Chickpea and Pigeonpea Economies in Asia

Facts, Trends and Outlook

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Citation: Parthasarathy Rao P, Birthal PS, Bhagavatula S and Bantilan MCS . 2010. Chickpea and Pigeonpea Economies in Asia: Facts, Trends and Outlook. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 76 pp. ISBN: 978-92-9066-530-4. Order code: BOE 049.

Abstract

This report provides a factual assessment of consumption, production and marketing of pulses in Asia, and explores future prospects for the pulses sector by focusing on chickpea and pigeonpea, the two most important pulse crops grown in the continent. Chickpea and pigeonpea are important grain legumes and play a significant role in the food and nutrition security of the poor in developing countries of Asia. Together, these crops account for 41% of Asia's pulses production. Asia accounts for 88% of global chickpea production and 90% of global pigeonpea production. Within Asia, India is the largest producer of both crops, accounting for 75% of Asia's chickpea as well as pigeonpea production.

Global yields of both chickpea and pigeonpea are low, and have been relatively stagnant for much of the last two decades. India has a dominating influence on these trends owing to its large share in the global production of these crops. A number of biotic and abiotic factors limit realization of yield potential. The sluggish growth in chickpea and pigeonpea yields in India can be attributed to: (i) the shift in crop area from favorable to marginal environments; (ii) the slow uptake of improved varieties and other production technologies; and (iii) its cultivation on poor soils under erratic rainfall conditions.

On the demand side, however, buoyed by increasing incomes in both Asia and Africa, demand for both the crops is set to increase in the medium term, doubling in Asia and Africa over the period 2000 to 2020. Trade in chickpea is relatively robust and has been growing over time. Close to 10% of the total chickpea produced in 2003-05 entered the international market. For pigeonpea, Myanmar is a major exporter followed by Malawi, Kenya, Uganda and the Dominican Republic. International prices of both chickpea and pigeonpea declined in real terms until 2006. Since then, prices for both crops have increased in line with the general rise in prices of all agricultural commodities.

The scope of raising chickpea and pigeonpea production in Asia through area expansion alone is limited. Therefore, the main challenges for research and development are to bridge the gap between actual and attainable yield by enhancing farmers' access to quality inputs, improved technologies and information; and improve the competitiveness of pulse crops through domestic incentives related to production, marketing, processing, and prices in line with cereals and competing crops.

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2010

Acknowledgments

The authors express their gratitude to Drs PK Joshi, Director, National Academy of Agricultural Research Management (NAARM), Hyderabad, KB Saxena, Principal Scientist (Pigeonpea Breeding), ICRISAT-Patancheru, and Solomon Asfaw, Regional Scientist (Economics), ICRISAT-Nairobi, for their critical comments and suggestions that helped us bring this report to its present form. They are also grateful to the Bill & Melinda Gates Foundation (BMGF) under Tropical Legumes II project and the International Fund for Agricultural Development (IFAD) for their funding support. The authors are solely responsible for any errors of omission or otherwise.

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Executive Summary

Chickpea and pigeonpea are two important grain legumes in Asia, and make a significant contribution to the food and nutrition security of the people, particularly the vegetarians. Grains of both the pulses can be consumed in various forms – raw, roasted and boiled and further processed as flour and decorticated grains (dal). Further, being legume crops they contribute towards improving soil fertility by fixing atmospheric nitrogen in the soil. This property has the added benefit of saving on external applications of nitrogenous fertilizer, and thus is environment friendly.

Together the two pulses account for 41% of Asia's total pulses production. Asia accounts for 88% of global chickpea and 90% of global pigeonpea production. India is the largest producer of both pulses, accounting for 75% of Asia's chickpea and pigeonpea production. The other important chickpea producing countries are Pakistan, Turkey, Mexico, Canada and Australia. Myanmar and recently some countries in Africa have emerged as pigeonpea producers. In India, chickpea and pigeonpea are largely grown under rainfed conditions. Their cultivation is largely confined to the semi-arid tropics, which account for 60% of the country's chickpea and 76% of pigeonpea area.

Global yields of both chickpea and pigeonpea are low (700–800 kg ha^{-1}), and have been relatively stagnant for the last two decades. India has a dominating influence on yield trends owing to its large share in the global production of these crops. A number of biotic and abiotic factors limit realization of their yield potential. The sluggish growth of chickpea and pigeonpea yield in India can be attributed to: (i) the shift in crop area from favorable to marginal environments; (ii) the slow uptake of improved varieties and other production technologies; and (iii) their cultivation on poor soils under erratic rainfall conditions. Despite the lower average yield at the all-India level, at a more disaggregated district level there has been some shift in the area from lower yield ranges to higher yield range particularly for chickpea. For pigeonpea while yields have remained stagnant, area under pigeonpea has been increasing in India and is the main factor driving its production.

Chickpea and pigeonpea are almost exclusively used for food. In 2001-03, of the total global chickpea supply, nearly three-fourths (5.8 million t) was used for food, and the rest for feed and seed. The pattern of utilization, however, varies across countries/regions. For example, feed use is largely concentrated in developed countries, whereas chickpea forms a major component of human diets in developing countries. Pigeonpea consumption has been increasing faster in Africa (from a low base) than in Asia.

Trade in chickpea is relatively robust and has been growing over time. Close to 10% of the total chickpea produced in the world in 2003-05 entered the international market. Both the *desi* and *kabuli* types of chickpea are traded in the international market. The *desi* type accounts for approximately 80% of the total trade in chickpea. The *kabuli* type commands a higher price owing to larger seed size compared to the *desi* type. Australia is the largest exporter of *desi* type chickpea. Mexico, Turkey and Canada export mainly *kabuli* type chickpea. India is by far the largest importer accounting for over a quarter of global imports and 40% of Asia's imports. For pigeonpea, Myanmar is a major exporter followed by Malawi, Kenya, Uganda and the Dominican Republic. Myanmar accounts for 85%-90% of the total pigeonpea imports of India.

International prices of both chickpea and pigeonpea declined in real terms mainly due to the entry of non-traditional growing countries, such as Canada and Australia for chickpea and Myanmar for pigeonpea. However, the recent (2006-08) rise in global prices of all agricultural commodities has also led to rise in prices of both chickpea and pigeonpea since these crops also experienced short-term supply shocks owing to droughts in the major exporting countries and robust demand from importing countries.

Buoyed by increasing incomes in both Asia and Africa, food demand for both the crops is set to increase in the medium term. In Asia, demand for chickpea is set to double from 7 million t to 14 million t from 2000 to 2020, while in Africa it is projected to increase from 0.4 million t to 0.7 million t over the same period. Production figures for both these regions also show increases but the trade deficit is likely to grow for Asia by 2020. India, will continue to be a net importer of chickpea, importing close to 1.7 million t to meet its domestic requirements, while Africa on the other hand, will become a net exporter in 2020. Increased exports from both Australia and North America are also forecast. Interestingly, Myanmar's demand for chickpea is forecast to increase as well, and the domestic production will not be sufficient to meet this. Therefore, its imports will rise, creating a trade deficit of 102,000 t in 2020. World prices of chickpea are projected to increase gradually, peaking in 2017 and gradually tapering off thereafter.

Demand for pigeonpea will continue the increasing trend that has been observed thus far. Africa is set to increase its exports of pigeonpea as production increases faster than domestic demand there. Pigeonpea production in India is also set to increase from 2.6 million t in 2000 to 4 million t in 2020, but the net trade situation is likely to worsen due to faster growth in demand. In contrast, the net trade position of Myanmar will improve, settling at a trade surplus position.

Despite the continued increase in demand for food and feed, it should be noted that agriculture is becoming increasingly vulnerable and sensitive to limiting factors such as land availability, climate change effects, and the increasing frequency of extreme events. Therefore the main challenges for research and development are to (i) bridge the gap between actual and attainable yield by enhancing farmers' access to quality inputs, improved technologies and information; (ii) improve the competitiveness of pulse crops through domestic incentives related to production, marketing, processing, prices etc in line with cereals 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. Background

To ensure domestic food security, agricultural research and development policies of most Asian countries in the past have emphasized the production of staple cereals like rice and wheat (Parthasarathy Rao and von Oppen 1987; Kumar et al. 2007). These policies succeeded in raising their production and enabling many countries, notably India, to become self-sufficient in cereal production and even occasional exporters (FAOSTAT http://www.faostat.fao.org). However, in this process pulses were, by and large, ignored, resulting in stagnant and low yields and increased dependence on imports to meet growing domestic demand. In fact, per capita consumption of pulses has fallen, and is a matter of concern, particularly in South Asia where 39% of the population is poor (earning less than US$1.25 per day) and 21% of the population is undernourished. Pulses being a rich and cheaper source of protein can contribute towards overcoming the problem of nutritional insecurity. Additionally, cultivation of pulses contributes towards improving soil health through biological nitrogen fixation (Ali and Kumar 2009), and thus enhances the sustainability of agricultural production systems.

Globally, 58.6 million t of pulses were produced in 2005-07, up from 45.1 million t in 1981-83. Dry beans, which include *Phaseolus* species (kidney beans, lima beans, and tepary beans) and *Vigna* species (azuki bean, mung bean, black gram) comprise the largest category of pulses grown in the world. Dry peas and chickpea are the second and third most popular pulses, respectively (Figure 1). In 2005-07, Asia accounted for 46% of the global pulses production with chickpea and dry bean being the major pulses – together these account for 60% of Asia's total pulses production (Figure 2). Pigeonpea with a share of 11% ranks next. India is the single largest producer of pulses, accounting for about half of Asia's total pulses production.

The rise in pulse production in Canada and Australia, the area expansion under pulses in Africa, and the export-oriented production of pulses in Myanmar have contributed to the

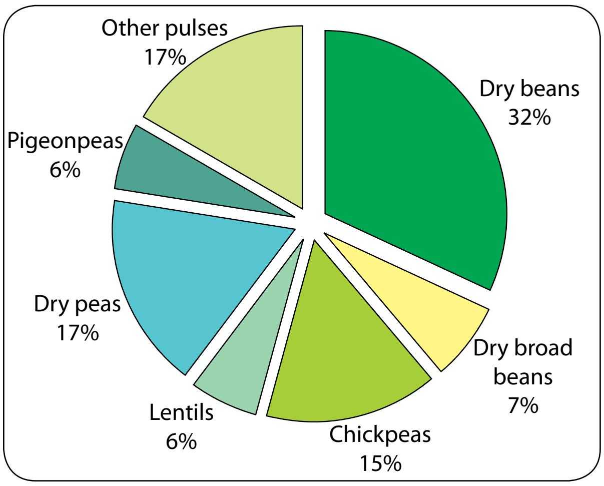


Figure 1. The share of different pulses in global production, 2005-07.

Source: FAOSTAT

modest increase in global pulses production. Developing countries account for around 70% of the global pulses production. There is, however, a large difference in the yield of pulses between developed (1640 kg ha^{-1}) and developing countries (765 kg ha^{-1}) (Annexure 1). This is probably due to differences in the use of quality inputs, technology, and infrastructure.

Owing to low and stagnant yields of pulses in developing countries, their production also did not grow as rapidly as that of cereals and oilseeds (Annexure 2). During 1981-2007, pulses production grew at 0.9% per annum

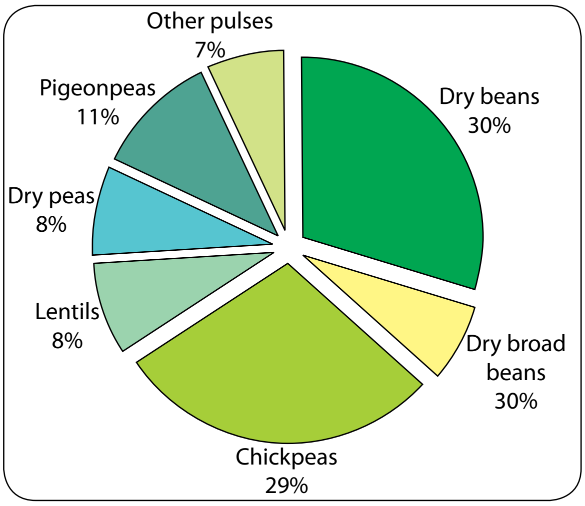


Figure 2. The share of different pulses in Asia's total pulses production, 2005-07.

Source: FAOSTAT

as compared to 1.2% for cereals and 4.1% for oilseeds. Growth in production, area and yields of pulse crops in Asia followed a similar trend.

Notwithstanding sluggish growth in pulses production in Asia, increasing population and rising per capita incomes are fuelling growth in demand. Global consumption of pulses increased from 40 million t in 1981-83 to 50 million t in 2001-03. However, owing to sluggish growth in production, their per capita consumption has been declining. In India, the largest producer and consumer of pulses, the per capita consumption declined from 11.6 kg year^{-1} in 1983 to 9 kg year^{-1} in 2004/05 (Kumar et al. 2009).

In order to meet growing demand, trade in pulses has increased. Close to 15% of the total pulses production finds its way to international markets. The volume of trade increased three-fold between 1981-83 and 2005-07, from 3 million t to 10 million t. Myanmar, Australia and Canada have emerged as important exporters since the late 1980s. India, on the other hand, continues to be a net importer, accounting for 2.5 million t or 25% of global pulse imports in 2005-07. Hence, Asia continues to be a net importer of pulses despite large exports from China and Myanmar (Annexure 3).

This report highlights trends in production, trade, consumption and utilization of chickpea and pigeonpea. The data was collected from FAOSTAT (http://www.faostat.fao.org) for all major producing countries and regions. Disaggregated data at state and district levels for India were compiled from different published sources. The report is organized into six chapters. Chapters 2 and 3 present a factual assessment of the situation of chickpea and pigeonpea, 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, technology and trade protection. Conclusions and implications are given in the last chapter.

The facts and trends relating to chickpea and pigeonpea in Asia presented in this report will provide valuable direction to researchers working on these crops, research managers, stakeholders along the value chain and policy makers in improving the overall efficiency of these crops to meet the requirements of their producers and end users.

2. Chickpea: Facts and Trends

Chickpea (*Cicer arietinum*), with 11 million ha under its cultivation and 8.8 million t of production in 2005-07, is the third most important pulse crop in the world after dry beans and dry peas. It occupies 15.3% of the total pulses area and contributes 14.6% to total pulses production.

Chickpea is a highly nutritious grain legume crop. It is an important source of energy, protein, minerals, vitamins, fibers and other potentially health-beneficial phyto-chemicals. Mature chickpea grains contain between 12% and 31% proteins — higher than any other pulse crop; 60% to 65% carbohydrates and 6% fat (Geervani 1991). Chickpea is also a good source of soluble and insoluble fibres, vitamins (B vitamins), potassium and phosphorus, hence is increasingly advocated in health-conscious diets. Chickpea is one of the cheapest sources of protein (Joshi et al. 2002; Byerlee and White 2000); hence it can play an important role in overcoming problems related to nutritional insecurity of the poor in developing countries where it is grown and consumed.

On the basis of grain size, colour and taste, chickpea is classified into *desi* chickpea and *kabuli* chickpea. Grains of *desi* chickpea are small in size, are light to dark brown in colour, and have a thick seed coat. Grains of *kabuli* chickpea are bigger in size, have a whitish-cream colour and thin seed coat. The *desi* type however, is more prominent – it accounts for close to 80% of global chickpea production, and *kabuli* type chickpea comprises the rest (Agbola et al. 2002). *Desi* chickpea can withstand cooler temperatures and matures quicker than *kabuli* chickpea.

Crop Distribution

Chickpea is a crop of temperate regions, generally cultivated on sandy loam soils under low rainfall conditions. It has a deep tap-root system which enhances its capacity to withstand moisture stress. The crop, however, is sensitive to excessive moisture and extreme climatic conditions.

