal land tenure and corrupt exemption from export payments. These entrepreneurial Chinese agriculturists were well established by the 1950s when they were deemed squatters and forcibly ejected.[135]

In the early days, less famous than its colonially dominated neighbours, Thailand received a lower price as a result of poorer cultivation and management techniques. Although a member of the Second International Rubber Regulation Scheme, Thai production statistics are unreliable as a result of illegal plantings and lack of will to abide by the agreement. Cross-border smuggling allowed rubber

[131] FAO (1999)
[132] Ungphakorn, Puey and Yossundara, Suparb (1955)
[133] Thomson, V. (1967)
[134] Skinner, G.W. (1951)
[135] Silcock, T.H. (1970)

traders to maximise prices and Thailand found itself the beneficiary of tolerant producer partners who valued survival of the agreement above rejection of one, albeit expanding, producer. By 1935, Thailand had achieved permission to export more than 30,000 ton, four times its 1934 allowance.[136]

Over the period from 1910 to 1940, exports increased from some 13 ton to more than 44,000 ton. Prices varied widely with the over-supply which the international agreements sought to regulate. Planting associated with perceived high prices led to over-production approximately 12 years after such periods, which in the case of Thailand, tended to be followed by agreements to increase export quotas.

Before World War II, rubber planting in Thailand was less efficient than that in Malaysia which used European methods based on imported labour.[137] World War I created demand, which restrictions on export from British colonies amplified as an opportunity for large expansion of the Thai rubber industry. Through this time, Thailand's, simple production methods, surpassed the opportunistic bush planting of rubber trees of Indonesia and expansion, in conjunction with tin mining also through the Chinese-Thai community, financed the development of some important Thai banks. Further expansions in rubber planting during World War II and the Korean War produced surplus output about seven years later.[138]

The external environment then shifted with competition from synthetic rubbers[139] which necessitated a more intensive form of rubber production based on high yielding varieties, practical and effective use of bud-grafting, and improved agronomic management. Replanting schemes had been successfully devised and implemented in Malaysia,[140] although these were not adopted in Thailand until the late 1950s. The total area replanted to improve varieties over the period 1961 to 1965 was 166,000 rai of which some 51,000 was associated with cyclone relief for damaged plantations. Difficulties of accelerating replanting by government

[136] McFadyean, A. (1944)
[137] Rowe, J.W.F. (1936)
[138] Silcock, T.H. (1970)
[139] McHale, T.R. (1961)
[140] Fisk, E.K. (1967)

directive were the common ones of small-holder independence, risk-averse decision making, and rising distrust of government schemes. In any case, the scheme eventually gained momentum and Thailand introduced its own research capacity which followed the tentative path of development of the industry itself, before becoming a consistent contributor to expansion of the Thai rubber industry.

By 1960, the Thai rubber industry was characterised as being significantly different from other major producers with some 80 percent of planted acreage managed through small holdings of less than 50 rai and estates exceeding 250 rai representing less than 10 percent, and foreign ownership being virtually zero.[141] Thailand's improvement of the rubber industry relied heavily on obtaining bud wood and kernel seeds from Malaysia and the copying of techniques adopted or devised in Malaysia. Improvement of sheet smoking factories, development of small-holder-cooperative size hand-operated machinery, creation of a latex assessment laboratory, as well as the beginning of training for Thai rubber experts flowed from international assistance to the rubber industry from the 1950s.[142] By the late 1950s, the Ministry of Agriculture[143] had noted that rubber was assuming great importance to the Thai economy and contained the potential for great improvement in efficiency, production output, and price; it therefore appealed to the international community for continued foreign assistance through expertise and training.

