Groundnut and Soybean Economies in Asia

Facts, Trends and Outlook

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Citation: Birthal PS, Parthasarathy Rao P, Nigam SN, Bantilan MCS and Bhagavatula S. 2010. Groundnut and Soybean Economies in Asia: Facts, Trends and Outlook. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 92 pp. ISBN: 978-92-9066-531-1. Order code: BOE 050.

Abstract

This report provides a factual assessment of demand, production and international trade in oilseeds and their products in Asia, and explores future prospects for the oilseed sector by focusing on groundnut and soybean, the two most important crops grown in the continent. Rising per capita incomes and increasing urbanization are fuelling rapid growth in demand for edible oils in most Asian countries, raising their consumption rates close to the global average. Further, demand for oilcake meals – as animal feed – too has been increasing fast due to rapid growth in the livestock sector.

During the last two and a half decades, Asia's production of groundnut and soybean grew at an impressive rate. Groundnut production increased at an annual rate of 3.1%, from 12.5 million t in 1981-83 to 24.0 million t in 2005-07, and soybean production increased from 10.9 million t to 27.4 million t at an annual rate of 3.7%. These increases, however, were not sufficient to meet the increasing demand for edible oils and oilcakes, forcing many countries, notably China and India, to import huge quantities of the same. Yields of both groundnut and soybean are lower in Asia than in developed countries because of a number of biotic and abiotic stresses, like farmers' lack of access to quality inputs, improved technologies and information, and frequent attacks by pests and diseases. More importantly, these crops are grown in marginal environments characterized by poor soils, low and uncertain rainfall and poor irrigation infrastructure that restrict realization of their true potential.

Factors underlying demand growth in the recent past have been quite robust and these are unlikely to subside in the near future; indicating that demand for edible oils and oilcakes will continue to grow. Asia is land scarce; and the scope to bring additional area under cultivation of oilseeds is extremely limited. The main challenges for research and policy are to narrow down the yield gap by enhancing farmers' access to quality inputs, improved technologies and practices and information; to enhance competitiveness of oilseed crops through domestic and border protection measures in relation to their substitutes and competing crops; and to improve efficiency of oilseeds research, targeting crop breeding for improved tolerance to moisture stress and resistance to insect pests and diseases, besides increasing investment in research for sustained improvement in the genetic potential of oilseed crops.

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International Crops Research Institute for the Semi-Arid Tropics
Patancheru 502 324, Andhra Pradesh, India

2010

Acknowledgements

The authors express their gratitude to Drs PK Joshi, Director, National Academy of Agricultural Research Management (NAARM), Hyderabad, India and Franklin Simtowe, Regional Scientist (Agricultural Economics), ICRISAT, Nairobi, for their critical comments and suggestions that helped bring this report to its present shape. They are also grateful to the International Fund for Agricultural Development (IFAD) and the Bill & Melinda Gates Foundation (BMGF) for their funding support. The authors, however, are solely responsible for errors of omission or otherwise.

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Executive Summary

Globally, groundnut and soybean are the two most important oil-bearing leguminous crops that contribute significantly to the food and nutrition security of the poor, particularly in developing countries where they are widely grown. Grains of both crops are rich in energy and protein, and can be consumed in various forms – raw, roasted, boiled and processed or crushed to produce edible oils of high quality. Their haulms and oilcake meals are an excellent protein-rich feed for livestock and poultry. Further, by virtue of belonging to the *leguminoceae* family, they fix atmospheric nitrogen in the soil and contribute to improving soil fertility, thus saving on external application of nitrogenous fertilizers and consequently reducing cost of production.

Asia is an important producer and consumer of groundnut and soybean. In 2005-07, it contributed about 66% to the global production of groundnut and 13% of soybean. Though these crops are grown throughout the continent, their production is concentrated in China and India. China accounts for around 60% each of the groundnut and soybean produced in Asia, and India 27% of groundnut and 33% of soybean. During the last two and a half decades, their production in Asia has grown at an impressive rate. Groundnut production increased at an annual rate of 3.1%, from 12.5 million t in 1981-83 to 24.0 million t in 2005-07, and soybean production rose from 10.9 million t to 27.4 million t at an annual rate of 3.7%. While growth in soybean production was area-driven, a larger share of growth in groundnut production came from yield improvements.

Yields of both groundnut and soybean are lower in Asia than in developed countries. In 2005-07, Asia's average yields of groundnut and soybean were 1.8 t ha^{-1} and 1.4 t ha^{-1} respectively, compared to their corresponding yields of 3.2 t ha^{-1} and 2.6 t ha^{-1} for developed countries. However, there is a considerable inter-country variation in yields within Asia. Groundnut yields in China, Vietnam and Turkey hover around developed countries' average, while they are much less for the rest of Asia, particularly in India which accounts for close to half of Asia's groundnut area. Soybean yield ranges from 1.0 t ha^{-1} to 1.8 t ha^{-1} in much of Asia, but there is a considerable gap between actual yield and attainable yield in most countries in the region. Low yields of groundnut and soybean are due to a number of biotic and abiotic constraints, such as farmers' lack of access to quality inputs, improved technologies and information, and frequent attacks by pests and diseases. More importantly, these crops are grown in marginal environments characterized by acute shortage of irrigation water, and low and uncertain rainfall that restrict realization of their true potential.

Both groundnut and soybean are multipurpose crops, used as food, feed and intermediate inputs in the food processing industry. In Asia, approximately 55% of the available groundnut and 72% of soybean are crushed to produce vegetable oils for human consumption, and the rest, excluding about 10% as feed, seed and wastage, is used directly as food, processed or otherwise. Fuelled by a sustained rise in per capita income and a fast-growing urban population, Asia's demand for groundnut and soybean products has been increasing rapidly. During the past two decades, demand for groundnut oil increased from 2.0 million t in 1981-83 to 3.3 million t in 2001-03; and for soybean oil from 2.9 million t to 9.8 million t. Likewise, demand for oilcake meals has grown rapidly throughout the continent because of strong growth trends in livestock production. Demand for groundnut oilcake meal increased from 2.4 million t in 1981-83 to 4.5 million t in 2001-03 and that for soybean oilcake meal from 9.1 million t to 38.4 million t.

Groundnut and soybean are at extreme ends of the spectrum when it comes to international trade. While soybean is one of the most traded agricultural commodities in the international market, trade in groundnut is sparse; only 5% of the global groundnut output is traded in the international market, as against 58% of soybean. Groundnut is traded as edible nuts, edible oil and oilcake meal, but edible nuts account for two-thirds of the total trade. Likewise, about 50% of the international trade in soybean takes place in the form of beans. Between 1993-95 and 2003-05, trade in soybean and soybean products almost doubled, while trade in groundnut and groundnut products declined because of increasing food safety concerns over their contamination with aflatoxin.

Asia is a net exporter of groundnut and its products. On the other hand, it imports huge quantities of soybean and soybean products. In 2003-05, it accounted for close to 60% of global imports of soybeans and soybean oil and 25% of soybean oilcake meal. China is the main importer of soybean and soybean products.

Caused by rapid growth in production and exports from developing countries, international prices of both groundnut and soybean declined in real terms, but saw an upward swing after 2001 because of their tighter supplies and greater diversion of some oilseeds towards the manufacture of bio-diesel. The rise in prices of oilseeds and their products could partly be also due to a spillover effect of the rising prices of foodgrains.

Demand for groundnut and soybean is likely to remain buoyant in Asia, as factors underlying demand growth (income growth and urbanization) have been quite robust in the recent past in much of Asia, and the trends therein are unlikely to change in the near future. Demand for groundnut and soybean in 2020 is expected to be 1.6 times more than that in 2000. However, domestic production is unlikely to keep pace with increasing demand, and about half the demand will be met through imports. But the bulk of imports will remain concentrated in China. Asia as a whole will also face a trade deficit in groundnut, mainly due to increasing demand and tighter supplies in India and Indonesia. China, however, will remain a net exporter of groundnut.

Since China and India are the main producers and consumers of groundnut and soybean, projected demand and supply with 'business-as-usual' assumptions are likely to be sensitive to changes in production systems (technology), income growth and trade policy. If growth in per capita income in these countries were to accelerate, the demand for groundnut will increase faster, leading to a further rise in trade deficit in India, and a turnabout for China from a net exporter to a net importer. Trade deficit in soybean will increase in both China and India. However, there is a possibility of raising production by augmenting yield growth. With acceleration in yield growth, India will face a decline in trade deficit in groundnut and soybean, and China will experience a further rise in trade surplus in groundnut, and a marginal decline in trade deficit in soybean.

The scope to raise groundnut and soybean production in Asia through area expansion is extremely limited. Hence, while enhancing production, the main challenges for research and development are to: (i) bridge the gap between actual and attainable yields by enhancing farmers' access to quality inputs, improved technologies and information; (ii) incentivize farmers to improve the competitiveness of oilseed crops through domestic and border protection measures in relation to their substitutes and competing crops; and (iii) achieve a technological breakthrough that not only overcomes yield barriers but also provides effective protection against insect pests and diseases, and resistance to moisture stress.

1. Introduction

Spurred by sustained growth in per capita income, increasing population and urbanization, demand for oilseeds and oilseed products–edible oils and oilcake meals–has been growing rapidly in much of Asia. During the last two decades, Asia's edible oil demand more than trebled, from 12.8 million t ha^{-1} in 1981 to 39.1 million t ha^{-1} in 2003 (FAOSTAT: http://www.faostat.fao.org). The non-food consumption of vegetable oils, which constitutes about one-fifth of their total demand, experienced a similar growth. Annual per capita consumption of edible oils increased from 4 kg in 1981 to 10 kg in 2003. This rapid increase led to bridging the consumption gap between Asia and the rest of the world. In 1981, Asia's per capita consumption was 43% below the world average, which declined to 10% in 2003. Likewise, the demand for oilcake meals – used primarily as feed for livestock and poultry – also grew rapidly, from 24 million t in 1981 to 75 million t in 2003. In 2003, Asia accounted for close to half of the global consumption of edible oils and 40% of oilcake meals.

China and India are the two main consumers of oilseeds and their products in Asia. Together, they account for approximately two-thirds of Asia's total consumption of edible oils as well as oilcake meals. Further, per capita consumption of edible oils has been increasing there despite growing population. Between 1981 and 2003, China's annual per capita consumption increased almost four-fold, from 3 kg in 1981 to 11 kg in 2003; and in India it doubled from 5 kg to 10 kg. Their share in Asia's oilcake meal consumption remained around 60% during this period.

Increasing demand for oilseeds and their products has been accompanied by increases in their domestic production. Asia's production of oilseeds increased from 53 million t in 1981 to 130 million t in 2003, and of vegetable oils from 15 million t to 70 million t. Interestingly, Asia is a net exporter of vegetable oils. During 2003-07, Asia's annual exports of palm oil stood at 22.8 million t (81% of total exports of vegetable oils) and imports at 15.3 million t (60% of total imports of vegetable oils), leaving a trade surplus of 7.5 million t. The surplus was mainly because of huge exports of palm oil from Malaysia – during 2003-07, on an average Malaysia exported 12.9 million t of palm oil, which is close to half of the world's exports. Nevertheless, Asia is a net importer of oilcake meals and oilseeds. During this period, Asia's mean net imports of oilseeds and oilcake meals stood at 44.9 million t and 6.8 million t, respectively.

Both in China and India, domestic production of oilseeds has not kept pace with their growing demand, leading to a surge in imports of edible oils. During 2003-07, China's annual trade balance in vegetable oils was negative to the tune of 7.2 million t and India's 4.4 million t. China also imported huge quantities of oilseeds (28.4 million t), mostly soybeans, to meet its domestic demand. India, on the other hand, has been a net exporter of oilcake meals (5 million t), mainly soybean oilcake meal.

This report focuses on groundnut and soybean, two important oil-bearing crops grown in Asia. Both these are leguminous crops and fix atmospheric nitrogen in the soil. This improves soil fertility and saves on external applications of nitrogenous fertilizers. Their grains, besides being an important source of edible oil, are rich in proteins, vitamins and minerals and contribute towards improving the nutritional security of the poor. Their leaves and oilcake meals make excellent feed for livestock and poultry, and contribute towards raising their productivity.

Together, soybean and groundnut account for two-thirds of the world's oilseed production (Table 1). Soybean, however, is a more important oilseed crop than any other oil-bearing crop. In 2005-07, it accounted for 56% of the oilseed production, 29% of the total

Table 1. Global production (in million t) of oilseeds and oilseed products, 2005-07.

Commodity	Oilseeds	Vegetable oil	Oilcake meals
Copra	5.5	3.4	1.8
Cottonseed	43.8	4.7	14.6
Palm kernel	10.1	4.4	5.3
Groundnut	33.2	5.1	5.9
Rapeseed	47.2	17.0	25.9
Soybean	221.0	34.2	145.6
Sunflower	28.6	10.1	11.0
Total	**389.4**	**117.9***	**215.5****

* Total includes palm and olive oils.
**Total includes fish meal.
Source: http://www.fas.usda.gov/psdonline/circulars/oilseeds.pdf

vegetable oils and two-thirds of the oilcake meals supplies.

In Asia, soybean and groundnut are widely grown under varied agro-climatic conditions. Asia occupies approximately one-fifth of the world's soybean area and contributes 13% to total oilseed production. Asia's share is much higher in groundnut area (56%) and production (67%).

During the past two and a half decades, Asia's soybean production has grown at an annual rate of 3.7%, from 10.9 million t in 1981-83 to 27.4 million t in 2005-07, mainly driven by area expansion. On the other hand, Asia's groundnut production grew from 12.5 million t to 24.0 million t at an annual rate of 3.1%, with a larger share of incremental output coming from yield improvements. Nonetheless, soybean productivity remains low in Asia (Figure 1), with average yield being 40% less than the world average of 2.3 t ha^{-1}. Groundnut yield is, however, higher in Asia (1.9 t ha^{-1}) compared to the world average (1.6 t ha^{-1}), mainly because of higher yield in China (3.0 t ha^{-1}), the world's largest producer. In India, which accounts for close to half of Asia's groundnut area, yield is much less (1.0 t ha^{-1}).

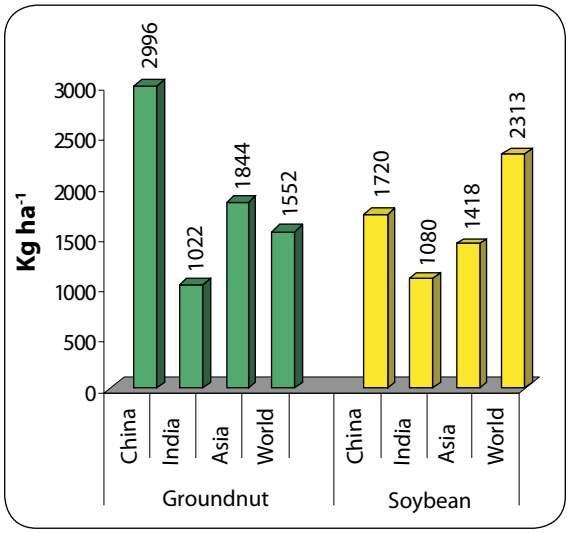


Figure 1. Yields of groundnut and soybean in Asia and the world, 2005-07.
Source: FAOSTAT (http://www.faostat.fao.org).

Low yields of soybean and groundnut in India and many other Asian countries can be attributed to their unfavorable production environments. They are mainly cultivated on marginal lands under rainfed conditions with minimal application of external inputs. For example in India, fertilizer use in soybean is one of the lowest (43 kg ha^{-1}) among crops, and hardly 2% of the area receives irrigation water. Adoption of improved cultivars and production practices has lagged behind due to lack of information, underdeveloped seed production and delivery systems, and poor markets and transport infrastructure. Besides, these crops face higher production risk due to uncertain rainfall which discourages farmers from adopting improved cultivars, using quality inputs and investing in farm infrastructure, inputs and technology.

This report presents facts and trends related to area, yield and production of groundnut and soybean, their utilization pattern, trade and prices in Asia. It also explores prospects for growth of these crops in major producing countries under varying technological, income and trade regimes. The findings serve as a valuable input to scientists, research managers, agro-processors and policymakers in targeting their efforts and investments towards improving efficiency of production,

marketing and processing of groundnut and soybean in particular, and oilseeds in general.

The report is organized in six chapters. Chapters 2 and 3 present a factual assessment of the situation of groundnut and soybean, in terms of demand, supply, trade and prices. Issues related to markets, institutions and policies are discussed in Chapter 4. In Chapter 5, we attempt to explore future prospects for these crops under alternative scenarios of income growth, technology and trade protection. Conclusions and implications are given in the last chapter.

2. Groundnut: Facts and Trends

Groundnut (*Arachis hypogaea*), also known as peanut, occupies 9% of the world's oilseed area, and contributes close to 5% to vegetable oil production. It is an important crop from the perspective of food and nutrition security of poor smallholder farmers in developing countries where it is grown widely. Groundnut seeds (kernels) contain 40-50% fat and 20-30% protein and are also an important source of vitamin E, niacin, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium. Groundnut kernels can be consumed directly – raw, roasted, boiled and processed, or indirectly as confectionery and cooking oil. Byproducts of groundnut are used as animal feed (oil pressings, seeds, green material and haulms) and industrial raw material (oilcake meals). Shells can be used as animal feed, burnt for fuel, or used in particle board manufacturing, and as filler in feed and fertilizer industry. Such multiple uses make groundnut an excellent cash crop for domestic as well as export markets.

Crop Distribution

Groundnut is grown in over 100 countries across the world under different agro-ecological environments on about 23 million ha (Table 2). Its cultivation, however, is largely confined to developing countries of Asia and Africa, which account for a bulk of the total groundnut area as well as production (Figure 2 and Table 2). Asia accounts for 56% of the world's groundnut area and contributes over two-thirds to total production. The corresponding figures for Africa are 39% and 25%, respectively.

Table 2. Area, yield and production of groundnut in different regions of the world.

Region/ country	Area ('000 ha)			Yield (Kg ha^{-1})			Production ('000 t)		
	1981-83	1993-95	2005-07	1981-83	1993-95	2005-07	1981-83	1993-95	2005-07
World	**18,760**	**21,690**	**23,078**	**1,026**	**1,285**	**1,552**	**19,257**	**27,873**	**35,807**
Developed countries	**606**	**686**	**581**	**2,788**	**2,523**	**3,222**	**1,690**	**1,732**	**1,872**
Europe	11	12	11	2,107	1,102	842	24	14	9
North America	558	651	544	2,902	2,579	3,359	1,620	1,679	1,827
Oceania	36	23	26	1,254	1,725	1,357	46	40	36
Developing countries	**18,154**	**21,004**	**22,497**	**968**	**1,245**	**1,508**	**17,567**	**26,141**	**33,935**
Africa	6,175	7,211	8,998	687	786	978	4,243	5,669	8,801
Latin America	645	419	506	1,352	1,715	2,310	872	718	1,169
Asia	**11,334**	**13,374**	**12,993**	**1,099**	**1,477**	**1,844**	**12,452**	**19,754**	**23,965**
East Asia	2,452	3,714	4,710	1,647	2,578	2,994	4,038	9,574	14,102
China	2,410	3,690	4,698	1,649	2,582	2,996	3,973	9,529	14,074
South Asia	7,503	8,042	6,485	886	992	1,020	6,648	7,977	6,612
India	7,394	7,898	6,359	883	991	1,022	6,530	7,824	6,501
Pakistan	67	97	85	1,212	1,081	735	81	105	63
Southeast Asia	1,339	1,555	1,752	1,245	1,316	1,766	1,667	2,047	3,094
Indonesia	483	669	709	1,663	1,638	2,073	804	1,095	1,471
Myanmar	528	482	655	985	943	1,435	520	455	940
Thailand	118	96	66	1,234	1,499	1,734	146	144	115
Vietnam	131	242	256	897	1,225	1,878	117	296	481
West Asia	41	53	41	2,392	2,663	3,562	99	140	147
Turkey	24	30	25	2,156	2,360	3,331	52	70	83

Source: FAOSTAT (http://www.faostat.fao.org).

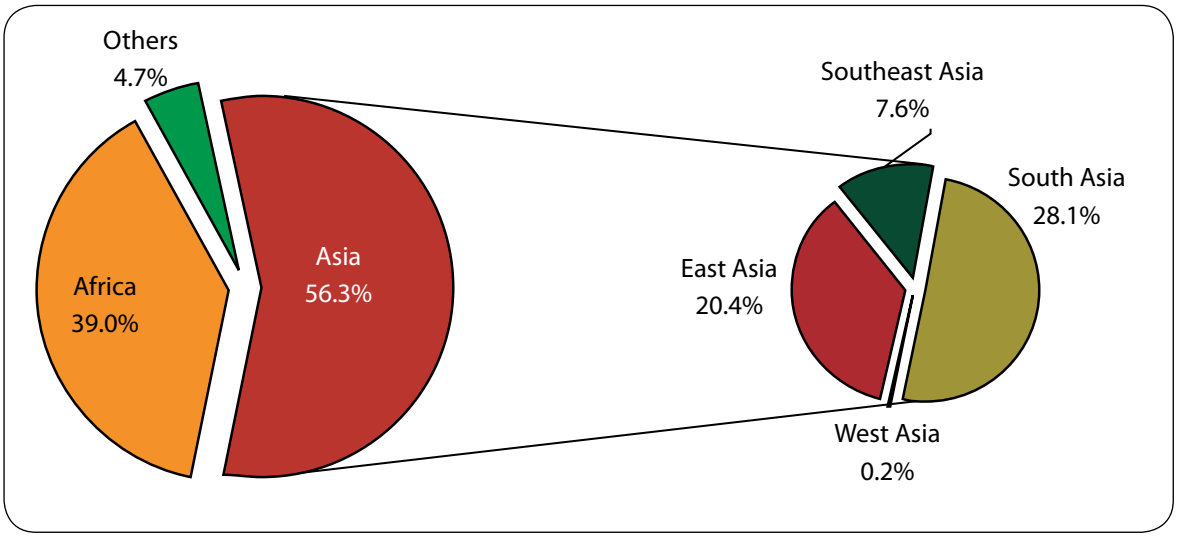


Figure 2. Distribution of global groundnut area, 2005-07.

Source: FAOSTAT (http://www.faostat.fao.org).

In Asia, groundnut is grown on 13 million ha, mainly in South Asia and East Asia (Figure 2 and Table 2). South Asia accounts for close to half of Asia's total groundnut area, and another half is shared by East Asia (36%) and Southeast Asia (14%). In South Asia, its cultivation is largely confined to India, and in East Asia to China. Together, India and China occupy 48% of the global and 85% of Asia's groundnut area. Indonesia, Myanmar and Vietnam are important groundnut growing countries in Southeast Asia. Though their share in Asia's groundnut area is low, it is an important crop in these countries, being cultivated on 6.3% of the arable land in Myanmar, 4.1% in Vietnam and 3.2% in Indonesia.

In India, groundnut is an important oilseed crop. In 2005-06, it accounted for one-fourth of the total 28 million ha under oilseeds, and contributed 29% to total oilseeds production (28 million t). It is grown largely under rainfed conditions during the main rainy season (Jun/Jul – Oct/Nov); 83% of the groundnut area is rainfed, and the remaining 17% is irrigated mainly in the postrainy season. Around 80% of groundnut production comes from the rainy season crop, and the rest from the postrainy season crop. Although groundnut is grown throughout India, it has a larger concentration in the southern states of Andhra Pradesh, Karnataka and Tamil Nadu, which together occupy 53% of the country's total groundnut area and contribute 40% to total groundnut production (Map 1 and Annexure 1). Gujarat, Rajasthan and Maharashtra account for 39% of the area and 54% of total production. Across agro-ecological zones, about 73% of groundnut area lies in the semi-arid tropics, and the rest in the arid (15%), humid (9%) and temperate (3%) regions (Figure 3).

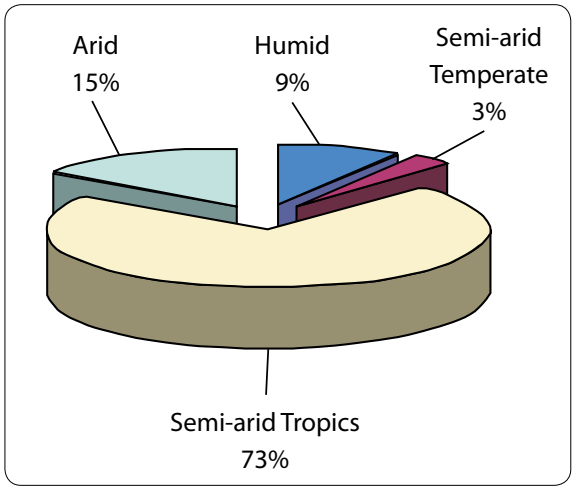
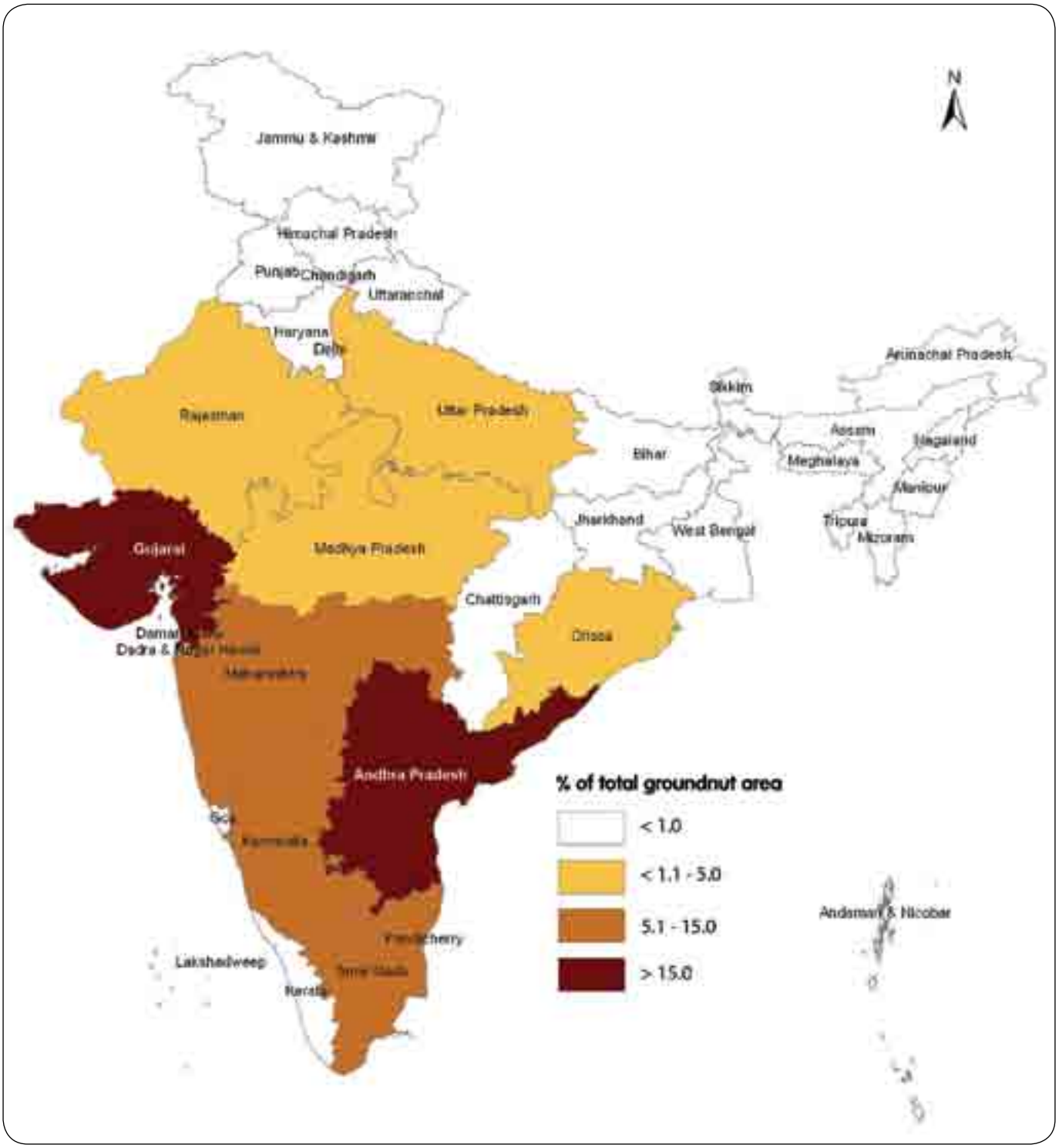


Figure 3. Distribution of India's groundnut area across agro-ecological zones, 2003-05.