Globally, chickpea is grown on 11 million ha. However, most of the chickpea area is concentrated in South Asia, which accounts for more than three-fourths of the world chickpea area (Figure 3). With advances in plant breeding, despite being a crop of the temperate region, chickpea cultivation is gradually spreading to sub-tropical and tropical regions of Africa, North America and Oceania. In Africa, it is grown mainly to utilize fallow lands. Africa's share in global chickpea area has gradually increased to 4.6% in 2005-07 from 3.8% in 1981-83.

In North America and Oceania, chickpea is a new crop. Introduced there in the 1980s, its area has expanded considerably. In 2005-07, North America and Oceania accounted for 1.6% and 2% of the world chickpea area, respectively. This rapid expansion of chickpea to non-

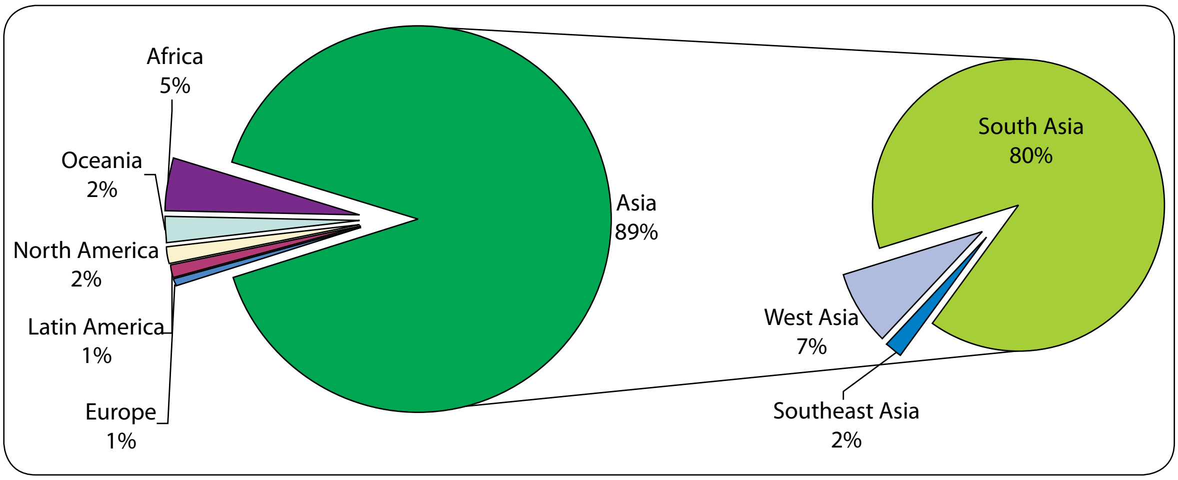


Figure 3. Global distribution of chickpea area, 2005-07.

Source: FAOSTAT

traditional areas was aided by the huge export opportunities to the Indian subcontinent where chickpea is widely consumed, and the demand for pulses, including chickpea, far exceeds its domestic production. Also, increasing globalization of the agri-food markets under the World Trade Organization created more export opportunities for North America and Oceania.

Asia accounts for 89% of the global chickpea area, i.e. 9.9 million ha, and 80% of it is cultivated in South Asia (Figure 3). West Asia accounts for almost the rest of the chickpea area. India is the largest producer of chickpea in the world. It accounts for two-thirds of the global and 72% of Asia's chickpea area. Pakistan and Iran are other important chickpea growing countries in the region. In 2005-07, these two countries accounted for about 11% and 7% of Asia's chickpea area, respectively (Table 1).

In India, chickpea is largely grown under rainfed conditions; only one-third of the area is irrigated (GOI, various years). Its cultivation is largely confined to the semi-arid tropics[1], which occupy 61% of the country's total chickpea area (Figure 4). Semi-arid temperate regions account for about a quarter of the total chickpea area in India.

Table 1. Trends in chickpea area, yield and production.

Country/region	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	9,760	10,281	10,961	649	699	802	6,332	7,183	8,796
Developed countries	140	246	451	574	1,004	1,094	80	247	494
Europe	139	63	61	570	781	774	79	49	47
North America	0	1	172	0	1,429	1,302	0	1	224
Oceania	1	182	218	1,161	1,079	1,019	1	197	223
Developing countries	9,620	10,035	10,510	650	691	790	6,252	6,936	8,303
Africa	372	446	506	647	582	781	241	260	395
Latin America	185	150	116	950	1,277	1,387	176	191	161
Asia	9,062	9,439	9,888	644	687	783	5,835	6,485	7,746
East Asia	0	1	2	0	1,143	4,097	0	1	10
South Asia	8,538	8,327	8,861	628	657	759	5,361	5,471	6,724
India	7,284	6,785	7,090	653	778	801	4,753	5,278	5,680
Pakistan	879	1,039	1,065	425	422	685	374	439	730
Iran	198	653	683	593	484	432	118	316	295
Southeast Asia	163	158	204	785	658	1,101	128	104	225
Myanmar	163	124	204	785	630	1,101	128	78	225
West Asia	362	946	817	957	956	955	346	905	779
Turkey	260	762	527	1,033	928	1,059	268	707	558

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

[1]The different agro-ecological zones are differentiated on the basis of average annual temperatures, annual rainfall and soil types. Humid regions are those with the length of growing period (LGP) exceeding 270 days. The semi-arid tropics are those regions where the LGP ranges from 70-180 days, and all months have a mean monthly temperature greater than 18°C and a daily mean temperature greater than 20°C during the growing period. The semi-arid temperate regions are those where the LGP ranges from 70-180 days, daily mean temperature during the growing period is in the range of 5-20°C, and they have one or more months with monthly mean temperature, corrected to sea level, below 5°C. Arid regions are those where the LGP is less than 75 days (TAC 1992).

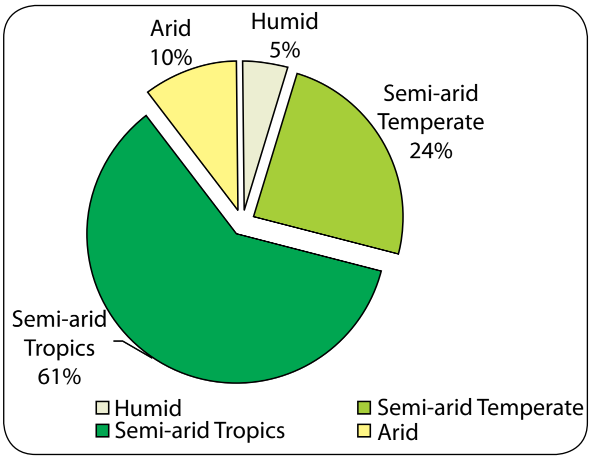
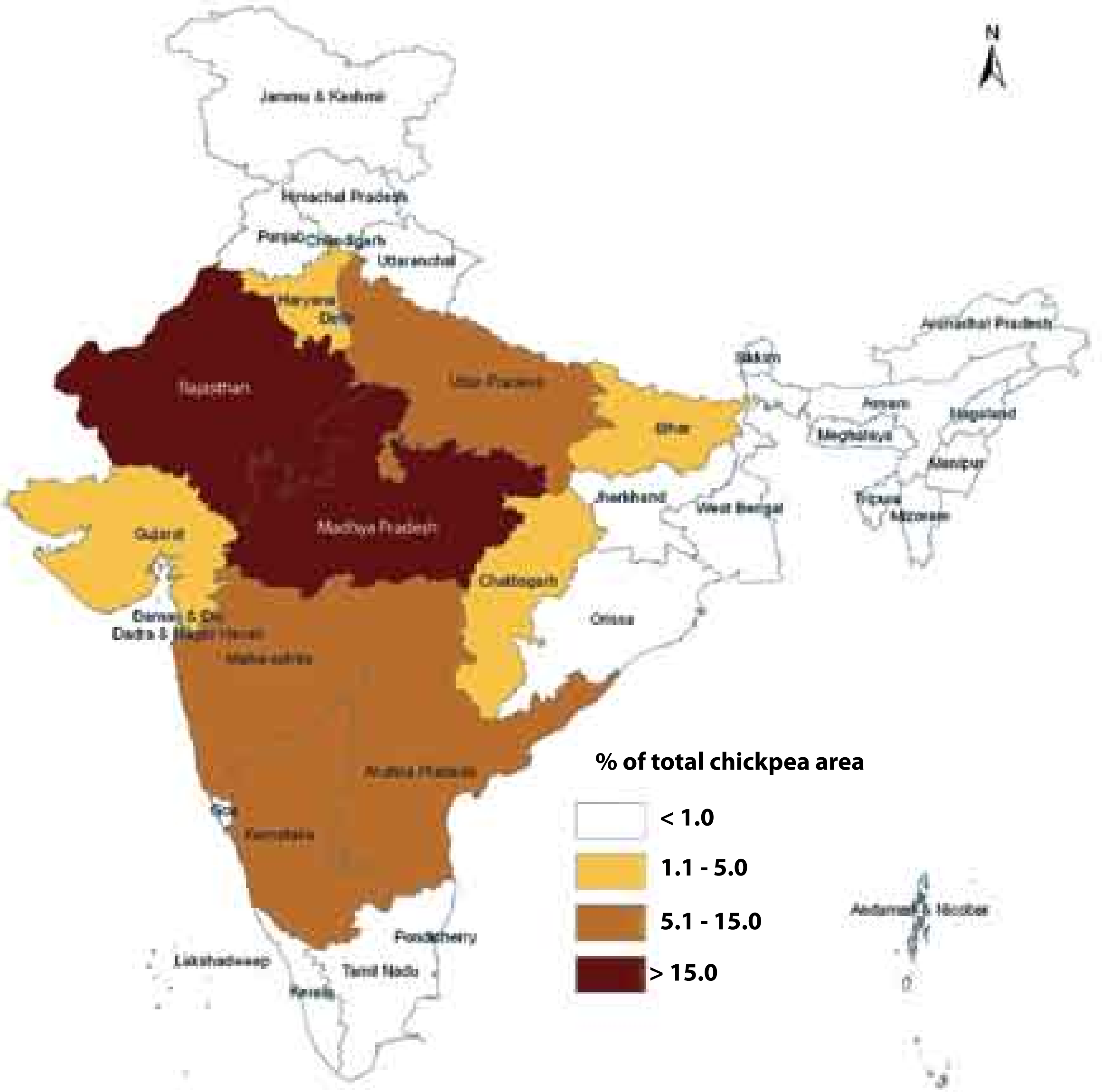


Figure 4. Distribution of chickpea area across agro-ecological zones in India, 2002-04.

Source: ICRISAT database

A more disaggregated distribution of chickpea area in India by state is shown in Map 1. In the early 1970s, chickpea cultivation was concentrated in the northern states of Punjab, Haryana and Uttar Pradesh; western state of Rajasthan and central state of Madhya Pradesh. However, during the last few decades, with increasing availability of short- and medium -duration varieties, chickpea cultivation has expanded considerably in the hot, dry climates of the central and peninsular regions (Madhya Pradesh, Maharashtra and Andhra Pradesh). Annexure 4 elaborates on state averages in area, yield and production of chickpea.



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

Trends in Area, Yield and Production

Area

Global chickpea area has not expanded much during the last two decades. It increased from 9.8 million ha in 1981-83 to 11 million ha in 2005-07, at an annual rate of 0.4% (Tables 1 and 2). Expansion of chickpea area was more pronounced in Africa, where it increased at an annual rate of 1.1% during the same period, compared to 0.2% in Asia. In both Africa and Asia, area expansion occurred mainly between 1981 and 1995 (Annexure 5).

In North America and Oceania, chickpea was introduced during the 1980s. In 2005-07, their share in total chickpea area increased to 1.6 and 2.0%, respectively. Area under chickpea expanded by leaps and bounds albeit from a low base (55% in North America and 14.9% in Oceania). However, this trend was reversed in Oceania beginning the late nineties, with area declining by more than 5% during 1996-2007 (Annexure 5). Within Asia, the rate of area expansion was higher in West Asia (3.2%) than in any other region. Turkey is an important chickpea growing country in this region, and changes in chickpea area in West Asia are closely related to changes that occur in Turkey. For instance, in Turkey, chickpea area expanded on poor quality lands due to better utilization of fallow areas following research and extension efforts and export promotion policies of the government (Kelley and Rao 1996; Joshi et al. 2000). The area increase, however, slowed down after 1995 and declined by 2.8% per year between 1995 and 2007. In South Asia, which accounts for the bulk of chickpea area and production, chickpea area has remained relatively stagnant during the last two and a half decades (Table 2).

In India, the trend in chickpea area is characterized by considerable fluctuations. Chickpea area declined from 7.3 million ha in 1981-83 to 6.8 million ha in 1993-95 but again recovered and reached 7.1 million ha in 2005-07. Nonetheless, chickpea area in India has contracted at a rate of 0.3% per year during the last 25 years (Table 2).

Table 2. Annual compound growth rates (%) of chickpea area, yield and production, 1980-2007.

Country/region	Area	Yield	Production
World	0.35	0.94	1.30
Developed countries	5.95	1.68	7.73
Europe	-1.21	0.44	-0.78
North America[1]	55.9	-1.2	54.1
Oceania[2]	14.9	-0.8	14.0
Developing countries	0.20	0.88	1.08
Africa	1.05	0.75	1.81
Latin America	-1.97	2.03	0.02
Asia	0.19	0.88	1.07
East Asia	NA	NA	NA
South Asia	-0.03	0.94	0.90
India	-0.32	1.09	0.77
Pakistan	0.34	1.52	1.86
Iran	5.71	-1.12	4.52
Southeast Asia	0.42	0.70	1.12
Myanmar	0.42	0.70	1.12
West Asia	3.16	-0.46	2.69
Turkey	2.34	-0.34	1.99

Source: FAOSTAT: http://www.faostat.fao.org.
1. Growth rates of area, yield and production for North America relate to the time between 1992 and 2007.
2. Growth rates of area, yield and production for Oceania relate to the time between 1983 and 2007.

In Pakistan and Iran, the other important chickpea growing countries in South Asia, chickpea area has expanded considerably over the last 25 years. Between 1981-83 and 2005-07, chickpea area in Pakistan increased by 21%, from about 0.88 million ha to 1.07 million ha. In Iran, it increased more than three-fold, from a mere 0.2 million ha in 1981-83 to 0.68 million ha in 2005-07. On the other hand, chickpea area declined considerably in Bangladesh and Nepal. In Bangladesh, efforts are being made to promote short-duration chickpea cultivars in the postrainy season when considerable amount of land remains fallow after rainy season rice harvest (Musa et al. 2001).