By 1972, Thailand was the third largest rubber producer in the world behind Malaysia and Indonesia, contributing some 11 percent of world and 12 percent of Asian raw rubber production.[144] The production area had grown over the preceding decade by some 150 percent to more than 5.6 million rai (900,000 hectare).[145] Yields calculated for the period were less than 250 kilogram per hectare across multi-age stands; thus it was expected that yields would rise by the early 1970s to more than 275 kilogram per hectare, by 1975 to 325 kilogram per hectare, by 1980 to 400 kilogram per hectare, and by 1985 to 540 kilogram per hectare.[146]

[141] Ministry of Agriculture (1961)
[142] FAO (1954)
[143] Ministry of Agriculture (1961)
[144] FAO (1972a)
[145] Donner, W. (1978)
[146] Reed, M.E. et al (1971)

In fact, by 1987 the average national yield was 126 kilogram per rai (790 kilogram per hectare), a figure which rose to 223 kilogram per rai (1,400 kilogram per hectare) by 1996. The planted and tappable areas, production, yield, and farm price and value for rubber across the decade 1987 - 1996 are presented in Table 8.15. This indicates a continuing rise in planted area of about six percent over the decade and a rise in the tappable area of some 12 percent giving a rise in production of some 100 percent which, associated with a general rising farm price through the decade, led to an increase in farm value of 200 percent.

Table 8.15 *Rubber: Area, Production, Yield, Farm Price and Value, 1987 - 1996*[147]

Year	Planted '000 rai	Tappable '000 rai	Production '000 ton	Yield kg/rai	Farm Price baht/kg	Farm Value million baht
1987	10,800	8,449	1,061	126	18.30	19,416
1988	10,849	8,468	1,151	136	21.78	25,068
1989	10 ,899	8,541	1,310	153	17.66	23,134
1990	10,961	8,719	1,418	163	17.18	24,361
1991	11,022	8,824	1,500	170	16.26	24,390
1992	11,124	8,872	1,712	193	16.80	28,761
1993	11,213	9,067	1,811	200	16.00	28,976
1994	11,308	9,213	1,988	216	22.64	45,008
1995	11,376	9,348	2,061	221	31.13	64,158
1996	11,444	9,495	2,121	223	27.53	58,391

Thailand's departure from the two decade old International Natural Rubber Organisation in 1999, which caused its closure, indicates the critical position occupied by Thailand in world rubber production. From an unwelcome entrant to a colonial plantation dominated industry, Thailand developed a small-holder based industry which has received higher than predicated returns through skilful international negotiation. Forming a cartel with Malaysia, Thailand now seeks to raise rubber prices from their 30 year low to the benefit of producer small-holders, a difficult task in the face of global oversupply.[148]

[147] Office of Agricultural Economics (1998)
[148] FEE (1999)

Fibre, Extraction and Other Crops

Fibre crops including kenaf, jute, ramie, cotton, kapok and silk, have been, or are, of importance to Thailand. Crops of importance for oil or other product extraction include sesame, oil palm, castor bean, and opium, while other crops of importance include pepper, tobacco, and coffee.

Fibre Crops

Kenaf (*Hibiscus pungens*) is the most important fibre crop in Thailand, while remnant industries of jute, kapok, cotton, and to an extent ramie continue. Thailand ranks fourth behind India, Bangladesh, and China in jute and related products and yet is not a large producer. Global production figures for jute and jute-like fibres are presented in Table 8.16. Several other kinds of fibre yielding plants are also of continuing importance at householder level in rural villages.[149] While kenaf is inferior to jute for rope and sack production, the plant's suitability to the drier conditions of the Northeast has allowed the huge Thai rice export market to create a demand for kenaf gunny sacks in an example of building on Thailand's leadership in rice exports. The industry was associated with the upland cropping boom, a government desire for creating an agro-industrial industry for the Northeast, and the opportunity to utilise a new product after a failure of the Bangladesh jute crop.[150] The successful development of the kenaf industry with strategic protection

Table 8.16 *World Jute and Jute-like Fibre in 1995: Area, Production and Yield*[151]

Country	Harvested Area '000 rai	Production '000 ton	Yield kg/rai
World Total	**11,252**	**2,863**	**254**
Africa	131	16	122
NC & South America	195	34	342
Asia	10,926	2,813	257
India	5,569	1,527	274
Bangladesh	2,938	770	262
China	1,375	270	196
Thailand	*438*	*105*	*240*

149 Ministry of Agriculture (1961)
150 Silcock, T.H. (1970)
151 FAO (1995a)

associated with another huge industry was an opportunity not open to other fibres such as cotton and silk.