Source: ICRISAT database.



Map 1. Distribution of groundnut area in India across states, 2003-05.

Groundnut is an important food and cash crop in China. In 2007, it occupied 4.6 million ha, equivalent to 3% of China's arable land. It shares close to one-third of the total oilseeds area in the country and contributes nearly half to total oilseed production. Henan and Shandong are leading groundnut producing provinces which together account for about 40% of China's groundnut area (Map 2) and half of its groundnut production (Annexure 2). Hebei, Guangdong, Sichuan, Guangxi and Anhui are other important groundnut growing provinces, each sharing 5%-7% in total groundnut area. Groundnut is grown in rotation with various crops in diverse cropping systems in different provinces (Yao 2004). In Shandong, the crop is grown in summer following winter wheat. It is also rotated with sweet potato, corn, tobacco and vegetables in other regions.

Trends in Area, Yield and Production

Area

During the last two and a half decades, world groundnut area has expanded by 25%, from 18.8 million ha in 1981-83 to 23.1 million ha in 2005-07 (Table 2), at an annual rate of 1.11% (Table 3). Africa and Asia accounted for most of the additional area brought under groundnut cultivation during this period. The pace of area expansion, however, slowed down after the mid-1990s. Growth in world groundnut area decelerated to 0.28% during 1996-2007, from 1.45% during 1981-95 (Annexure 3).

Asia's groundnut area grew at an annual rate of 0.55%, from 11 million ha in 1981-83 to 13 million ha in 2005-07. Rapid growth occurred in China, where it almost doubled from 2.4 million ha in 1981-83 to 4.7 million ha in 2005-07. Among others, the main factor behind rapid expansion of groundnut area in China was its comparative advantage over other crops cultivated under similar agro-climatic conditions (Yao 2004). From Table 4 which shows gross returns for groundnut and other crops, it is evident that groundnut cultivation is more remunerative than most other field crops – gross returns from groundnut were 2-3 times greater compared to those from wheat, soybean and rapeseed.

Table 3. Annual growth (%) in groundnut area, yield and production, 1981-2007.

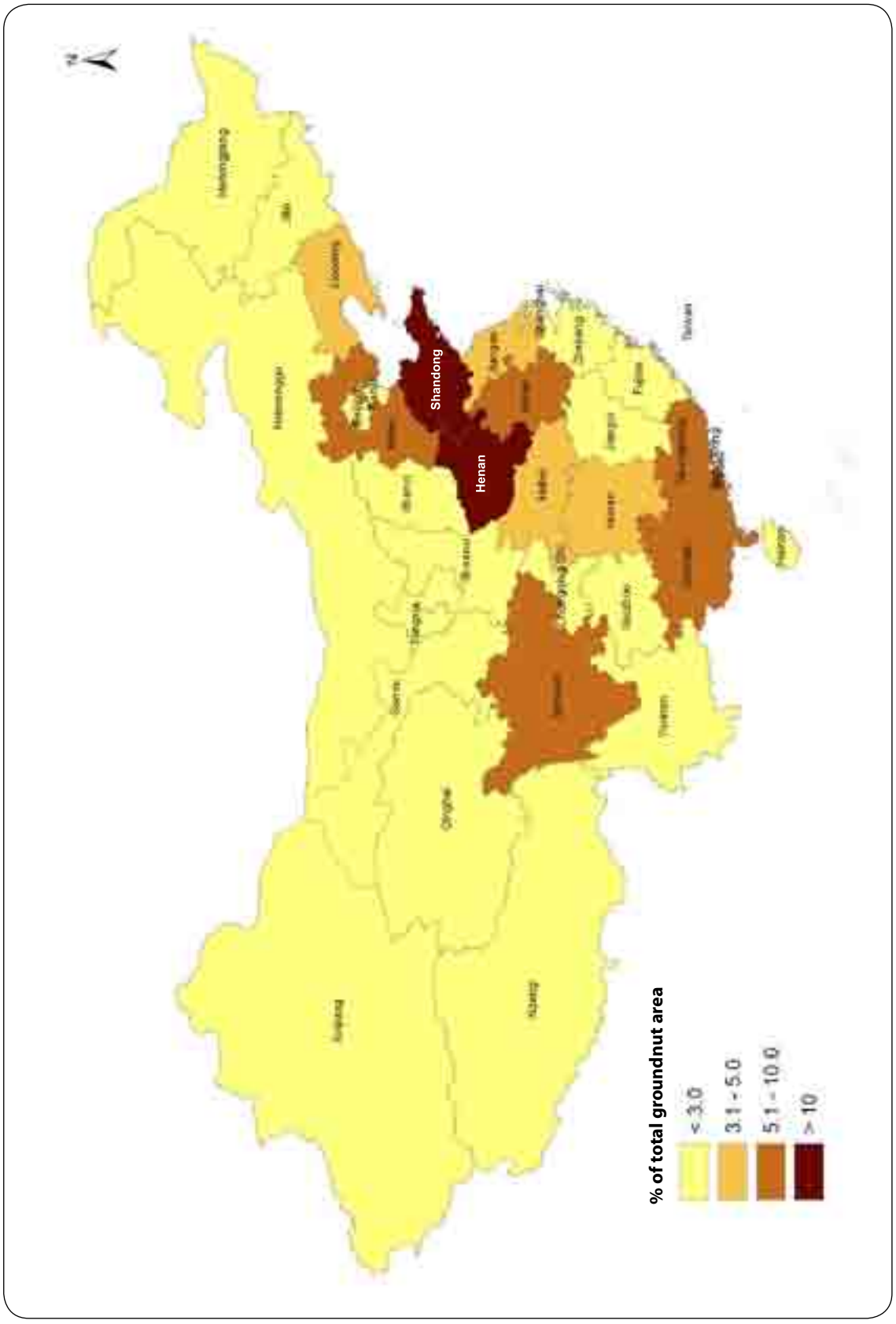
Region/country	Area	Yield	Production
World	**1.11**	**1.90**	**3.03**
Developed countries	**-0.55**	**0.77**	**0.22**
Europe	-0.93	-4.48	-5.35
North America	-0.44	0.74	0.30
Oceania	-2.59	1.82	-0.84
Developing countries	**1.16**	**2.06**	**3.24**
Africa	2.39	1.54	3.96
Latin America	-0.82	1.72	0.90
Asia	**0.55**	**2.57**	**3.14**
East Asia	3.01	2.73	5.82
China	3.08	2.72	5.88
South Asia	-0.76	1.00	0.23
India	-0.80	1.02	0.22
Pakistan	2.07	-1.19	0.85
Southeast Asia	0.86	1.37	2.24
Indonesia	1.39	0.73	2.13
Myanmar	0.63	1.61	2.25
Thailand	-2.74	1.23	-1.54
Vietnam	2.27	3.14	5.48
West Asia	0.61	1.41	2.01
Turkey	0.93	1.36	2.30

Source: Estimated using data from FAOSTAT (http://www.faostat.fao.org).

Table 4. Gross returns (in US$ ha^{-1}) from groundnut vis-à-vis other crops in China.

Crop	1991-93	1998-2000	2005-07
Groundnut	721	1153	1718
Maize	411	1175	1301
Rapeseed	324	373	465
Rice	752	1518	2245
Soybean	367	542	692
Wheat	401	540	972

Source: FAOSTAT (http://www.faostat.fao.org).



Map 2. Distribution of groundnut area in China across provinces, 2004-06.

During 1981-2007, groundnut area expanded in India also, but in an oscillating manner. It increased marginally from 7.4 million ha in 1981-83 to 7.9 million ha in 1993-95, and then declined drastically to 6.4 million ha in 2005-07 (Table 2). Groundnut in India is largely grown under rainfed conditions, and the recent decline in its area can be attributed to consecutive droughts in major producing regions, and also to the increasing competition from crops like Bt cotton, soybean and maize.

Southeast Asian countries experienced a positive trend in groundnut area, which increased from 1.3 million ha in 1981-83 to 1.8 million ha in 2005-07 (Table 2). The trend, however, varied across countries. During this period, groundnut area in Indonesia increased by 47%, but mostly during 1981-95. In Vietnam, it almost doubled, from 131,000 ha in 1981-83 to 256,000 ha in 2005-07. On the other hand, groundnut area declined in Thailand and Philippines. In Myanmar too, groundnut area declined between 1981-83 and 1993-95, but improved afterwards.

Yield

During the last two and a half decades, significant improvements have been observed in groundnut yield in Asia. Between 1981-83 and 2005-07, it increased by 0.7 t ha^{-1}, from 1.1 t ha^{-1} to 1.8 t ha^{-1} (Table 2). Almost every country in the region, except Pakistan, experienced an increasing yield trend. Spectacular yield increases occurred in East and Southeast Asian countries. Yield almost doubled in China and Vietnam, and increased by 40%-50% in Indonesia, Thailand and Myanmar. In fact, yield growth in Vietnam was higher than that in any other country in the region. India realized a marginal yield gain (16%) during this period. Yield improvements in both China and India, however, have slowed down in recent years, while they accelerated in most Southeast Asian countries (Annexure 3). Rapid growth in groundnut yield, especially in East and Southeast Asia, occurred because of the introduction of high-yielding, stress-resistant varieties and improved production practices including balanced fertilization, chemical pest control and polythene mulching (Box 1).

There is considerable regional variation in groundnut yield within Asia. It is higher in East and Southeast Asian countries. Average groundnut yield is about 3 t ha^{-1} in China and close to 2 t ha^{-1} in Thailand, Vietnam and Indonesia, as compared to 1 t ha^{-1} in India (Figure 4). Such wide inter-country variations can be attributed to differences in production systems, technology adoption and input use.

Box 1. Polythene mulching for higher yield

Notwithstanding negative externalities of polythene to the environment, polythene mulching, along with other improved cultivation practices, has contributed significantly to raising groundnut production and productivity in China. Polythene films of 0.004 mm-0.014 mm thickness are used for mulching, which creates suitable conditions for plant growth by influencing soil temperature, moisture, texture and microbial activities. It prevents late set pegs penetrating the soil and thus saves nutrients for earlier set pegs, and is also effective in controlling weeds. In China, 18%-49% higher yield was recorded with polythene mulching than without it. Oil, protein and essential amino acids were also higher in seeds harvested from fields using polythene mulching.

Adapted from Yao (2004)

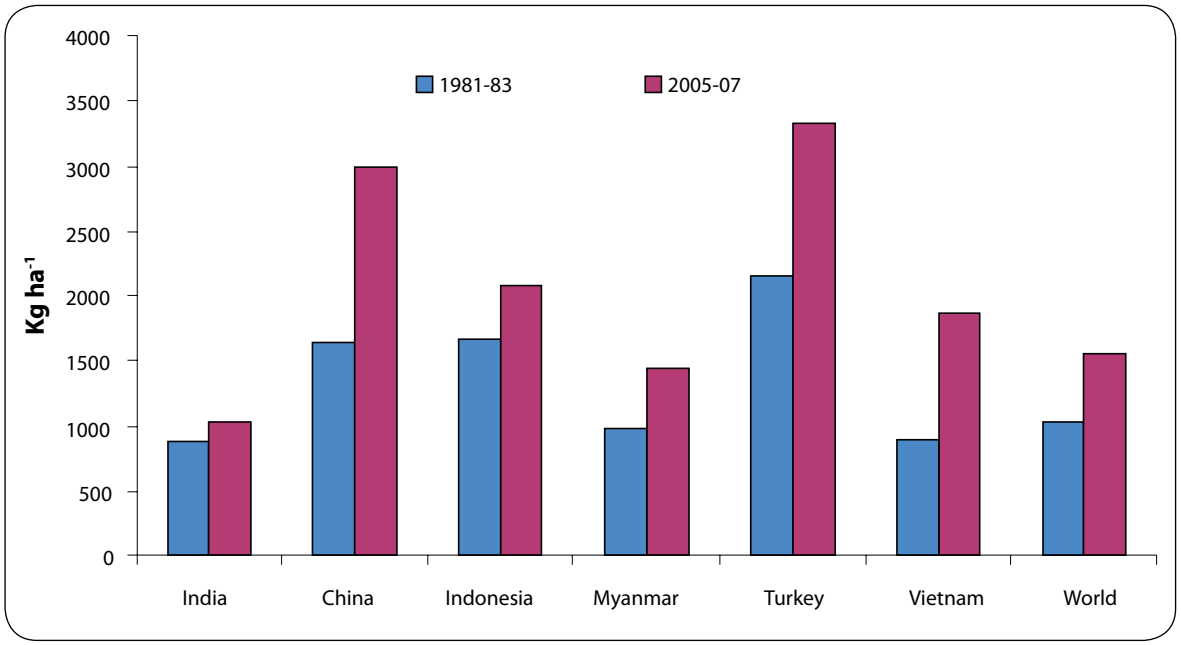


Figure 4. Groundnut yields in select Asian countries and the world.

Source: FAOSTAT (http://www.faostat.fao.org).

In both China and India, there is a considerable intra-country variation in groundnut yield. It ranges from 1.3 t ha^{-1} to 4.5 t ha^{-1} across different provinces in China. In Henan, Shandong, Hebei and Anhui, which are important groundnut producing provinces, yield is higher (3.5 t ha^{-1} - 4.5 t ha^{-1}) compared to the national average of 3 t ha^{-1} (Map 3). There has been a considerable increase in area under high-yielding varieties in major producing provinces. In 2004-06, average yield on 61% of the total groundnut area was above 3 t ha^{-1}, and on another 36% it ranged between 2 t ha^{-1}-3 t ha^{-1} (Figure 5).

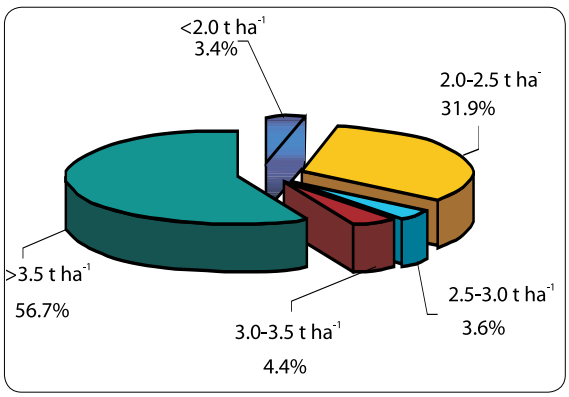


Figure 5. Distribution of groundnut area in China by yield levels, 2004-06.

Source: USDA (http://www.ers.usda.gov/Data/China).

In India, though average yield is low, there has been a significant improvement during the last two decades (Figure 6). In 1980-82, average yield on approximately half of the groundnut area was less than 700 kg ha^{-1}. In 2001-03, while the low-yielding area fell to 27%, the share of area with yields exceeding 1050 kg ha^{-1} increased to 53% from 23% in 1980-82. However, yield gains were greater in humid environments, where yield is higher and stable compared to that in the semi-arid tropics (Figure 7).

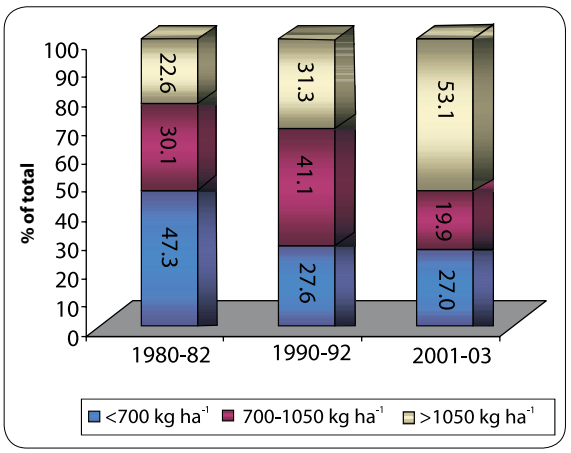
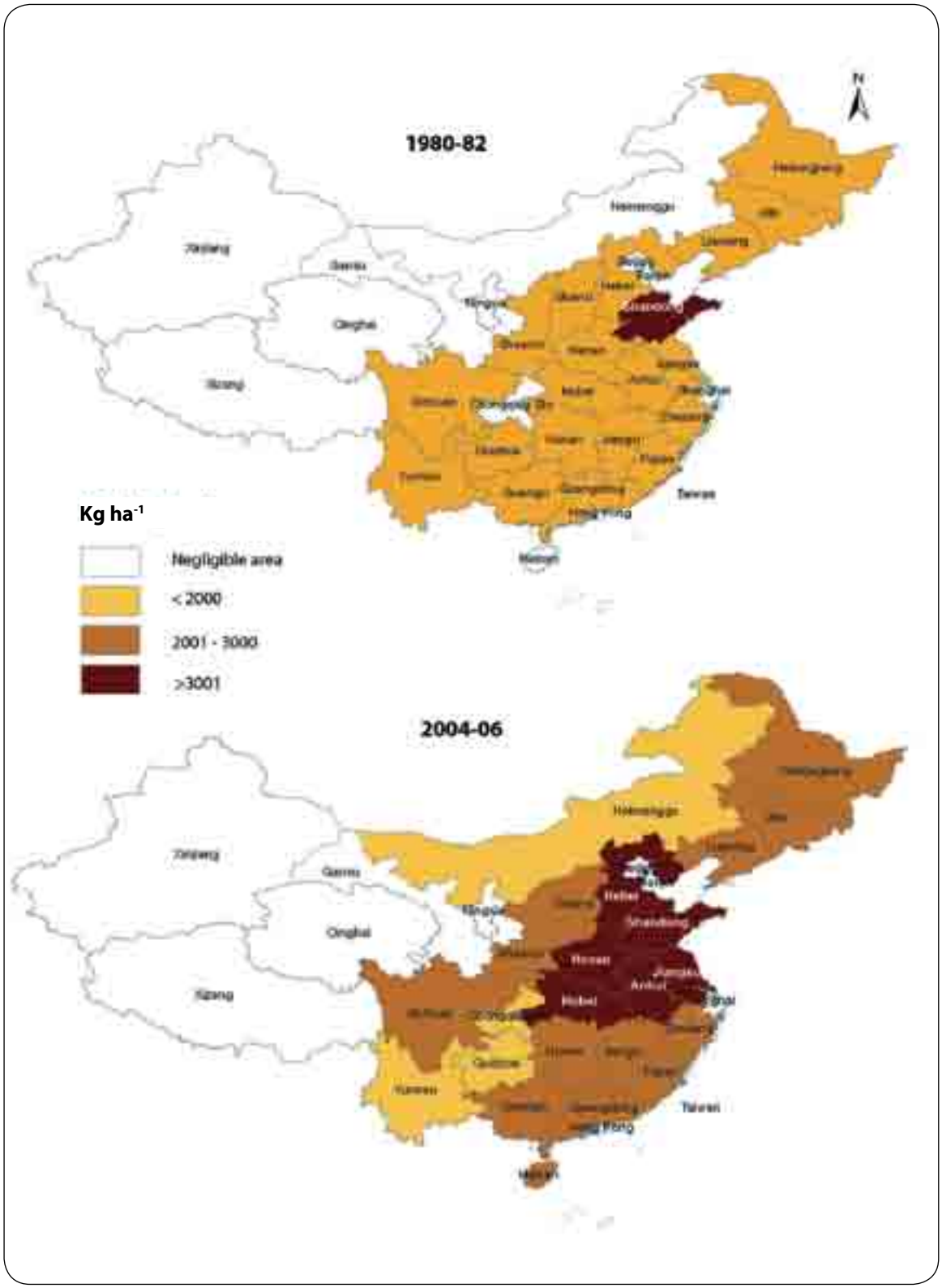


Figure 6. Distribution of groundnut area in India by yield levels.

Source: ICRISAT database.



Map 3. Groundnut yield in different provinces in China.

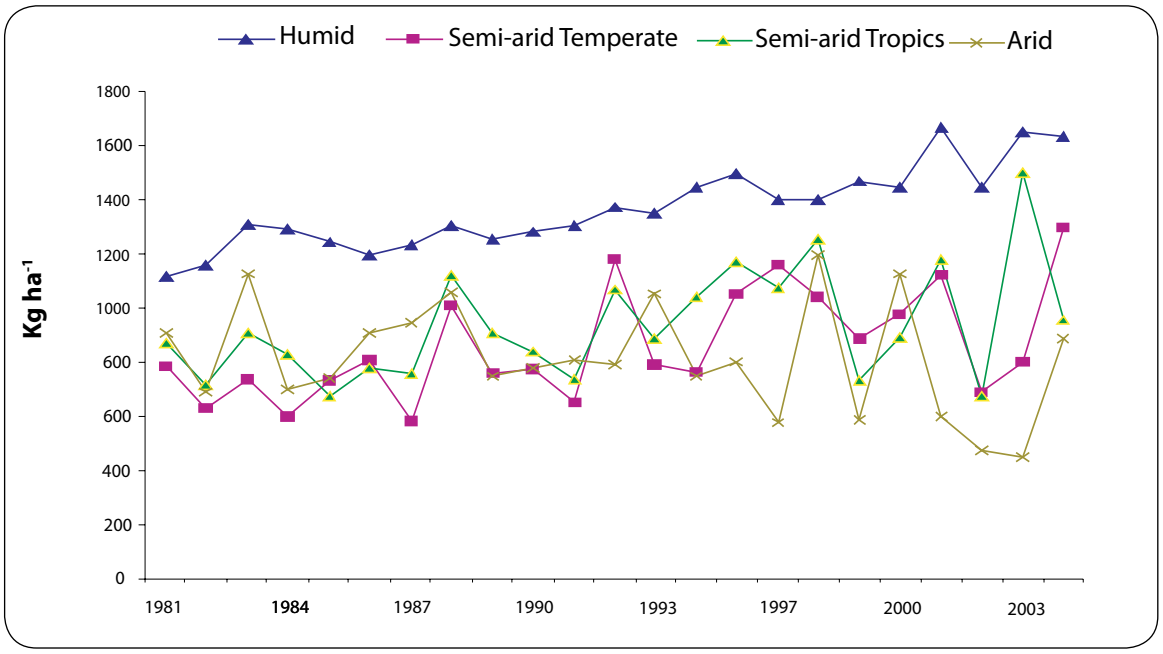


Figure 7. Trends in groundnut yield in different agro-ecological zones in India.
Source: ICRISAT database.

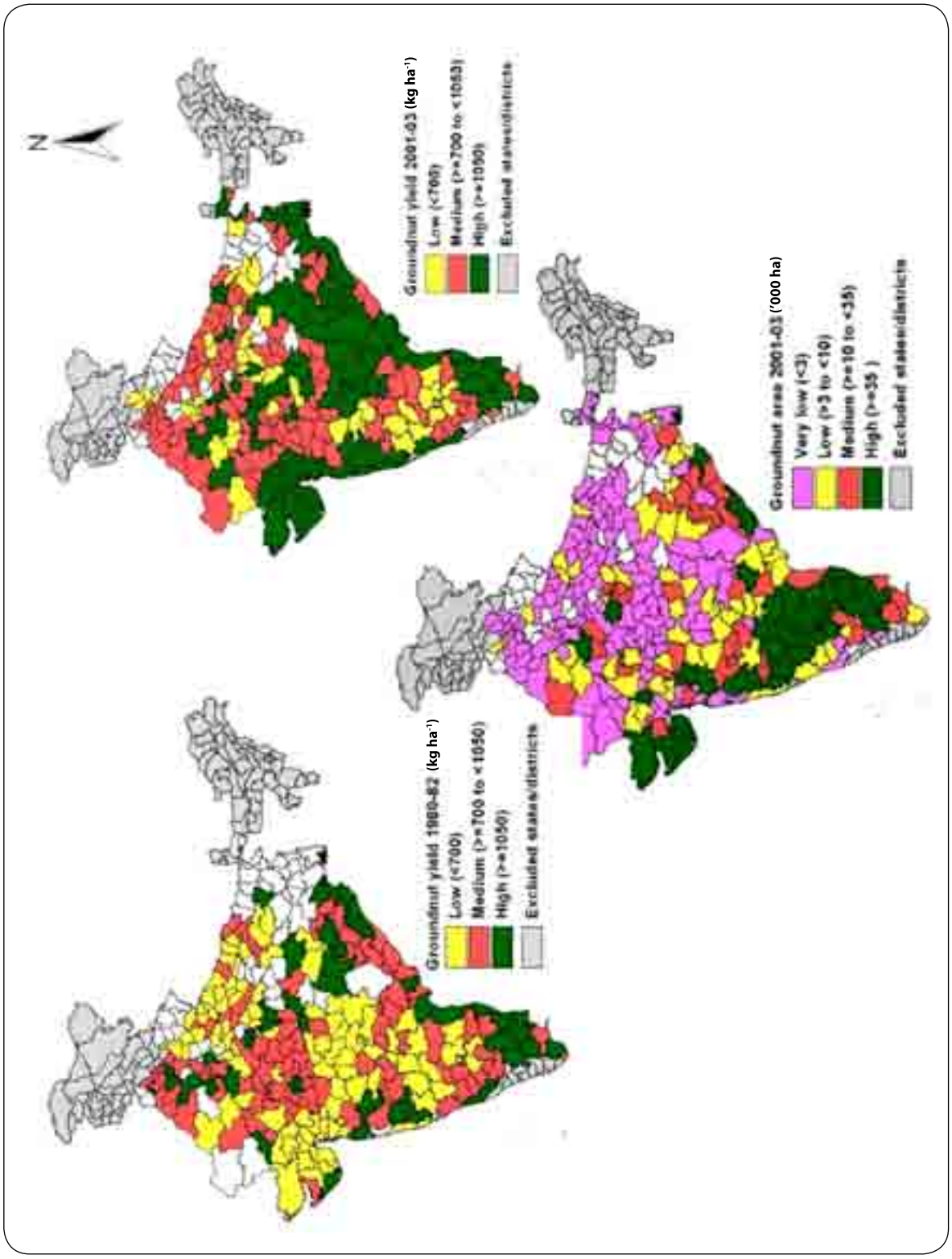
The changing landscape of yield distribution is also corroborated by Map 4, which shows the classification of Indian districts with high, medium and low yields and shifts therein over time. Between 1980-82 and 2001-03, a large number of districts moved from low to medium to high yielding categories. There are still many districts, particularly in peninsular India (Andhra Pradesh and Karnataka), where yield is low. Interestingly, groundnut yield is greater in non-traditional groundnut producing districts, particularly in eastern India (Orissa, West Bengal and coastal Andhra Pradesh), although it is cultivated on a limited area in these districts.

Low yield in the southern peninsula is because of low and erratic rainfall and high pressure of diseases and insect pests. Droughts are frequent, causing substantial loss in production. Often questions are raised about frequency, intensity and impact of drought on production and livelihood of farmers. From district-level data aggregated at the agro-ecological zone level, we observe that groundnut yield in the semi-arid tropics remains 10% or more below the trend in 1 out of every 4 years. In some years, the shortfall is as much as 40%. When rainfall is good, yield is also higher; for instance in 2003 groundnut yield was 40% more than the trend yield. Box 2 illustrates variability in groundnut yield in Anantapur district of Andhra Pradesh, where groundnut is grown on about 0.9 million ha.

Production

World groundnut production increased from 19 million t in 1981-83 to 36 million t in 2005-07 at an annual rate of 3% (Tables 2 and 3). Such a rapid increase in production was driven by robust growth in Asia and Africa. During this period, groundnut production in Africa increased at an annual rate of close to 4%, and in Asia at 3.1%. The rate of growth was higher during 1981-95 than during 1996-2007 (Annexure 3). Asia's share in world groundnut production has remained between 65% and 70% during the last two and a half decades.