Although chickpea is more adapted to temperate climates, technological advancements in chickpea breeding have made it possible to cultivate it in semi-arid climates. For instance, in India chickpea area has gradually shifted towards the semi-arid tropics (Figure 5). In 1980-81, chickpea area in the semi-arid temperate and semi-arid tropics was pretty much the same (2.7-2.9 million ha). In 2004-05, it increased by 50% in the semi-

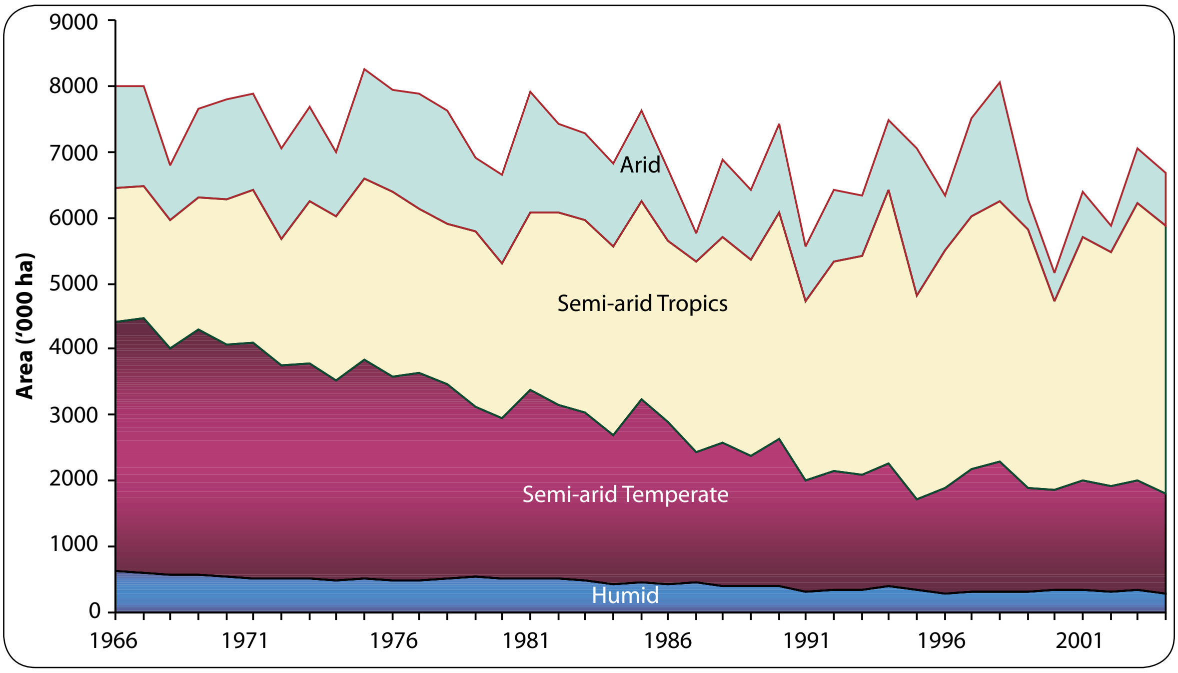


Figure 5. Trends in chickpea area in different agro-ecological zones of India, 1966-2003.

Source: ICRISAT database

arid tropics and decreased by 47% in the semi-arid temperate region. The semi-arid tropics now account for over 61% of India's total chickpea area as against 38% in 1981-83. This expansion in area in the semi-arid tropics can be attributed to: (i) the availability of improved short-to-medium duration varieties capable of escaping terminal drought; and (ii) chickpea's competitive advantage over other crops grown during the same season.

The rapid decline in chickpea area in semi-arid temperate regions of India has been primarily due to the declining competitiveness of chickpea in relation to crops like rapeseed, mustard and wheat -- the area of which has expanded considerably partly displacing chickpea. For instance, the area under rapeseed-mustard and wheat in the semi-arid temperate regions expanded by 83% and 16%, respectively, in the last two decades or so.

The shift in chickpea area from the temperate SAT is reflected at the state level with a drastic decline in area in the northern states of India (Figure 6), the Green revolution belt. Between 1965-69 and 2000-04, total chickpea area in the states of Uttar Pradesh, Bihar, Haryana, Punjab and West Bengal declined by 75%, from 4.3 million ha to 1.1 million ha, and their contribution to national production fell from 3.1 million t to 1.0 million t (Figure 7). On the other hand, chickpea area expanded rapidly in the semi-arid tropics of Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, and Maharashtra. Here, the combined chickpea area almost doubled, from 2.2 million ha to 4.2 million ha and their contribution to total production increased from 1.0 million t to 3.2 million t.

It is obvious from these trends that the landscape of chickpea production is changing. Its production is gradually shifting from the semi-arid temperate to semi-arid tropics, which implies that chickpea can be grown successfully under varying environments provided varieties and production technologies suited to different agro-climatic conditions are available.

Yield

Unlike rice and wheat, chickpea has not demonstrated any significant productivity gains. Between 1981-83 and 2005-07, global chickpea yield increased at an annual rate of 0.9%, from 649 kg ha^{-1} to 803 kg ha^{-1} (Tables

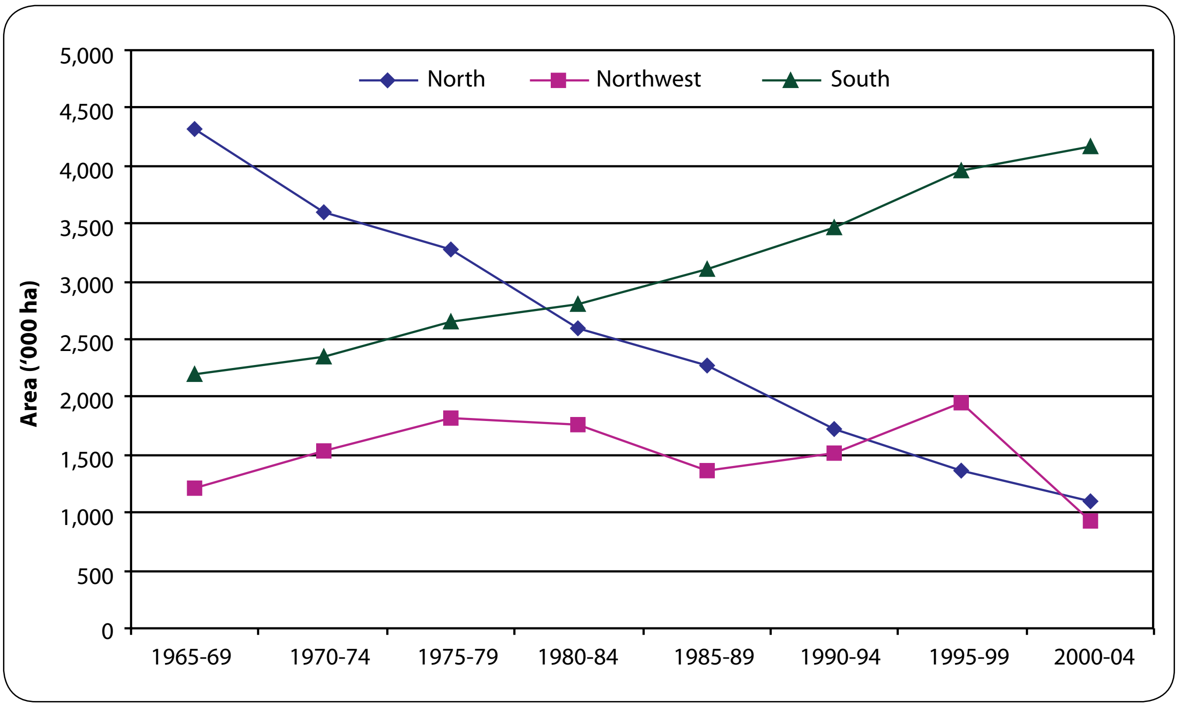


Figure 6. Regional trends in chickpea area in India, 1965-2004.

Source: ICRISAT database

Note: The category North includes Bihar, Haryana, Punjab, Uttar Pradesh, and West Bengal. Northwest includes Gujarat and Rajasthan. South includes Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu.

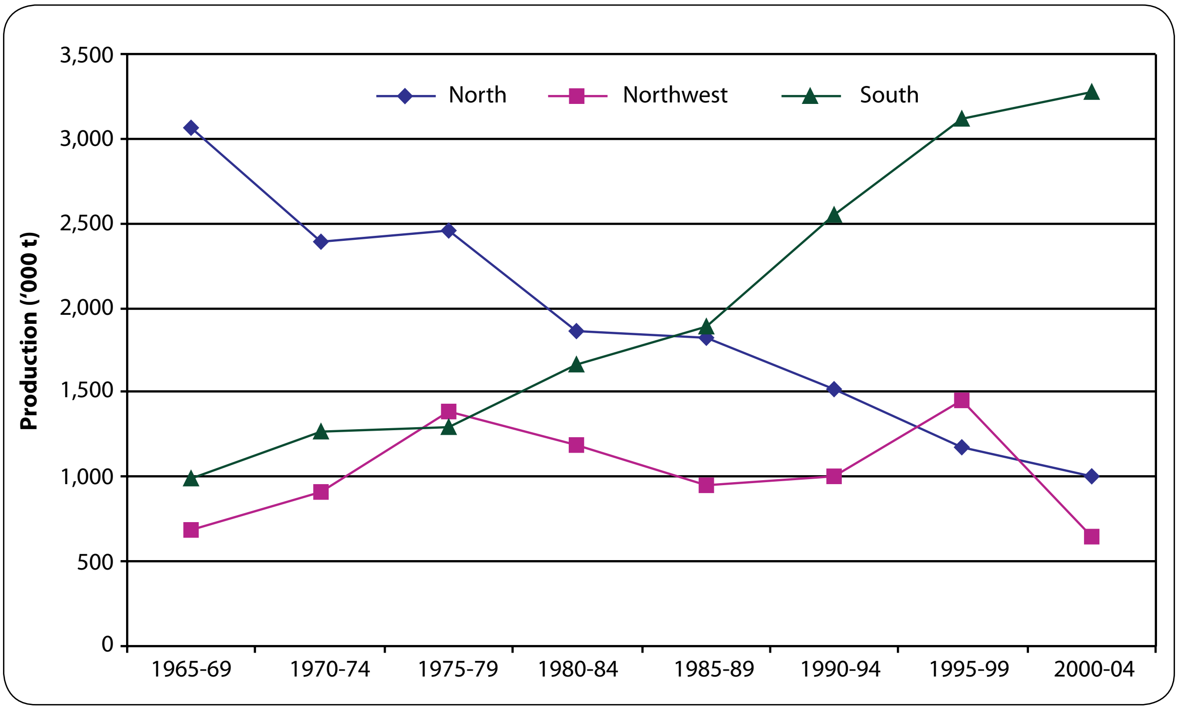


Figure 7. Regional trends in chickpea production in India, 1965-2004.

Source: ICRISAT database

Note: The category North includes Bihar, Haryana, Punjab, Uttar Pradesh, and West Bengal. Northwest includes Gujarat and Rajasthan. South includes Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu.

1 and 2). Most of the growth in yield occurred after the mid-1990s (Annexure 5).

Chickpea yield is lower in traditional chickpea growing regions, compared to that in non-traditional chickpea growing regions. Chickpea yield in Asia and Africa were almost at par (781-783 kg ha^{-1}) in 2005-07, but lower by about 40% compared to yields in North America and 25% in Oceania. Chickpea yield in China – a non-traditional chickpea growing country, is reported to be over 4 t ha^{-1} (Table 1)!

Among the traditional chickpea growing countries, there has been no significant difference in yield. In 2005-07, it varied between 685 kg ha^{-1} and 844 kg ha^{-1}, except in Iran where it was less than 500 kg ha^{-1}. In fact, chickpea yield in Iran declined considerably since 1981-83. In India, chickpea yield grew at an annual rate of 1.1% during 1981-2007. The rate of increase was higher until the mid-1990s, but slowed down afterwards (Annexure 5). As against this, in most other countries where chickpea yield was on a decline until the mid-1990s, yield levels started increasing. For instance, in Myanmar, chickpea yield declined at an annual rate of 3.7% between 1981-83 and 1993-95, but almost doubled between 1993-95 and 2005-07. Adoption of improved varieties and crop production practices contributed to this remarkable increase in yield.

The sluggish growth in chickpea yield can be attributed to: (i) the shift in chickpea area from favorable to marginal environments; (ii) the slow uptake of improved varieties and other production technologies; and above all (iii) its cultivation on poor soils under erratic rainfall conditions. For example, in India chickpea yield has remained higher in the semi-arid temperate region; hence the national average yield did not show any significant improvement due to a larger shift in area from semi-arid temperate to semi-arid tropics where yield levels are lower (Figure 8).

Despite a slower growth in yield at the all-India level, at a disaggregated (district) level we find a considerable shift in chickpea area from a lower to higher yield category. This is evident from the classification of chickpea area by three yield categories – low (less than 600 kg ha^{-1}); medium (600 to 800 kg ha^{-1}) and high (greater than 800 kg ha^{-1}) as shown in Figure 9. For instance, in 1980-82 chickpea yield was less than 600 kg ha^{-1} in 39% of the total chickpea area, and more than 800 kg ha^{-1} in only 20% of the area. During the last two decades, the situation reversed. In 2001-03, the share of chickpea area under low yield declined to 23%, while its share under high yield increased to 49%.

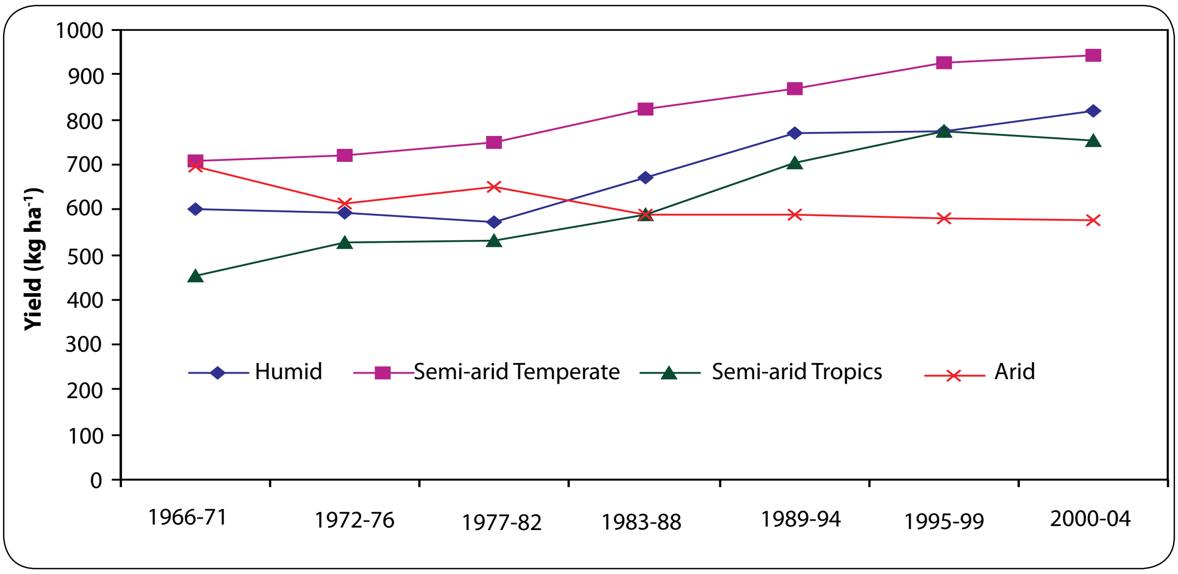


Figure 8. Trends in yield levels in different agro-ecological zones in India, 1966-2004.
Source: ICRISAT database