Initially mixed with jute to produce gunny sacks through the late 1940s and 1950s, kenaf became an export commodity itself by 1957 when 10,000 ton was exported. Expansion of planted area continued through the 1950s and 1960s to some 2.4 million rai with adoption through farmer word of mouth rather than government extension.[152] Export of jute rose from some 15 percent of production in 1950 to some 68 percent of production by 1970.

Produced with no or minimal fertiliser inputs, kenaf has joined cassava as a crop associated with environmental decline. In common with cassava, kenaf does not cause decline, but rather cultivation methods and poverty of producers creates a need to continue to produce meagre crops in order to survive in a cash economy. Kenaf is also polluting in its farm-level processing which relies on retting in ponds and natural water reservoirs for ten to twelve days to separate clean fibre for drying. The fouled black-coloured residual water is a conspicuous if localised form of agro-industrial pollution which is highlighted by the relative scarcity of dry-season water in kenaf production areas.[153] Research has eventually determined methods to utilise kenaf in paper manufacture and stimulated private investment, and government incentives, for a paper mill in the kenaf growing Northeast.

Over the decade 1988 - 1997, kenaf production showed a rapid decline (Table 8.17) associated with difficulties of production and the introduction of alternative crops. Against a 56 percent reduction in area, production has fallen only 37 percent because average yields have increased by some 39 percent. The majority (94 percent) of kenaf is produced in the Northeast with the balance produced in the Central region; Central yields of around 336 kg per rai in 1997 exceeded yields in the Northeast by 42 percent.

[152] Chaiyong, Chuchart (1961)
[153] Platenius, H. (1963)

Table 8.17 *Kenaf: Area, Production, Yield, Farm Price and Value, 1988 - 1997*[154]

Crop Year	Planted Area '000 rai	Production '000 ton	Yield kg/rai	Farm Price baht/kg	Farm Value million baht
1988	1,005	158	173	4.49	709.4
1989	810	157	199	4.63	726.9
1990	793	149	200	6.69	996.8
1991	799	157	207	4.39	689.2
1992	622	127	216	6.96	883.9
1993	598	126	220	6.12	771.1
1994	576	127	237	4.85	616.0
1995	511	116	247	5.66	656.6
1996	452	105	239	9.69	1,017.5
1997	437	99	240	7.88	780.1

Ramie (*Boehmerie nivea)* has been grown for centuries for its durable fish net fibres. Requiring well-drained soil, the agronomy of the crop has been determined through local knowledge as has its use of leaves, which contain around 25 percent protein, for poultry and other livestock feed, and as a green manure.[155] A labour intensive crop, with limited international demand, ramie production has continued to decline since the 1960s.

Kapok (*Bombax penteandra*), a ubiquitous sight in rural Thailand, continues to be used for its short unspinnable fibre and edible seed oil. Suitable for stuffing upholstery and bedding, the domestic association of the crop precluded it from statistical reporting until 1957 when production was of the order of 90,000 ton of fibre. Export in the 1960s reached 20,000 ton per year with the majority being sourced from the Northeast.[156] Production since 1988 has risen slightly from increased planting to produce a rising farm value for the crop. Table 8.18

Table 8.18 *Kapok: Area, Production, Yield and Farm Value, 1988 - 1997*[157]

Crop Year	Planted Area '000 rai	Production '000 ton	Yield kg/rai	Farm Price baht/kg	Farm Value million baht
1988	291	40	183	6.31	252.6
1992	317	37	171	9.18	340.5
1997	339	46	188	8.00	371.2

[154] Office of Agricultural Economics (1998)
[155] Ministry of Agriculture (1961)
[156] Donner, W. (1978)
[157] Office of Agricultural Economics (1998)

presents summary information for production and prices for kapok from 1998 - 1997.