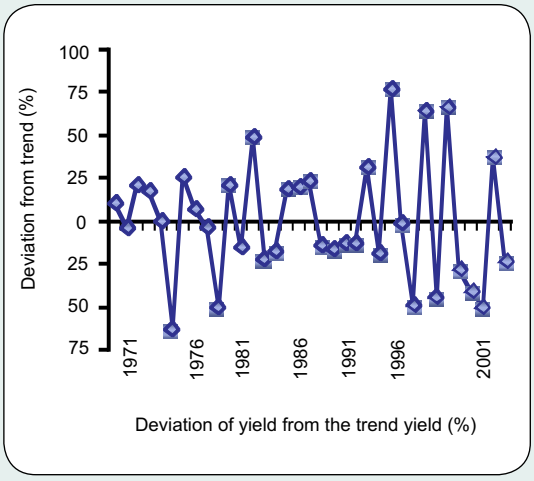
There is, however, considerable variation in output growth across Asia. The most rapid increase in groundnut production occurred

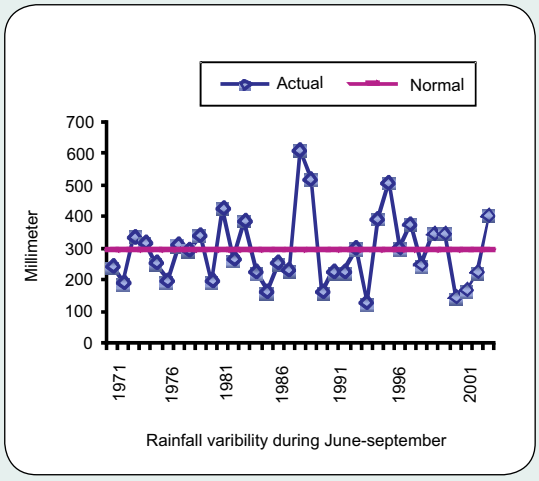


Map 4. Inter-regional variations in groundnut area and yield in India.

Box 2. Variability in groundnut yield in Anantapur

Approximately three-fourths of India's groundnut area falls in the semi-arid tropics characterized by low and erratic rainfall, poor and marginal soils and low agricultural productivity. Drought is a frequent phenomenon, and its frequency and impacts vary across space. Anantapur – a district in the state of Andhra Pradesh – falls under the semi-arid tropics and is known for its groundnut production. The district accounts for 14% of India's total groundnut area. Over three-fourths of the total cropped area in the district is under groundnut, but mainly in the rainy season. In the postrainy season, fields remain fallow. Production risk is very high. The figures below show variation in groundnut yield and rainfall from their trends. Every alternate year is a drought year in Anantapur during which, a yield decline of around 20% is common. The probability of yield falling 20% or more below the trend is 27%.





Source: Calculated using data from the ICRISAT database.

in China (Figure 8 and Table 3), from a mere 4 million t in 1981-83 to 14 million t in 2005-07 at an annual rate of 5.9%. As a result, China consolidated its position in the global as well as Asia's groundnut economy. Its share in Asia's groundnut production increased from 32% in 1981-83 to 59% in 2005-07. This was due to a combination of factors including technological change and policy support in the form of prices, relaxation of market controls, and improvements in marketing facilities. The growth was propelled by area expansion as well as yield improvement. Groundnut production also increased rapidly in Southeast Asia, particularly in Indonesia, Vietnam and Myanmar. It is interesting to observe that yield improvement was the main driver of growth in these countries.

Groundnut production in India, which accounts for a quarter of Asia's production, has been lackluster. During 1981-2007, it increased at an annual rate of just 0.22%. However, the rate of growth was higher during 1981-95 but decelerated afterwards (Annexure 3). The increase in groundnut production in India in the earlier period was mainly due to a favorable policy environment, with the Government of India investing considerable resources in promoting oilseed production. Sluggish growth in production after 1995 was due to a combination of factors such as rapid increase in imports of edible oils at a declining import tariff rate, consecutive droughts in major groundnut producing regions and increasing competition from crops like Bt cotton and soybean.

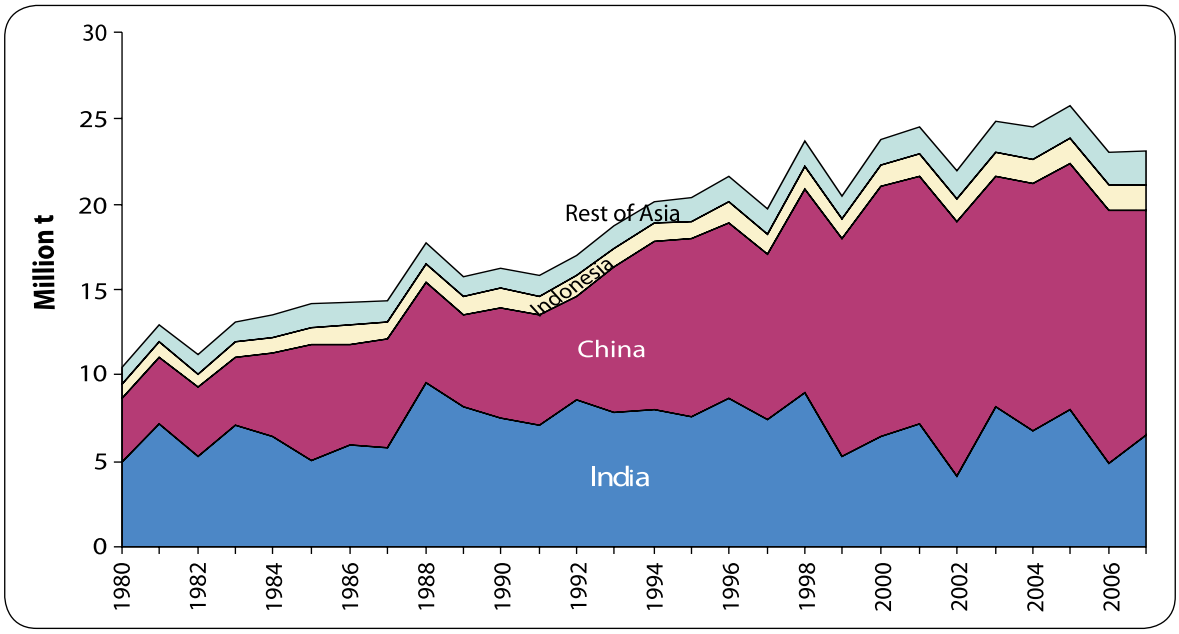


Figure 8. Trends in groundnut production in Asia.
Source: FAOSTAT (http://www.faostat.fao.org).

Though production trends in much of Asia have weakened, yield improvements continue to be the main driver of growth in groundnut production during 1996-2007 (Figure 4). The contribution of yield growth to output growth, however, varies across countries. In China, both area expansion and yield improvements contributed almost equally to the robust output growth experienced during 1981-95. Later on, production grew because of area expansion. In most Southeast Asian countries, contribution of yield to output growth improved. In contrast, in India yield growth was the main driver of output growth during 1981-95 (Annexure 3).

Production Constraints

Groundnut yield is low in most Asian countries, except in China and Vietnam, owing to a number of biotic and abiotic stresses, including its cultivation on marginal lands, moisture stress and frequent droughts, disease and pest attacks, low input use, etc. In addition, low output prices reduce incentives for farmers to invest in productivity-enhancing technologies such as improved seeds, fertilizers and pesticides.

Groundnut being a rainfed crop, its yield is largely determined by the quantum and temporal distribution of rainfall. It performs well even under low rainfall conditions if the rainfall is evenly distributed during the growing period. Moisture stress at critical growth stages can reduce yield substantially (Dhandhalya and Shiyani 2009). Irrigation is limited to a very small proportion of the total groundnut area. Hence, groundnut yield is uncertain and production is riskier, discouraging farmers from investing in technology, inputs and irrigation.

Lack of adoption of improved technologies is one of the main factors limiting improvement in groundnut yield. A majority of farmers grows traditional varieties that are adapted to local agro-ecological conditions, but have low genetic yield potential. In recent years, a number of new varieties with higher yield, better tolerance to drought and higher resistance to insect pests and diseases have been released by national and international agricultural research systems. However, their adoption is constrained by a lack of access to seed (seed requirement of groundnut is as high as 80 kg ha^{-1}-120 kg ha^{-1}) and outturn is

low and uncertain. Poor storage conditions and low use of seed treatment chemicals reduce seed quality. Seed multiplication and delivery systems too are poor. Private sector participation in seed multiplication and delivery is limited because of high seed requirement and a low multiplication factor. The public sector too has not shown much interest in multiplication and distribution of seed.

Groundnut is susceptible to a large number of fungal, viral and bacterial diseases, though all of them may not be economically important (Roy and Shiyani 2000). Diseases such as rust, early leaf spot, late leaf spot and bacterial wilt can cause considerable yield loss. Several insect pests such as the tobacco caterpillar, gram pod borer and leaf miner are economically important insects, reducing groundnut yield.

Aflatoxin contamination (by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*) is an important constraint affecting groundnut quality in most Asian countries. It is a major health risk to both humans and animals, and importing countries place strict restrictions on acceptable aflatoxin levels.

In addition to biophysical constraints, domestic and international trade policies have acted as disincentives to groundnut production. For example, with the implementation of the Agreement on Agriculture under WTO, many countries in Asia reduced import tariff on edible oils, which led to inflows of cheap imports like palm oil.

Utilization

Groundnut is a multi-purpose crop. Groundnut kernels are consumed directly raw, roasted and boiled or crushed for edible oil. Its byproducts are used as animal feed (oil pressings, seeds, green material and haulms) and industrial raw material (oilcake meal and fertilizer). Shells can be used as feed for livestock, burned for fuel, used in manufacturing of particle boards, etc.

Table 5. Trends in utilization of groundnut (in shell equivalent) in Asia ('000 t).

Region/ country	1981-83				2001-03			
	Total availability	Processing	Confectionery	Other uses[1]	Total availability	Processing	Confectionery	Other uses
World	**19,037**	**10,148**	**6,699**	**2,191**	**35,086**	**18,378**	**13,292**	**3,416**
Europe	584	291	289	4	994	260	727	7
North America	1,699	277	1,315	107	1,989	362	1,527	100
Oceania	49	4	41	3	72	6	63	3
Africa	3,945	1,814	1,412	718	8,343	4,564	2,595	1,183
Latin America	595	460	93	43	514	332	140	42
Asia	**12,103**	**7,300**	**3,488**	**1,315**	**23,183**	**12,857**	**8,244**	**2082**
East Asia	4,049	2,083	1,584	381	14,384	8,328	5,017	1,039
China	3,979	2,021	1,584	373	14,350	8,300	5,017	1,033
South Asia	6,494	5,263	443	788	6,467	5,029	501	936
India	6,376	5,177	427	772	6,322	4,923	483	915
Pakistan	81	58	12	11	104	73	16	16
Southeast Asia	1,656	1,359	126	171	2,071	1,763	135	174
Indonesia	802	728	0	74	753	690	0	63
Myanmar	520	464	0	56	728	665	0	63
Thailand	139	23	97	20	127	7	105	15
Vietnam	117	105	0	12	385	359	0	26
West Asia	89	80	1	8	139	125	5	9
Turkey	50	46	0	4	78	72	0	5

1. Other uses include seed, waste and feed.
Source: FAOSTAT (http://www.faostat.fao.org).

Table 5 shows the utilization pattern of groundnut in Asia and the world. Globally, over half of the groundnut produced is crushed into oil for human consumption or industrial uses, and slightly less than 40% is used directly as food, raw or processed as snacks. However, this pattern of utilization varies widely across regions. In Europe and North and Central America, more than three-fourths of the available supply is used as food, while in Asia 35% is utilized for food and 55% is crushed into oil. Within Asia too there are considerable differences in its utilization pattern. In China, 58% of the total supply is used to produce oil and 35% is consumed as food. In Thailand, a considerable proportion of the total supply is consumed as food. In most other countries including India, a considerable proportion is crushed to produce edible oil.

The use of groundnut, as direct food and processed products, has been expanding in most countries in Asia. In China, driven by increasing domestic supply, its utilization as food increased three-fold, and as processed products four-fold during 1981-2003. In India too, utilization of groundnut as food and processed products increased, but not as significantly as in China.

Table 6 depicts changes in consumption of groundnut oil in Asia. Groundnut meets 4.5% of the global edible oil demand. Between 1981-83 and 2001-03, global consumption of groundnut oil increased by 65%, from 2.9 million t to 4.7 million t. Asia accounts for close to 70% of the total groundnut oil consumed in the world – pretty much the same as its share in production. During this period, the total consumption of groundnut oil in Asia increased by 66%.

Groundnut fulfilled 6% of Asia's total demand for edible oils in 2001/03. Between 1981-83 and 2001-03, demand for groundnut oil in the region increased by 66%, from about 2 million t to 3.3 million t, and was driven by a tremendous increase in its consumption in China (250%). In Southeast Asia, particularly

Table 6. Trends in consumption ('000 t) of groundnut oil in Asia.

Region/country	1981-83	1991-93	2001-03
World	**2,859**	**3,947**	**4,716**
Europe	370	251	204
North America	91	86	99
Oceania	2	3	3
Africa	399	744	1114
Latin America	30	12	30
Asia	**1,966**	**2,851**	**3,265**
East Asia	456	933	1,574
China	454	927	1,571
South Asia	1,362	1,764	1,459
India	1,338	1,735	1,431
Pakistan	17	20	19
Southeast Asia	145	149	228
Indonesia	17	27	28
Myanmar	112	99	149
Thailand	6	5	12
Vietnam	6	15	36
West Asia	2	2	3

Source: FAOSTAT (http://www.faostat.fao.org).

Vietnam, demand for groundnut oil also increased rapidly. On the other hand, demand in India remained in the range of 1.33 million t to 1.74 million t despite a rapid increase in demand for edible oils as a whole. India meets a considerable proportion of its edible oil demand through imports of palm oil, one of the cheapest edible oils available in the international market. Groundnut oil in India is one of the costliest ones.

Figure 9 shows trends in consumption of groundnut oil vis-à-vis palm oil in India. The share of groundnut oil in the edible oil market, which was around one-third until 1991, declined to 20%-25% in the late 1990s and further to less than 15% in 2001-03. On the other hand, the market share of palm oil increased from 10% in 1995 to about 30% in 2003. India's imports of palm oil increased considerably after it lifted quantitative restrictions on imports and reduced import tariffs in the late 1990s. In China too, there has been a steady rise in the market share of palm oil, from 5% in the early 1980s to 15% in

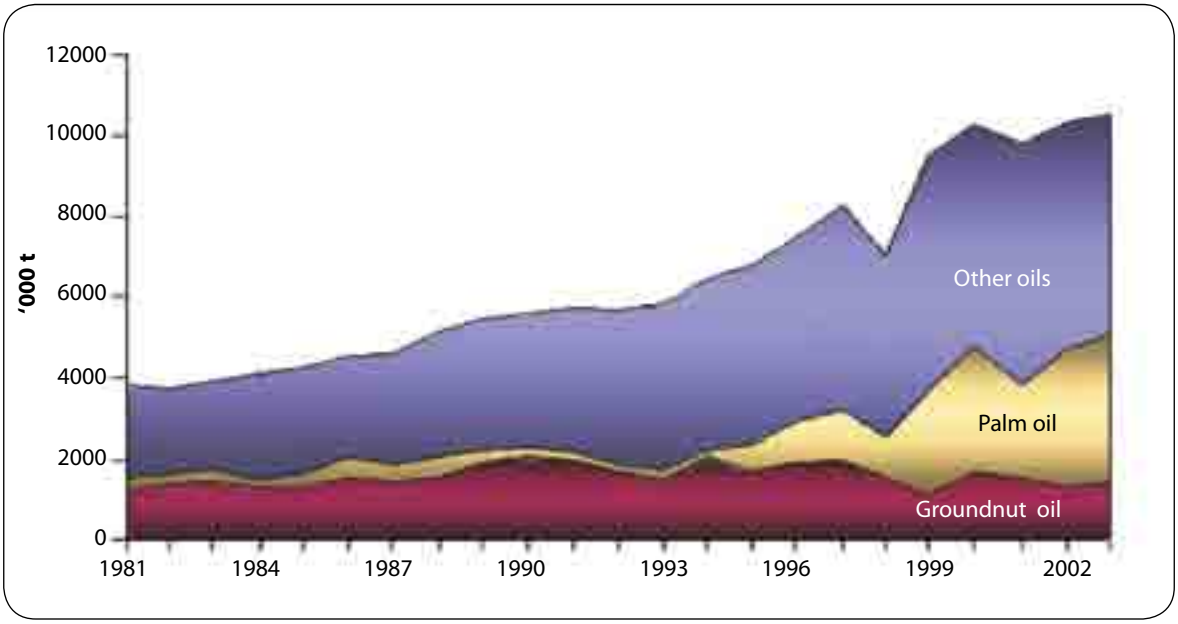


Figure 9. Trends in consumption of groundnut oil vis-à-vis palm oil in India.
Source: FAOSTAT(http://www.faostat.fao.org).

2003, while the share of groundnut remained around 15% during this period.

Groundnut oilcake meal, an important byproduct of groundnut crushed for oil, is used as a protein supplement in animal feed. Supply of groundnut meal is directly related to the demand for groundnut oil. Nonetheless, demand for groundnut meal has a high degree of substitutability; hence its demand depends on factors like the relative prices of cakes of other oilseeds and other feed substitutes, including cereal-based substitutes. Table 7 shows the consumption of groundnut oilcake meal in Asia vis-à-vis the world. Globally, groundnut oilcake meal accounts for about 2.5% of the total oilcake meal supply. In Asia, its share in total supply is 40%. Nonetheless, there has been a rapid growth in its demand in Asia. Between 1981-83 and 2001-03, its total consumption increased by 90% as against a 75% increase in global demand. Rapid increases took place in China, Thailand and Vietnam. The demand for groundnut oilcake meal in India, by and large, remained static.

Demand for animal feed is derived from demand for livestock products. In most Asian countries, fuelled by rapid income growth and a fast-growing urban population, demand for animal products has been growing faster compared to foodgrains. Annual per capita meat consumption in Asia more than doubled,

Table 7. Trends in demand ('000 t) for groundnut oilcake meal in Asia.

Region/country	1981-83	1991-93	2001-03
World	**3,749**	**4,748**	**6,568**
Europe	699	361	222
North America	83	165	162
Oceania	2	5	3
Africa	463	619	1,644
Latin America	100	58	96
Asia	**2,350**	**3,541**	**4,442**
East Asia	535	1,922	2,263
China	531	1,920	2,261
South Asia	1,599	2,033	1,795
India	1,571	1,994	1,762
Pakistan	20	26	23
Southeast Asia	214	358	377
Myanmar	148	160	233
Thailand	10	96	54
Indonesia	22	55	43
Vietnam	8	38	43
West Asia	1	5	5

Source: FAOSTAT (http://www.faostat.fao.org).

from 11 kg in 1981-83 to 27 kg in 2001-03. There was a substantial increase in per capita meat consumption in China, from 15 kg to 54 kg. In India, though annual per capita meat consumption is low, it increased from 3 kg to 5 kg between 1981-83 and 2001-03. The main drivers of demand for oilcake meal in Asia were the expanding dairy and poultry sectors.

International Trade

International trade in groundnut and its products is thin; only 5% of the global production (in shell equivalent) is traded in international markets (Diop et al. 2004). It is traded in the form of edible groundnuts (shelled and in shell), edible oil and oil cake meal. Amongst different forms, shelled groundnut is the most traded, having a share of 56% in the total trade in groundnut products in 2003-05 (Table 8). Groundnut oil and oilcake meal each has almost an equal share in the groundnut trade.

Since the 1980s, international trade in groundnuts has undergone a significant change, in volume as well as composition. Between 1981-83 and 1993-95, total value of groundnut trade increased by 11%, but then contracted by 24% between 1993-95 and 2003-05. The decline was more pronounced in the case of oilcake meal, whose share in total trade dropped from 35% in 1993-95 to 16% in 2003-05. The share of edible groundnuts (in shell and shelled), on the other hand, increased from about 50% to 67%. Among the important reasons for the decline in trade in groundnut products (oil and oilcake meal) are their declining competitiveness in relation to their substitute products, and increasing consumer concern over aflatoxin contamination, especially when agri-food markets are globalizing and food safety and quality standards are becoming stringent in international markets (Box 3).

Table 8. Trends in global exports (in US$ million) of groundnut and groundnut products.

Product	1981-83	1993-95	2003-05
Groundnut in shell	89	115	155
Groundnut shelled	553	820	784
Groundnut oil	304	273	243
Groundnut oilcake meal	727	647	224
Total	**1,673**	**1,855**	**1,406**

Source: FAOSTAT (http://www.faostat.fao.org).

Confectionery groundnut: International trade in confectionery groundnut increased rapidly until the mid-1990s. Global exports of shelled groundnut increased by more than 60% between 1981-83 and 1993-95, but have declined marginally since then. Developing countries account for more than three-fourths of the global exports (Table 9). The volume of exports from developing countries has also increased.

Asia accounts for over half of the global exports of confectionery groundnut, which almost doubled between 1981-83 and 1993-95, from 290,000 t to 584,000 t, but stagnated afterwards. Latin American and Caribbean countries control one-fifth of the global exports, followed by North America (13%). United States is the single largest exporter of confectionery groundnut from North America, and Argentina and Brazil from Latin America.

China is the largest exporter of confectionery groundnut in the world. It shares over one-third of the global exports and 62% of the total exports from Asia. India with a share of 22% in Asia's total exports, is the second largest exporter. Exports of shelled groundnut, both from China and India, have been rising but more rapidly from India. Between 1981-83 and 2003-05, China's exports increased by 115% and India's by 263%. Vietnam is also an important exporter of confectionery groundnut, whose exports increased until the mid-1990s, but declined considerably afterwards. In fact, in the mid-1990s, Vietnam was the second largest exporter of confectionery groundnut from Asia after China.

Global imports of confectionery groundnut increased by 83% between 1981-83 and

Box 3. Aflatoxin contamination in groundnut

A number of agricultural commodities are attacked by fungi that produce mycotoxins which cause deterioration in their quality. Among various mycotoxins, aflatoxins have considerable potential to cause harm to human beings, livestock and poultry through the food chain. Aflatoxin contamination is caused by the fungus *Aspergillus*. There are two species of this fungus: *Aspergillus flavus* predominantly occurs in Asia and Africa, and *Aspergillus parasiticus* is mostly found in the Americas. Groundnut is often contaminated by aflatoxin, both at pre- and post-harvest stages. Consumption of aflatoxin-contaminated food can cause cancer, reduce immunity and impair growth. In view of such harmful effects, many countries have strengthened regulations by setting permissible limits to check imports of aflatoxin-contaminated groundnut and groundnut products (see table below).

Permissible limits of aflatoxin contamination						
	1995			2003		
Aflatoxin and commodity	Median (µg/kg)	Range (µg/kg)	No. of countries	Median (µg/kg)	Range (µg/kg)	No. of countries
Afla B1 in foodstuff	4	0-30	33	5	1-20	61
Afla B1 + B2 +G1+ G2 in foodstuff	8	0-50	48	10	0-35	76
Afla M1 in milk	0.05	0-1	17	0.05	0.05-15	60
Afla B1 in feedstuff	5	5-50	25	5	5-50	39
Afla B1 + B2 +G1+ G2 in feedstuff	20	0-1	17	20	0-50	21
Source: FAO (2006).						

Though it is difficult to reduce aflatoxin contamination altogether, it can be minimized following appropriate pre- and post-harvest preventive and curative management practices. Pre-harvest management includes the use of aflatoxin-resistant varieties, seed treatment, use of gypsum, farmyard manure and *Trichoderma*, avoidance of terminal drought conditions, removal of dead plant, and crop harvest at right maturity. Post-harvest management requires minimizing mechanical damage to pods, drying pods below a moisture level of 8%, stripping pods immediately after drying, stacking pod-filled gunny bags on wooden planks and their storage in aerated waterproof structures.

2003-05. Growth, however, was higher until the mid-1990s. The growth was fuelled by developing countries. Their share in global imports increased from 30% in 1981-83 to 40% in 2003-05. Europe accounts for the bulk of imports of confectionery groundnut. Since the early 1980s, its share in global imports has remained between 40% and 60%. Asia's share in global imports is about 25%, yet it retains its status of being a net exporter. In Asia, imports of confectionery groundnut are confined to East and Southeast Asian countries (except Vietnam). China and India too import small quantities. Both

Table 9. Exports and imports ('000 t) of confectionery groundnut by region and country.

Region/ country	Exports			Imports		
	1981-83	1993-95	2003-05	1981-83	1993-95	2003-05
World	**713**	**1,163**	**1,066**	**705**	**1,162**	**1,285**
Developed countries	**184**	**238**	**157**	**496**	**654**	**777**
Europe	20	146	86	425	548	684
North America	172	194	132	62	92	78
Oceania	4	2	7	9	14	16
Developing countries	**517**	**821**	**841**	**209**	**508**	**508**
Africa	160	90	63	20	86	91
Latin America	67	147	193	7	49	101
Asia	**290**	**584**	**584**	**182**	**373**	**317**
East Asia	211	362	363	106	77	51
China	169	347	363	0	2	3
South Asia	35	84	127	0	1	21
India	35	84	127	0	0	0
Southeast Asia	39	137	71	70	280	189
Vietnam	26	113	61	0	0	0
Indonesia	0	0	0	38	136	85
West Asia	5	1	15	5	15	55

Source: FAOSTAT (http://www.faostat.fao.org).

account for the bulk of global exports and have a positive trade balance. Most other countries in Southeast and West Asia are net importers of confectionery groundnut.

Groundnut oil: International trade in groundnut oil is thin and has been declining in both value and volume. Since the early 1980s, the global market shrunk by almost half – total exports of groundnut oil declined from 434,000 t in 1981-83 to 292,000 t in 1993-95 and further to 222,000 t in 2003-05 (Table 10). The declining trends prevailed across developing as well as developed countries. The share of developed countries declined to 44% in 2003-05 from 57% in 1981-83.

India and China are two major exporters of groundnut oil, each having a share of about 10% in the global pie. China's exports, however, shrank drastically, from 61,000 t in 1981-83 to 20,000 t in 2003-05. In contrast, India's exports picked up in the early 2000s, which otherwise were negligible. Decline in China's exports can be attributed to increasing domestic demand. In fact, both India and China import huge quantities of palm oil to meet their domestic demand. The decline in exports of groundnut oil was nearly universal. Between 1981-83 and 2003-05, exports of groundnut oil fell by 35-40% in Europe, Asia and Latin America and by 75% in Africa.

Traditionally, Europe has been the largest importer of groundnut oil. It accounted for about 70% of global imports in 2003-05. Africa and North America are other important importers. Most countries in Asia (except China and India) are net importers. Nevertheless, imports of groundnut oil have been falling. The contracting international market for groundnut oil can be attributed to the availability of cheaper substitutes like palm oil. Between 1981-83 and 2003-05, global exports of palm oil increased 6.5 times, from 3.7 million t to 23.8 million t in 2003-05.

Groundnut oilcake meal: International trade in groundnut oilcake meal is small and has fallen sharply since the mid-1990s. Its global exports shrank by 11% between 1981-83

Table 10. Exports and imports ('000 t) of groundnut oil by region and country.

Region/ country	Exports			Imports		
	1981-83	1993-95	2003-05	1981-83	1993-95	2003-05
World	**434**	**292**	**222**	**430**	**324**	**233**
Developed countries	**249**	**150**	**97**	**355**	**253**	**200**
Europe	80	56	52	348	242	166
North America	11	33	13	5	9	32
Oceania	0	0	0	2	2	3
Developing countries	**342**	**203**	**156**	**76**	**71**	**33**
Africa	169	94	44	25	14	9
Latin America	99	67	66	2	2	2
Asia	**74**	**42**	**46**	**49**	**55**	**23**
East Asia	66	38	21	40	46	18
China	61	31	20	7	12	2
South Asia	0	0	21	0	0	0
India	0	0	21	0	0	0
Southeast Asia	9	3	1	9	6	4
West Asia	0	0	3	1	2	1

Source: FAOSTAT (http://www.faostat.fao.org).

and 1993-95, and further by 65% between 1993-95 and 2003-05. Developing countries control 90% of the global exports; in 2003-05, Asia and Africa accounted for 72% and 10% of the global exports, respectively (Table 11). There has been a significant decline in exports of groundnut oilcake meal from both Africa and Asia, but at a faster rate from Africa.

Table 11. Exports and imports ('000 t) of groundnut oilcake meal by region and country.

Region/ country	Exports			Imports		
	1981-83	1993-95	2003-05	1981-83	1993-95	2003-05
World	**727**	**647**	**224**	**718**	**666**	**202**
Developed countries	**55**	**57**	**11**	**657**	**259**	**55**
Europe	24	39	7	657	255	41
North America	31	18	4	0	1	14
Oceania	0	0	0	0	3	0
Developing countries	**672**	**591**	**213**	**61**	**407**	**147**
Africa	251	140	22	11	16	4
Latin America	79	51	28	1	11	24
Asia	**342**	**399**	**162**	**49**	**380**	**119**
East Asia	9	35	6	1	28	60
China	9	35	6	0	24	59
South Asia	322	343	152	1	0	2
India	313	343	152	0	0	0
Southeast Asia	12	21	4	46	349	54
Indonesia	0	5	0	6	185	27
Malaysia	0	0	0	24	33	0
Thailand	0	0	0	3	127	27
West Asia	0	0	0	0	3	3

Source: FAOSTAT (http://www.faostat.fao.org).