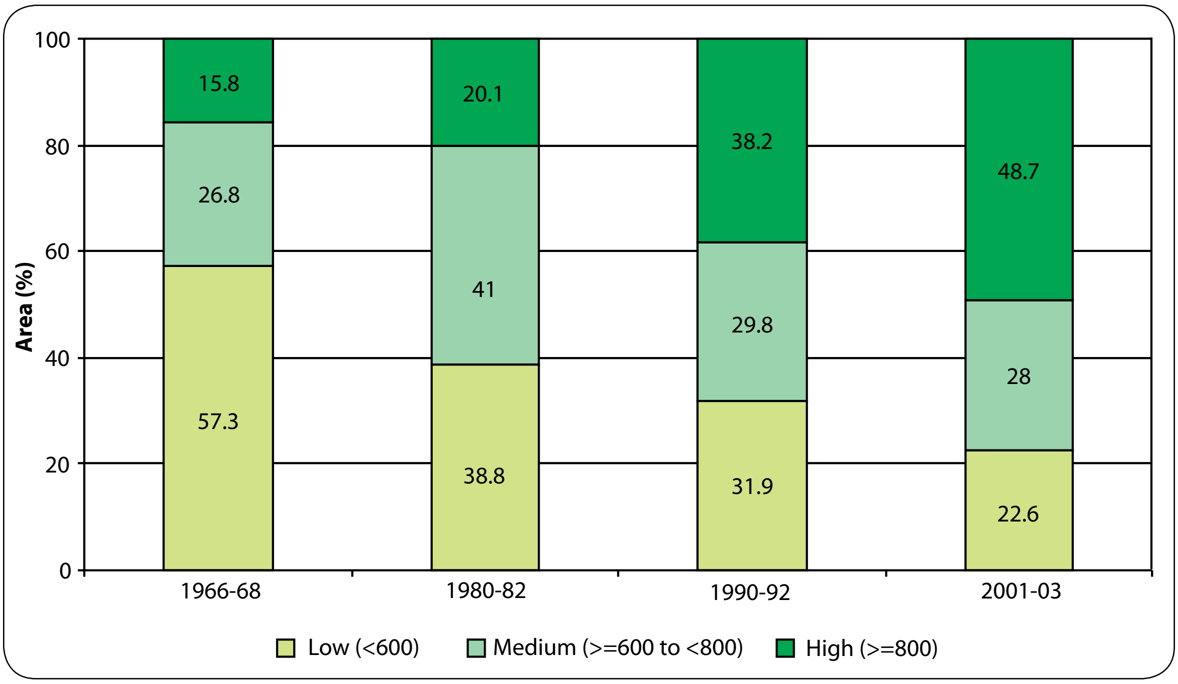
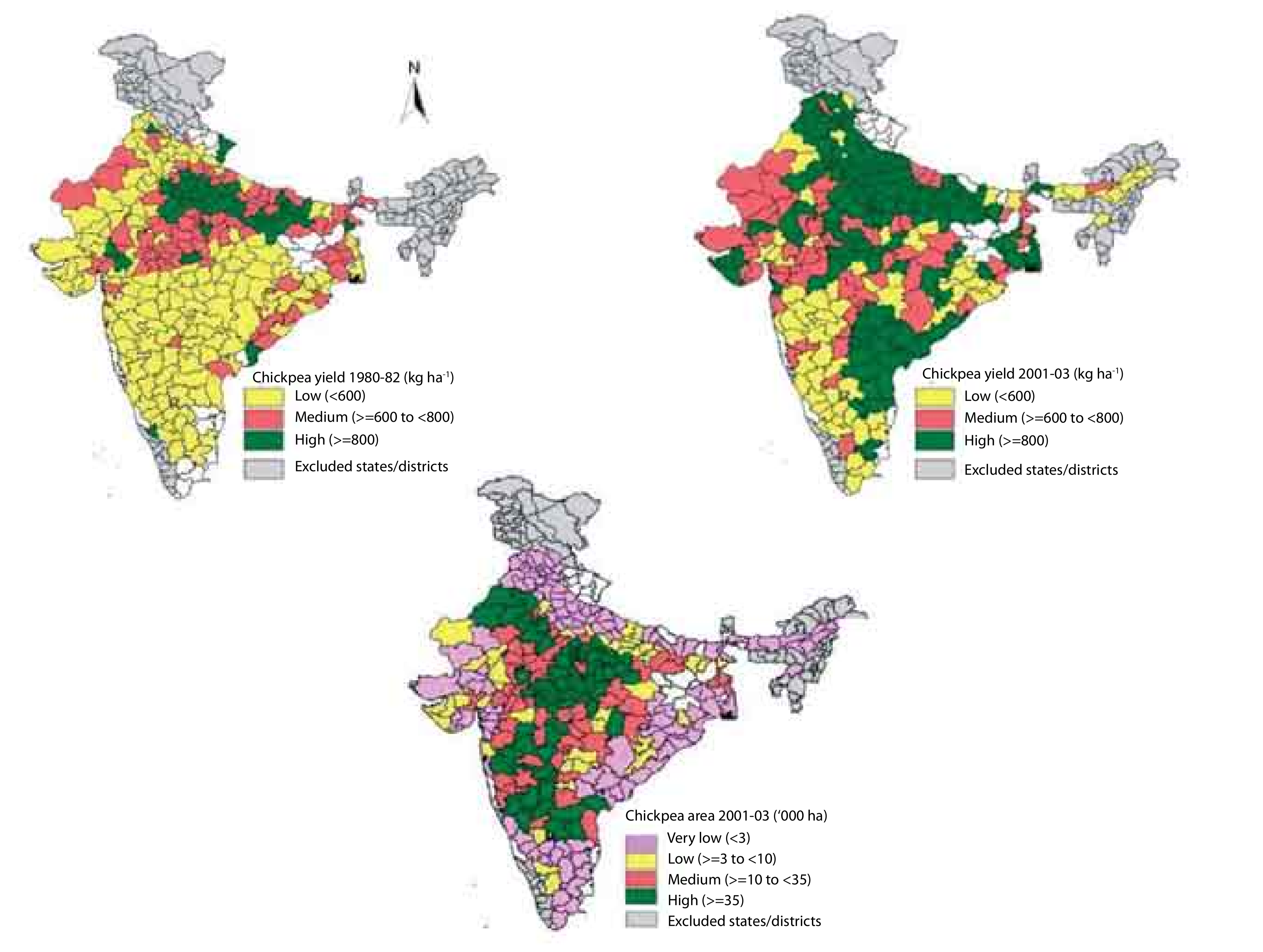


Figure 9. Distribution of chickpea area by yield levels, 1966-2003.

Source: ICRISAT database

The increase in chickpea yield is further corroborated by the spatial distribution of chickpea yield which shows considerable increase within districts between 1982 and 2003 (Map 2). Between 1980-82 and 2001-03, a considerable proportion of chickpea area moved from low to medium to high yield category. There are still however considerable areas, particularly in the states of Maharashtra and Karnataka, that remain in the low-to-medium productivity category. For a break up of area, yield and production of chickpea in the important growing states and districts of India, see Annexure 4.

Chickpea yield shows considerable variability because it is grown on residual soil moisture in the postrainy season, and the crop often faces terminal drought in the absence of protective irrigation or rainfall. Figures 10 and 11 show the variations in annual chickpea yield in the semi-arid temperate and semi-arid tropic zone respectively from 1966 to 2004. In the semi-arid tropics, the probability of yield falling below the trend yield is 0.4, implying that farmers face a low rainfall situation almost every third year. Whenever there is a low rainfall year, a 5% to 10% reduction in yield is common in the semi-arid tropics. As against this, chickpea yield is more stable in the semi-arid temperate region, primarily due to the availability of protective irrigation.



Map 2. Inter-regional variations in chickpea area and yield in India.

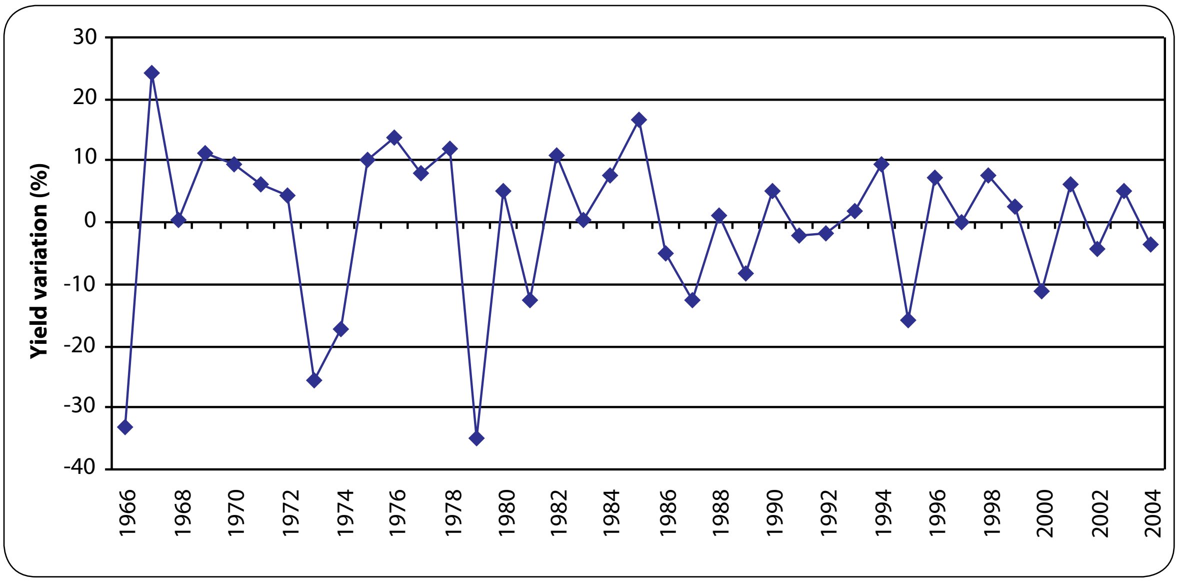


Figure 10. Variation in chickpea yield in semi-arid temperate India, 1966-2004.

Source: ICRISAT database

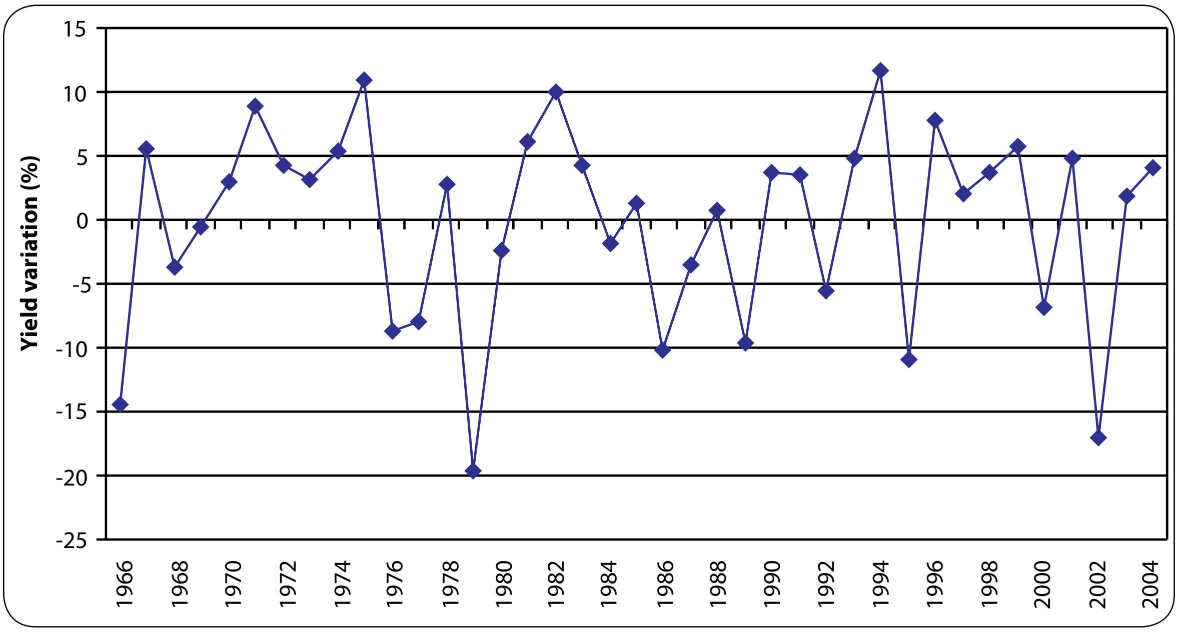


Figure 11. Variation in chickpea yields in the semi-arid tropics in India, 1966-2004.

Source: ICRISAT database

Production

Global chickpea production increased from 6.3 million t in 1981-83 to 7.2 million t in 1993-95 and further to 8.8 million t in 2005-07 at an annual rate of 1.3% (Tables 1 and 2). Both area expansion and productivity improvements contributed to increased production; the contribution of yield, however, was almost twice the contribution of area.

Rapid increase in chickpea production occurred in North America and Oceania. In North America, chickpea cultivation was almost absent until the early 1990s, but it spread considerably in recent years. Similarly, in Oceania (mainly in Australia), chickpea production grew by leaps and bounds until the mid-1990s, but the pace of growth slowed down afterwards (Figure 12). In these regions, growth in production was mainly driven by area expansion (Annexure 5). It may be noted that chickpea production in North America and Oceania is mainly for exports. Between 1980 and 2007, chickpea production in Africa grew at an annual rate of 1.8%, but mostly after the mid-1990s. Further, growth in the latter period was fuelled more by yield improvements than by area expansion.

Asia accounts for 88% of the global chickpea production, slightly less than its share in area. Chickpea production in Asia increased from 5.8 million t in 1981-83 to 7.7 million t in 2005-07, at an annual rate of 1.1%. Growth in production was led by yield improvements. In India, chickpea production increased at an annual rate of 0.9% during this period (Table 2). The rate of increase was, however, faster during 1981-83 and 1993-95. Growth in output was exclusively due to productivity gains.

In Pakistan, chickpea production doubled from 0.37 million t in 1981-83 to 0.73 million t in 2005-07, at an annual rate of 1.9%. The growth was faster after the mid-1990s and was driven by yield improvements. In contrast, growth in chickpea production between 1981 and 1995 was primarily due to area expansion. Similarly, in Iran, chickpea production grew very fast during 1981-83 to 1993-95 primarily due to area expansion. On the other hand, in Bangladesh and Nepal, chickpea production continued to decline and mainly due to contraction in area.

In Turkey, production of chickpea grew at an annual rate closer to 2% during 1981-2007. But, area expansion accounted for most of the production increase there. Growth, however, decelerated after 1995 because of area contraction.

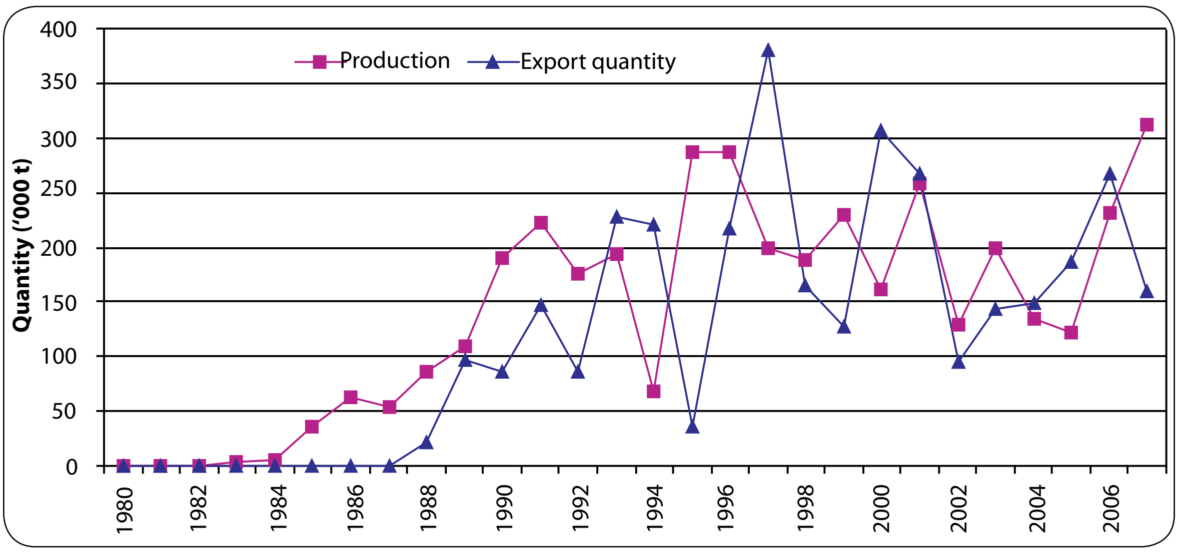


Figure 12. Trends in chickpea production and exports in Australia, 1980-2007.

Source: FAOSTAT

Utilization

Chickpea is an important component of the diet of the people in those countries where it is grown extensively. It is used as food and as feed. As food, it can be used in many forms – raw, sprouted, roasted, as *dal* (decorticated split cotyledons), flour, etc. Cooked and sprouted grains and green pods are used as a vegetable or salad; and tender leaves are eaten like spinach. Being a rich and cheaper source of vegetable protein, it enriches a cereal-based diet and thus contributes to the nutritional security of the poor. Chickpea is consumed in a wide range of products – whole seed, *dal* and *besan* (flour). In India, three-fourths of the available chickpea supply is consumed as *dal* and *besan* and the rest is consumed as whole seed – boiled, sprouted or roasted (Jambunathan and Singh 1990; Agbola et al. 2002). In Africa and North and Central America, it is consumed as whole seed after soaking, sprouting, fermenting, boiling, steaming, roasting, parching or frying. In South Asia, green chickpeas, harvested 10-15 days before maturity, are consumed as vegetable. Also, in South Asia, chickpea flour is widely used to make snacks, curries and is mixed with wheat flour to make *chapattis* (unleavened breads). In Myanmar, chickpea flour is used to make noodles. In South America, it is used as a salad and in stews. Mashed chickpea mixed with oils and spices (hummus) is a popular hors d'oeuvre in the Mediterranean Middle East. Dry seeds, husks, stems and leaves can be used as animal feed.