Cotton (*Gossypiem aboreum*) has been a traditional domestic crop, and its weaving a traditional village industry, which declined substantially with imported cotton cloth from India beginning in the Ayutthaya period. By the 1920s, the industry was a mere remnant of its original extent.[158] After World War II, national attempts to develop a cotton industry ultimately failed through poor management of genetic material, diseases, and insect attack. The production area for cotton in the period 1915 to 1919 has been estimated at around 30,000 rai, which had declined to some 20,000 rai by the period 1930 - 1934.[159]

In 1938, a cotton variety introduced from Cambodia was found to be less hardy, although desirable in other ways, than the native short-staple Thai cotton, and field experiments were conducted at Sukhothai to adapt a line for Thailand.[160] Planted areas rose from some 231,000 rai (37,000 hectare) in 1950 to a peak in 1968 of more than 813,000 rai (130,000 hectare) in response to government restriction of imports,[161] although this had declined to around 194,000 rai (31,000 hectare) by 1970.[162] Cotton Bollworm and the American Army worm (*Heliothis armigera*) and the inability to quarantine production areas produced the decline; nevertheless, cotton has been considered an economic crop since 1961 as a result of its high demand within the country and the somewhat anomalous existence of a major cheap-labour based manufacturing industry for export.[163]

Technical research conducted through the 1980s[164] confirmed earlier enthusiasm,[165] and identified constraints related to shortage of seed material, inconsistency of fibre quality, and high costs of production.[166] However, low returns relegated the crop to poor soils and suggest that it may remain an orphan

[158] Credner, W. (1966)
[159] Silcock, T.H. (1970)
[160] Ministry of Agriculture (1961)
[161] Paopongsakorn, Nipon (1995)
[162] Donner, W. (1978)
[163] Evenson, J. P. (no date)
[164] Evenson, J.P. (1987)
[165] Ratanakomut, Konthip (1987)
[166] Bromsupha, Suttipun (1987)

crop with possible village level significance for the immediate future. The main production areas for cotton continue to be in the North (53 percent) and Central (32 percent) with no significant production in the South[167]. Production over the past decade indicates a tendency of decline in area and production and a general increase in yields(Table 8.19). Thailand is a extremely small world producer of cotton.

Table 8.19 *Cotton: Area, Production, Yield and Farm Value, 1988 - 1997*[168]

Crop Year	Planted Area '000 rai	Production '000 ton	Yield kg/rai	Farm Price baht/kg	Farm Value million baht
1988	412	74	187	12.53	927
1989	442	106	240	10.73	1.137
1990	399	86	218	14.25	1,225
1991	461	97	218	14.04	1,361
1992	621	129	210	10.96	1,413
1993	483	99	222	10.48	1,037
1994	328	67	216	12.15	814
1995	355	78	226	15.90	1,240
1996	363	81	235	15.05	1,219
1997	337	75	234	12.51	938

Sericulture, a romantic and centuries-old industry associated with village handicrafts and palaces, has been the subject of attempts at expansion from a 1902 Department[169] of Sericulture under Professor Toyama and eight other Japanese experts,[170] through to recent foreign aid initiatives. Small silk worms, small individual cocoon output, and traditional practices complement current practices employed in Thai village systems. Production facilities include reeling and threading to make natural silk cloth woven as an under-house village product which, in association with tourism and fashion industries, has developed into an export industry.[171] In 1997, parts of the silk industry produced total values of some 500 million baht from woven fabrics of silk and related products.[172]

[167] Office of Agricultural Economics (1998)
[168] Office of Agricultural Economics (1998)
[169] Brown, I. (1980)
[170] Thomson, V. (1967)
[171] Ministry of Agriculture (1961)
[172] Office of Agricultural Economics (1988)

Oil and Extraction Crops

Sesame has been grown at least since last century; the area in the period 1915 - 1919 was estimated to be 7,000 rai. This rose to more than 10,000 rai between 1925 - 1929, falling back to 7,000 rai in the period 1935 - 1939.[173] With the expansion of cropping areas, introduction of multiple cropping particularly in the North, and the development of oil extraction processing facilities, sesame expanded to become a significant export; some 332 ton of sesame seed oil valued at around 20 million baht was exported in 1997.[174] Areas, production, and prices have risen over the past decade producing a rise in farm value of more than 130 percent (Table 8.20).