China is the largest producer of groundnut oilcake meal, and much of it is consumed domestically as animal feed. On the other hand, India is its largest exporter, accounting for over two-thirds of the global exports in 2003-05. India's exports were steady until the mid-1990s, but declined drastically afterwards, reaching only 152,000 t in 2003-05. This can be attributed to stringent aflatoxin regulation norms by importing countries (Box 3).

Global imports of groundnut oilcake meal have declined sharply in the past two decades, from 718,000 t in 1981-83 to 666,000 t in 1993-95 and further to 202,000 t in 2003-05. The big change, however, is Asia's emergence as the largest importer of groundnut oilcake meal displacing Europe that used to be a major market until the mid-1990s. In fact, Europe accounted for over 90% of the global imports in 1981-83, which declined to 38% in 1993-95 and further to 20% in 2003-05. On the other hand, Asia's share increased to 60% in 2003-05, from a mere 7% in 1981-83. China and Japan were the main importers in 2003-05. The increasing demand was driven by a fast-expanding livestock industry there (Birthal and Parthasarathy Rao 2009). In 1993-95, Indonesia and Thailand were the main importers, but their share declined drastically after the late 1990s due to the financial crisis that caused a setback to their poultry industry – a major consumer of oilcake meals (Delgado et al. 1999).

International Prices

In real terms, the international prices of edible groundnuts and groundnut oil declined, (Figure 10). During 1980-2005, the price of shelled groundnut declined at an annual rate of 3.3% and of groundnut oil by 1.8%. Prices were higher during the 1980s and earlier when the world groundnut market was dominated by the United States, and China was not an important exporter of groundnut or its products. United States accounted for 27% of the global exports of groundnut during the 1980s, which declined to 18% during 1995-2006. On the other hand, China's share increased from a mere 4% during the 1980s to 28% during 1995-2006. Decline in prices can partly be attributed to increasing exports of groundnut from China, apart from domestic and trade policies of the major producing countries.

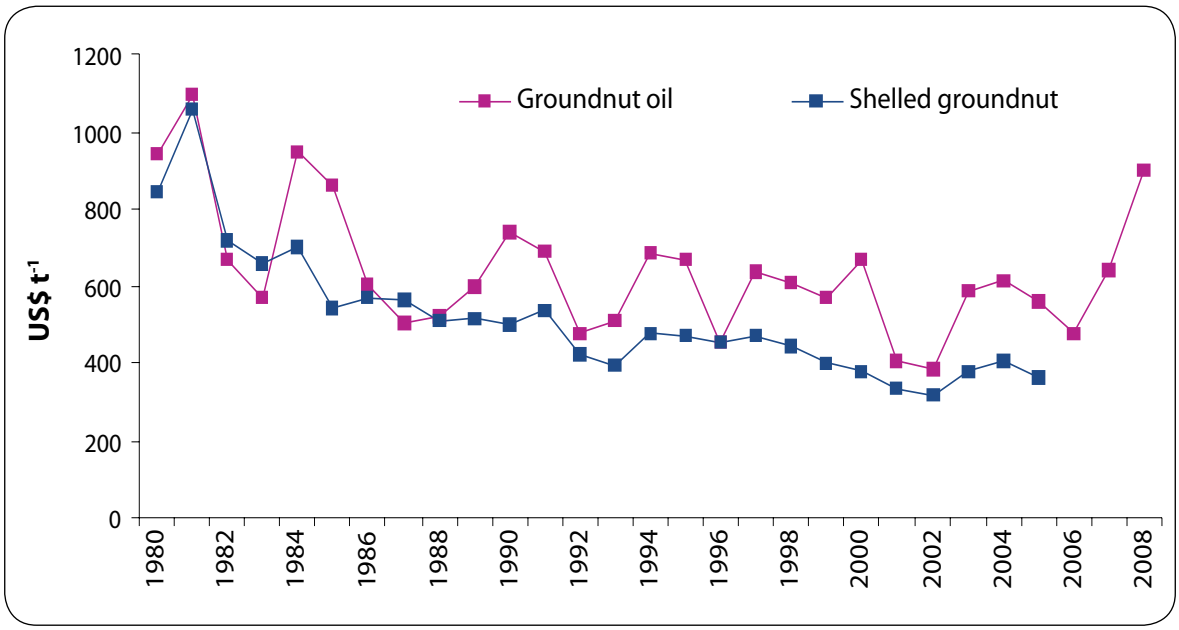


Figure 10. Trends in world export prices of groundnut kernels and groundnut oil (at 1983-84 constant US$).

Source: FAOSTAT (http://www.faostat.fao.org).

Since 2006, real prices of groundnut oil and shelled groundnut have increased dramatically, from US$ 450 t^{-1} in 2006 to US$ 900 t^{-1} in 2008. From the year 2000 onward, prices of all oilseeds have shown an increasing trend, which reflects a spillover effect of rising prices in the grain market, increased demand for oilseeds (rapeseed and soybean) for biofuel and tighter global supplies.

Farm-gate price is one of the measures of a country's competitiveness in production and thereby exports. We have compared producer prices of groundnut in major producing countries to examine their competitiveness in production. Figure 11 shows trends in producer prices of groundnut in China, India and USA (at 1983-84 constant US$). Real producer prices of groundnut in China and India have remained below US prices. The price of groundnut in USA, however, has declined rapidly. With steady growth in production, China emerged as the main competitor to US exports. This seems to be one of the most important reasons for a secular decline in groundnut prices in USA. However, the real price of groundnuts in China showed a cyclical pattern; increasing during 1991-96, declining until 1999, and increasing thereafter. In India, real prices declined until 2000, but increased thereafter. In 2003-05, real prices of groundnut in USA and India were at par, but lower than those in China. These trends imply considerable scope to improve the efficiency of groundnut production in India and China. Although groundnut yield has remained higher in USA than in China, since the mid-1990s it has increased faster in USA (2.3%) than in China (1.2%).

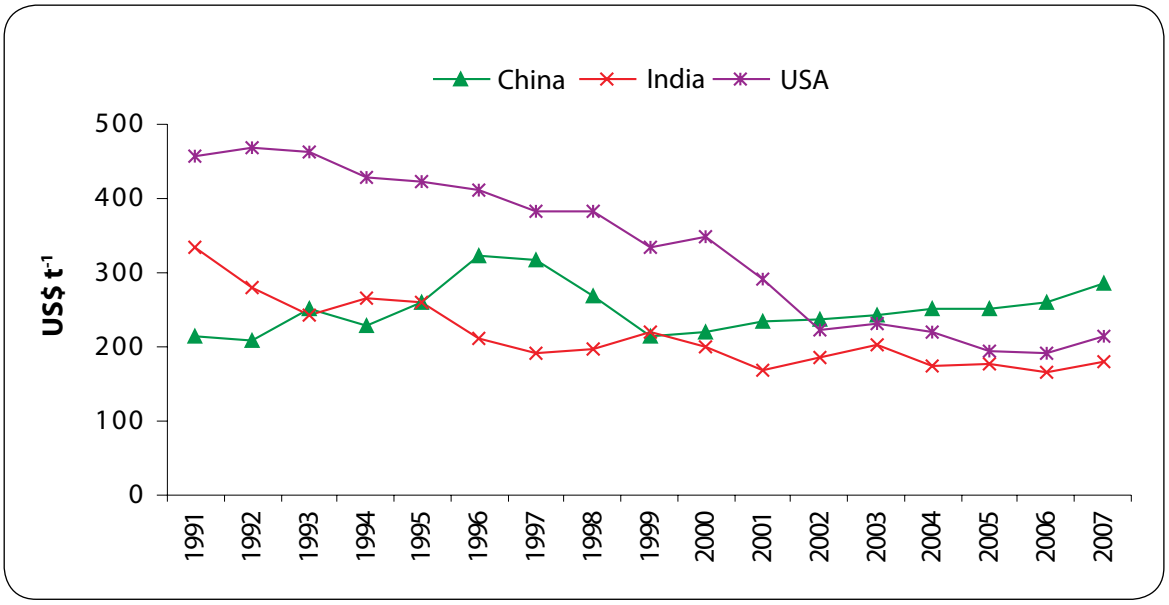


Figure 11. Real producer prices of groundnut in China, India and the USA (at 1983-84 constant US$).

Source: FAOSTAT (http://www.faostat.fao.org).

3. Soybean: Facts and Trends

Soybean (*Glycine max*) is one of the most important and fastest growing oil-bearing crops in the world. During 1981-2007, the world's soybean area grew at an annual rate of 2.6% and production by 4% – higher than the growth in area and production of most other food crops. Soybean accounts for 37% of the global area under oilseeds, and contributes 28% to vegetable oil production. The crop's adaptability to varied agro-ecological environments – the tropics, subtropics and temperate – is one of the main reasons for its rapid spread across the globe.

Soybean is a high-value nutritive crop, hence it plays a significant role in overcoming problems of food and nutritional insecurity, especially in developing countries (Thoenes 2004). On an average, soybean contains 34% protein, 35% carbohydrates and 20% fat, besides several minerals (calcium and phosphorus) and vitamins (A and B). Soybean oil is highly digestible and has almost no saturated fats. From the perspective of sustainability of agricultural systems, soybean's leguminous nature helps improve soil fertility.

Consumption of soybean-based foods has been a long tradition in many Asian and African countries. Traditional soy-foods like tofu, miso, tempeh, soya sauce, etc, are derived either directly from whole fresh beans or from processing beans into soy milk. In recent years, soy-foods have expanded to include fresh beans and sprouts, grain products (soy bread, pasta and flour), dairy substitutes (soymilk and cheese) and meat substitutes. Soybean oilcake meal is an excellent feedstuff for livestock and poultry. Soybean oilcake meal comprises 60% of the global oilcake meal production.

Crop Distribution

Though soybean can be grown in different environments, its cultivation is largely concentrated in Latin America and North America, which together occupy over three-fourths of the global soybean area (Table 12). United States, Brazil and Argentina are important soybean growing countries in these regions, and account for 30%, 23% and 16% of the global soybean area, respectively. In Latin America, soybean area has expanded spectacularly during the last two and a half decades, from 11 million ha in 1981-83 to 41 million ha in 2005-07, at an annual rate of about 5%. Rapid expansion, however, occurred in the most recent decade (Annexure 4). Soybean area also expanded in North America, but not as much as in Latin America. In fact, soybean area in North America declined by 2.7 million ha between 1981-83 and 1993-95, but recouped to reach 31 million ha in 2005-07. The tremendous increase in soybean area in these countries occurred because of rapid adoption of genetically modified herbicide-tolerant soybean seeds (Box 4).

In Asia, soybean is grown on over 19 million ha, equivalent to one-fifth of the global soybean area (Table 12). However, its cultivation is concentrated in China in East Asia and in India in South Asia (Figure 12), which together account for over 90% of Asia's total soybean area. Southeast Asia accounts for about 6%, and most of it is concentrated in Indonesia and Vietnam.

In China, soybean is grown on over 9 million ha, equivalent to 6% of the arable land. Heilongjiang province is the leading soybean producer and accounts for 37% of the country's soybean area and production (Map 5 and Annexure 5). Anhui, Neimenggu, Jilin and Henan are other important soybean producing provinces (Annexure 5). Together, they account for 30% of China's total soybean area and 25% of the total production.

In India, soybean has emerged from a little known crop until the early 1970s to an important oilseed crop. In 2005-06, it accounted for about 27% of the total 28 million ha under oilseeds, and contributed 24% to the total 28 million t of oilseeds produced in the country. Over 90% of India's soybean area lies in

Table 12. Area, yield and production of soybean in different regions of the world.

Region/ country	Area ('000 ha)			Yield (kg ha^{-1})			Production ('000 t)		
	1981-83	1993-95	2005-07	1981-83	1993-95	2005-07	1981-83	1993-95	2005-07
World	**51,170**	**61,505**	**94,087**	**1,705**	**2,052**	**2,313**	**87,229**	**126,203**	**217,598**
Developed countries	**29,147**	**26,171**	**33,062**	**1,930**	**2,423**	**2,629**	**56,268**	**63,401**	**86,915**
Europe	1,355	1,119	1,999	850	1,533	1,577	1,152	1,716	3,153
North America	27,747	25,023	31,041	1,984	2,463	2,697	55,038	61,633	83,717
Oceania	46	30	22	1,701	1,775	2,116	78	52	46
Developing countries	**22,023**	**35,333**	**61,025**	**1,406**	**1,777**	**2,141**	**30,961**	**62,802**	**130,682**
Africa	468	883	1,190	796	683	1,156	373	603	1,375
Latin America	11,375	18,281	40,541	1,728	2,155	2,515	19,655	39,402	101,950
Asia	**10,180**	**16,169**	**19,294**	**1,074**	**1,410**	**1,418**	**10,934**	**22,797**	**27,357**
East Asia	8,533	9,442	9,734	1,122	1,653	1,701	9,572	15,606	16,556
China	8,003	8,939	9,198	1,173	1,672	1,720	9,384	14,948	15,817
South Korea	308	315	298	1,178	1,237	1,156	363	390	345
Japan	146	72	142	1,491	1,468	1,618	218	106	230
North Korea	189	115	95	1,264	1,408	1,721	239	161	164
South Asia	684	4,682	8,320	749	1,016	1,095	512	4,759	9,112
India	694	4,575	8,197	700	1,004	1,080	486	4,591	8,855
Iran	51	78	96	1,940	1,895	2,388	99	148	230
Southeast Asia	948	2,002	1,190	876	1,171	1,331	830	2,344	1,584
Indonesia	686	1,452	592	856	1,138	1,296	587	1,651	768
Vietnam	91	124	223	713	953	1,434	65	119	320
Thailand	127	350	142	1,111	1,427	1,537	141	499	218
Myanmar	26	47	134	731	812	1,079	19	38	144
West Asia	16	38	15	1,236	2,176	3,459	19	83	51

Source: FAOSTAT (http://www.faostat.fao.org).

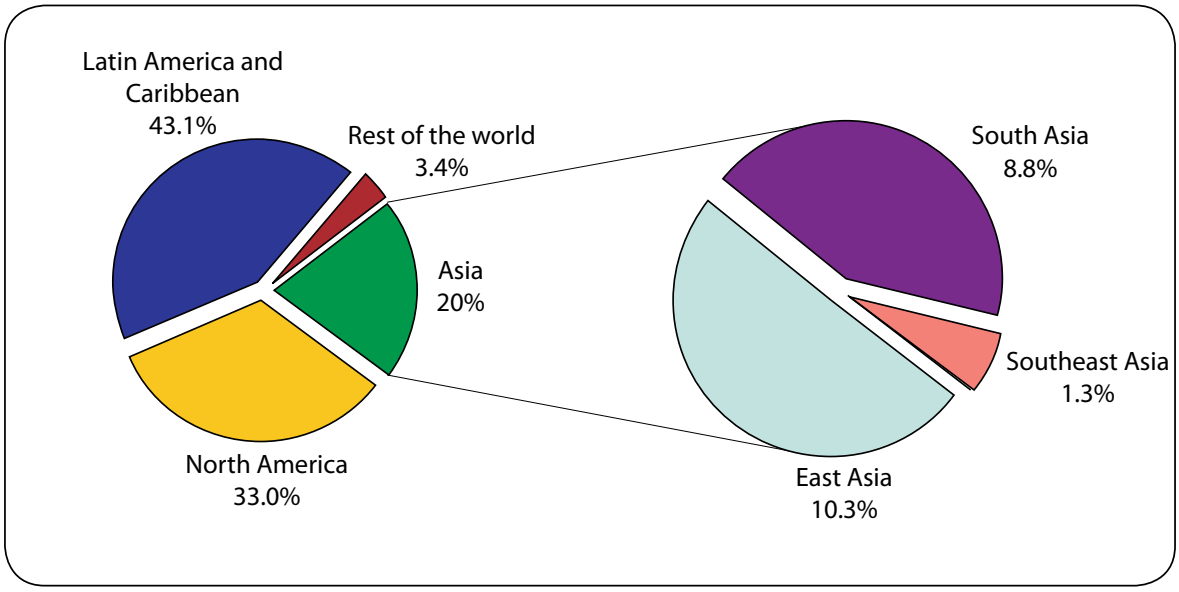
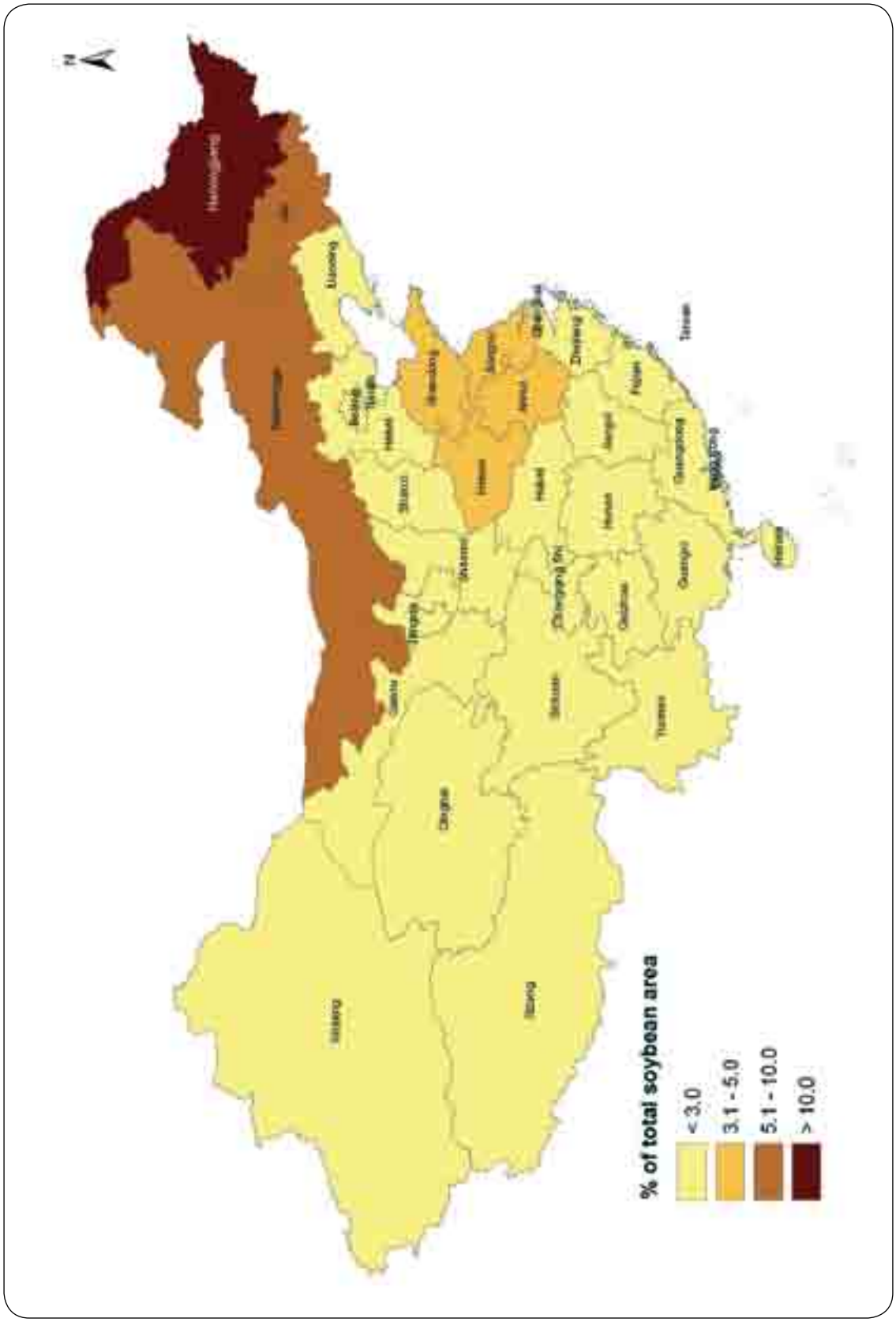


Figure 12. Distribution of global soybean area, 2005-07.

Source: FAOSTAT (http://www.faostat.fao.org).



Map 5. Distribution of soybean area in China across provinces, 2004-06.

Box 4. Technology-led expansion in soybean area

Genetically modified (GM) herbicide-tolerant soybean was first commercially introduced in 1996 in the United States. Since then, the area under GM soybean across the world has increased considerably, reaching over one-third of the total soybean area in 2007. In the USA and Argentina, GM varieties have almost completely replaced traditional varieties. In 2008, approximately 98% of the total soybean in Argentina, 92% in the USA and 64% in Brazil were cultivated with GM seeds. One of the main reasons for such a rapid spread of GM soybean was its potential to reduce herbicide use and the cost of production. According to Brookes and Barfoot (2008), the yield of genetically modified soybean was no different from traditional soybean varieties, but GM soybean could reduce herbicide use by 28% in USA, 20% in Argentina and 4% in Brazil, leading to a saving in production cost ranging from US$ 24 ha^{-1}-US$ 88 ha^{-1}.

A global assessment of the impacts of GM soybean suggests a reduction in herbicide use by 19% and an increase in farm income by US$ 4.14 billion, primarily due to savings in cost of weed control. An additional impact of GM soybean had been the planting of a second crop of soybean in the same growing season. Cultivation of a second crop is facilitated by ease of management of the GM soybean crop, which allows farmers to use reduced or no-tillage; hence more time for planting, growing and harvesting a second crop. GM crops also contribute towards reduction in greenhouse gases – which result from a reduced use of fuel due to less frequent herbicide or insecticide applications and also reduced use of fossil energy in cultivation (no till system). Brookes and Barfoot (2008) estimated permanent carbon dioxide savings from reduced fuel use (with GM soybean) closer to 1 billion kg. Additional soil carbon sequestration resulting from reduced tillage (with GM soybean) could reduce carbon dioxide emissions by 8.5 billion kg.

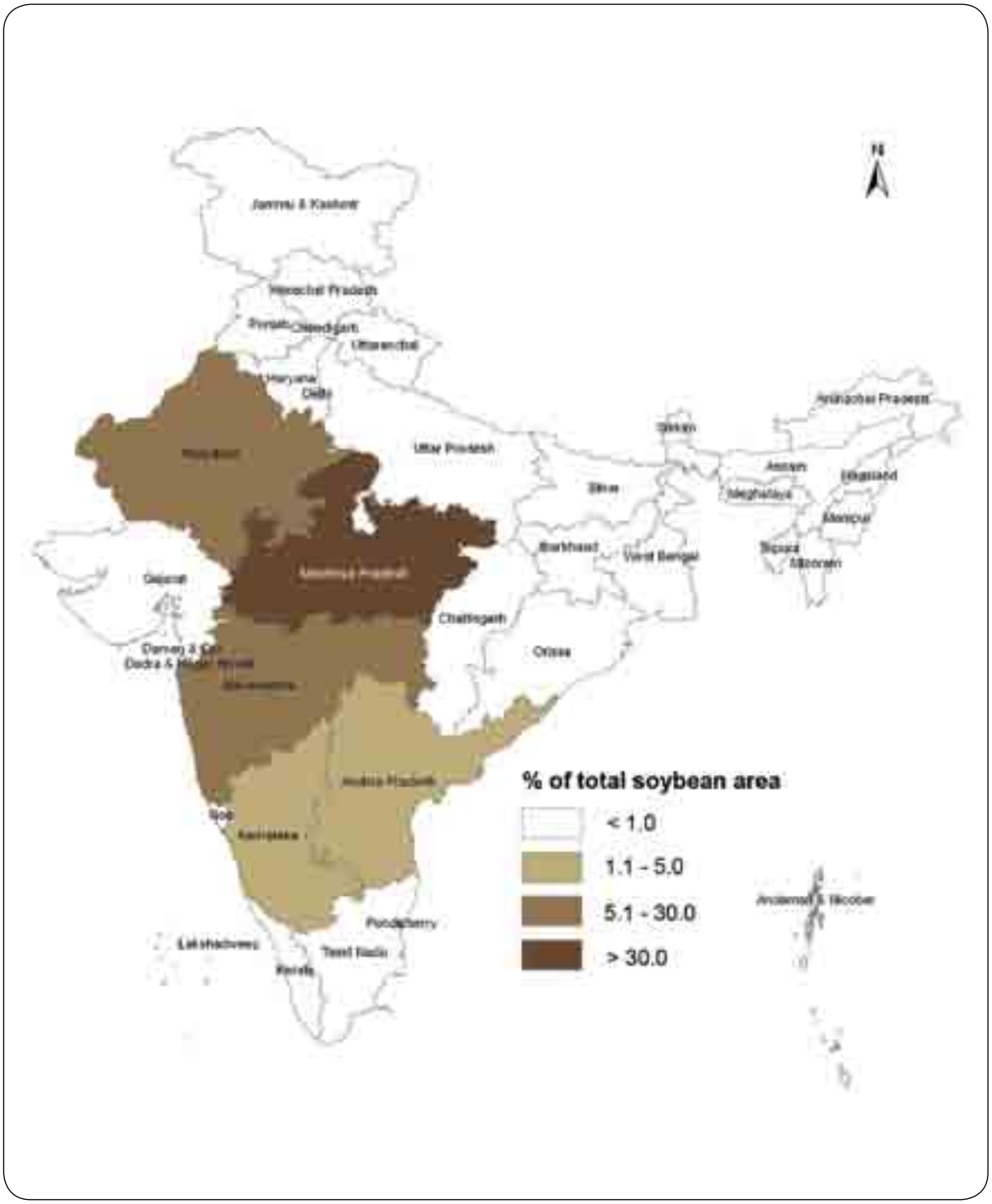
the semi-arid tropics. The crop is grown under rainfed conditions, and hardly 2% of the total area is irrigated. Most of the soybean area in India is in the states of Madhya Pradesh (55%), Maharashtra (31%) and Rajasthan (10%). State-wise distribution of soybean area in India is shown in Map 6 (also see Annexure 6).

Trends in Area, Yield and Production

Area

The world's soybean area has expanded rapidly during the last few decades. Between 1981-83 and 2005-07, it increased from 51 million ha to 94 million ha at an annual rate of 2.6% (Table 12). Soybean area expanded much faster in Latin America and Africa, at an annual rate of 4.9% and 4.1%, respectively as compared to 2.7% in Asia and 0.9% in North America.

In India, soybean area grew tremendously, albeit from a low base. Soybean was a little known crop until 1970. It was introduced in rainfed regions of Madhya Pradesh in the early 1970s, and since then its cultivation has expanded rapidly (Dupare et al. 2008). It increased from a mere 0.7 million ha in 1981-83 to over 8 million ha in 2003-05 at an annual rate of 10.6% (Figure 13 and Table 13). Initially, the crop was targeted to utilizing rainy season fallow lands, but subsequently it started replacing less profitable foodgrain crops



Map 6. Distribution of soybean area in India across states, 2003-05.

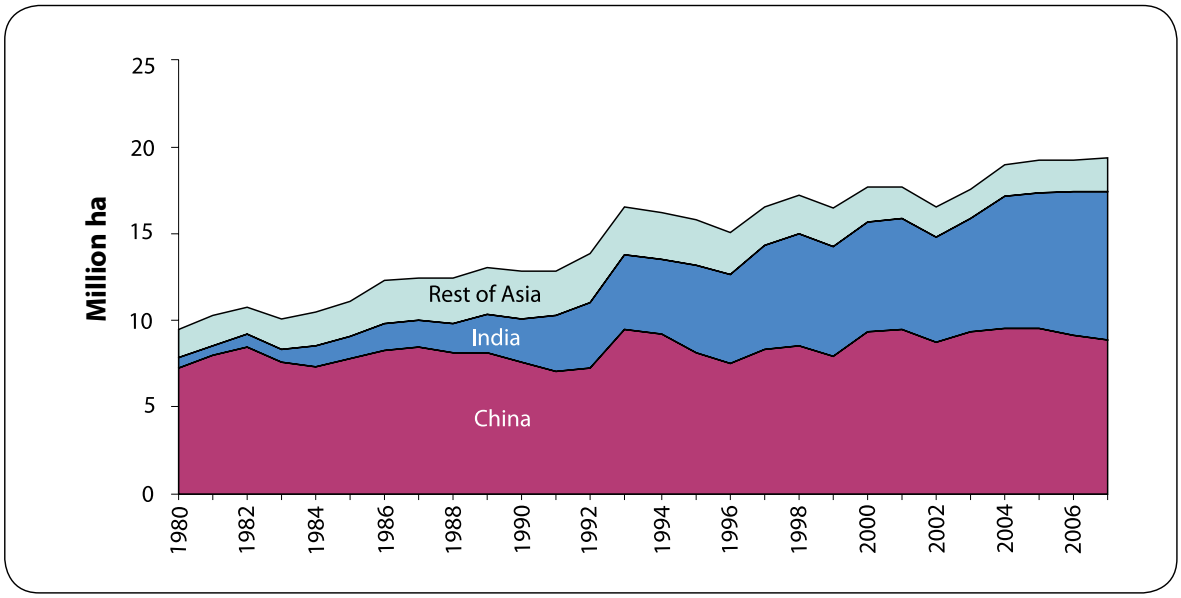


Figure 13. Trends in soybean area in Asian countries.