In 2001-03, of the global chickpea supply, nearly three-fourths (5.8 million t) was used for food and the rest for feed and seed (Table 3). In proportionate terms, uses of chickpea have remained unchanged during the last two decades; in absolute terms, its consumption as food, however, increased by 1.1 million t since 1981-83.

Table 3. Trends in chickpea utilization ('000 t), 1981-2003.

	1981-83				2001-03			
Regions	Total availability	Food	Food manufacture	Other uses[1]	Total availability	Food	Food manufacture	Other uses[1]
World	6,225	4,740	35	1,449	7,586	5,775	6	1,806
Europe	128	108	0	21	207	150	0	58
North America	118	41	0	76	259	97	0	162
Oceania	1	1	0	0	11	1	0	10
Africa	272	222	0	50	426	357	0	69
Latin America	26	23	0	2	27	26	0	1
Asia	5,680	4,345	35	1,300	6,605	5,124	6	1,475
Eastern Asia	0	0	0	0	4	1	0	2
South Asia	5,357	4,116	14	1,228	5,635	4,355	6	1,275
India	4,756	3,705	0	1,051	4,801	3,846	0	955
Iran	114	93	0	21	124	41	0	82
Pakistan	380	232	0	148	630	388	0	243
Southeast Asia	131	98	22	12	175	162	0	13
Myanmar	128	94	22	12	171	158	0	13
Western Asia	184	131	0	53	704	501	0	203
Turkey	121	75	0	46	496	305	0	191

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

Chickpea's utilization pattern varies across regions and countries. In Asia, approximately 78% of the total chickpea supply is used as food; and the total demand for chickpea as food increased from 4.3 million t in 1981-83 to 5.1 million t in 2001-03. In Africa, its use as food increased, in absolute as well as proportionate terms. In 2001-03, approximately 84% of the total chickpea supply in Africa was used as food, marginally higher than in 1981-83. In Europe, the food demand for chickpea increased, but its share in the total demand fell to 72% in 2001-03. On the other hand, the proportion of total chickpea supply consumed as food is low in North and Central America (about one-third). In Oceania, chickpea is rarely used for food; and most of the chickpea produced is exported.

Chickpea is also used as animal feed. Globally, 14% of the total available chickpea supply in 2001-03 was used as feed, and this proportion has not changed much since 1981-83. Use of chickpea as feed is more prominent in North and Central America and Europe where about 55% and 20% of the chickpea supply, respectively is used as feed. Further, in North and Central America, the demand for chickpea as feed has more than doubled during the last two decades. In Asia, about 13% of the total chickpea supply is used as feed, but mainly byproducts obtained after milling.

Within Asia, there is a considerable difference in the uses of chickpea. In India, about 80% of the total supply is used as food and 13% as animal feed, and this pattern has not undergone any significant change over the last two decades. Also, no significant changes were observed in the demand for chickpea as food and feed, with the demand for chickpea as food increasing by 141,000 t while its demand as feed decreased by 19,000 t between 1981-83 and 2001-03. Pakistan is the second largest consumer of chickpea in the region, and close to two-thirds of total chickpea supply is used as food and 25% as feed. Like in India, the pattern of chickpea utilization did not undergo any noticeable change in Pakistan. Nonetheless, the demand for chickpea as food increased from 232,000 t in 1981-83 to 388,000 t in 2001-03. In Bangladesh and Nepal, where chickpea is used as food, and rarely as feed, the total supply of chickpea declined considerably during this period.

In Myanmar, chickpea is used mainly as food, and its demand as food increased considerably, from 95,000 t in 1981-83 to 158,000 t in 2001-03. The share of food in total availability increased from 74% to 93% during this period. In Turkey, the domestic demand for chickpea increased more than four-fold between 1981-83 and 2001-03, from 121,000 t to 496,000 t. The share of food in total availability, however, remained around 60%. Though feed use of chickpea was non-existent in Turkey in the early 1980s, its feed use increased to 94,000 t in 2001-03, accounting for close to one-fifth of the total demand.

Production Constraints

During the last two decades, chickpea area has declined in India, and almost collapsed in Bangladesh and Nepal. In India, the largest decline in area occurred in the Indo-Gangetic plains, primarily because of its declining competitiveness with respect to competing crops like wheat and rapeseed-mustard. Many factors contributed to this declining competitiveness. Joshi et al. (2000) found less profit, higher risk and lack of improved technologies as major factors. Besides, the high input technique of cultivation associated with modern wheat varieties was not compatible with the traditional mixed or sequential cropping of chickpea.

Chickpea is grown in the postrainy season on residual soil moisture without irrigation. Hence, terminal drought and heat stresses are major constraints to production, particularly in the semi-arid tropics.

In India, there is widespread deficiency of sulphur and zinc in chickpea growing regions, adversely affecting productivity. About 40% of the pulses area has low to medium population of native rhizobium. Lack of quality culture in adequate quantities is an important constraint to the popularization of biofertilizers.

Botrytis grey mould (BGM) is a major constraint to chickpea production in South Asia, and is another factor responsible for the collapse of chickpea crops in the Indo-Gangetic plains. Ascochyta blight also causes substantial quantitative and qualitative losses in chickpea production. *Kabuli* type chickpea is susceptible to blight and may require significant management efforts for control. Fusarium wilt is another important disease of chickpea, causing significant yield loss.

Helicoverpa armigera is a major threat to chickpea production. The insect has become resistant to almost all the pesticides used to control it and turned out to be polyphagus. On an average, between 20% and 40% of the crop is annually lost due to damage caused by pod borers.

Lack of supply of quality seeds is a major constraint to raising chickpea yield. Farmers often use home-produced seeds year after year. Seed replacement rate is low; in India it is as low as 4%. Public sector seed companies are able to meet a small proportion of seed demand, but private sector involvement is low in this market owing to lack of an assured market.

There is considerable potential to grow chickpea in rice-fallows in the postrainy season in many parts of South Asia. There are, however, a number of constraints such as lack of availability of short-duration chickpea varieties that can withstand terminal drought conditions, lack of protective irrigation facilities, lack of short-duration varieties of the preceding rice crop, soil hardiness after rice harvest, animal grazing, etc. that discourage farmers to undertake cultivation of chickpea or any other crop after rice harvest (Joshi et al. 2000; Joshi et al. 2002; Musa et al. 2001).

International Trade

Close to 10% of the total chickpea produced in 2003-05 entered the international market. In absolute terms, chickpea trade expanded considerably during the last two decades. Between 1981-83 and 2003-05, global exports of chickpea increased two and a half times, from 247,000 t to 870,000 t (Figure 13 and Table 4).

Until the early 1980s, chickpea exports were monopolized by a few developing countries. Turkey, Syria and Mexico together accounted for 95% of the global exports. Gradually, non-traditional chickpea growing countries like Australia and Canada began to produce chickpea primarily for exports to the Indian subcontinent. This led to a considerable decline in the share of developing countries in global chickpea exports, from 99% in 1981-83

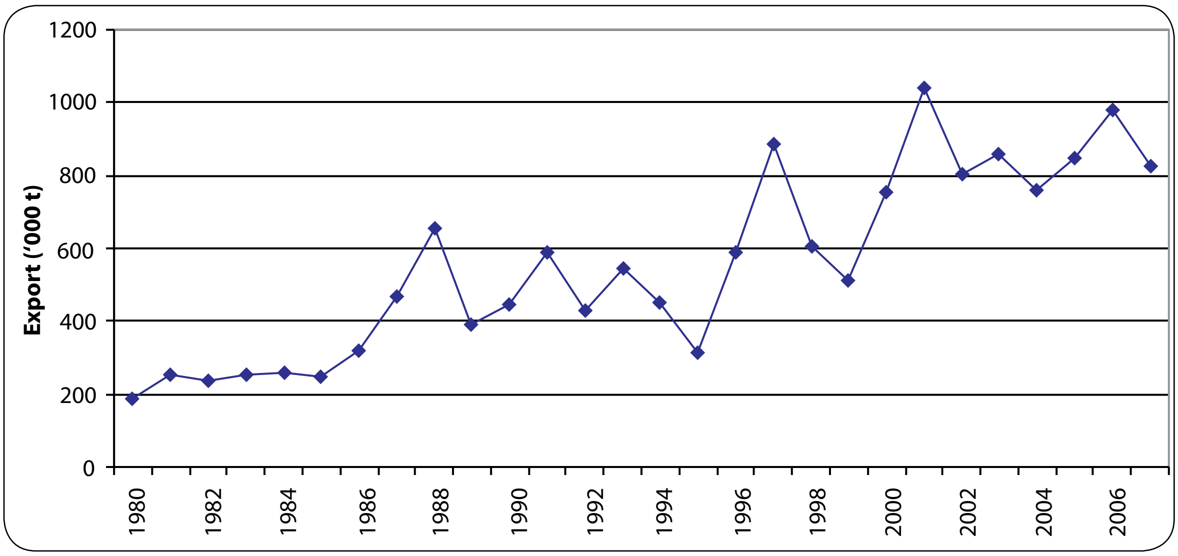


Figure 13. Global export trends for chickpea, 1980-2006.
Source: Source: FAOSTAT

to 68% in 2003-05. In absolute terms, however, chickpea exports from developing countries increased from 245,000 t in 1981-83 to 592,000 t in 2003-05. Asia's export was almost stagnant at 187,000 t until the mid-1990s but increased to 356,000 t in 2003-05. Turkey has been an important exporter of chickpea from Asia. Since the mid-nineties, Iran and Myanmar have emerged as important exporters from Asia.

Chickpea imports grew rapidly in developing countries than in developed countries. Between 1981-83 and 2003-05, developing countries' imports increased six times as compared to a three-time increase in imports of the developed countries. Asia continued to account for a sizeable share of the imports. Further, Asia's imports increased considerably; from 59,000 t in 1981-83 to 286,000 t in 1993-95 and further to 571,000 t in 2003-05, with a corresponding increase in its global share from 38% to 68% (Table 4).

There occurred a significant geographical diversification in chickpea imports within Asia. In the early 1980s, West and South Asia shared 68% and 20% of Asia's total imports, respectively. In 2003-05, the share of South Asia in total Asian imports increased to 76%, while the share of West Asia declined to 22% (Table 4). There was a significant increase in imports by India, Bangladesh and Pakistan. India has emerged as a main importer of chickpea since the early 1990s. In 2003-05, it accounted for over a quarter of the global and 39% of Asia's imports. In West Asia, countries like Iraq, Jordan, Syria and Lebanon are the main chickpea importers.

Table 4. Trends in chickpea trade ('000 t) by region and country.

	Exports			Imports		
Regions	1981-83	1993-95	2003-05	1981-83	1993-95	2003-05
World	247	438	870	155	471	840
Developed countries	2	182	278	57	132	158
Europe	2	12	30	45	118	142
North America	0	8	88	12	14	16
Oceania	0	162	160	0	0	0
Developing countries	245	256	592	98	339	682
Africa	2	4	132	29	38	85
Latin America	55	65	104	10	15	27
Asia	188	187	356	59	286	571
Eastern Asia	0	1	0	0	1	2
South Asia	1	2	118	12	219	435
India	1	0	20	3	74	225
Iran	0	1	80	3	0	0
Pakistan	0	0	17	6	98	94
South East Asia	3	1	49	6	5	7
Myanmar	0	0	48	0	0	0
Western Asia	184	184	183	40	61	127
Turkey	164	143	149	0	0	0

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

International Prices

Chickpea Export Prices

Both *desi* and *kabuli* types of chickpea are traded in the international market. The *kabuli* type commands a higher price owing to its larger seed size, and the *desi* type is smaller in size and is relatively cheaper. The *desi* type accounts for approximately 80% of the total trade in chickpea. Among the main exporters, Australia is the largest exporter of *desi* type chickpea; Mexico, Turkey and Canada export mainly *kabuli* type chickpea.

Figure 14 shows trends in the world prices of chickpea (average of *kabuli* and *desi* types) in real terms[2]. Real prices of chickpea declined at a rate of 3.5% per annum during 1980-2005, rising only slightly since the early 2000s (1.1% during 2000-05). The decline was due to increased supply – chickpea production grew close to 2% per annum during 1980-2000. During 2003-06, chickpea prices rose in response to its increased demand as feed because of the recovery of the livestock industry in Europe; and increasing diversion of maize -- a close feed substitute -- for production of ethanol. During this period, chickpea prices in India rose by 55% in 2007 over 2005[3]. International prices of chickpea are also closely related to chickpea production in India, which accounts for approximately half of Asia's imports.

The recent rising trend in chickpea prices is expected to be sustained in the short term owing to supply shortages due to bad harvests in Australia and Canada; rising import demand from India due to shortfall in domestic production; and the abolition of tariffs on imports of pulses to India.

Producer Prices

To examine the competitiveness of chickpea production across countries, we compare producer prices of chickpea at 1983/84 constant US$ prices for *kabuli* and *desi*

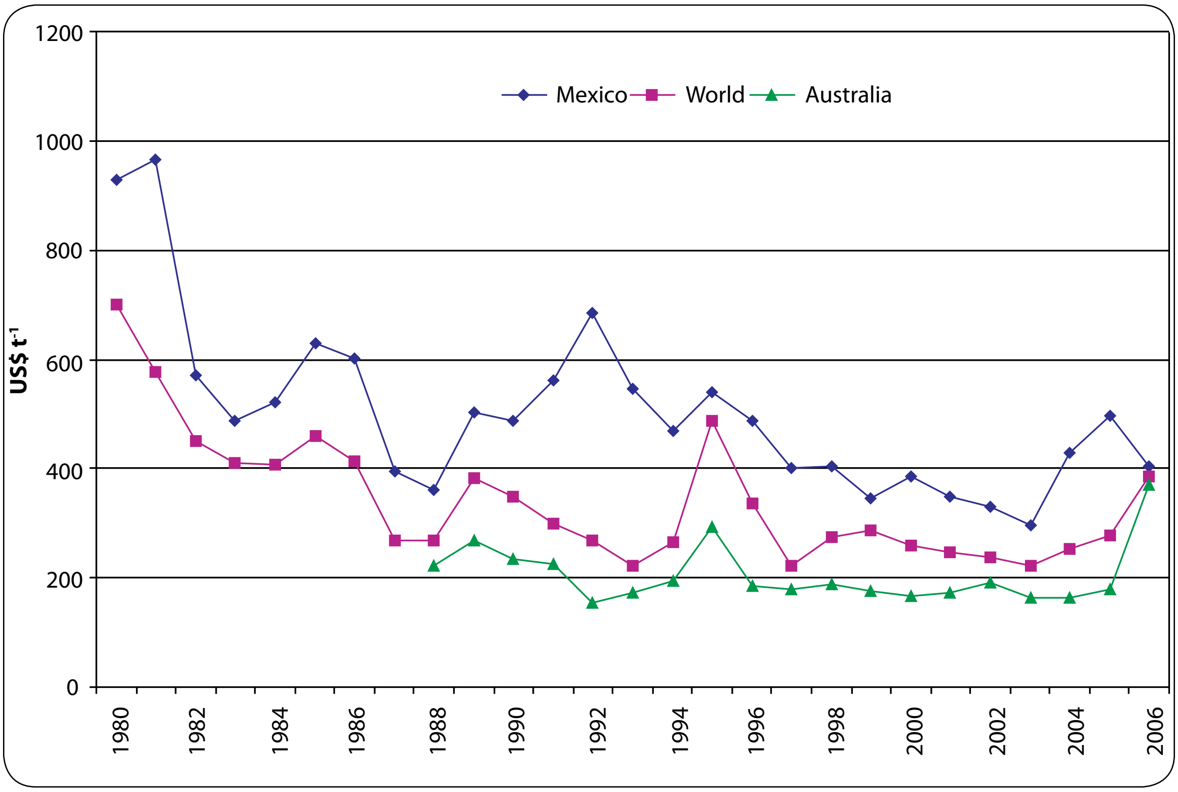


Figure 14. Trends in global real export prices of chickpea, 1980-2006 (at 1983-84 constant prices).