Table 8.20 *Sesame seed: Area, Production, Yield and Farm Value 1988 - 1997*[175]

Crop Year	Planted Area '000 rai	Production '000 ton	Yield kg/rai	Farm Price baht/kg	Farm Value million baht
1988	283	27	96	9.26	252
1989	314	27	87	10.48	286
1980	331	28	83	14.95	410
1991	365	29	80	13.37	390
1992	385	32	83	11.08	354
1993	371	32	85	8.43	265
1994	377	33	87	8.95	293
1995	371	32	86	9.77	310
1996	381	34	88	18.00	603
1997	386	34	89	17.12	587

Producing some 2.3 million ton of palm oil in 1995,[176] Thailand ranks as the distant fourth highest producer behind Malaysia (60 million ton), Indonesia (27 million ton), Nigeria (10 million ton) and Brazil (4.6 million ton).[177] Grown only in the South, some 90 percent of production is consumed domestically as vegetable and palm oil. Each processing facility requires a production area of around 40,000 rai for efficient operation, which under extensive modern management conditions may be represented by as few as 10 farm managers. The suitability of plantation

[173] Silcock, T.H. (1970)
[174] Office of Agricultural Economics (1998)
[175] Office of Agricultural Economics (1998)
[176] Office of Agricultural Economics (1998)
[177] FAO (1995a)

management for the crop is demonstrated in the continuation and enhancement of past colonial-style systems in Malaysia, the leading producer. Potential to increase both palm oil production and oil palm plantings has stimulated government assistance to expand the industry. The principal provinces of production are Krabi, Surat Thani, Chumphon, and Satun. In a total planted area exceeding one million rai, yields have increased in each producing province, with the highest yields being obtained in the provinces of Krabi (2,674 kilogram per rai), Surat Thani, Ranong, Trang, and Satun.[178]

Castor bean plantings for castor oil have declined markedly from more than 260,000 rai to less than 70,000 rai over the period 1988 to 1997. With a decline in yields over the same time frame, the farm value of the crop has declined from 153 million baht in 1988 to 39 million baht in 1997.[179]

Opium, an extraction crop long important to Thailand, has not been fully accounted in national statistics. From Rama III's attempts to suppress trading, his successor sold the opium monopoly to Chinese traders for revenues to the three ministries of Finance, Interior and Foreign Affairs. King Chulalongkorn established a State monopoly in 1908 and price rises through the 1920s increased government revenues by 250 percent peaking in 1917 at 25 percent of government income. Restricted Indian supplies in the 1930s stimulated illegal trading in Thailand with government seizure of illegal opium prompting a suggestion that the Ministry of Finance purchase additional opium from Kengtung for trading. Rejecting this idea, the government introduced official opium poppy cultivation in Chiang Mai and Chiang Rai provinces and cancelled import licenses; by 1939 government opium receipts exceeded one million pounds,[180] while influential individuals' receipts were substantial and rising. World War II disruption in other opium producing areas widened opportunities for military leaders and other groups assisted by USA interests surrounding Vietnam. Declared illegal in 1957, entrenched opium interests belied government intent.[181] Foreign supported opium replacement projects of the 1970s and 1980s[182] showed technical crop and livestock alternatives which

[178] Office of Agricultural Economics (1998)
[179] Office of Agricultural Economics (1998)
[180] Thomson, V. (1967)
[181] Phongpaichit, Pasuk and Baker, C. (1997)
[182] Falvey, L. (1977b)

were finally made viable with road access and government service delivery, to produce the 1990s outcome of Thailand being a negligible producer of opium.