Source: FAOSTAT (http://www.faostat.fao.org).

Table 13. Annual growth rates (%) in area, yield and production of soybean, 1981-2007.

Region/country	Area	Yield	Production
World	**2.57**	**1.41**	**4.01**
Developed countries	**4.02**	**-1.65**	**2.29**
Europe	-0.71	2.54	1.77
North America	0.94	1.38	2.33
Oceania	-3.42	0.83	-2.48
Developing countries	**0.86**	**4.98**	**5.88**
Africa	4.14	1.30	5.54
Latin America	4.91	1.84	6.83
Asia	**2.69**	**0.95**	**3.67**
East Asia	0.67	1.63	2.31
China	0.80	1.72	2.53
South Korea	-0.37	-0.46	-0.83
Japan	-0.61	0.13	-0.48
North Korea	-3.51	0.59	-2.95
South Asia	10.25	1.56	11.97
India	10.61	1.84	12.65
Iran	2.44	1.04	3.51
Southeast Asia	-0.12	1.56	1.43
Indonesia	-1.48	1.59	0.09
Vietnam	3.02	3.06	6.17
Thailand	-1.04	1.23	0.18
Myanmar	8.56	1.58	10.28
West Asia	-3.66	2.72	-1.18

Source: FAOSTAT (http://www.faostat.fao.org).

such as sorghum, pearl millet and black gram (Bisaliah 1986). This is corroborated by Figure 14 that shows trends in soybean vis-à-vis sorghum area in Madhya Pradesh. Gradually, the crop spread to neighboring areas of Maharashtra and Rajasthan having similar climatic conditions as the soybean growing regions of Madhya Pradesh.

In China, soybean area did not expand as fast as in India. Between 1981-83 and 2005-07, only an additional 1.2 million ha was brought under its cultivation, raising the total area to 9.2 million ha in 2005-07. Across provinces, soybean area expanded rapidly in Heilongjiang, where it almost doubled from 1.9 million ha in 1981-83 to 3.5 million ha in 2005-07, and in Inner Mongolia where it increased from 200,000 ha to 770,000 ha during this period. Soybean area also expanded in Anhui (30%), where it is grown on about one million ha. In other major soybean growing provinces such as Henan, Jilin, Liaoning and Shandong, soybean area has declined considerably since the early 1980s.

Trends in soybean area for Southeast Asian countries are mixed. It increased considerably in Indonesia and Thailand until the mid-1990s, but fell significantly afterwards. Though Vietnam and Myanmar account for a

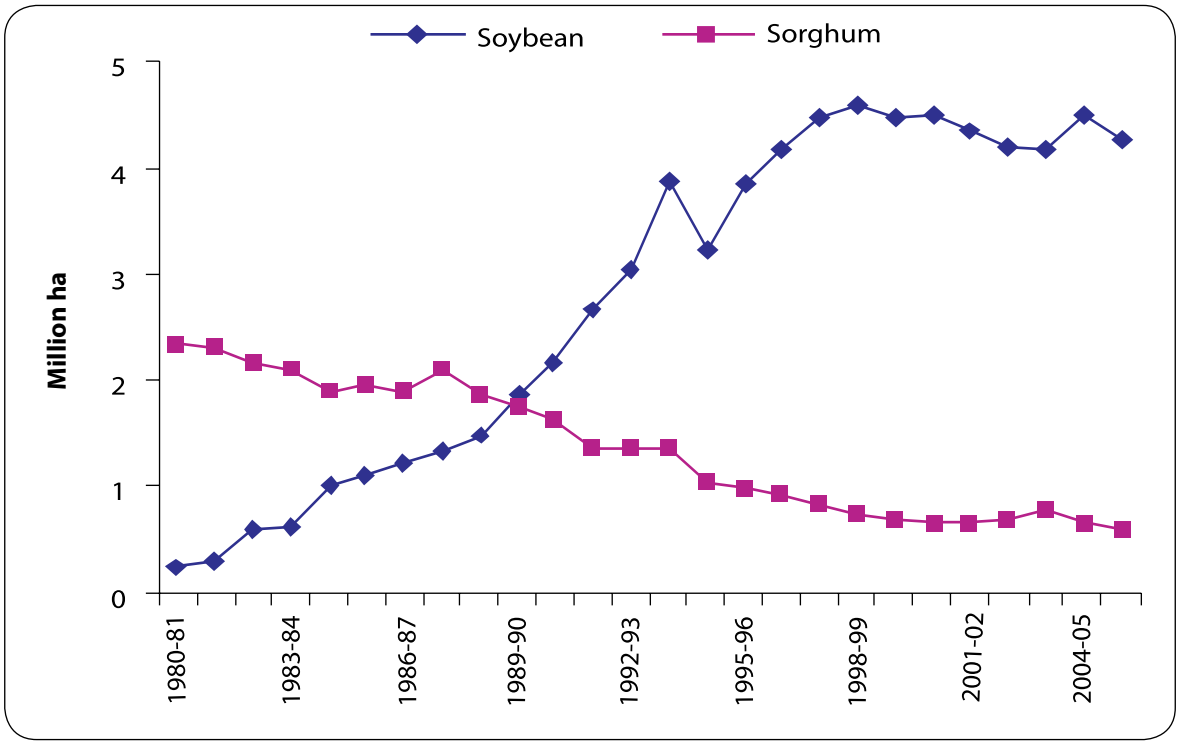


Figure 14. Trends in sorghum and soybean area in Madhya Pradesh, India.

Source: ICRISAT database.

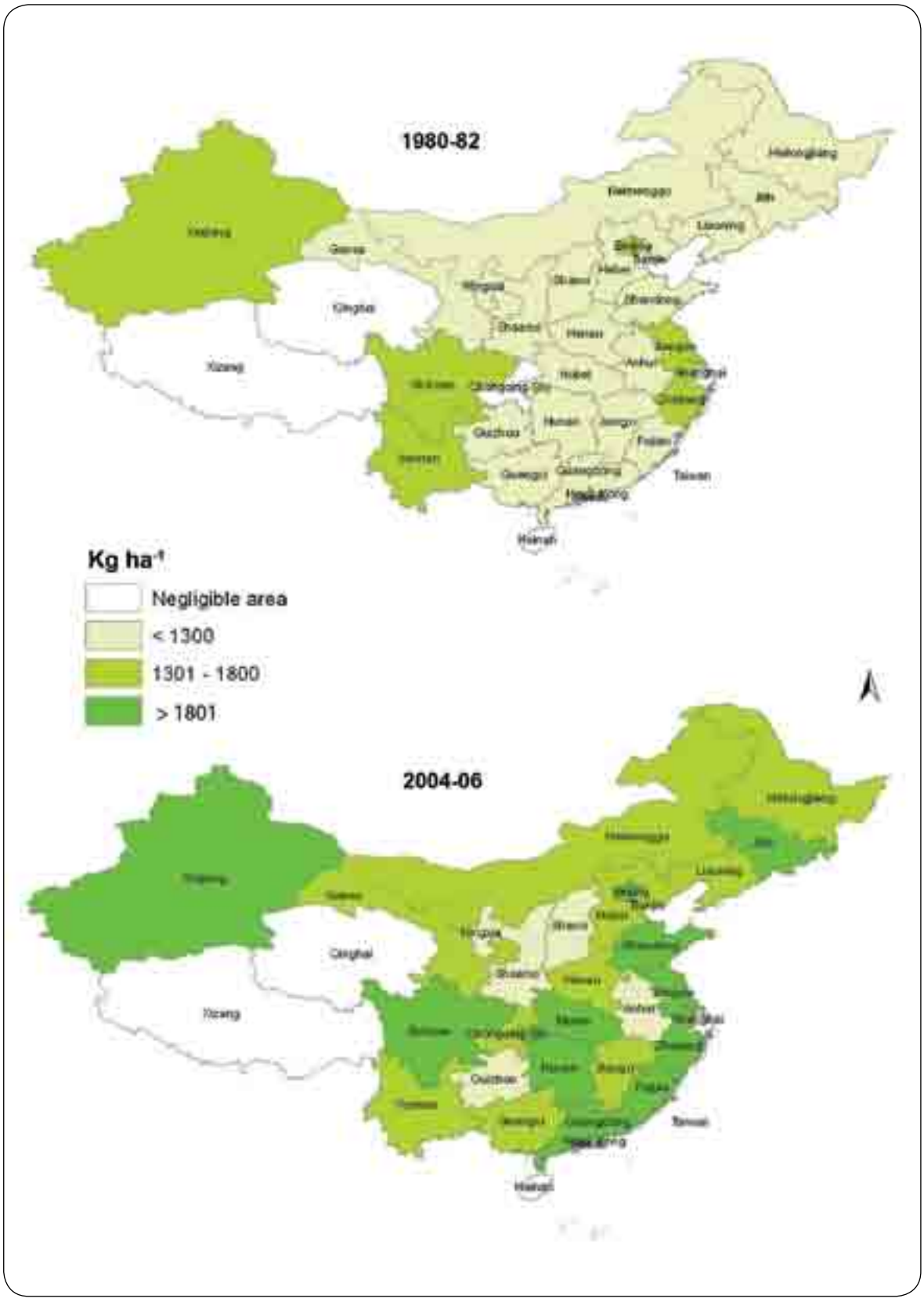
small share in Asia's total soybean area; it has been rising consistently there. For instance in Vietnam, soybean area increased from 91,000 ha in 1981-83 to 124,000 ha in 1993-95 and further to 223,000 ha in 2005-07. This happened because of increasing availability and adoption of high-yielding varieties and other crop management technologies.

Yield

Global average soybean yield increased from 1705 kg ha^{-1} in 1981-83 to 2052 kg ha^{-1} in 1993-95 and further to 2313 kg ha^{-1} in 2005-07, at an annual rate of 1.4%. Asia's average yield is about 40% less compared to the world average. Between 1981-83 and 2005-07, Asia's soybean yield increased at an annual rate of 0.95%, less than the growth in global yield. And most of the growth in yield occurred between 1981-83 and 1993-95 (Annexure 4).

There is considerable inter-country variation in soybean yield within Asia. It ranges from 1079 kg ha^{-1} in Myanmar to 2388 kg ha^{-1} in Iran. Yields in China and India are 1720 kg ha^{-1} and 1080 kg ha^{-1}, respectively. In both these countries, there is significant intra-regional variation. In China, it ranges from as low as 860 kg ha^{-1} in Ningxia province to as high as 3051 kg ha^{-1} in Shanghai province. Note that both these provinces are not important for soybean production – their share in China's total soybean area hardly exceeds 0.5%. In Heilongjiang province, which is a major contributor to soybean production, average yield is 1734 kg ha^{-1} (Map 7). In other soybean producing provinces such as Neimenggu and Henan, average yield is around 1500 kg ha^{-1}. In Jilin, also an important soybean growing province, average yield is 2729 kg ha^{-1}.

Figure 15 shows the distribution of soybean area according to yield levels. In 2004-06, on 24% of the total soybean area in China, average yield was below 1500 kg ha^{-1}, and on another 62%, it ranged from 1500 kg ha^{-1} to 2500 kg ha^{-1}. Only on 14% of the area soybean yield was more than 2500 kg ha^{-1}.



Map 7. Regional variation in soybean yield in China.

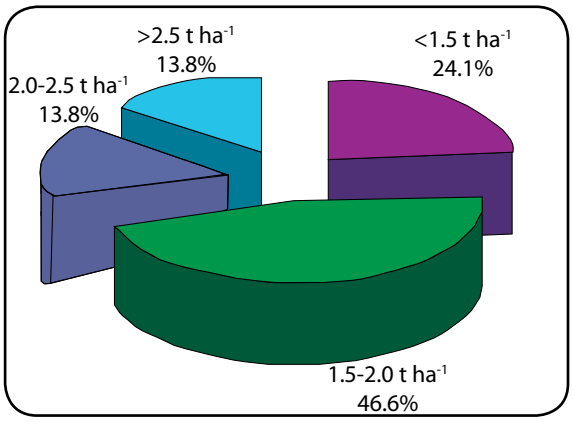


Figure 15. Distribution of soybean area in China by yield levels, 2004-06.
Source: USDA (http://www.ers.usda.gov/Data/China).

In India, soybean is largely grown in the semi-arid tropics, where rainfall is low and uncertain; hence its yield is also low and uncertain (Figure 16). Nonetheless, there are significant inter-regional differences in yield levels (Map 8). Although until the early 1990s there was no significant difference in yield across different agro-climatic zones (Figure 16), the difference widened later on. During the 1990s, yield either declined or remained stagnant, except in the humid zone where it continued on a positive trend.

Map 8 shows the spatial distribution of soybean yield in India. In 2001-03, the high-yielding areas were concentrated in the western and central parts of India. In terms of area, a large chunk is in central India, where its yield is not high. Central India – mainly parts of Madhya Pradesh – accounts for 57% of the total soybean area, and most of the rest is distributed between Maharashtra and Rajasthan.

Between 1981-83 and 2005-07, there was a substantial increase in soybean yield in both China and India (Figure 17), but more so until the mid-1990s (Annexure 4). During this period, it increased by 43% in China as well as in India. In India, soybean yield hardly exceeded 760 kg ha^{-1} on 89% of area under its cultivation in 1980-82 (Figure 18). However, with advances in breeding technology, yield improved. By 2001-03, soybean yield was between 760 kg ha^{-1} and 1140 kg ha^{-1} on about half of the area and more than 1140 kg ha^{-1} on 20% of the area. In China too, the area under high yield has increased significantly.

Soybean yield has also increased in Indonesia and Thailand but at a diminishing rate. In

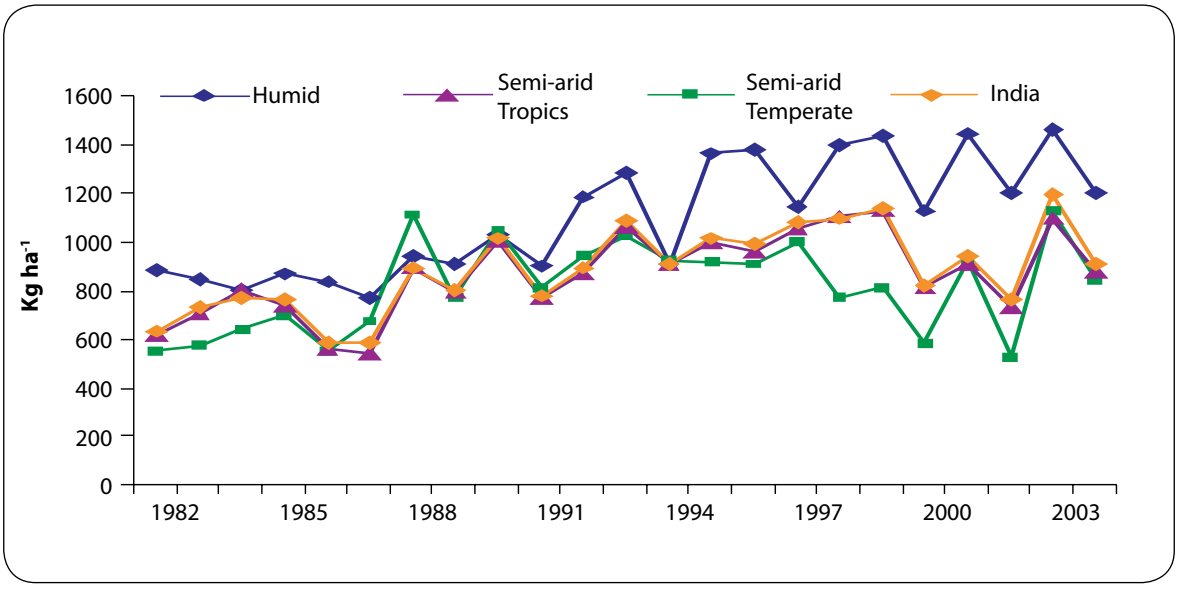
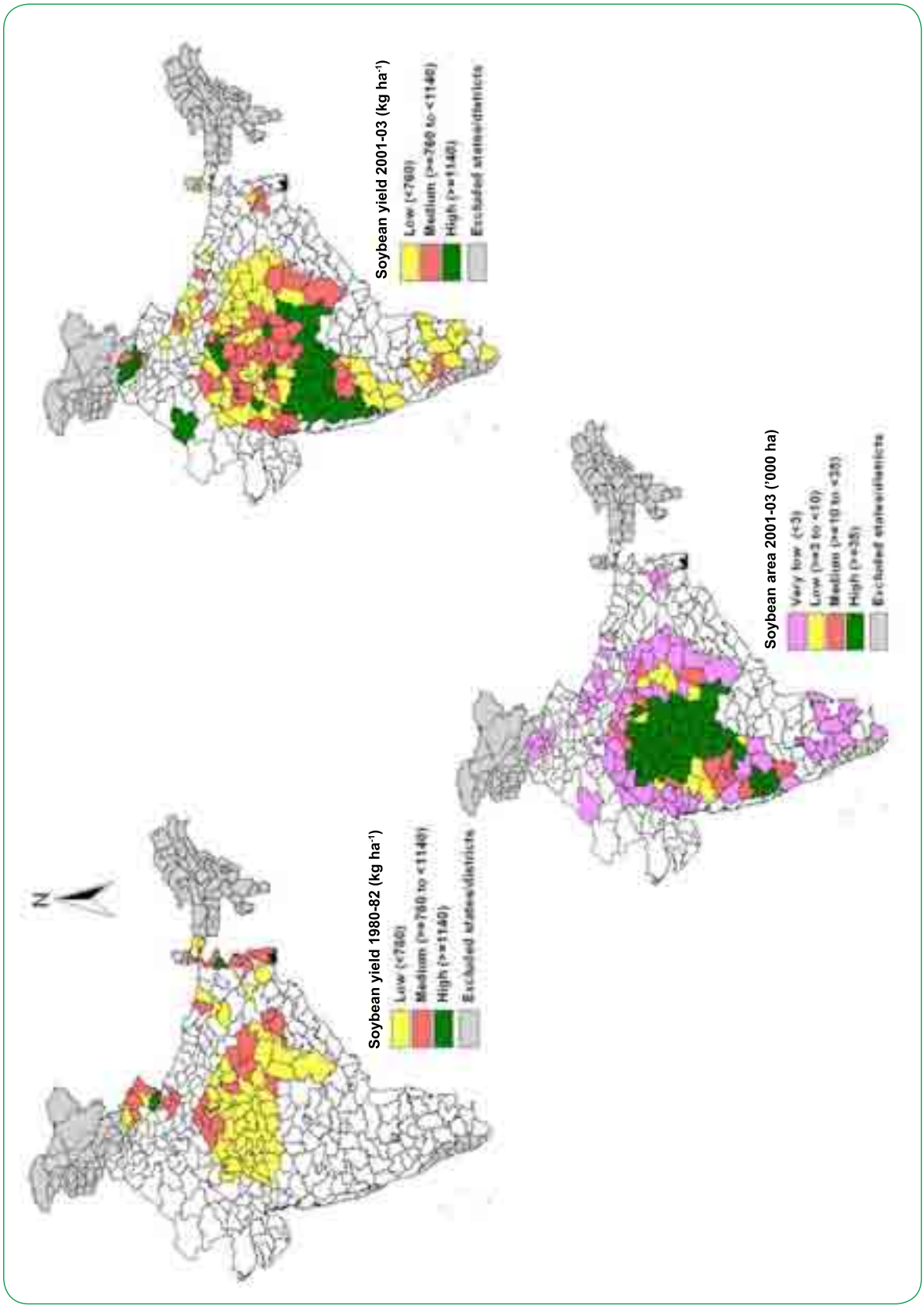


Figure 16. Trends in soybean yield in different agro-ecological regions in India.
Source: ICRISAT Database.



Map 8. Inter-regional variations in soybean area and yield in India.

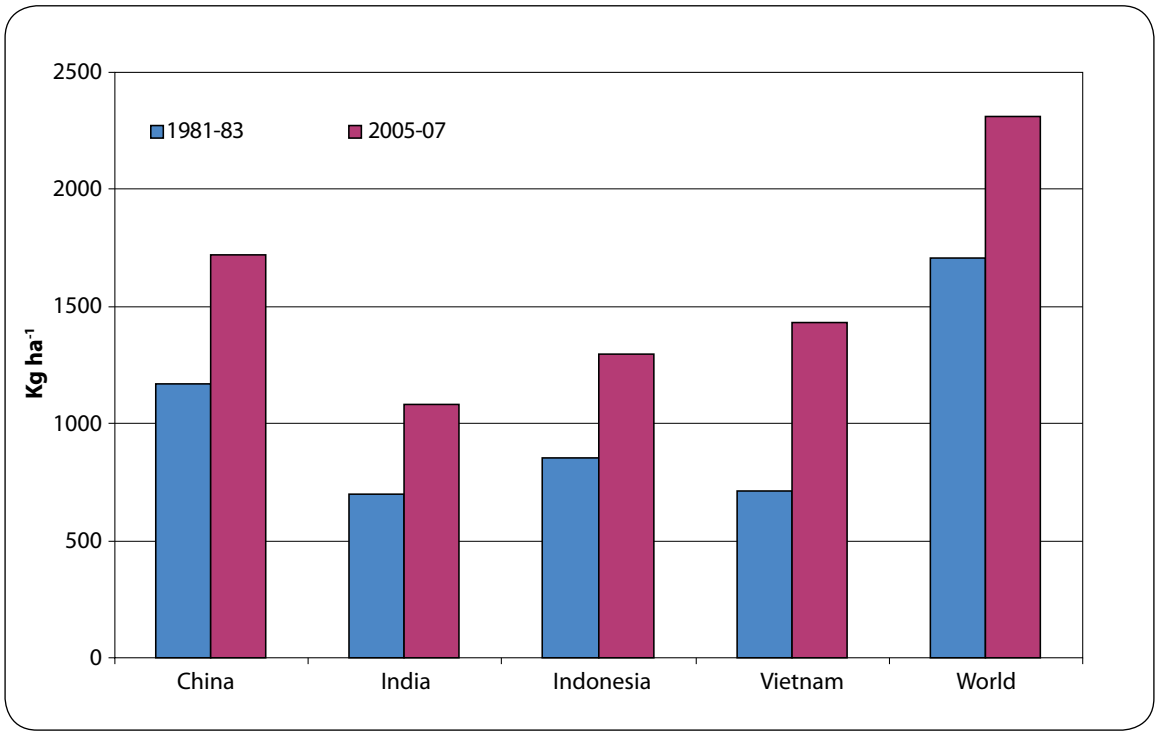


Figure 17. Changes in soybean yield in major growing countries in Asia.
Source: FAOSTAT (http://www.faostat.fao.org).

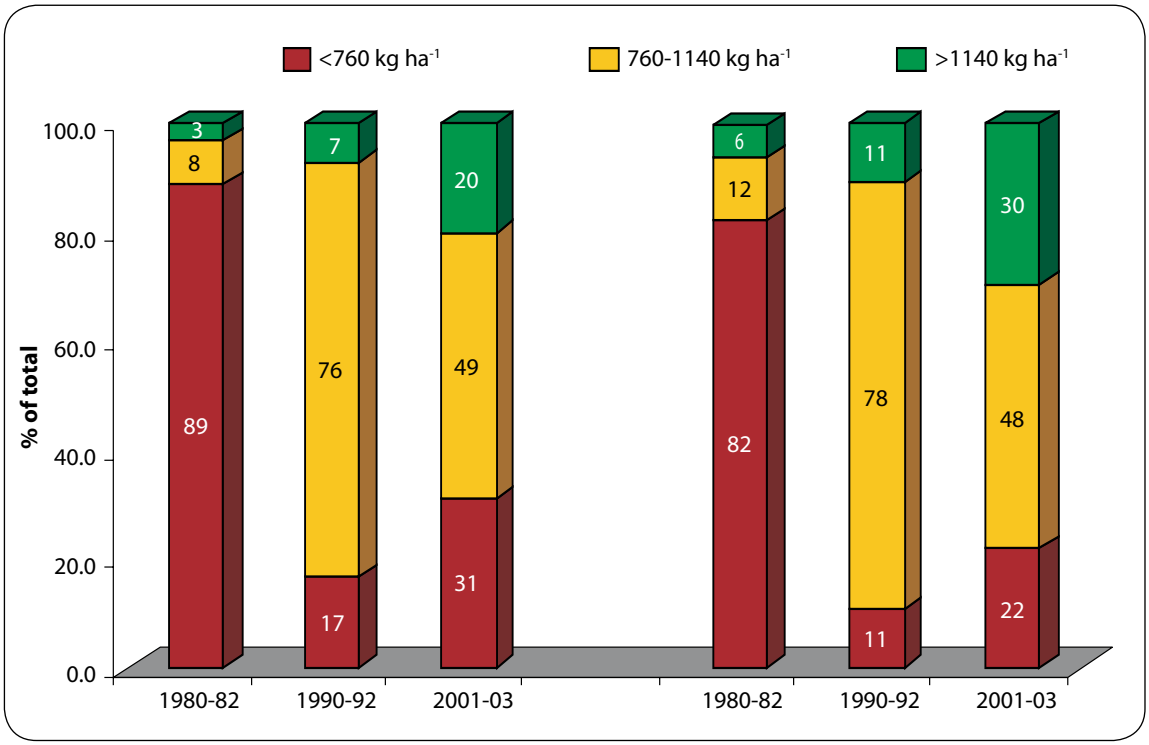


Figure 18. Distribution of soybean area and production in India by yield levels.
Source: ICRISAT Database.

Vietnam, Myanmar, Iran and Korea, yield increased at an accelerated rate.

Production

Globally, soybean production increased from 87 million t in 1981-83 to 126 million t in 1993-95 and further to 218 million t in 2005-07 and at an accelerated rate (Table 12 and Annexure 4). Asia contributes nearly 13% to global soybean production, and its contribution, in absolute terms, increased from 11 million t in 1981-83 to 27 million t in 2005-07, at an annual rate of 3.7% (Table 13). Growth in soybean production, however, decelerated considerably from about 5% a year during 1981-95 to 1.8% in the latter period (Annexure 4). Growth in world soybean production resulted from both area expansion and yield improvements, but a larger contribution came from area.

Most soybean producing countries in Asia experienced robust growth in production (Figure 19). China and India account for 58% and 32% of Asia's soybean production, respectively. Its production in India increased tremendously, from a mere 0.5 million t in 1981-83 to 4.6 million t in 1993-95 and further to 8.9 million t in 2005-07, at an annual rate of 12.6%. The growth, however, resulted from area expansion, as expected. Area expanded at an annual rate of 10.6% (Annexure 4).

In China, soybean production increased from about 10 million t in 1981-83 to 17 million t in 2005-07, at an annual rate of 2.5% (Table 12). Growth has however decelerated in recent years. But unlike in India, growth in China's soybean production was driven by yield improvements. In Vietnam, soybean production grew rapidly due to both area expansion and yield improvements. In Myanmar too, there was a significant growth in soybean production, but most of it resulted from area expansion.