Source: FAOSTAT

[2] Although the price levels of the two types of chickpeas differ, the price trends are more or less similar.

[3] Calculated using data from http://www.agmarket.nic.in

chickpeas in selected countries. Since separate price data for *kabuli* and *desi* chickpeas is not available, countries have been grouped on the basis of their predominant production/trade of either *desi* or *kabuli* chickpeas. Canada is the only exception where both types are equally important; hence the prices reported could be treated as the average of both.

For *kabuli* chickpea, prices are lower in Iran and Mexico compared to Turkey (Figure 15). Prior to 2002, prices in Iran were higher while real prices in Turkey showed an increasing trend particularly in the last 5-7 years reversing the competitive situation. For *desi* chickpea, prices are lower in Australia and Pakistan compared to those in India (Figure 16). Since 1991 the real producer prices of chickpea witnessed a modest decline in India, Pakistan and Australia. Chickpea prices were lower in Australia untill 2001 than in India and Pakistan, indicating Australia's competitiveness in chickpea production. However, Pakistan emerged more competitive after 2001.

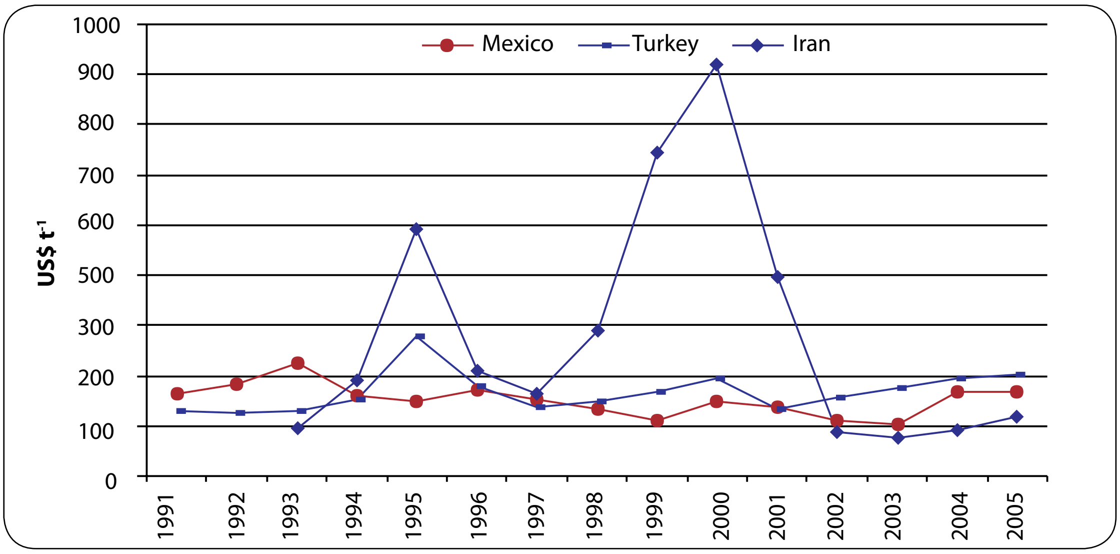


Figure 15. Trends in real producer prices of kabuli chickpea in major growing countries, 1991-2005 (at 1983-84 prices).

Source: FAOSTAT

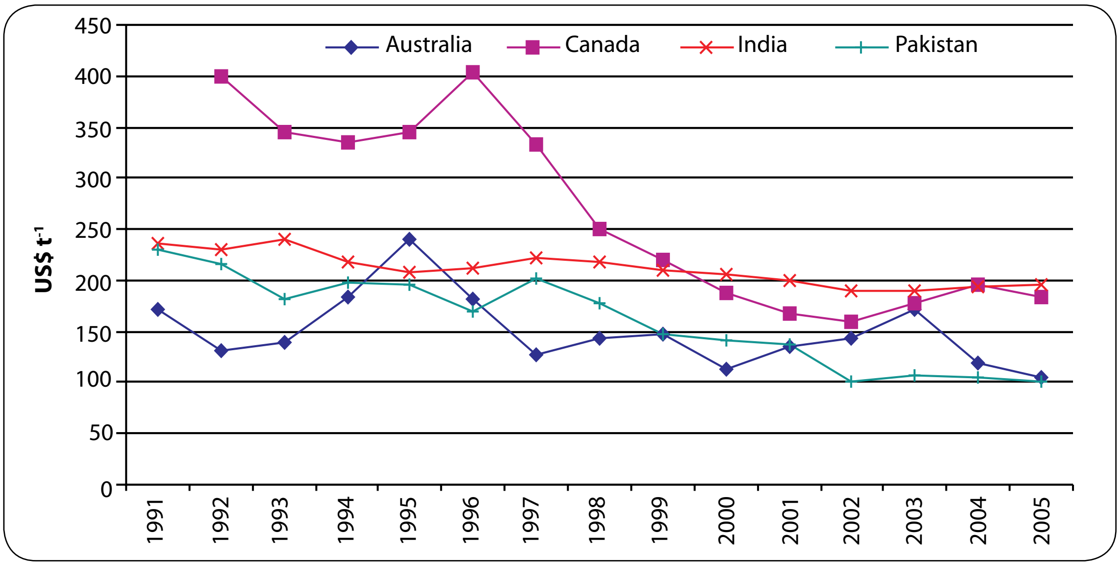


Figure 16. Trends in real producer prices of desi chickpea in major growing countries, 1991-2005 (at 1983-84 prices).

Source: FAOSTAT

3. Pigeonpea: Facts and Trends

Pigeonpea is an important pulse crop grown in the tropics and subtropics lying between 30°S and 30° N. It occupies 6.5% of the world's total pulses area and contributes 5.7% to total pulses production. The crop has its origin in India, and spread to Africa more than 4000 years ago (van der Maesen 1980).

Pigeonpea is grown in rainfall-scarce regions often on degraded soils, and is the preferred crop in such marginal environments because of its tap root system that allows optimum utilization of soil moisture and nutrients and enhances capacity to withstand intermittent moisture stresses. Traditional pigeonpea cultivars are of medium to long duration (ranging from 150 to 280 days) and are grown as an intercrop with sorghum and cotton which face greater production risk. In other words, pigeonpea provides resilience to the sustainability of production systems and acts as a cushion against income shocks arising due to failure of short-duration intercrops.

Pigeonpea is a multipurpose crop. Its grains are used as food, and are rich in protein, averaging a protein digestibility of 70% when cooked (Singh 1991). Its leaves are an excellent fodder for animals, and stems are an important source of domestic fuel, and raw material for thatching roofs and fencing fields.

Crop Distribution

The reported area and production statistics of pigeonpea are often under-estimated as these do not include its area and production while grown as homesteads in backyards and as a hedge crop. It may be noted that homestead production is quite common in many countries in Asia and Africa. Reported statistics suggest that pigeonpea is globally grown on an area spanning 4.6 million ha with a grain output of 3.4 million t. Its cultivation is confined to developing countries, mostly in Asia and Africa (Figure 17 and Table 5). As such, Asia and Africa (mainly Eastern and Southern Africa) occupy 89% and 10% of the total pigeonpea area, respectively (Table 5).

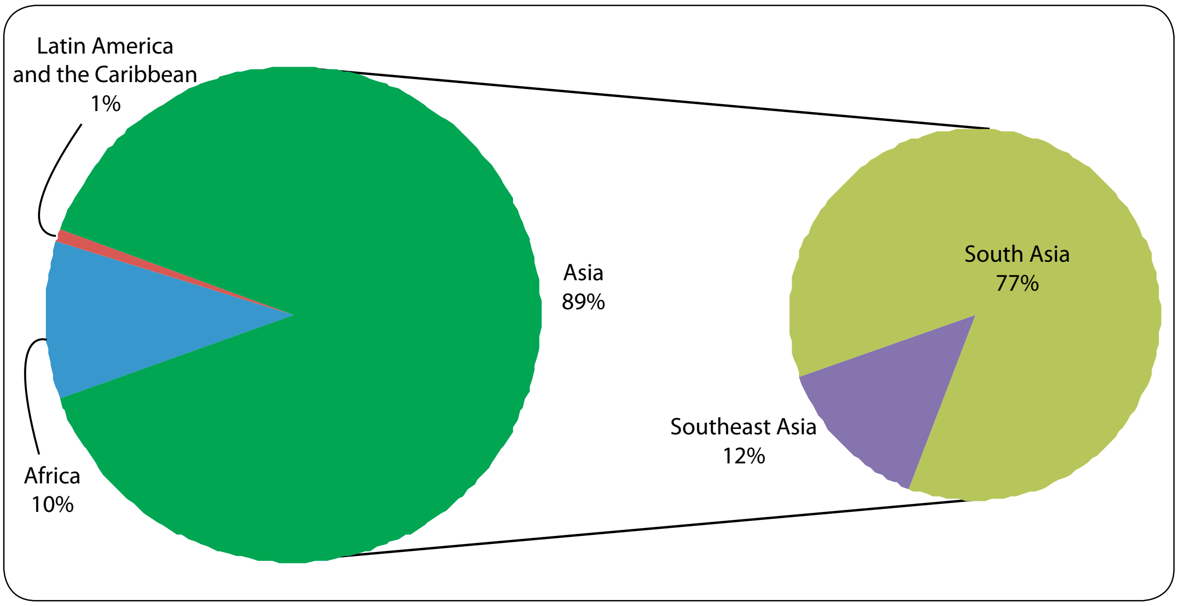


Figure 17. Global distribution of pigeonpea area, 2005-07.

Source: FAOSTAT

Table 5. Trends in area, yield and production of pigeonpea.

	Area ('000 ha)			Yield (kg ha^{-1})			Production ('000 t)		
Country/region	1981-83	1993-95	2005-07	1981-83	1993-95	2005-07	1981-83	1993-95	2005-07
World	**3,286**	**4,142**	**4,641**	**696**	**680**	**742**	**2,285**	**2,817**	**3,445**
Developing countries	**3,286**	**4,142**	**4,641**	**696**	**680**	**742**	**2,285**	**2,817**	**3,445**
Africa	225	361	477	614	627	676	138	226	322
Latin America	45	57	33	744	731	798	33	41	27
Asia	3,016	3,725	4,131	701	684	749	2,114	2,549	3,096
South Asia	2,954	3,504	3,565	704	688	716	2,081	2,409	2,551
India	2,924	3,474	3,543	705	688	715	2,061	2,389	2,532
Nepal	18	24	20	639	730	920	12	17	19
Southeast Asia	63	221	566	534	632	963	34	140	545
Myanmar	63	221	565	534	632	962	34	140	544

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

In Asia, pigeonpea is grown on 4.1 million ha, but its cultivation is largely restricted to South Asian countries, mainly India which accounts for 86% of Asia's total pigeonpea area and contributes 82% to total production. Myanmar accounts for almost the rest. Pigeonpea is also grown in Nepal, but on a very limited area. Recently, the crop has also been introduced in China, and its area has increased from a mere 50 ha in 1999 to more than 100,000 ha by 2006. Its initial success in China is mainly because it did not replace any other crop, and is grown mostly on wastelands (CGIAR 2007). There is potential to grow pigeonpea in Northeast Thailand but statistics on area and production are not available.

In India, pigeonpea is grown on 3.5 million ha. Like other pulses, pigeonpea is grown under rainfed conditions; 96% of the pigeonpea area in India is un-irrigated (GOI various years). Though this crop can be grown under varied agro-ecological environments, in India more than three-fourths of the pigeonpea area is concentrated in the semi-arid tropics (Figure 18). A more disaggregated distribution of pigeonpea in India is shown in Map 3. Annexure 6 gives state averages of area, yield and production of pigeonpea.

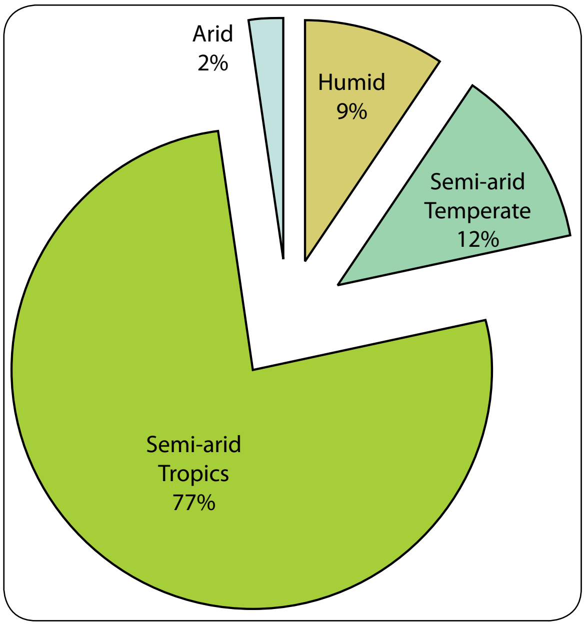
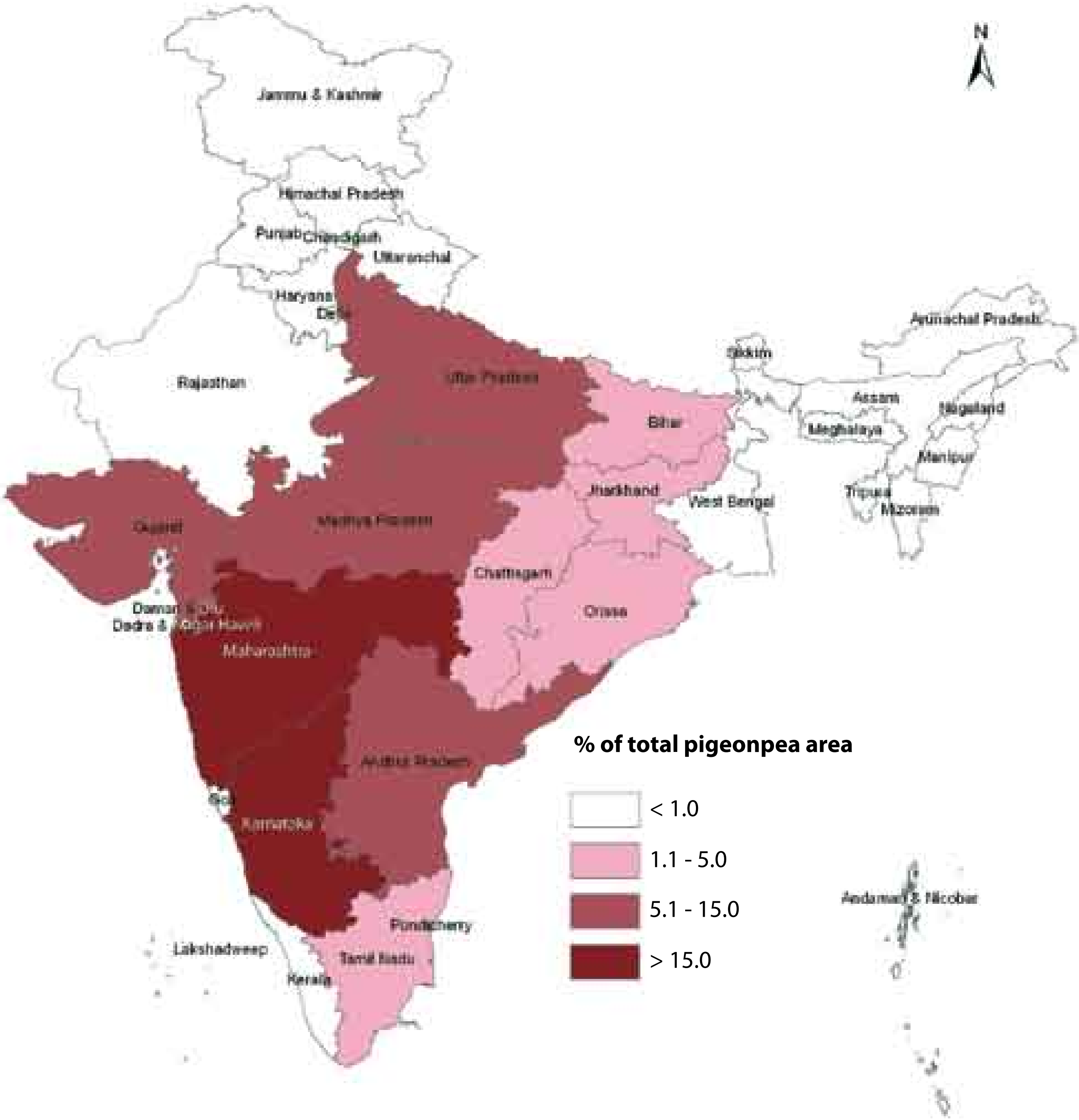


Figure 18. Distribution of pigeonpea area in India by agro-ecology, 2003-05.