Other Crops

Pepper (*Piper nigrum linm.*), tobacco, coffee, and sorghum are of some importance in Thailand. Pepper expanded around the turn of the century in response to international trade. Planted areas averaged some 45,000 rai in 1912[183] declining by 1935 - 1939 to some 5,500 rai.[184] A mainly domestic crop, pepper was probably introduced from India some 2,000 years ago, and was an element of trade between Indonesia, China, and Europe from the twelfth century with Thailand contributing to that trade by the sixteenth century. Subsequent rapid decline in areas reflects global over-supply, and some diseases and pests uncontrollable until recent times. Continuing as a backyard species with a few vines per household,[185] production is concentrated in the high rainfall southeastern provinces of Chantaburi and Trad. Semi-intensive production involves application of manure, chemical fertilisers, and mulched and burnt pepper leaves on average planted areas of six rai with approximately 340 posts per rai, which produce fruit from year three to at least year fifteen. Late 1980s increases in global demand led to a trebling of planted Thai area from some 10,000 rai in 1986 to 32,000 rai in 1990 until rising labour costs and declining prices of the 1990s stimulated inter-planting with durian and other fruit trees and some abandonment of pepper plots. Current government programs aim to stimulate improved cultivation to increase production for domestic needs.[186]

Producing some 86,000 ton of coffee beans in 1995, Thailand is a minor producer.[187] The *Robusta* variety accounts for some 95 percent of the production area which is concentrated in the six southern provinces of Chumphon, producing more than 50 percent, Surat Thani, Ranong, Nakhon Si Thammarat, Krabi, and Phangnga.[188] Exporting 75 percent of production, Thailand makes up only about

[183] Ministry of Agriculture (1961)
[184] Silcock, T.H. (1970)
[185] Ministry of Agriculture (1961)
[186] Paopongsakorn, Nipon (1995)
[187] FAO (1995a)
[188] Office of Agricultural Economics (1992)

one percent of world-traded coffee. Increasingly interplanted with coconut, betel, mango, rambutan, durian, mangosteen, and other fruit trees at a density of some 120 coffee trees per rai, declining prices and rising harvesting costs have caused government to assist farmers to replace coffee with fruit trees and cattle pastures.[189] Coffee areas rose from 440,000 rai to 540,000 rai in 1991, subsequently declining to 440,000 rai, while yields showed a general increase from 138 kilogram per rai in 1988 to 198 kilograms per rai in 1997, leading to production peaking in 1995.[190]

Tobacco production has been relatively constant, until recent decades, covering some 60,000 rai in the period 1915 – 1919 and some 62,000 rai in 1935 - 1939. Production of Virginia tobacco from 1957 - 1965 ranged from 7,000 to 9,000 ton per year with local varieties bearing between 40,000 to 60,000 ton per year. Tobacco was purchased through a government monopoly and in more recent decades through a private and government oligopoly, although a significant proportion has always been traded privately, especially local varieties which were exempt from the monopoly.[191] Tobacco areas increased through the 1970s in response to foreign involvement and new markets, and have subsequently decreased from 135,000 rai in 1988 to 59,000 rai in 1997, with total production declining from 193,000 ton to 134,000 ton while yields rose from around 1,400 kilogram per rai to around 2,300 kilogram per rai.[192]

Sorghum, introduced as an alternative cereal crop to supply expanding livestock industries, relies on hybrid varieties supplied through multi-national agribusiness houses. About half of production occurs in the North followed by the Central region with some small production in the Northeast. Producing a globally insignificant 200,000 ton per year, Thailand claims potential for expansion. Areas planted over the decade 1988 to 1997 have declined marginally from around 1.2 million rai to 0.9 million rai, with production varying between 190,000 and 250,000 ton per year. Yields have shown a continuing increase from 192 to 268 kilogram per rai leading to a farm value rise from 424 million baht to 619 million baht.[193]

[189] Paopongsakorn, Nipon (1995)
[190] Office of Agricultural Economics (1998)
[191] Silcock, T.H. (1970)
[192] Office of Agricultural Economics (1998)
[193] Office of Agricultural Economics (1998)