Production Constraints

Soybean yield is low in most Asian countries compared to that in Argentina, Brazil and

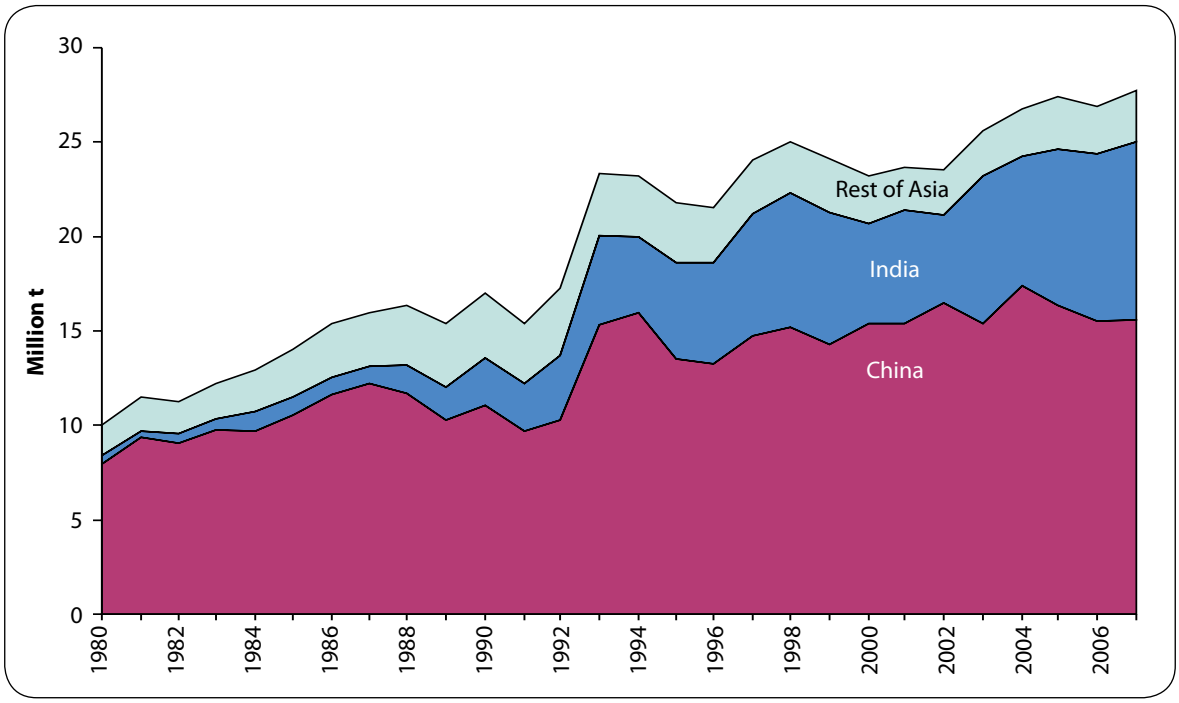


Figure 19. Trends in soybean production in India, China and the rest of Asia.
Source: FAOSTAT (http://www.faostat.fao.org).

the USA. Many factors contribute to this. Although soybean is a hardy crop, irrigation water remains the main limiting factor in raising its yield. Except at critical growth stages like germination, flowering and pod formation, soybean is generally considered to be tolerant to moisture stress. Moisture stress during seed development can adversely affect seed yield and its quality.

Soybean is grown on marginal lands under rainfed conditions. Input use is low and farmers rarely invest in fertility-enhancing soil and water management techniques and inputs because of high production risk (Deosthali et al. 2005).

Since poor longevity of seed stored between growing seasons is an important constraint to raising soybean yield in the humid tropics, it is often not grown here unless sophisticated seed processing technology is available. This constraint can be overcome by transporting seed to dry areas at planting time, where seed keeping quality is better.

Slow adoption of improved technologies is a major constraint to improving soybean yield (Singh et al. 2001). A majority of farmers grows old varieties that have become susceptible to diseases. In recent years, a number of new varieties with higher yield potential, drought tolerance and pest and disease resistance have been released by national and international agricultural research systems but their adoption remains low because of lack of information, poor seed delivery systems and lack of adaptation to local conditions.

Insect pests, diseases and weeds are other important constraints to soybean production. Soybean being a luxuriant crop with lush green, soft succulent foliage, is attacked by a number of insect pests. The soybean aphid, stem fly, white fly, blue beetle, tobacco caterpillar, armyworm, bean leaf beetle, grasshoppers, girdle beetle, green and grey semi-looper and leaf miner are important insect pests, causing substantial yield loss. The crop is also susceptible to a large number of fungal, viral and bacterial diseases, though all of these may not cause significant economic loss. Diseases such as rust, Sclerotinia stem rot, Phytophthora root and stem rot, soybean cyst, Fusarium root rot, and Rhizoctonia blight cause considerable yield loss in Asia (Wrather et al. 2001). In China, the diseases that cause most damage include mosaic, rust, frog-eye leaf spot, downy mildew, soybean cyst and Fusarium root rot. In India, extensive yield losses occur due to Fusarium root rot, pod and stem blight, Rhizoctonia foliar blight and Sclerotinia stem rot.

Unbalanced use of fertilizers is another important limiting factor to raising soybean yield, especially in India. Farmers generally apply nitrogenous and phosphatic fertilizers; application of potassic fertilizers is rare while potassium is an important nutrient for improving seed yield and its quality. A review of experimental evidence from India shows that application of potassium can raise soybean yield by 20%-40% (Vyas and Imas 2008).

Utilization

Approximately 85% of the soybean produced in the world is crushed to produce edible oil, and the rest is used as food, feed and seed. This pattern has not undergone any significant change during the last two decades, but varies across regions/countries. In Africa, a considerable proportion of available soybean supply is also used directly as food.

On an average, 72% of the available soybean supply in Asia is utilized to produce oil and 18% is consumed as food (Table 14). This pattern differs substantially from what prevailed in the early 1980s. The share of soybean as food fell drastically from 35% while its use for crushing increased from 55% in 1981-83. Across Asia, the proportion of soybean consumed as food is high in East and Southeast Asian countries. For instance in China, 15% of available soybean is used as food as compared to 5% in India. Further, in both India and China,

Table 14. Trends in soybean utilization ('000 t).

Region/ country	1981-83				2001-03			
	Total availability	Food	Food manufacture	Other uses[1]	Total availability	Food	Food manufacture	Other uses
World	**88,745**	**7,169**	**74,323**	**7,254**	**182,834**	**10,824**	**154,798**	**17,212**
Europe	16,152	4	15,738	410	20,203	96	17,846	2,261
North America	35,021	12	31,304	3,705	54,485	77	48,197	6,210
Oceania	93	1	61	31	88	4	41	43
Africa	400	112	252	37	1,800	595	1,038	167
Latin America	16,384	280	15,112	992	52,853	668	49,392	2,793
Asia	**18,944**	**6,679**	**10,423**	**1,842**	**53,413**	**9,384**	**38,291**	**5,738**
East Asia	16,455	4,071	10,818	1,567	41,470	6,772	28,700	5,998
China	10,628	2,912	6,332	1,384	34,234	5,529	23,032	5,672
South Korea	365	162	163	40	418	230	146	42
Japan	4,645	662	3,864	119	5,228	849	4,135	244
North Korea	817	336	458	24	1,591	164	1,387	40
South Asia	597	167	341	88	7,628	362	6,559	707
India	484	165	239	79	6,737	298	5,760	679
Iran	98	0	91	7	634	0	612	22
Southeast Asia	1,266	963	215	87	3,485	2,251	971	263
Indonesia	902	834	0	67	2,007	1,867	2	139
Vietnam	57	45	7	5	179	144	23	13
Malaysia	177	0	177	0	641	0	641	0
Thailand	138	63	64	11	1,198	125	980	94
West Asia	559	2	458	98	1,412	66	1,260	85

1. Other uses include as seed, waste and feed.
Source: FAOSTAT (http://www.faostat.fao.org).

the proportion of soybean utilized as food declined considerably. In China, about 7% of the available soybean supply is also utilized as feed for livestock and poultry. Elsewhere, its use as animal feed is negligible.

Notwithstanding these changes in utilization pattern, supply of soybean in Asia has increased tremendously over the last two decades, and most of the incremental supply was utilized for crushing. Between 1981-83 and 2001-03, the quantity of soybean crushed for oil increased 3.7 times compared to a 1.4 fold increase in its demand as direct food (Table 14). In India, demand for crushed soybean increased by 21-fold and in China by about five-fold, much higher than the increase in its demand as direct food.

Table 15 shows trends in consumption of soybean oil. Between 1981-83 and 2001-03, global consumption almost doubled from 11.6 million t to 22.6 million t. Asia accounts for 43% of the global demand, up from its share of 25% in 1981-83. This indicates a faster growth in demand in Asia than in the rest of the world. Demand in Asia increased from 2.9 million t in 1981-83 to 9.8 million t in 2001-03. Rapid growth in demand was fuelled by China. India partially contributed to the increasing demand. In 2001-03, China accounted for about half of Asia's total soybean oil demand, as against 29% in 1981-83. In fact, soybean oil accounts for 45% of the edible oil market in China. In India, its market share is 17%, which has remained almost unchanged during the

Table 15. Trends in consumption ('000 t) of soybean oil.

Region/country	1981-83	1991-93	2001-03
World	**11,695**	**14,788**	**22,586**
Europe	1,585	1,662	1,926
North America	4,589	5,798	7,444
Oceania	54	63	38
Africa	474	529	879
Latin America	1,824	2,526	2,591
Asia	**2,895**	**4,148**	**9,812**
East Asia	1,482	2,083	5,909
China	834	1,246	4,811
Japan	537	585	715
South Korea	69	198	336
South Asia	1,132	1,601	3,060
India	552	671	2,172
Iran	332	437	404
Southeast Asia	43	183	293
Thailand	23	66	144
West Asia	230	263	382
Turkey	115	124	165
Israel	71	58	103

Source: FAOSTAT (http://www.faostat.fao.org).

last two decades. In absolute terms, demand for soybean oil increased considerably since the early 1990s. Demand was muted during the 1980s in both China and India, but showed a significant growth afterwards.

Soybean oilcake meal is widely consumed across the world. It has penetrated most markets of the world because of its increasing demand as animal feed, especially in intensive livestock and poultry production systems in developed and developing countries. During the last two decades, global demand has almost doubled from 58 million t in 1981-83 to 121 million t in 2001-03 (Table 16). Of the total global demand, 56% emanated from Europe and North America. Its demand in Asia, Africa and South America has also been growing rapidly.

Asia's demand for soybean oilcake meal increased from 9.1 million t in 1981-83 to 38.4 million t in 2001-03, doubling its share in global demand from 16% to 32%. In 2001-03, China accounted for about half of Asia's total soybean oilcake meal consumption, up from 40% in 1981-83. In contrast, India, which is the second largest producer of soybean in Asia, accounts for only 5% of the total soybean oilcake meal consumption. The demand in India, however, has increased tremendously, from a mere 41,000 t in 1981-83 to 1.9 million t in 2001-03. Indonesia, Thailand, Iran and the Republic of Korea also experienced robust growth in demand. Japan with a share of 10% in Asia's total consumption, is the second largest consumer after China; its demand, however, did not grow much. Soybean oilcake meal is an important ingredient of poultry feed and the rapid expansion in its demand in Asia can be attributed to the fast-growing poultry sector. For instance, between 1981 and 2003, poultry meat and egg production each increased

Table 16. Trends in soybean oilcake meal consumption ('000 t) in Asia.

Region/country	1981-83	1991-93	2001-03
World	**58,280**	**71,811**	**120,911**
Europe	23,356	24,121	33,197
North America	19,416	25,966	34,853
Oceania	76	165	384
Africa	613	1,161	3,163
Latin America	3,035	4,637	11,113
Asia	**9,135**	**14,490**	**38,374**
East Asia	7,404	9,619	25,313
China	3,729	4,358	18,692
Japan	3,035	3,680	3,979
South Korea	512	1,397	2,364
South Asia	266	822	3,638
India	41	334	1,897
Iran	214	445	1,287
Southeast Asia	769	2,290	4,934
Indonesia	115	423	1,492
Philippines	319	742	1,406
Malaysia	220	663	969
West Asia	137	576	1,056
Turkey	24	330	860
Israel	265	225	543

Source: FAOSTAT (http://www.faostat.fao.org).

eight-fold in China; and in India, poultry meat production increased 12-fold and egg production four-fold (FAOSTAT: http://www.faostat.fao.org).

International Trade

Soybean is one of the most traded agricultural commodities in the international market. In 2003-05, close to 58% of the global production entered the international market in one form or another. Table 17 shows trends in soybean trade. In 2003-05, soybean accounted for about half of the total value of soybean trade. This was followed by oilcake meal (34%) and oil (17%). The share of soy-foods was negligible.

Table 17. World exports (US$ million) of soybean and its products.

Product	1981-83	1993-95	2003-05
Soybeans	7,074	7,108	15,469
Soybean oil	1,784	3,024	5,393
Soybean cake	4,886	5,835	10,806
Other products[1]	15	97	156
Total	**13,759**	**16,064**	**31,824**

1. Other products include processed foods.
Source: FAOSTAT (http://www.faostat.fao.org).

International trade in soybean and its products has expanded rapidly during the last decade or so. Total value of soybean trade that was almost stagnant until the mid-1990s, doubled by 2003-05. Rapid growth occurred in trade of beans and oilcake meal. Trade in soy-foods too has been increasing rapidly.

Soybeans: Global exports of soybeans increased from 27 million t in 1981-83 to 63 million t in 2003-05 and at an accelerated rate (Table 18). Developing countries contributed to the spectacular growth in exports – their share increased from 14% in 1981-83 to 30% in 1993-95 and further to 52% in 2003-05. One important feature of the beans exports is their concentration in Latin America (Brazil and Argentina) and North America (USA). Together, these account for 95% of global soybean exports. The USA, which used to be a dominant exporter, now faces stiff competition from Brazil and Argentina. North America's share in global exports fell from 85% in 1981-83 to 45% in 2003-05, while the Latin American countries, Argentina and Brazil, consolidated their position from a 14% share in 1981-83 to 51% in 2003-05.

Though Asia accounts for 13% of global soybean production, its share in global exports is negligible (<1%). High domestic demand for soybean and its products restricts exports by Asian countries. China and India are the main exporters from the continent. In 2003-05, they shared 70% and 18% of Asia's beans exports, respectively.

Though developing countries account for over half of the total exports of soybeans, they also import huge quantities. Imports by developing countries increased five-fold during the last two decades, from 9 million t in 1981-83 to 45 million t in 2003-05, raising their share in global imports from 34% to 71%. On the other hand, imports by developed countries have remained almost unchanged at around 17 million t (Table 18). European countries account for a bulk of the developed countries' imports. Among developing countries, China is the largest importer of soybeans, accounting for close to 40% of the global imports.

Asia accounts for 60% of the global imports of soybeans. Between 1981-83 and 2003-05, its imports increased five-fold, from 7.5 million t to 38 million t, primarily because of a steep increase in imports by China. In fact, China has remained the single largest importer of soybeans in Asia, accounting for two-thirds of Asia's total soybean imports in 2003-05. Further, China's imports increased almost ten-fold, from 2.6 million t in 1993-95 to 24.8 million t in 2003-05. Japan, Indonesia and Thailand are other importers in the region.

Table 18. Trends in exports and imports of soybeans ('000 t) by region and country.

Region/ country	Exports			Imports		
	1981-83	1993-95	2003-05	1981-83	1993-95	2003-05
World	**27,341**	**30,277**	**62,681**	**27,330**	**30,358**	**63,662**
Developed countries	**23,408**	**21,240**	**30,337**	**17,928**	**15,506**	**18,658**
Europe	236	566	1,892	17,461	15,180	17,953
North America	23,171	20,670	28,440	445	254	676
Oceania	0	4	5	22	72	30
Developing countries	**3,934**	**9,038**	**32,344**	**9,402**	**14,852**	**45,004**
Africa	1	27	34	40	314	951
Latin America	3,760	8,426	31,830	1,879	3,572	6,260
Asia	**173**	**585**	**480**	**7,482**	**10,966**	**37,792**
East Asia	147	540	347	6,453	8,815	30,937
Japan	0	0	0	4,512	4,859	4,587
China	0	527	333	1,537	2,618	24,829
South Korea	0	0	1	578	1,261	1,374
South Asia	0	0	84	3	40	942
India	2	0	83	0	10	0
Iran	0	0	1	0	0	809
Southeast Asia	26	44	45	497	1,449	3,809
Indonesia	0	0	0	315	711	1,132
Malaysia	4	14	18	181	491	817
Thailand	2	0	0	1	115	1,578
West Asia	0	0	1	530	628	2,075
Turkey	0	0	1	2	86	882
Israel	0	0	0	480	512	615
United Arab Emirates	0	0	0	0	0	276

Source: FAOSTAT (http://www.faostat.fao.org).

Tremendous growth in imports of soybeans and their products was driven by economic expansion of developing countries.

Soybean oil: Soybean oil is the next most important edible oil traded in the international market, after palm oil. Globally, over 10 million t of soybean oil was exported in 2003-05, and the bulk of exports were from Latin American countries. Exports from developing countries have grown considerably over the last two decades or so. Between 1981-83 and 2003-05, these increased seven-fold, while exports from developed countries remained almost stagnant (Table 19). In fact, exports of soybean oil from North America fell considerably, in absolute as well as relative terms.

Though Asia is not an important exporter of soybean oil, its exports have been on the rise. In 2003-05, Asia accounted for only 4% of the global exports. An interesting feature of Asia's soybean oil exports is that these are quite diversified geographically, unlike beans. Malaysia and Iran are important exporters from Asia. Neither China nor India figures among the main exporters because of their high domestic demand.

Trade flows (exports and imports) of soybean oil have largely remained confined to developing countries. In 2003-05, they accounted for 85% of the global imports, compared to 72% in 1981-83. Asia and Africa account for the bulk of global imports; 57% and 14%, respectively.

Table 19. Trends in soybean oil exports and imports ('000 t) by region and country.

Region/ country	Exports			Imports		
	1981-83	1993-95	2003-05	1981-83	1993-95	2003-05
World	**3,364**	**5,220**	**10,149**	**3,424**	**4,915**	**9,560**
Developed countries	**2,237**	**1,950**	**2,261**	**938**	**817**	**1,438**
Europe	1,303	1,093	1,603	888	691	1,233
North America	934	857	656	8	56	158
Oceania	0	0	2	41	69	47
Developing countries	**1,127**	**3,269**	**7,889**	**2,486**	**4,099**	**8,122**
Africa	0	6	17	442	697	1,348
Latin America	1,073	2,971	7,457	510	935	1,326
Asia	**54**	**292**	**414**	**1,535**	**2,466**	**5,447**
East Asia	14	71	62	113	974	2,449
China	1	55	33	40	885	2,075
South Korea	1	5	5	0	29	214
South Asia	0	46	116	1,177	1,031	2,439
India	1	0	7	534	56	1,231
Iran	0	44	109	334	517	773
Bangladesh	0	0	0	39	200	299
Southeast Asia	31	155	183	56	112	142
Malaysia	0	79	147	5	28	61
West Asia	9	13	53	199	334	389
Turkey	1	1	7	120	170	134
Iraq	0	0	0	1	26	84

Source: FAOSTAT (http://www.faostat.fao.org).

Most Asian countries are net importers of soybean oil. China and India together account for about one-third of global imports. Chinese imports increased from a mere 40,000 t in 1981-83 to 0.9 t in 1993-95, and further to 2.1 million t in 2003-05. Until the mid-1990s, India imported soybean oil occasionally, but its imports increased substantially after adopting liberal trade policies in the mid-1990s. Iran, Bangladesh, Pakistan and Turkey are other important importers of soybean oil.

Soybean oilcake meal: Between 1981-83 and 2003-05, global exports of soybean oilcake meal increased from 21 million t in 1981-83 to 52 million t in 2003-05 (Table 20). So did imports. Demand for oilcake meal is derived from demand for livestock and poultry products. The expanding demand for livestock and poultry products, especially in developing countries, has been the driver behind the spectacular growth in trade in soybean oilcake meal. Developing countries' exports increased from 10 million t in 1981-83 to 40 million t in 2003-05, and their share in global exports increased from 48% to 76%. The exports originate largely from Brazil and Argentina, which together account for 60% of global exports. Exports from Europe and North America did not show any significant increase.

Asia contributes more than 8% to the global exports of soybean oilcake meal. In absolute terms, its exports increased from a mere 0.6 million t in 1981-83 to 3.3 million t in 1993-95

Table 20. Trends in soybean oilcake meal exports and imports ('000 t) by region and country.

Region/ country	Exports			Imports		
	1981-83	1993-95	2003-05	1981-83	1993-95	2003-05
World	**21,053**	**30,132**	**51,806**	**20,585**	**28,482**	**50,734**
Developed countries	**10,941**	**9,045**	**12,344**	**17,603**	**19,493**	**30,507**
Europe	4,554	4,336	7,450	17,176	18,543	28,890
North America	6,387	4,710	4,893	398	755	1,254
Oceania	0	0	1	28	195	363
Developing countries	10,113	21,087	39,462	2,982	8,989	20,226
Africa	10	92	42	431	985	2,317
Latin America	9,473	17,729	35,190	999	2,059	5,038
Asia	**630**	**3,265**	**4,230**	**1,552**	**5,944**	**12,872**
East Asia	395	806	665	333	1,761	3,071
China	391	806	664	1	101	158
Japan	3	0	0	178	857	1,284
South Asia	151	2,426	3,279	146	547	1,110
India	151	2,426	3,271	1	0	4
Iran	0	0	8	143	505	684
Southeast Asia	38	24	26	812	2,534	6,635
Philippines	0	0	0	297	792	1,286
Vietnam	0	0	0	0	32	1,108
Indonesia	0	0	1	115	514	1,714
Malaysia	1	6	23	82	419	823
Thailand	0	0	0	181	730	1,687
West Asia	46	8	256	262	1,096	2,052
Turkey	0	2	21	0	233	461
Jordan	6	5	8	41	115	226
Saudi Arabia	0	0	0	23	397	491
Syrian Arab Republic	1	6	23	58	127	316

Source: FAOSTAT(http://www.faostat.fao.org).

and further to 4.2 million t in 2003-05. India is the largest exporter, accounting for over three-fourths of Asia's total exports, and there has been a rapid rise in its exports. In fact, India exports approximately 60% of the total soybean oilcake meal output. China also exports small quantities of soybean oilcake meal.

Developing countries are also the main importers of soybean oilcake meal, and their imports have grown considerably, from 3 million t in 1981-83 to 20 million t in 2003-05, raising their share in global imports from 14% to 40%. Imports by developed countries also increased, but at a slower rate. Europe accounts for a bulk of the developed countries' imports. Some Latin American countries also import soybean oilcake meal.

Asia accounts for about a quarter of the global imports of soybean oilcake meal, mostly China and Southeast Asian countries like Indonesia, Thailand, Philippines and Vietnam. Together, these account for three-fourths of Asia's total imports. West Asia accounts for 10% of Asia's imports.

International Prices

International prices of soybean and its products (edible oil and oilcake meal) were on a decline in real terms until 2001 (Figure 20). Prices started showing an upward trend afterwards. Interestingly, the prices of all soybean products exhibit a similar trend, indicating that markets for soybean and its products tend to integrate vertically. For

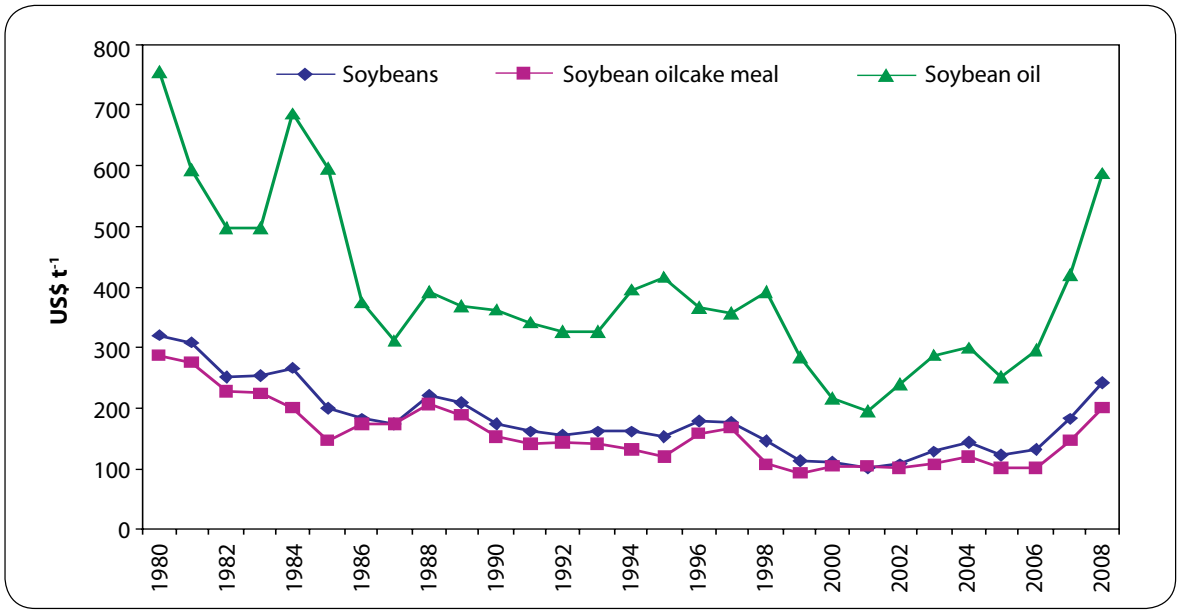


Figure 20. Trends in global real export prices of soybean and its products (at 1983-84 constant US$).
Source: FAOSTAT (http://www.faostat.fao.org).

example, the price of beans, oil and meal declined at an annual rate of around 4% during 1980-2001. After 2001, prices increased but at slightly varying rates. During 2002-08, the price of beans, meal and oil increased at an annual rate of 11.4%, 9.5% and 13%, respectively.

The decline in prices until 2001 can be attributed to rapid growth in soybean production in Argentina and Brazil, and also a significant increase in their exports. The rise in prices after 2001 was due to fast increasing imports of soybean and its products by China. Prior to 1999, China hardly even imported 5 million t, but by the year 2000, its imports had shot up to 13 million t, and further to 29 million t in 2005. The price rise after 2005 is a reflection of the overall increase in prices of all commodities due to reasons such as increased policy-induced biofuel production from grains/edible oils, depletion of global stocks of all food crops, and the spike in crude oil prices.

Figure 21 shows the behavior of producer prices of soybean in major producing countries such as Argentina, Brazil, China, India and USA

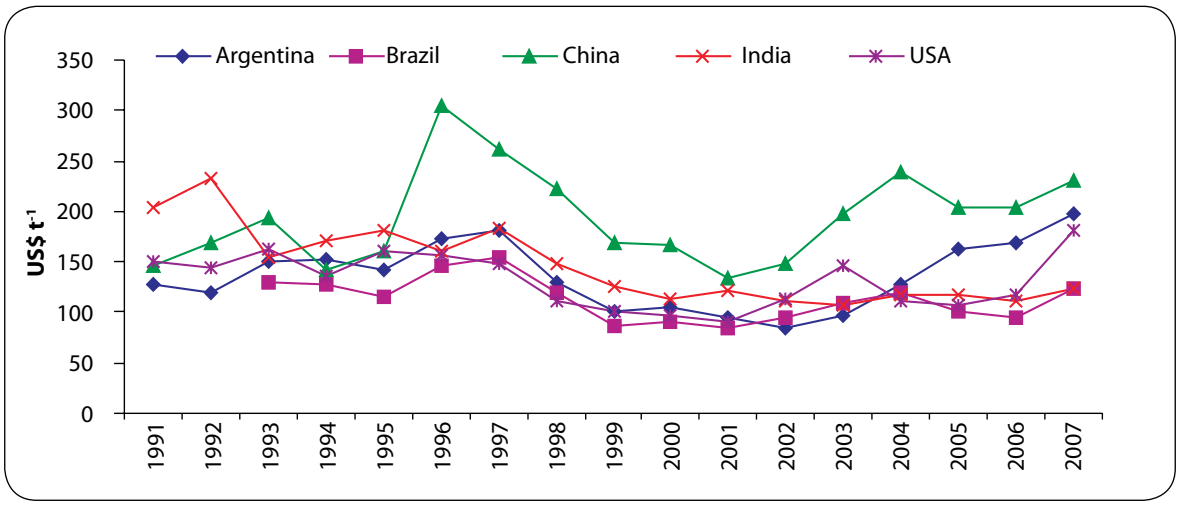


Figure 21. Trends in real producer prices of soybean (at 1983-84 constant US$).
Source: FAOSTAT(http://www.faostat.fao.org).