Source: ICRISAT database



Map 3. Distribution of pigeonpea area in India across states, 2003-05.

Trends in Area, Yield and Production

Area

Between 1981-83 and 2005-07, the world's pigeonpea area expanded by 46%, from 3.3 million ha to 4.6 million ha at an annual rate of 1.3% (Tables 5 and 6). Area grew rapidly in Africa, albeit from a low base. It grew at an annual rate of 3.3% during this period. Pigeonpea area also expanded considerably in Asia, by 37% between 1981-83 and 2005-07. The rate of increase was higher between 1981-83 and 1993-95 in both Asia and Africa (Annexure 7). For instance, of the total addition to the pigeonpea area between 1981-83 and 2005-07 in Asia, two-thirds was added between 1981-83 and 1993-95.

Table 6. Annual growth rates (%) in pigeonpea area, yield and production, 1981-2007.

Country/region	Area	Yield	Production
World	**1.3**	**-0.1**	**1.2**
Developing countries	**1.3**	**-0.1**	**1.2**
Africa	3.3	0.8	4.1
Latin America	-1.4	0.2	-1.2
Asia	1.2	-0.1	1.0
South Asia	0.6	-0.4	0.2
India	0.5	-0.4	0.2
Nepal	1.6	1.5	3.1
Southeast Asia	11.5	2.0	13.7
Myanmar	11.4	2.0	13.6

Note: Growth rates below 1% are by and large insignificant.
Source: FAOSTAT (http://www.faostat.fao.org)

In Asia, about 1.1 million ha of additional area was brought under pigeonpea cultivation between 1981-83 and 2005-07 (Table 5). Of this, India and Myanmar shared 55 and 45%, respectively. Further analysis shows that while India accounted for most of the additional area (78%) between 1981-83 and 1993-95, Myanmar accounted for bulk of the additional area (85%) between 1993-95 and 2005-07. In India, an additional 0.62 million ha was brought under pigeonpea cultivation between 1981-83 and 2005-07.

Rapid increase in pigeonpea area can be attributed to the availability of short-to-medium-duration wilt-resistant varieties and increase in pigeonpea prices in relation to its competing crops as well as substitute pulses. Availability of short-duration varieties enabled double cropping in some regions e.g. with wheat in central India (Joshi et al. 2000). In the semi-arid tropics of India, pigeonpea is largely grown as an intercrop with cotton, sorghum and soybean. However, with the introduction of medium-duration varieties, pigeonpea is also being grown as a sole crop. For example, the adoption of wilt-resistant medium-duration variety ICP 8863 on a large scale could happen because of its tolerance to wilt, shorter duration and higher yield (Bantilan and Joshi 1996). In recent years, soybean and pigeonpea intercrops have gained importance in Madhya Pradesh and Maharashtra[4] .

At present, more than three-fourths of India's total pigeonpea area falls in the semi-arid tropics. Nevertheless, significant changes have taken place in the spatial distribution of pigeonpea area during the last two decades. Between 1981-83 and 2003-05, its area in the semi-arid tropics increased from 2.0 million ha in 1981-83 to 2.6 million ha in 2003-05, raising the share of the semi-arid tropics in total pigeonpea area from 60% to 76% (Figure 19). On the other hand, during this period pigeonpea area declined in the semi-arid temperate zone by 37%; from 0.65 million ha to 0.43 million ha. Pigeonpea area in the humid zone remained almost stagnant. Decline in pigeonpea area in the semi-arid temperate zone was largely due to its declining competitiveness in relation to crops like rice. For instance, between 1981-83 and 2005-07, while pigeonpea yield remained almost stagnant, rice yield increased by more than 60% (GOI, various years).

In India, among the major pigeonpea growing states, Maharashtra's share in total production increased from 18% in 1970 to 31% in 2004,

[4] http://dacnet.nic.in/Pulses/

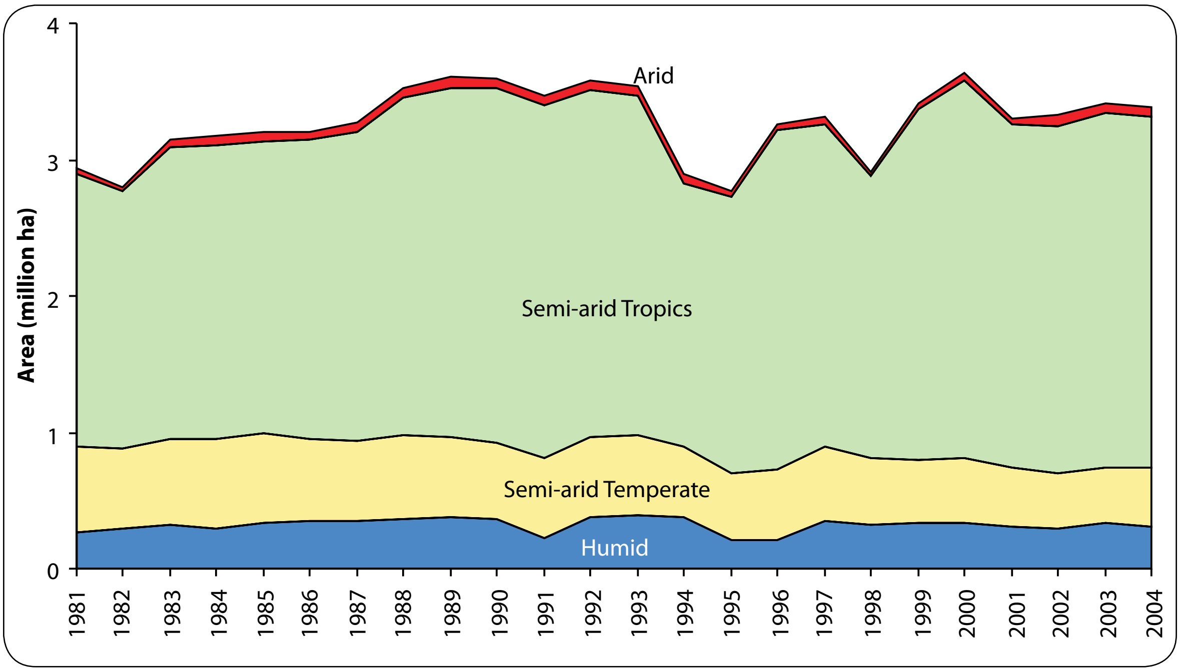


Figure 19. Trends in pigeonpea area in different agro-ecological regions in India, 1981-2004.

Source: GOI

and the share of Uttar Pradesh fell to half, from 36% to 18%. These changes are also reflected at the district level. Between 1966 and 2003, pigeonpea area decreased in a number of districts and increased in several others. The scatter diagram of districts (Figure 20) captures these changes. Points on the diagonal line represent districts where the area under pigeonpea in 2001-03 was the same as that in 1966-68. Points above the line represent those districts where area increased in 2001-03 over 1966-68 and the points below the line represent those where area declined.

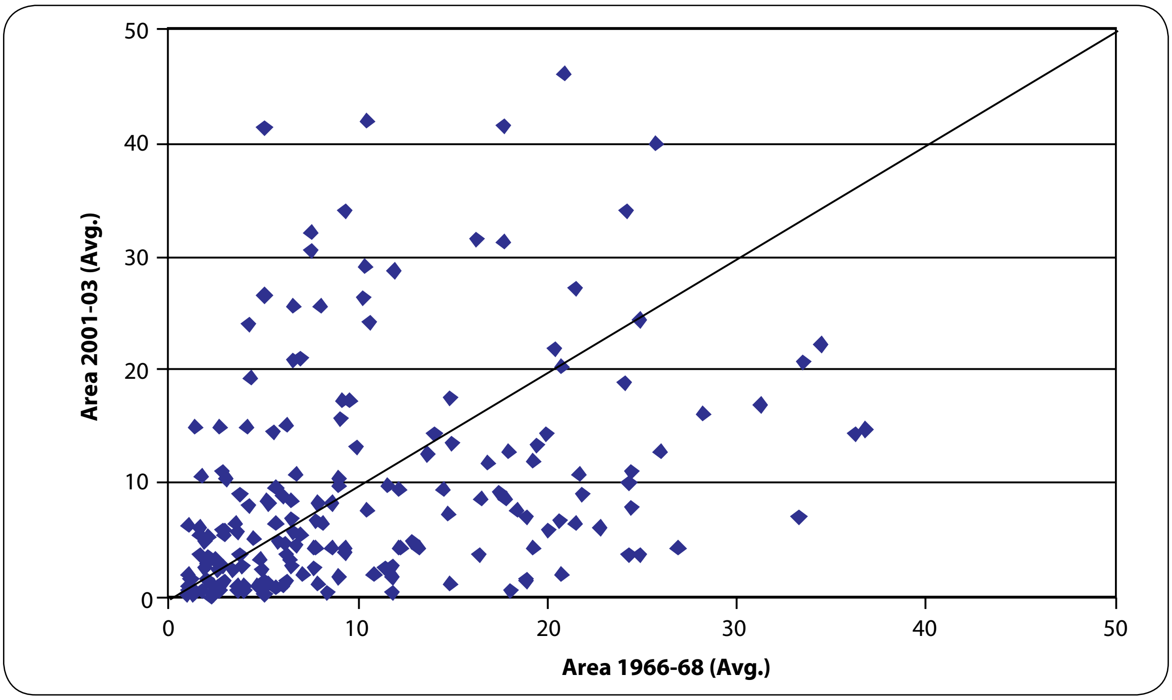


Figure 20. District-level change in pigeonpea area ('000 ha) in India, 1966-2003.

Source: GOI

Yield

Global pigeonpea yield increased modestly, from 696 kg ha^{-1} in 1981-83 to 742 kg ha^{-1} in 2005-07 (Table 5). Average pigeonpea yield for Asia is similar to the world average, as the latter is influenced by the yield in India which accounts for the bulk of global pigeonpea area and production. Pigeonpea yield in India was 715 kg ha^{-1} in 2005-07, and has by and large remained stagnant since the early 1980s. Also, there is no significant difference in pigeonpea yield between Asia and Africa where it is grown widely. Nonetheless, pigeonpea yield grew faster in Africa than in Asia (Annexure 7).

But, within Asia there are significant inter-country differences in pigeonpea yield and trends therein. Yield was higher in Myanmar, and increased by 80%, from 534 kg ha^{-1} in 1981-83 to 962 kg ha^{-1} in 2005-07. Productivity gains have been quicker in recent years (Annexure 7). Pigeonpea yield in Nepal was similar to that in Myanmar, 920 kg ha^{-1} in 2005-07, and has been rising (Table 5).

Although there has been no dramatic change in India's average pigeonpea yield, it varies considerably across regions. Yield has always remained higher in the semi-arid temperate region (Figure 21), but it has been declining overtime. In other regions, pigeonpea yield did not show any significant trend, positive or negative. But because of a decelerating trend in the semi-arid temperate zone, the yield gap between the semi-arid tropics and semi-arid temperate region has been closing.

Despite no significant improvements in pigeonpea yield in India, some notable improvements have occurred in some parts of the country. This is revealed by the classification of pigeonpea area by yield levels – low (<600 kg ha^{-1}); medium (600 - 770 kg ha^{-1}) and high (>770 kg ha^{-1}) in Figure 22. Between 1966-68 and 1980-82, pigeonpea area in India falling in the high yield range, increased from 18% to 33%, and the share of area in the low yield range declined from 64% to 43%. However, in the subsequent period (after 1980-82), no significant change in the distribution of pigeonpea area by yield is evident. In 2001-03, the high yield area comprised 30% of the total pigeonpea area, the medium yield 20% and the low yield area 50%.

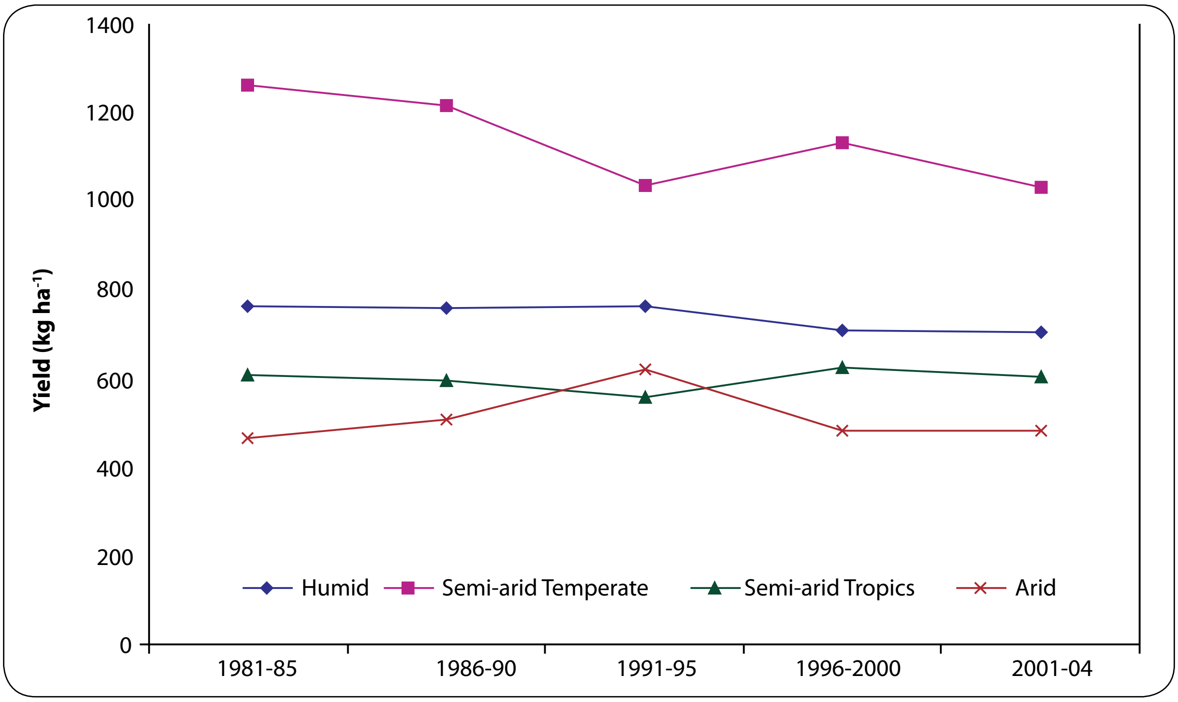


Figure 21. Trends in pigeonpea yields in different agro-ecological zones in India.