Fruits and Vegetables

Originating in association with household gardens, fruit crops have developed into a major Thai industry. Technologies introduced with Chinese immigrants, evident in the mounding of soil around trees, suggest that larger scale orcharding is less than a century old. Various propagation methods have evolved, been adapted, and in some cases, invented to suit the production of superior fruit lines with a strong selection emphasis on taste and form. Commercial importance has risen with market road improvement.[194] Production in the period 1958[195] - 1965[196] indicates a rise for pineapples from some 90,000 to 300,000 ton, for water melons from 20,000 to nearly 200,000 ton and bananas from 325,000 to 1.2 million ton. Canning factories developed through the 1960s based particularly on pineapple and large plantations have diversified into longan, asparagus, baby corn, mushrooms, and bamboo shoots.

The most common fruit tree crop of Thailand has traditionally been the mango. In the 1960s, the estimated total of some 33 million fruit trees was broken down into mango (34 percent), orange (27 percent), jackfruit (13 percent), lime (eight percent), durian (seven percent), rambutan (seven percent), and longan (four percent).[197] Thailand has developed into the world's major pineapple producer with a peak production of 2.5 million ton in 1993 falling to 2.1 million ton in 1995 representing more than 20 percent of the world's crop and more than twice that of the second highest producer, the Philippines in 1993.[198] The fall of recent years results from a reduction from the peak area of 624,000 rai in 1993 to a 1996 area of 521,000 rai, and from a peak yield in 1993 of 4,150 kilogram per rai compared to a decadal average of 3,917 kilogram per rai. A general trend of rising prices has assisted a continuing rise in overall receipts such that the 1996 farm value of 5.6 billion baht is the highest for the period 1987 to 1996. In 1997, Thailand exported some 280,000 ton of processed pineapple valued at 5.9 billion baht.[199]

[194] Silcock, T.H. (1967)
[195] Ministry of Agriculture (1958)
[196] Ministry of Agriculture (1965)
[197] National Statistics Office (1963)
[198] FAO (1995a)
[199] Office of Agricultural Economics (1998)

Vegetable growing was expanded and initially dominated by Chinese immigrant farmers who caused a diversification of both Thai agriculture and the Thai diet. Thai transliteration of Chinese names for vegetables confirm their origins. Statistics have only been gathered since 1960[200] when some 24 types of vegetable are listed for the estimated 1.9 million rai (300,000 hectare) planted to vegetables producing some 1.2 million ton per year. Until the 1970s, two major vegetable groups, cabbage and cucumber, accounted for more than 30 percent of the area and more than 40 percent of production. Other major vegetable crops of that period included; onion, eggplant, chilli, long bean, pumpkin, Chinese mustard, and Chinese radish produced predominantly (54 percent) in the Central Plain with the balance spread relatively evenly across the other three regions.[201]

Some major vegetable crops of the 1990s include shallot, garlic, onion, chilli, ground nuts and soya bean. In terms of shallot, the major producing provinces are Sisaket, Chiang Mai, Lamphun, Uttaradit, Sukhothai, and Petchabun. Planted area has risen over the period 1992 to 1997 by some 20 percent to nearly 100,000 rai, producing more than 200,000 ton and providing a farm value of some 1.5 billion baht.[202] While Thailand produces less than two percent of the world's garlic, this figure is better understood by removing the overwhelming (64 percent of global production) production of China which raises Thailand's figure to five percent of world production.[203] Major garlic producing provinces in Thailand are Chiang Mai, Lamphun, and Mae Hong Son. Planted area has tended to reduce over the decade to 1997, while production has increased as a result of rising yield. In 1997, 171,000 rai produced 147,000 ton of garlic with a farm value of 2.4 billion baht.[204] Onion production in Thailand is a solely domestic crop with a production of 88,000 ton in 1995 against the total world production of more than 30 million ton.[205] The major onion producing province is Chiang Mai with 90 percent of the 99,000 tons produced in 1997. Over the past decade planted areas have risen by some 66 percent to more than 25,000 rai contributing to a production increase of 125 percent which, in association with a rise in yield to 3,941 kilogram per rai of 34 percent,

---

[200] Ministry of Agriculture (1961)
[201] Donner, W. (1978)
[202] Office of Agricultural Economics (1998)
[203] FAO (1995a)
[204] Office of Agricultural Economics (1998)
[205] FAO (1995a)

produced a farm value of some 412 million baht in 1997 compared to 157 million baht in 1988.