(at 1983-84 constant US$) since 1991. Three distinct phases of price behavior are evident in these countries: (i) a rising trend until 1997; (ii) a declining trend during 1997-2001; and (iii) a somewhat rising trend after 2001.

Nonetheless, there is a considerable difference in producer prices across countries. Throughout 1991-2005, producer prices remained low in Brazil than in any other country indicating its competitive advantage in soybean production and exports. Argentina ranked next in competitiveness, and was closely followed by USA. Brazil's edge stemmed from its extensive application of low-cost no-till technologies. Producer prices of soybean are higher in China, reflecting a lack of competitiveness of production there. In recent years, producer prices have risen faster in Argentina, USA and Brazil compared to those in India and China. Higher prices of soybean in China and India are due to lower yields than those in Argentina, Brazil and USA. Soybean yields in Latin America and North America are above 2.5 t ha^{-1} compared to 1.7 t ha^{-1} in China and 1.0 t ha^{-1} in India.

4. Markets, Institutions and Policies

Most Asian countries are deficit in oilseeds, and import oilseeds and/or their products to meet growing domestic demand. However, to increase domestic production and reduce reliance on imports, many countries in the region, particularly those which import a significant proportion of their total demand (oilseeds, oilcake meals and edible oils) provide market, institutional and policy support to their farmers, processors and consumers. This section briefly discusses some important measures undertaken to enhance production and productivity of oilseeds in the broader context of globalization and market liberalization.

Institutional Support

A number of countries in the world provide support to oilseed farmers to stimulate domestic production for import substitution or export promotion. For example, Brazil and Argentina extend easy lines of credit to soybean producers so as to enable them to adopt new technologies and invest in farm infrastructure. China provides subsidies to farmers for adoption of improved technologies, and also for production of quality seeds, especially of soybean (FAO 2005). It also provides subsidies to purchase high quality grains and soybean seeds (Box 5).

India launched a Technology Mission on Oilseeds (TMO) in the mid-1980s with the aim of achieving self-sufficiency in oilseeds by improving production and processing efficiency. Under the Mission, central and state governments provided subsidized seeds of improved varieties of oilseeds and promoted technologies for pest management, besides protecting farmers from threats of cheap imports through tariff and non-tariff measures. The Mission continued until the mid-1990s, and contributed substantially towards raising oilseed production, from 10.8 million t in 1985-86 to 24.7 million t during 1998-99. The Mission's success was largely due to the protectionist policy of controlling external competition through quantitative restrictions and high import tariffs. However, consequent to the removal of quantitative restrictions and reduction in import tariffs under WTO, cheap imports of palm oil increased, and domestic oilseed production came under pressure.

In most Asian countries, agricultural research has been continuously emphasizing development and dissemination of high-yielding, disease- and pest-resistant varieties and improved production practices. China, Bangladesh and India have been targeting

Box 5. Evolving subsidies in China

In 2004, China introduced a number of policies to benefit farmers, a reversal of its centuries-old practice of taxing agriculture. Policies instituted in the 1950s taxed farm produce to subsidize urban consumers and industrial production, but those policies were abandoned by the early 1990s. During the 1990s, China subsidized procurement, storage and export of grains. These policies, however, proved very costly, and only meagre funds reached farmers. After its entry into the World Trade Organization in 2001, China began exploring ways to directly subsidize farmers who were believed to be vulnerable to foreign competition. In 2004, it introduced direct subsidies for farmers, and began to phase out the centuries-old taxation on agriculture. It made provision for subsidies to purchase seeds and machinery, besides enhanced allocation of funds for agricultural research and infrastructure.

Adapted from: Gale et al. (2005)

their efforts and investments to breeding and dissemination of improved varieties and technologies through farmer participatory approaches to close the yield gap (difference between actual and obtainable yield) which continues to be very high for most oilseed crops (Singh et al. 2001; Chand et al. 2004), and also to shift the yield frontier upward through technological advances.

Marketing and Price Support

Marketing policies pose a particular challenge to the development of the oilseed sector. Policymakers have to strike a balance between the diverging interests of producers, processors, and consumers (FAO 2005). In many countries, marketing policies were designed to provide assured markets and stable prices to oilseed producers. This was often done in coordination with the domestic crushing industry. To expand crushing capacity and add value to domestically-produced oilseeds, the crushing industry provided tax exemption or relief and other fiscal and regulatory incentives. China, for instance, opened up its processing sector to foreign investment in 2004 after its domestic processing industry suffered losses due to low prices. Foreign firms now have a stake in 64 of the 97 major soybean-crushing companies and control 80% of the country's total soybean processing capacity (Xiang 2009). In order to protect farmers from plummeting prices, the Chinese government established a 'protection price of US$ 0.15 kg^{-1} in 2008 (Xiang 2009). This policy, however, did not have the anticipated impact as farmers had difficulty getting their soybeans to collection centres. Besides, support prices also led to an increase in domestic prices, which adversely affected local processors. China also maintains central reserves in order to regulate and control market prices.

India provides price support to major oilseeds in the form of Minimum Support Prices (MSP). If market prices fall below the minimum support price, the government is committed to procure farmers' produce at the MSP. Minimum support prices for soybean and groundnut have been steadily increasing. However, this had little impact on oilseed production because of the influx of huge quantities of cheap imports of edible oils, mainly palm oil. Another reason for the MSP's ineffectiveness in raising oilseed production has been the quicker rise in the MSP of competing crops (Figure 22). During the early 1990s, the MSP for foodgrains

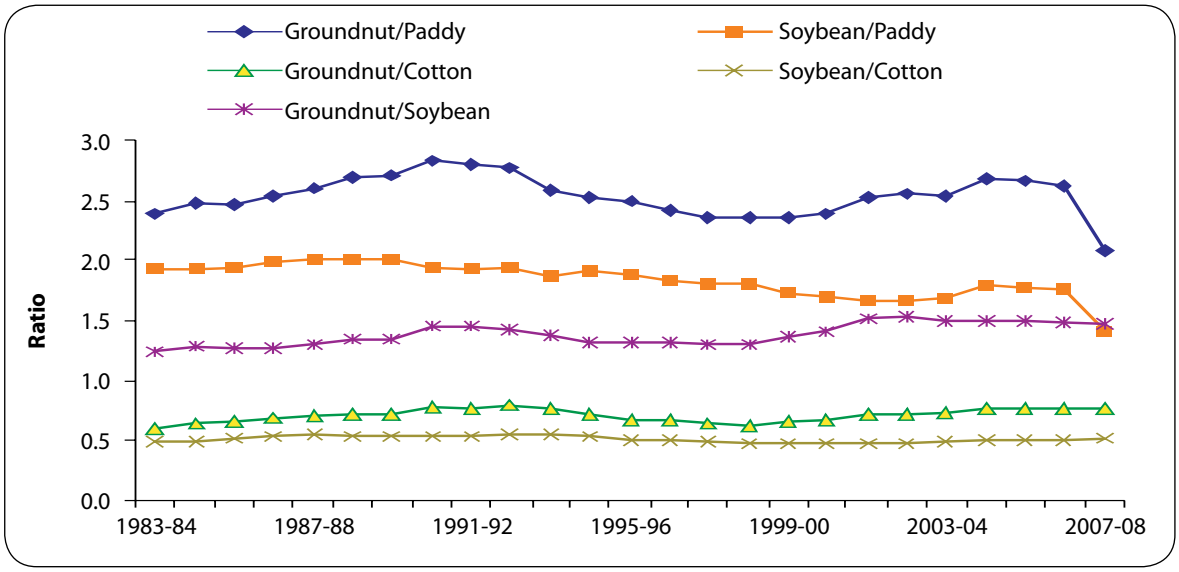


Figure 22. Trends in minimum support prices for groundnut and soybean in relation to paddy and cotton in India.

Source: GoI (various years).

did not increase much relative to the MSP of oilseeds. Besides, the government also maintained control over imports of edible oils. These measures led to an improvement in prices of oilseeds relative to competing crops, and led to an increase in oilseed production. For example, oilseed production increased by 70% between 1987-88 and 1994-95. However, after the mid-1990s, due to a liberal import policy, oilseed prices declined relative to other crops, resulting in a stagnation in production and a shift in oilseed area towards more remunerative competing crops.

Trade Policies

With increasing international trade in oilseeds and/or their products, trade policies have continued to be important tools of maintaining a balance between domestic demand and supply with due consideration to the diverging interests of producers, consumers and processors. Most developed countries are either natural exporters or non-producing consumers of oilseeds, and their tariffs have always been low (FAO 2005). In developing countries, bound tariffs have been high, but are rarely applied, leaving room for protectionist measures.

Additionally, unlike in developed countries, developing countries do not have resources to support direct payments to farmers. They, therefore, resort to tariffs and other border measures to control domestic prices. International trade in groundnut oil, as noted in the previous chapter, has consistently fallen. Trade in shelled groundnut and oilcake meal has also become sparse in recent times, particularly exports originating from India owing to aflatoxin contamination. Trade in soybeans, on the other hand, is growing rapidly, with China emerging as a major importer.

Since its accession to WTO in 2001, China has followed a policy of gradual trade liberalization. Tariffs on oilseeds and their products were set at relatively low levels. Binding tariff rate quotas have been in place for key imported oils. Earlier, only six state agencies were allowed to import groundnut and other oilseeds; later many private traders were granted access to import markets (Diop et al. 2004). However, trade policies continue to be influenced by self-sufficiency considerations. Border protection remains high and imported commodities are levied a value-added tax (VAT) of 13% on agricultural commodities and 17% on processed foods or industrial products (Persaud and Landes 2006). As in the past, government efforts to control imports of oilseed products continue to focus on stimulating domestic production and crushing/processing. Despite this, China continues to be the largest importer of oilseeds and oilseed products.

In India, imports of oilseeds and edible oils were restricted during 1989-94, a period corresponding to the TMO. Since 1994, when India began conforming to WTO rules and replacing quantitative trade restrictions with tariffs, imports of edible oils were placed under Open General License (OGL), allowing unlimited imports by private traders subject to applied tariffs. Palm oil, one of the cheapest edible oil in the international market, has dominated Indian imports since the mid-1990s. In 2003-05, it accounted for close to three-fourths of total edible oil imports by India. Soybean oil, generally the second cheapest oil in the international market, accounted for about 23% of the imports. India removed most restrictions on domestic trade (inter-state), storage and export of oilseeds by 1998, and permitted trading in groundnut futures in 2003-04. However, import tariff levels continued to remain very high for the three major products – groundnut, meal and oil until 2003-04. In response to rising domestic prices of edible oils in recent years, import duties for oilseeds have been lifted in order to increase domestic availability. Imports of edible oils to India increased from 1.3 million t in 1997-98 to 4.3 million t in 2005-06,

constituting 35%-40% of its total consumption. In addition, exports of edible oils were banned in 2007 and the ban was extended till 2010[2]. The export ban has particularly affected groundnut oil since India exports around 30,000 t of it a year.

Agro-processing Policies

Prices of edible oils in India were higher in the early 1990s. This attracted many agribusiness firms to invest in oilseed processing. As a result, there was a substantial expansion in oilseed processing capacity and an unprecedented increase in oilseed production. However, liberalization of the Indian economy at this point of time fundamentally changed the import regime of India's edible oils. After 1994, India eliminated state monopoly on imports and placed these under Open General License. Under the new trade regime, India also agreed to eliminate import quotas and placed upper bound limits on tariff levels. By 2009, India had reduced import tariff to the extent that it allowed duty-free purchases of crude edible oils and 7.5% duty on refined cooking oils.

India could not realize the full benefits of the import substitution policy as envisioned by the Technology Mission on Oilseeds. There were restrictions on inter-state movement of agricultural products, many oilseeds were reserved for small-scale industry, and small-scale processors did not have sufficient capital to invest in modern equipment and integrated processing plants (Box 6).

Box 6. Bottlenecks in reaping the full benefits of the import substitution policy in India

Under the small-scale industry reservation policy, expelling of groundnut, rapeseed, sesame and safflower oils was restricted to units with an investment of ₹ 0.5-7.5 million ($10,000-$170,000), effectively restricting their processing capacities to units much smaller by international standards. In addition, firms that manufacture oilseed processing equipment were subject to the same scale limits, restricting use of modern technology. Oilseed processors faced restrictions on the availability and cost of credit from commercial banks for the storage of oilseeds and oils. Oilseeds and their products and byproducts were subject to taxes at the point of sale, and if transported across state borders, to turnover, entry, and central sales taxes. Such taxes raise the cost of operating larger enterprises that assemble raw materials or transport products across state borders. Restrictions on inter-state movement of agricultural products were however lifted recently.

Futures trading in oilseeds and their products was not permitted; and oilseed processors were unable to legally use futures contracts to manage price risk. The legalization of futures trading was allowed for soybean and groundnut products, palm and rapeseed in 2003-04. However, with the increase in food prices in 2007-08, futures trading was suspended.

Adapted from: Persaud and Landes (2006).

2. Beginning in 1994, tariff liberalization in edible oils occurred in two distinct phases: Between 1994 and 1998, when customs duty on edible oils progressively fell to reach a low of 15% in July 1998; and the second after 1999 when custom duty witnessed an upward trend, touching a high of 92.2% for refined palm oil in April 2005. Between 1994 and 2005, import duties were revised 17 times creating apprehension and uncertainty for both edible oil producers and importers. As of 2008, the Government of India scrapped import duties on crude edible oils while duties on refined edible oils were set at 7.5%.

5. Outlook for Groundnut and Soybean

In this section, we examine plausible futures for groundnut and soybean in Asia, in terms of likely changes in their cropped area, production, yield, consumption, prices and trade. For this purpose, the IMPACT model developed by the International Food Policy Research Institute (IFPRI) has been used.

Model Description

The IMPACT model simulates the behavior of a competitive world market for agricultural commodities, and is specified as a set of countries or regional sub-models, within each of which supply, demand and market clearing prices for agricultural commodities are generated for each year. The country and regional sub-models are linked through trade in a non-spatial way, such that the effects on country-level production, consumption and commodity prices are captured through net trade flows in global agricultural markets. Demand is a function of prices, income and population growth. Growth in production in each country is determined by farm harvest prices and the rate of productivity growth. World agricultural commodity prices are determined annually at levels that clear international markets. The model uses a system of linear and nonlinear equations to approximate the underlying production and demand relationships, and is parameterized with country-level elasticities of supply and demand (Rosegrant et al. 2008).

The Water Simulation Module (WSM) is an important component of the IMPACT model. WSM simulates water availability for crops taking into consideration total renewable water, non-agricultural water demand, water supply infrastructure, and economic and environmental policies related to water management at the river basin, country, and regional levels. IMPACT-WATER (the integration of IMPACT and WSM) incorporates water availability as a stochastic variable with observable probability distributions to examine the impact of water availability on food supply, demand, and prices. This framework allows exploration of water availability's relationship with food production, demand, and trade at various spatial scales – from river basins, countries, or regions, to the global level over a horizon of 25 years.

The model was expanded in coverage of crops and geographical area by IFPRI and ICRISAT to include important dryland crops like millets, sorghum, chickpea, pigeonpea and groundnut and also to include countries in the semi-arid tropics. The version of the model used for this paper is the IMPACT-WATER model with the base year 2000 (a three-year average of 1999-2001 FAOSTAT data).

Plausible Futures and Alternative Scenarios

In the IMPACT-WATER model, there are several drivers that underlie the dynamics of agricultural production and consumption growth over time. The primary macro-economic drivers are income growth and population growth, which jointly determine the dynamics of per capita income for each country, which is a major determinant of commodity consumption behavior. The principal drivers for agricultural growth are those which determine the expansion or contraction of available land for agriculture, and the productivity growth of irrigated and rainfed crops, which reflects the improvements in agricultural technology and growth potential that can be realized over time. Other important policy relevant variables to consider are those which affect market prices of the commodities directly, such as marketing margins of the crops within their respective regions, as well as the degree of subsidy/protection that is given to either consumers or producers.

Based on the analysis of historical data and available evidence, many of the drivers are already embedded in the business-as-usual

baseline projections, in terms of income, crop yield, and livestock growth rates and observed trade policies in terms of marketing margins and protection levels for specific commodities in each country.

A better understanding of the current situation and future outlooks for soybean and groundnut in Asia requires a careful analysis of the assumptions of baseline business-as-usual conditions for several technological, socio-economic and policy factors, and a comparison of how this may change if other plausible technological, policy options and development pathways were to be followed. This paper examines the following changes in key drivers from baseline scenarios:

- A 25% increase in yield growth rate for groundnut and soybean in India, China and Vietnam (only groundnut)
- A 25% higher income growth rate in India and China
- Raising protection levels for groundnut and soybean in India and China.

For each of the alternative scenarios, the following outcome indicators have been examined:

- Impact on crop area
- Impact on production (supply)
- Impact on productivity
- Impact on demand (per capita food and feed)
- Effects on net trade
- Effects on world prices.

For each of these scenarios, deviations of the key selected outcome indicators from the baseline projections in 2020 are compared (business-as-usual). Such a comparison provides a better understanding of the potential responsiveness of the crops to important technological, socio-economic and trade-related changes.

Outlook for Groundnut

Table 21 presents results of the business-as-usual scenario where past trends in per capita income, groundnut yield and groundnut prices are assumed to continue to 2020. The demand for groundnut (in shell equivalent) in India will increase to 8.8 million t in 2020 from 6.2 million t in 2000. However, production increases are unlikely to catch up with demand increases, forcing the country to be a net importer of 0.70 million t of in-shell equivalent groundnut. In contrast, China will have a small trade surplus (0.71 million t), despite rapid increase in demand from 13.1 million t in 2000 to 22.0 million t in 2020. Its trade surplus will be marginally smaller than in 2000. Vietnam will also face a minor decline in its trade surplus from 93,000 t in 2000 to 75,000 t in 2020. Other countries like Indonesia and Myanmar will be importing more in 2020 than in 2000. On the whole, with business-as-usual assumptions, Asia will turn from a trade surplus to a trade deficit region, and Africa will have a stronger positive trade balance.

Table 21. Demand and supply projections ('000 t) for groundnut under a business-as-usual scenario.

Region/ country	Production		Demand		Net trade	
	2000	2020	2000	2020	2000	2020
Africa	8,617	13,322	8,411	12,264	88	940
Asia	22,574	34,869	22,530	36,527	541	-1,161
China	13,899	22,662	12,103	21,956	795	705
India	6,201	8,795	6,235	9,727	199	-699
Indonesia	948	1,339	1,405	2,135	-174	-512
Myanmar	641	871	640	1,040	2	-169
Vietnam	346	485	226	384	93	75

Let us examine responses of demand, supply and trade to changes in crop yields, income growth and trade protection measures, and compare these with the business-as-usual outcomes.

A 25% Increase in Yield Growth Rate

If growth in groundnut yield in India were to accelerate by 25%, yield will increase to 1379 kg ha^{-1} in 2020 and total production will be 5.2% higher compared to the level of production obtained with business-as-usual assumptions (Table 22). India had a trade surplus in groundnut in 2000, while the projections for 2020 with business-as-usual assumptions indicate a trade deficit of 699,000 t. However, with acceleration in yield growth, production will be 5.2% more and the trade deficit will decline by 58% (291,000 t). As a result, the export surplus of Africa and East Asia would decline. The effect of accelerated yield growth on per capita consumption of groundnut, however, will be marginal.

In China, if past growth in groundnut yield were to accelerate by 25%, by 2020 average groundnut yield will reach 4366 kg ha^{-1} and production will be 5% more compared to the business-as-usual projections. There would be a marginal decline in groundnut area. The largest impact would be on trade; China's trade surplus will increase to 1.48 million t, more than twice that obtained with business-as-usual assumptions. Imports to India will increase while exports from Africa will decline. Per capita food consumption in several countries will be higher by 1%-2%. World prices of groundnut will be lower by US$ 50 t^{-1}. At a similar rate of acceleration of yield growth in China and India, world prices would be more responsive to China's yield growth than India's (Figure 23). A 25% increase in yield growth rate in Vietnam is unlikely to have any significant effect on production and other economic variables in Vietnam and elsewhere in Asia.

A 25% Higher Income Growth Rate

A 25% higher growth in per capita income in India is unlikely to have any significant impact on area, production and yield of groundnut. Only trade is likely to be influenced by accelerated income growth. India's trade deficit will increase because of rising domestic demand, as the per capita consumption of groundnut in India will be higher by 6% over the business-as-usual projected consumption. Benefits of rising demand in India will accrue to Africa and China in terms of increased exports to India. World prices will be higher by US$ 50 t^{-1}.

Compared to India's groundnut economy, China's groundnut economy is more responsive to similar changes in per capita income. Groundnut production in China in 2020 will be greater by 3% over the business-as-usual projection. Interestingly, so will be the case in other major groundnut growing regions. A combination of area expansion and yield improvements will drive production growth. Per capita consumption of groundnut in China will be higher by 12.5% compared to the projected consumption with business-as-usual assumptions. With income growth and rising demand, China will turn from a net exporter to a net importer. Exports from Africa will double, and some exports to India will be diverted to China. World prices of groundnut will be more by US$ 100 t^{-1} over prices obtained with business-as-usual assumptions. With higher prices, per capita consumption in countries in Asia and Africa will decline.

Increasing Trade Protection

Trade protection and liberalization are measured on a scale of 0 to 1, where 0 represents free trade and 1 represents a completely closed economy. The value encompasses different trade policy measures such as trade quotas, export tariffs and quantitative restrictions. Under this scenario, India is assumed to systematically increase trade protection leading to complete

Table 22. Effects of an increase in yield, income and trade protection on groundnut economy.

Region/ country	Production		Yield		Demand		Net trade	
	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 (kg ha^{-1})	Change over baseline (%)	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 ('000 t)	Change over baseline (%)
A 25% increase in yield growth in China								
Africa	13.1	-1.5	1,019.9	-0.5	12.5	2.3	451.5	-52.0
North America	2.3	-1.3	4,114.2	-0.4	1.9	1.6	452.6	11.8
Asia	35.8	2.8	2,551.8	3.6	36.9	1.0	-561.0	51.7
South Asia	8.9	-1.4	1,302.2	-0.5	10.2	1.5	-1,068.4	-34.3
India	8.7	-1.4	1,299.9	-0.5	9.9	1.5	-965.6	-38.2
Southeast Asia	2.9	-0.6	1,708.5	-0.4	4.1	1.8	-956.0	-10.5
China	23.8	5.0	4,366.0	5.7	22.1	0.7	1,675.2	137.7
World	53.1	1.4	1,878.8	2.3				
A 25% increase in yield growth in India								
Africa	13.2	-0.6	1,023.4	-0.2	12.4	0.8	764.1	-18.7
North America	2.4	-0.5	4,124.5	-0.1	1.9	0.6	491.4	4.3
Asia	35.2	1.0	2,495.5	1.3	36.7	0.4	-944.9	18.6
South Asia	9.5	5.1	1,380.3	5.4	10.1	0.5	-390.3	51.0
India	9.3	5.2	1,379.5	5.6	9.8	0.5	-291.1	58.3
Southeast Asia	2.9	-0.2	1,712.4	-0.1	4.1	0.6	-897.6	-3.8
China	22.6	-0.4	4,122.5	-0.2	22.0	0.3	550.6	-21.9
World	52.6	0.5	1,852.2	0.8				
Complete trade protection in China								
Africa	13.2	-1.2	1,021.3	-0.4	12.5	1.7	577.3	-38.6
North America	2.4	-1.0	4,118.4	-0.3	1.9	1.2	468.1	8.8
Asia	34.9	0.0	2,451.2	-0.5	36.1	-1.2	-715.4	38.4
South Asia	9.2	2.4	1,320.3	0.8	9.4	-6.2	40.4	105.1
India	9.0	2.5	1,318.4	0.9	9.1	-6.4	141.7	120.3
Southeast Asia	2.9	-0.5	1,710.0	-0.3	4.1	1.3	-932.5	-7.8
China	22.5	-0.9	4,114.7	-0.4	22.1	0.5	386.9	-45.1
World	52.2	-0.4	1,832.6	-0.3				
Complete trade protection in India								
Africa	13.1	-1.6	1,020.1	-0.5	12.5	2.3	440.3	-53.2
North America	2.3	-1.4	4,114.8	-0.4	1.9	1.7	449.4	12.4
Asia	35.1	0.6	2,481.6	0.7	36.1	-1.1	-544.2	53.1
South Asia	8.9	-1.4	1,302.5	-0.5	10.2	1.5	-1,073.9	-34.9
India	8.7	-1.4	1,300.2	-0.5	9.9	1.5	-971.0	-39.0
Southeast Asia	2.9	-0.6	1,708.7	-0.3	4.1	1.9	-959.4	-10.9
China	23.0	1.6	4,155.5	0.6	21.3	-2.9	1,701.4	141.4
World	52.3	-0.1	1,846.4	0.5				

Continued...

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Region/ country	Production		Yield		Demand		Net trade	
	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 (kg ha^{-1})	Change over baseline (%)	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 ('000 t)	Change over baseline (%)
A 25% increase in income growth in India								
Africa	13.4	0.8	1,033.0	0.7	12.0	-2.0	1,286.5	36.9
North America	2.4	0.6	4,152.4	0.5	1.9	-0.1	529.4	-3.1
Asia	35.3	1.1	2,480.6	0.7	37.3	2.1	-1,540.3	-32.7
South Asia	9.1	1.3	1,319.1	0.7	10.6	6.0	-1,280.6	-60.9
India	8.9	1.3	1,316.8	0.7	10.3	6.2	-1,187.2	-69.9
Southeast Asia	2.9	0.6	1,723.4	0.5	4.0	-0.5	-825.3	4.6
China	22.9	1.1	4,157.8	0.7	22.1	0.8	771.7	9.5
World	52.9	1.0	1,851.1	0.7				
A 25% increase in income growth in China								
Africa	13.8	3.3	1,042.1	1.6	11.6	-5.5	2,050.0	118.1
North America	2.4	2.6	4,178.3	1.2	1.8	-2.4	619.6	20.7
Asia	35.9	3.0	2,499.7	1.4	38.9	6.4	-2,469.0	-112.6
South Asia	9.3	3.4	1,330.6	1.6	9.8	-2.5	-241.3	-69.7
India	9.1	3.4	1,328.3	1.6	9.5	-2.5	-156.0	77.7
Southeast Asia	3.0	1.6	1,733.2	1.1	3.9	-3.1	-689.6	20.3
China	23.3	3.0	4,190.7	1.5	24.7	12.4	-1,340.9	-290.2
World	53.9	3.0	1,863.9	1.4				

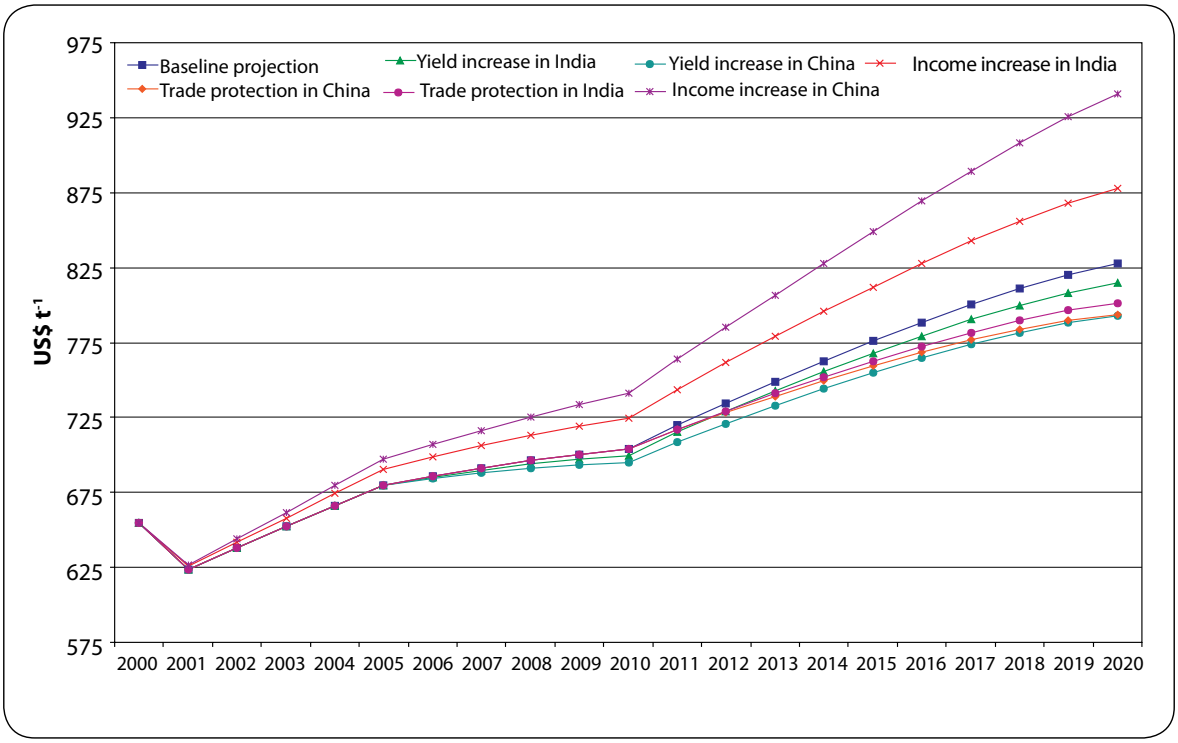

Figure 23. World groundnut prices under different scenarios.

protection by 2019. With this, groundnut production in India will be 2.5% more over the business-as-usual projection. Much of this increase will come from area expansion. The largest change will be in net trade. By 2020, India will turn from net importer to small exporter. Exports from Africa and East Asia will fall by 39% and 62%, respectively. World prices of groundnut will decline by US$ 25 t^{-1} due to protectionist measures in India.

As in India, it is assumed that China too will systematically increase its trade protection, providing full protection by 2019. As a result, groundnut production will be higher by 1.6% over the business-as-usual projection. Additional production will come from area expansion. The largest change will be in net trade. Exports from China will grow by 194%, while exports from Africa will fall. Imports to India will also increase. Per capita consumption of groundnut in China will be less. With trade protection, world prices will be lower compared to baseline projected prices.

From these findings, it is inferred that changes in groundnut yield and income growth in China will have a larger impact on production both within and outside Asia, compared to similar changes in India.

Outlook for Soybean

On the assumption that past trends in per capita income, soybean yield and its price will continue to 2020, demand for soybean (grain equivalent) in India will increase to 9.7 million t by 2020 (Table 23). Domestic production, however, will not be sufficient to meet the growing demand, forcing the country to be a net importer of 1.2 million t from a small net trade surplus in 2000. In 2020, China's demand for soybean will be huge – 45 million t – about 21 million t more than in 2000. As a result, its imports will increase further leading to a doubling of trade deficit from 11 million t in 2000 to 22 million t in 2020. Vietnam and Myanmar, which were self-sufficient in 2000, will turn out to be net importers. Latin American countries like Brazil and Argentina will be net gainers from expanding demand in Asia.

A 25% Increase in Yield Growth Rate

If soybean yield growth in India were to be 25% more than the existing growth, soybean production and yield each will be 7% more compared to their corresponding business-as-usual projections. This, however, is unlikely to influence production or yield in any other region. Major changes will be seen in net trade. India's imports will fall by 55% compared to baseline projections. Exports from other major producing and exporting regions will decline marginally (Table 24). Since India is not a major soybean producer, increase in production is unlikely to influence world prices in a significant way (Figure 24).

Table 23. Demand and supply projections ('000 t) for soybean under a business-as-usual scenario.

Region/ country	Production		Demand		Net trade	
	2000	2020	2000	2020	2000	2020
North America	77,465	91,206	51,366	65,106	26,564	26,099
Latin America	60,690	97,314	48,360	65,479	13,120	31,834
Asia	23,711	37,362	45,996	74,723	-22,533	-37,361
China	15,042	23,725	26,170	45,202	-11,438	-21,476
India	6,082	9,722	6,175	10,893	40	-1,170
Indonesia	1,077	1,843	2,306	3,343	-1,217	-1,500
Myanmar	98	127	93	199	5	-72
Vietnam	158	194	124	300	34	-107

Table 24. Effects of an increase in yield, income and trade protection on soybean economy.

Region/ country	Production		Yield		Demand		Net trade	
	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 (kg ha^{-1})	Change over baseline (%)	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 ('000 t)	Change over baseline (%)
A 25% increase in yield growth in India								
Africa	1.7	-0.1	1,569.1	0.0	2.5	0.2	-0.8	0.9
North America	91.1	-0.1	3,161.2	0.0	65.2	0.2	25.9	-0.8
Latin America	97.2	-0.1	3,355.8	0.0	65.6	0.2	31.6	0.8
Europe	2.8	-0.1	2,679.3	0.0	22.3	0.2	-19.6	-0.2
Asia	38.0	1.7	2,017.7	1.8	74.8	0.2	-36.8	1.4
South Asia	10.6	6.7	1,456.5	6.7	12.0	0.2	-1.4	31.0
India	10.4	6.8	1,448.5	6.9	10.9	0.2	-0.5	-55.1
Southeast Asia	2.7	-0.1	1,870.6	0.0	7.4	0.1	-4.6	-0.2
China	23.7	-0.1	2,470.4	0.0	45.3	0.2	-21.6	0.4
Oceania	0.1	-0.1	2,898.8	0.0	0.2	0.1	-0.1	-0.4
World	230.9	0.2	2,931.4	0.3				
A 25% increase in yield growth in China								
Africa	1.7	-0.2	1,568.1	-0.1	2.5	0.6	-0.8	2.3
North America	91.0	-0.3	3,159.7	-0.1	65.4	0.5	25.5	-2.2
Latin America	97.1	-0.2	3,354.1	-0.1	65.9	0.6	31.2	2.0
Europe	2.8	-0.2	2,677.9	-0.1	22.4	0.5	-19.6	-0.6
Asia	39.0	4.4	2,073.2	4.6	75.0	0.4	-36.0	3.6
South Asia	9.9	-0.2	1,363.0	-0.1	12.1	0.5	-2.2	-4.0
India	9.7	-0.2	1,353.6	-0.1	10.9	0.5	-1.2	6.5
Southeast Asia	2.7	-0.2	1,869.7	-0.1	7.4	0.3	-4.6	-0.6
China	25.4	7.1	2,650.6	7.3	45.4	0.4	-20.0	-7.0
Oceania	0.1	-0.1	2,897.7	-0.1	0.2	0.3	-0.1	-0.9
World	231.6	0.5	2,943.4	0.7				
Complete trade protection in China								
Africa	1.7	-0.1	1,569.2	0.0	2.5	0.2	-0.8	-0.8
North America	91.1	-0.1	3,161.4	0.0	65.2	0.2	25.9	0.7
Latin America	97.2	-0.1	3,356.0	0.0	65.6	0.2	31.6	0.7
Europe	2.8	-0.1	2,679.4	0.0	22.3	0.2	-19.6	-0.2
Asia	37.5	0.3	1,986.1	0.2	74.4	-0.4	-36.9	1.2
South Asia	9.9	-0.1	1,364.0	0.0	12.0	0.2	-2.1	-1.4
India	9.7	-0.1	1,354.6	0.0	10.9	0.2	-1.2	-2.2
Southeast Asia	2.7	-0.1	1,870.6	0.0	7.3	0.1	-4.6	-0.2
China	23.8	0.5	2,476.8	0.2	44.8	-0.8	-21.0	-2.4
Oceania	0.1	0.0	2,898.9	0.0	0.2	0.1	-0.1	-0.3
World	230.4	0.0	2,923.6	0.0				

Continued...

Continued...

Region/ country	Production		Yield		Demand		Net trade	
	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 (kg ha^{-1})	Change over baseline (%)	Scenario value in 2020 (Million t)	Change over baseline (%)	Scenario value in 2020 ('000 t)	Change over baseline (%)
A 25% increase in income growth in India								
Africa	1.7	-0.4	1,574.5	0.3	2.4	-1.0	-0.8	-2.2
North America	90.6	-0.6	3,167.0	0.2	64.6	-0.8	26.0	-0.2
Latin America	96.9	-0.4	3,362.5	0.2	64.8	-1.0	32.1	-0.7
Europe	2.8	-0.4	2,683.5	0.1	22.1	-0.8	-19.3	0.9
Asia	37.3	-0.1	1,986.4	0.2	75.0	0.4	-37.7	-1.0
South Asia	9.9	-0.1	1,367.3	0.2	12.8	6.7	-2.9	-38.9
India	9.7	-0.1	1,358.0	0.2	11.7	7.4	-2.0	-69.9
Southeast Asia	2.7	0.0	1,873.8	0.1	7.3	-0.6	-4.6	0.9
China	23.7	-0.1	2,476.2	0.2	44.9	-0.7	-21.2	-1.4
Oceania	0.1	-0.1	2,903.0	0.1	0.2	-1.1	-0.1	0.8
World	229.4	-0.5	2,927.8	0.1				
A 25% increase in income growth in China								
Africa	1.7	0.3	1,580.0	0.6	2.4	-2.7	-0.7	8.8
North America	91.2	0.0	3,174.9	0.4	63.7	-2.2	27.5	-5.4
Latin America	97.5	0.2	3,371.7	0.4	63.8	-2.6	33.7	-5.9
Europe	2.8	0.2	2,690.7	0.4	21.8	-2.1	-19.0	2.4
Asia	37.6	0.5	1,993.0	0.5	78.8	5.4	-41.2	-10.3
South Asia	10.0	0.5	1,372.1	0.6	11.7	-2.2	-1.8	15.1
India	9.8	0.5	1,362.7	0.6	10.7	-2.1	-0.9	24.1
Southeast Asia	2.7	0.6	1,878.2	0.4	7.2	-1.5	-4.5	2.7
China	23.8	0.5	2,484.2	0.5	49.9	10.4	-26.0	21.2
Oceania	0.1	0.2	2,908.8	0.3	0.2	-1.0	-0.1	2.9
World	230.8	0.2	2,936.1	0.4				

With a 25% acceleration in yield growth, China's soybean production in 2020 will be 7% more compared to the business-as-usual projections. Following this, Asia's production will also be higher by 4.4%. Even with this increase in domestic production, China will continue to import huge quantities. But world soybean prices are likely to remain unaffected.

A 25% Higher Income Growth Rate

If India's per capita income were to grow by 25% higher than the existing growth, its soybean economy is unlikely to undergo any significant change except that its trade deficit will be 70% higher over the business-as-usual projected deficit. Soybean demand in India will be 7% more. These changes in demand and production will not affect world soybean economies much. Soybean prices will be higher by US$ 5 t^{-1} over the baseline projected price.

A similar acceleration in income growth in China will fuel growth in domestic demand, which will be higher by 10% in 2020 over the baseline projected demand. This will influence net trade, with China importing 15% more than that projected under business-as-usual assumptions. Impact on world prices will be greater than experienced with a similar change in income growth in India. Global prices will be greater by US$ 10 t^{-1} than the baseline projected price.

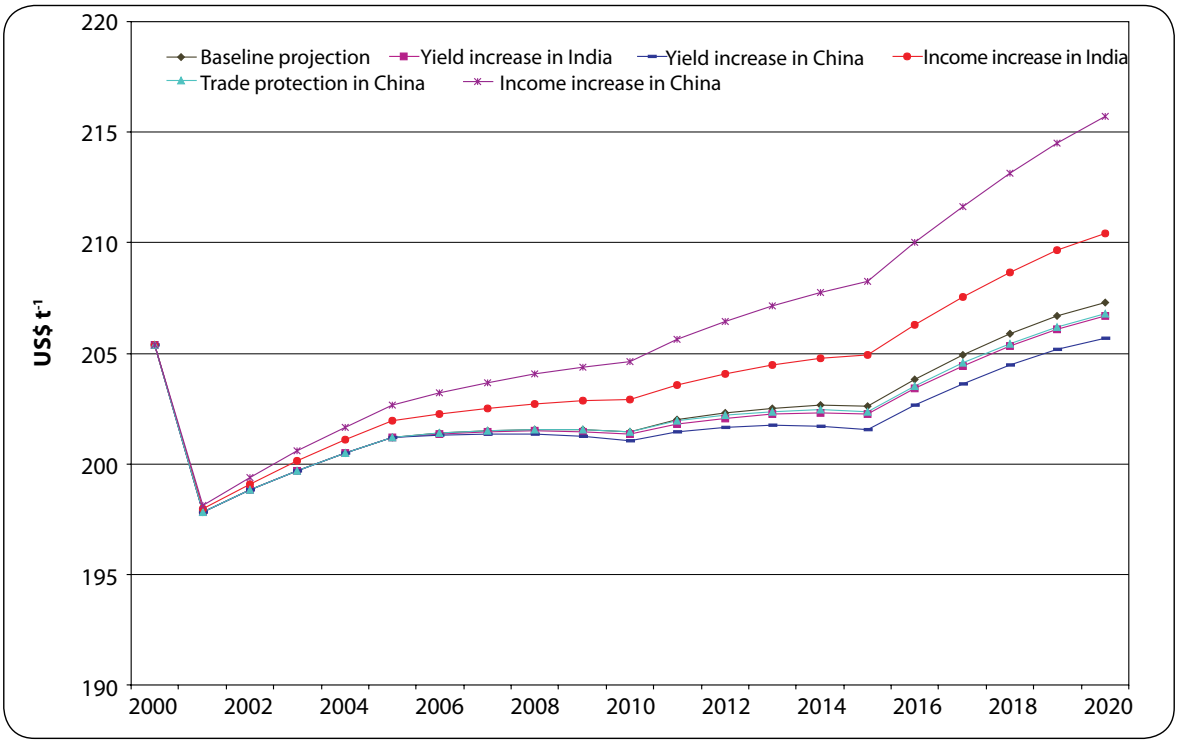

Figure 24. World soybean prices under different scenarios.

Increasing Trade Protection

Raising trade protection in China will have a negligible impact on soybean production or imports to China. There will also be no significant change in the world market prices of soybean.

Unlike groundnut, acceleration in soybean yield and income growth in India and China – the two largest soybean producers in Asia – do not cause any significant changes in global soybean production systems. At the most, impacts of these changes are restricted to the respective countries.

6. Conclusions and Implications

Owing to a sustained rise in per capita incomes, growing population and changing lifestyles, the demand for oilseeds, edible oils and oilcake meals has been growing rapidly in Asia to the extent that domestic production in most countries in the region is unable to catch up with rising demand. The factors underlying demand growth have been robust in the recent past, and are unlikely to subside in the near future, implying a further rise in demand for oilseeds and their products. In this report, we have presented trends and prospects for growth of the oilseed sector of Asia, focusing on groundnut and soybean, two most important crops grown in the region.

During 1981-2007, Asia's groundnut and soybean production grew at a rate of 3.1% and 3.7% a year respectively. Their performance across countries, however, has been mixed. While groundnut production in China grew at an impressive rate of 5.9%, its performance in India has been lackluster (0.22%). Groundnut production in Southeast Asian countries also grew at an impressive rate. Groundnut yield is higher in China than in any other country in the region, and it is one of the lowest in India. Interestingly, despite differing performances, yield improvements were the main drivers of growth in production in most countries. Soybean production in India increased at an annual rate of 12.6% as compared to a 2.5% growth in China. Vietnam and Myanmar too experienced robust growth.

Sources of output growth, however, were different across countries. In India and Myanmar, yield levels are low, and growth in production was driven by area expansion. In contrast, in China and Vietnam, yield levels are high and yield improvements were the main drivers of output growth. Inter-country differences in the performance of groundnut and soybean production were due to differences in production conditions, technology, cultivation practices and policies.

Despite impressive growth, domestic production could not catch up with growing demand in most countries in the region, and is unlikely to do so in the near future. If past trends in per capita income and production were to continue, by 2020 China's demand for soybean would increase to 45 million t and approximately half of this would be met through imports. Though India is currently self-sufficient in soybean, by 2020 its demand would increase to about 11 million t, and about 10% of this would be met through imports.

However, if these economies were to grow faster, the gap between demand and supply will increase further. Unlike soybean, production of groundnut will keep pace with domestic demand in China, leaving a surplus for exports. On the other hand, demand for groundnut in India will outstrip its production, forcing it to resort to imports. Volume of net trade in groundnut, both in China and India, comprises only a small fraction of their total supplies and changes therein are likely to be marginal.

The expanding demand for oilseeds and their products suggests that there are considerable opportunities for growth of the oilseed sector in Asia, which need to be harnessed by overcoming supply-side constraints through generation and diffusion of appropriate technologies for different production environments, and appropriate domestic and trade policies. Note that oilseed crops in much of Asia are grown in marginal environments characterized by low and erratic rainfall and limited irrigation facilities; hence higher production risks discourage farmers from investing in farm infrastructure, improved technologies and quality inputs. This has its implications for research and development. Oilseed research should re-orient its focus towards developing varieties that can withstand moisture stress, and are resistant to insect pests and diseases. Though varietal improvement under marginal environments is difficult, and will be slower, less certain and costlier in terms of investment and effort, it can be achieved. For instance, ICRISAT has

developed groundnut varieties which have improved tolerance to drought and aflatoxin.

An efficient seed system is a pre-condition for the dissemination and adoption of improved varieties. For oilseed crops, the seed system in most Asian countries is underdeveloped. While the public sector has not focused much on multiplication and distribution of seeds of oilseeds, the private sector finds these activities unremunerative because of uncertain seed demand induced by uncertainty in rainfall. Hence, there is a need to develop and promote informal seed systems at the village level, such as seed banks and farmer-to-farmer sale or exchange, especially for crops like groundnut whose seed requirement is voluminous and outturn is low. Besides, there is also a need to promote technical interventions, like mulching and Integrated Crop Management (ICM) that have been demonstrated to generate significant yield gains. The immediate concern should be of closing the yield gap that continues to be large; in India for soybean it ranges from 19%-65% under different production environments, and for groundnut in Vietnam it has been reported to range between 40% and 60% (Singh et al. 2001).

Water is the most limiting factor in rainfed agriculture. Rainfall is low and erratic, and surface and groundwater irrigation infrastructure is underdeveloped. The critical issue under such environments is the conservation of rainwater and its efficient use. Efforts and investments should be targeted towards conservation of rainwater and improving water use efficiency by promoting water-saving techniques such as sprinkler and drip irrigation.

Finally, there is a need to correct policy bias against oilseed crops in particular, and rainfed agriculture in general. In the past, policy emphasis in most Asian countries had been on increasing production of rice and wheat for foodgrain security, neglecting coarse cereals, pulses and oilseeds. Prices of oilseeds and their products were kept depressed through domestic price controls, and low import tariffs. Being low yielding, oilseed crops under such a policy environment lose their competitiveness over other crops grown under similar agro-climatic conditions. Hence, to increase production of oilseeds, there is a need to improve their profitability by providing remunerative prices, controlling imports of cheap edible oils and above all, disseminating high-yielding, drought-tolerant and insect- and pest-resistant varieties.

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Annexures

Annexure 1. Area, yield and production of groundnut in major growing districts of India, 2003-05.

State/district	Area ('000 ha)	Yield (kg ha^{-1})	Production ('000 t)
Andhra Pradesh	**1737**	**766**	**1330**
Anantapur	769	517	398
Kurnool	194	915	177
Chittoor	166	894	149
Cuddapah	151	544	82
Mahabubnagar	81	827	67
Srikakulam	57	876	50
Gujarat	**1986**	**1637**	**3251**
Junagadh	504	1691	852
Jamnagar	435	1056	459
Rajkot	403	1026	414
Amreli	295	1128	333
Bhavnagar	170	895	152
Kutch	65	1384	90
Karnataka	**942**	**654**	**616**
Chitradurga	173	701	121
Tumkur	138	520	72
Dharwad	112	440	49
Raichur	82	644	53
Bijapur	80	594	47
Belgaum	67	641	43
Bellary	63	567	36
Gulbarga	61	836	51
Madhya Pradesh	**212**	**1146**	**243**
Shivpuri	62	997	61
Maharashtra	**418**	**1077**	**450**
Kolhapur	68	1687	114
Satara	62	1412	87
Dhule	54	947	51
Orissa	**85**	**1200**	**102**
Cuttack	59	1672	99
Rajasthan	**272**	**1555**	**423**
Jaipur	44	1317	58
Tamil Nadu	**609**	**1654**	**1007**
Vellore	152	1197	182
Salem	100	1214	121
Cuddalore	87	1993	174
Thiruchirapalli	64	1435	92
Coimbatore	51	1371	70
Chengalpattu MGR	48	2850	137

Source: ICRISAT Database.

Annexure 2. Area, yield and production of groundnut in China by province, 2004-06.

Province	Area ('000 ha)	Yield (kg ha^{-1})	Production ('000 t)
Henan	963	3505	3374
Shandong	889	4049	3601
Hebei	313	4428	1384
Guangdong	309	2472	763
Sichuan	263	2145	563
Guangxi	242	2253	546
Anhui	237	3650	865
Jiangsu	195	3274	638
Liaoning	174	2122	369
Hubei	171	3540	606
Hunan	139	2305	321
Jiangxi	134	2378	319
Fujian	108	2361	255
Jilin	107	2558	273
Chongqing	54	1630	88
Guizhou	43	1749	76
Yunnan	42	1349	57
Hainan	42	2061	86
Shaanxi	29	2603	77
Heilongjiang	20	2206	45
Zhejiang	18	2697	48
Shanxi	14	2080	30
Inner Mongolia	13	1805	23
Beijing	9	2890	25
Xinjiang	2	2633	6
Tianjin	2	3482	8
Shanghai	1	3343	4
Gansu	1	1800	2

Source: USDA (http://www.ers.usda.gov/Data/China).

Annexure 3. Annual growth rate (%) in area, yield and production of groundnut in Asia vis-à-vis the world, 1981-2007.

Country/ region	Area		Yield		Production	
	1981-95	1996-2007	1981-95	1996-2007	1981-95	1996-2007
World	**1.45**	**0.28**	**1.69**	**1.56**	**3.17**	**1.83**
Developed countries	**1.18**	**-0.52**	**-0.84**	**2.00**	**0.31**	**1.49**
Europe	1.67	-1.00	-5.68	-3.93	-4.02	-4.92
North America	1.45	-0.45	-1.00	2.07	0.42	1.61
Oceania	-4.50	-2.01	2.46	0.52	-2.02	-1.81
Developing countries	**1.46**	**0.30**	**1.92**	**1.56**	**3.41**	**1.85**
Africa	1.82	0.81	1.40	1.70	3.25	2.52
Latin America and Caribbean	-3.21	-2.52	1.59	3.03	-1.64	0.51
Asia	**1.47**	**0.07**	**2.24**	**1.62**	**3.74**	**1.69**
East Asia	2.63	2.54	3.07	0.88	5.80	3.43
China	2.71	2.57	3.09	0.86	5.89	3.45
Japan	-6.31	-3.98	1.21	0.51	-5.18	-3.49
South Asia	0.97	1.58	1.50	0.00	2.59	-1.72
India	1.07	-1.77	1.50	0.07	2.58	-1.69
Pakistan	4.25	-1.07	-0.78	-3.91	3.44	-4.95
Southeast Asia	1.10	-1.76	0.43	1.88	1.39	3.50
Indonesia	2.86	0.88	-0.08	1.44	2.78	2.33
Myanmar	-1.12	3.91	-1.02	2.60	-2.13	6.60
Thailand	-2.00	-3.41	1.20	1.10	-0.83	-2.35
Vietnam	3.65	-0.05	2.55	3.70	6.29	3.64
Philippines	-1.28	-0.82	-0.26	0.85	-1.53	0.02
West Asia	2.35	-3.37	0.83	3.03	3.21	-0.45
Turkey	2.11	-2.68	0.54	3.14	2.66	0.37

Source: Calculated using data from FAOSTAT (http://www.faostat.fao.org).

Annexure 4. Annual growth rate (%) in area, yield and production of soybean in Asia vis-à-vis the world, 1981–2007.

Country/ region	Area		Yield		Production	
	1981-95	1996-2007	1981-95	1996-2007	1981-95	1996-2007
World	**1.5**	**4.1**	**1.6**	**0.8**	**3.1**	**4.9**
Developed countries	**3.6**	**6.0**	**-2.0**	**-3.9**	**1.5**	**1.9**
Europe	-1.2	6.1	4.5	-2.0	3.3	3.9
North America	-0.5	1.0	2.0	0.8	1.5	1.8
Oceania	-4.6	-5.4	1.0	1.0	-3.4	-4.5
Developing countries	**-0.6**	**1.3**	**5.8**	**6.3**	**5.2**	**7.6**
Africa	7.9	3.2	-2.6	2.2	5.2	5.5
Latin America	3.5	8.8	1.8	1.1	5.4	10.0
Asia	**3.6**	**1.9**	**1.3**	**-0.1**	**5.0**	**1.7**
East Asia	0.4	1.7	2.2	-0.1	2.6	1.6
China	0.5	1.7	2.4	-0.1	2.9	1.6
South Korea	0.0	-0.2	0.1	-0.4	0.0	-0.6
Japan	-4.9	5.9	-0.5	-1.3	-5.4	4.6
North Korea	-4.2	-0.8	1.1	1.1	-3.2	0.3
South Asia	15.1	3.5	2.6	-0.1	18.1	3.3
India	15.8	3.5	3.3	-0.3	19.7	3.2
Iran	2.7	3.7	-0.8	5.3	1.9	9.2
Southeast Asia	6.0	-4.6	2.4	1.1	8.5	-3.5
Indonesia	6.2	-8.9	2.4	1.0	8.8	-8.0
Vietnam	1.8	7.0	2.1	3.3	4.0	10.5
Thailand	7.1	-6.2	1.7	0.5	8.9	-5.7
Myanmar	4.9	8.1	0.5	2.8	5.4	11.1
West Asia	1.6	-6.5	1.5	5.7	3.0	-1.3

Source: Calculated using data from FAOSTAT (http://www.faostat.fao.org).

Annexure 5. Area, yield and production of soybean in China by province, 2004-06.

Province	Area ('000 ha)	Yield (kg ha^{-1})	Production ('000 t)
Heilongjiang	3514	1768	6213
Anhui	923	772	713
Inner Mongolia	768	1469	1128
Henan	524	1440	755
Jilin	493	2729	1346
Shaanxi	317	1045	331
Liaoning	258	1597	411
Hebei	256	1711	438
Shandong	235	2826	663
Shanxi	218	1290	282
Jiangsu	215	2469	531
Guangxi	214	1457	312
Sichuan	205	2298	470
Hunan	186	2193	408
Hubei	178	2292	408
Guizhou	130	1278	167
Zhejiang	126	2281	287
Yunnan	126	1367	172
Jiangxi	100	1796	179
Chongqing	97	1579	153
Gansu	90	1564	141
Fujian	87	2116	183
Guangdong	83	2275	189
Xinjiang	76	2755	211
Tianjin	26	1396	36
Ningxia	19	727	14
Beijing	12	2143	26
Hainan	6	1954	11
Shanghai	6	3294	19
Tibet	1	2222	1

Source: USDA (http://www.ers.usda.gov/Data/China).

Annexure 6. Area, yield and production of soybean in major growing districts of India, 2003-05.

State/district	Area ('000 ha)	Yield (Kg ha^{-1})	Production ('000 t)
Madhya Pradesh	**4318**	**996**	**4300**
Ujjain	394	725	285
Hoshangabad	352	787	277
Sehore	332	1019	338
Shajapur	310	759	236
Mandsaur	310	860	266
Dewas	270	1193	323
Rajgarh	257	781	201
Dhar	226	979	222
Indore	220	958	211
Guna	178	760	135
Ratlam	168	741	125
Sagar	165	782	129
Betul	162	747	121
Khandwa	159	545	87
Vidisha	117	930	109
Chhindwara	111	1016	113
Raisen	80	871	70
Seoni	80	976	78
Shivpuri	75	722	54
Khargone	73	701	51
Narsinghpur	73	1539	112
Maharashtra	**2013**	**1099**	**2213**
Nagpur	220	1019	224
Wardha	176	1181	208
Akola	166	1096	182
Amravati	160	932	149
Chandrapur	144	1101	159
Parbhani	132	1207	160
Yavatmal	118	975	115
Osmanabad	114	830	95
Buldhana	103	1236	127
Nanded	73	1124	82
Kolhapur	68	1805	123
Sangli	62	1801	111
Rajasthan	**620**	**1308**	**811**
Kota	196	1075	210
Jhalawar	160	705	113
Chittorgarh	115	815	94

Source: ICRISAT Database.

About ICRISAT

The International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, and 644 million of these are the poorest of the poor. ICRISAT and its partners help empower these poor people to overcome poverty, hunger and a degraded environment through better agriculture.

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ISBN: 978-92-9066-531-1 Order code: BOE 050 97-2010