Soya bean, probably introduced by Chinese immigrants more than 200 years ago,[206] and grown predominantly in upland areas until the 1930s, has been adapted to suit paddy fields following rice.[207] Soya bean production does not meet domestic demand and represents only 0.03 percent of global production.[208] More than 70 percent of production is in the North, where planted area appears to vary with price; in 1997, some 1.7 million rai produced some 359,000 ton with a farm value of 3.1 billion baht.[209] Groundnut expanded through the 1950s and by 1959 some 606,000 rai (97,000 hectare) produced some 122,000 ton mainly from intercropping with corn, cotton, and castor during the monsoon season.[215] In world terms, Thailand's production of some 150,000 ton represents less than 0.5 percent of production.[211] More than half of the crop is produced in the North and, overall, production area has declined along with production over the decade to 1997. In 1997, 619,000 rai produced some 147,000 ton of groundnuts with a farm value of 1.6 billion baht.[212]

Potatoes, not traditionally consumed, have been rapidly subsumed into the Thai diet while meeting new market demand from the hotel and restaurant trade.[213] Chilli is an important domestic crop introduced via the South by the Portuguese in the fifteenth century; it was planted on some 140,000 rai which produced 33,000 ton of farm value of 1.2 billion baht in 1997.[214]

Crop Seeds

Breeding and testing of new varieties has supported agricultural expansion. While most seed has been farmer-retained, a seed production industry has also

[206] Pookpakdi, A. (1990)
[207] Paopongsakorn, Nipon (1995)
[208] FAO (1995a)
[209] Office of Agricultural Economics (1998)
[210] Ministry of Agriculture (1961)
[211] FAO (1995a)
[212] Office of Agricultural Economics (1998)
[213] Scott, T.J. (1987)
[214] Office of Agricultural Economics (1998)

developed as part of agricultural modernisation.[215] The Seed Division of the Department of Agricultural Extension produced 0.4 percent of vegetable seed, three percent of rice seed, 26 percent of ground nut seed and 33 percent of soya beans seed.[216] Of seed imported to Thailand, maize and sorghum comprise around 40 percent of which hybrid sorghum seed was the majority (1,500 ton) in 1985 followed by Chinese kale (139 ton), morning glory (116 ton), radish (60 ton), green mustard (59 ton), Chinese mustard and Cantonese mustard (each 40 ton), and water melon (18 ton). Exports of seed from Thailand included morning glory (97 ton), Chinese kale (70 ton), and pumpkin (53 ton) among others. Recent Thai interest in intellectual property rights are likely to assist clarification of the role government in regulatory and legislative areas, including the ensuring of clean, disease free, and viable seed through all sources.[217]

Summary

Key points pertinent to Thai agriculture from the perspective of crops are:

- Rice remains the most important crop in terms of; Thailand's dominance of the world market, rice production by most small-holders, the fixed design of most irrigation systems, predicted increases in global cereal demand, alternative food product potential, and its historical integration with Thai culture.
- Upland crops have widened Thai perspectives of agriculture, small-holder adaptability, private sector roles, and export and processing potential, leading to Thailand becoming a significant exporter and/or producer of cassava, maize, sugar, oil palm, and beans, and the world leader in pineapple and rubber production and export, with unrealised potential in other crops, as indicated by the establishment of the kenaf industry.
- Socio-cultural links to agriculture, and rice in particular, continue to weaken from such influences as urbanisation, destruction of Tai social organisation surrounding *muang fai* irrigation systems, and substitution of glutinous rice in response to globalisation in the Central and South regions, which began centuries ago and was accelerated by application of Green Revolution technologies.

[215] Setboonsarng, Suthad et al (1990)
[216] Seed Division (1986)
[217] Setboonsarng, Suthad et al (1990)