Source: GOI

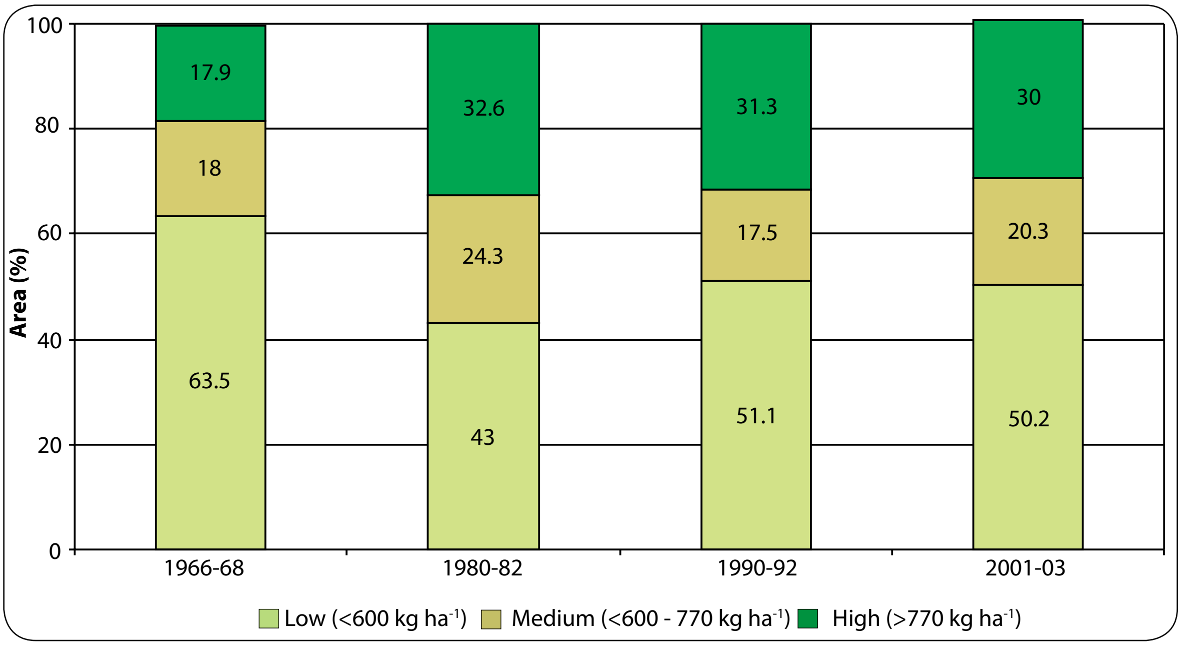
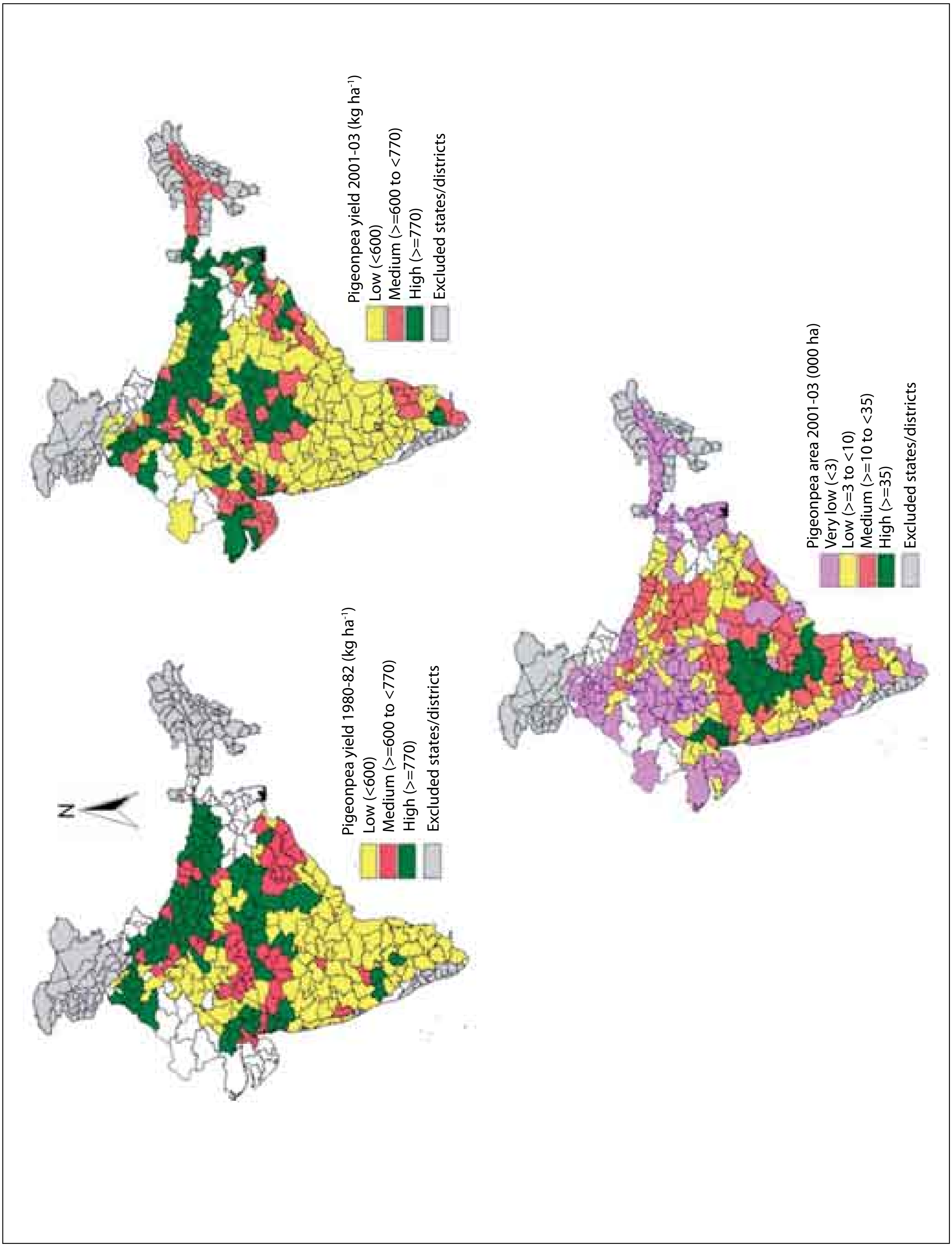


Figure 22. Distribution of pigeonpea area by yield levels, 1966-2003.

The stagnation in pigeonpea yield is further corroborated by its spatial distribution (Map 4). No major change in yield across districts was observed during 1980-2003. The distribution also reveals that high yields were mainly prevalent in the districts in the northern part of the country (falling under semi-arid temperate agro-climate) where the area under pigeonpea is declining. In much of peninsular India where pigeonpea area is presently concentrated, most districts fall in the low to medium yield categories.



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

The stagnation in average pigeonpea yield in India can partly be explained by the shift in area from favorable environments (semi-arid temperate) to marginal environments (semi-arid tropics) where average yields are about 40% less (Figure 21). The shift was however made possible due to the availability of medium-duration varieties that fit the cropping pattern in the semi-arid tropics (Bantilan and Joshi 1996).

Further, it has been observed that pigeonpea yield is quite erratic in the semi-arid tropics. Figure 23 shows the deviation in annual pigeonpea yield from the trend in the semi-arid tropics during the last four decades (1966-2004). The probability of yield falling below the trend is 0.5, implying that farmers face a low rainfall situation almost every second year. Whenever there is a low rainfall year, a 10% reduction in yield is common, and in case of very low rainfall, yield loss is higher than 10%. The frequency and intensity of yield shortfall has increased, particularly since the early 1990s, because of frequent low rainfall conditions.

Production

Between 1981-83 and 2005-07, world pigeonpea production grew at an annual rate of 1.2%, from 2.3 million t to 3.4 million t (Tables 5 and 6). The rate of growth accelerated after the mid-1990s (Annexure 7). Interestingly, growth in production was driven by area expansion. Of the 1.1 million t of additional pigeonpea produced between 1981-83 and 2005-07, more than 80% came from area expansion and the rest from yield improvement (Annexure 6). Area-driven growth was more pronounced during 1981-83 to 1993-95. Later on, though area expansion continued to be the main source of output growth, the contribution of yield also improved.

About 90% of the world's pigeonpea is produced in Asia despite its rapid spread in Africa. Although Asia's share in the global pigeonpea production has fallen marginally since the early 1980s, total production increased from 2.1 million t in 1981-83 to 2.5 million t in 1993-95 and further to 3.1 million t in 2005-07. This growth in production was driven exclusively by area expansion, mainly between 1981-83 and 1993-95. Between 1993-95 and 2005-07, yield also contributed marginally to production growth (Annexure 7). In Africa, pigeonpea production increased rapidly, from 138,000 t in 1981-83 to 226,000 t in 1993-95 and further to 322,000 t in 2005-07, at an annual rate of 4.1%. Thus, Africa's share in world pigeonpea production almost doubled -- from 5% in the early 1980s to 9% in 2005-07.

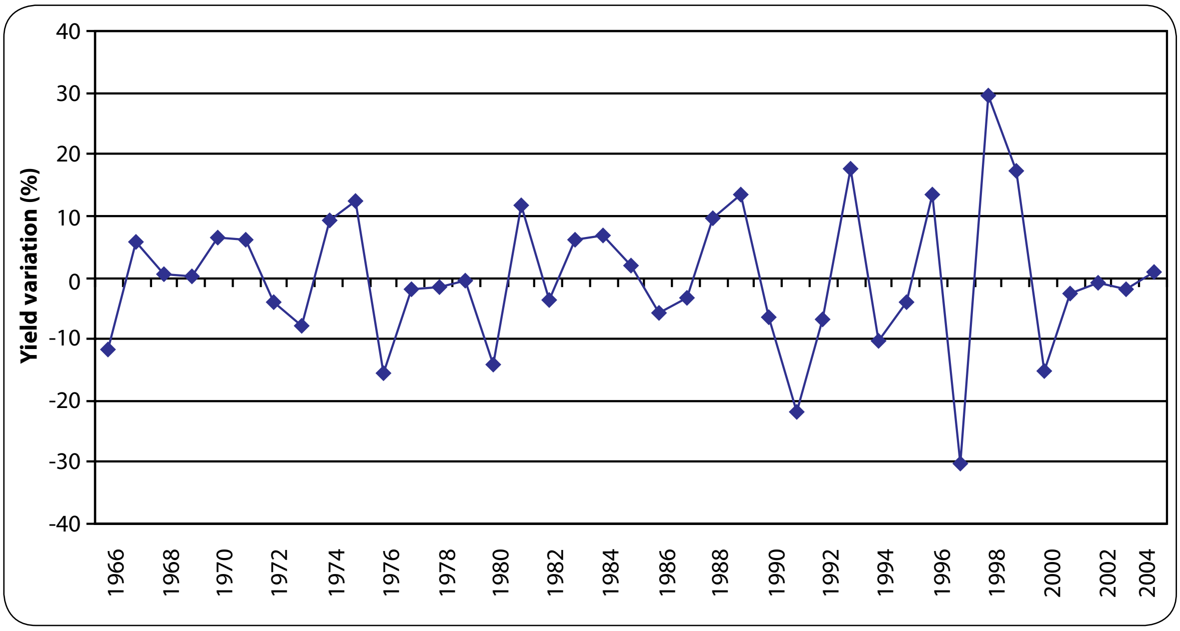


Figure 23. Deviation in pigeonpea yield from the trend in the semi-arid tropics, India, 1966-2004.

However, the growth in pigeonpea production globally continues to be area-driven.

India is the single largest producer of pigeonpea in the world. It produced close to three-fourths of the total pigeonpea in 2005-07, down from 90% in the early 1980s. This decline in its share was on account of: (i) the slow growth in domestic production, and (ii) the rapid spread of pigeonpea in other Asian and African countries. India's pigeonpea production increased from 2.0 million t in 1981-83 to 2.5 million t in 2005-07, at an annual rate of 0.20% (Tables 5 and 6). The modest growth in production between 1981-83 and 1993-95 was driven exclusively by area expansion. During the latter period, yield improvements also contributed to growth (Annexure 7).

India has seen a regional shift in pigeonpea production from semi-arid temperate areas to the semi-arid tropics. Until the 1970s, the semi-arid temperate region contributed around 40% to the total pigeonpea produced in the country. Its share, however, declined to around 25% in the early 1990s and further to less than 20% in 2003-05 (Figure 24). Until the mid-1980s, pigeonpea production in the semi-arid temperate region remained almost stagnant, but showed a secular decline afterwards, reaching 13% in 2003-05. The declining importance of pigeonpea in the temperate region could be attributed to its lack of competitiveness over other crops, stagnant yields and lack of availability of short-duration varieties that can fit into different production systems. More details on area, yield and production of pigeonpea in important growing states and districts in India are given in Annexure 6.

Myanmar is the second largest producer of pigeonpea in the world. Over the last two and a half decades, pigeonpea production increased considerably from 34,000 t in 1981-83 to 544,000 t in 2005-07 (Table 5 and Figure 25). Most of the incremental production occurred between 1993-95 and 2005-07 (14% a year), but was driven by area expansion. Nevertheless, the contribution of yield to output growth has improved over time. This was accomplished through incentives to increase acreage, improved access to fertilizers and farm machinery and various other policies since 1995.

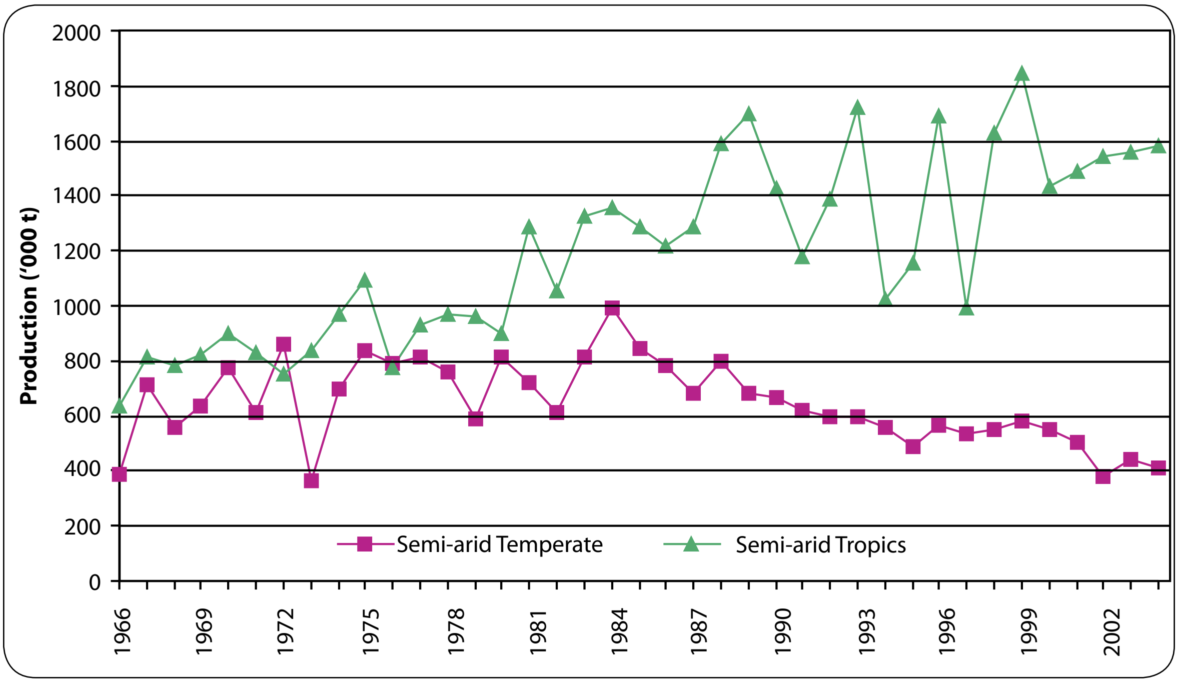


Figure 24. Production trends for pigeonpea by agro-ecological regions in India, 1966-2003.

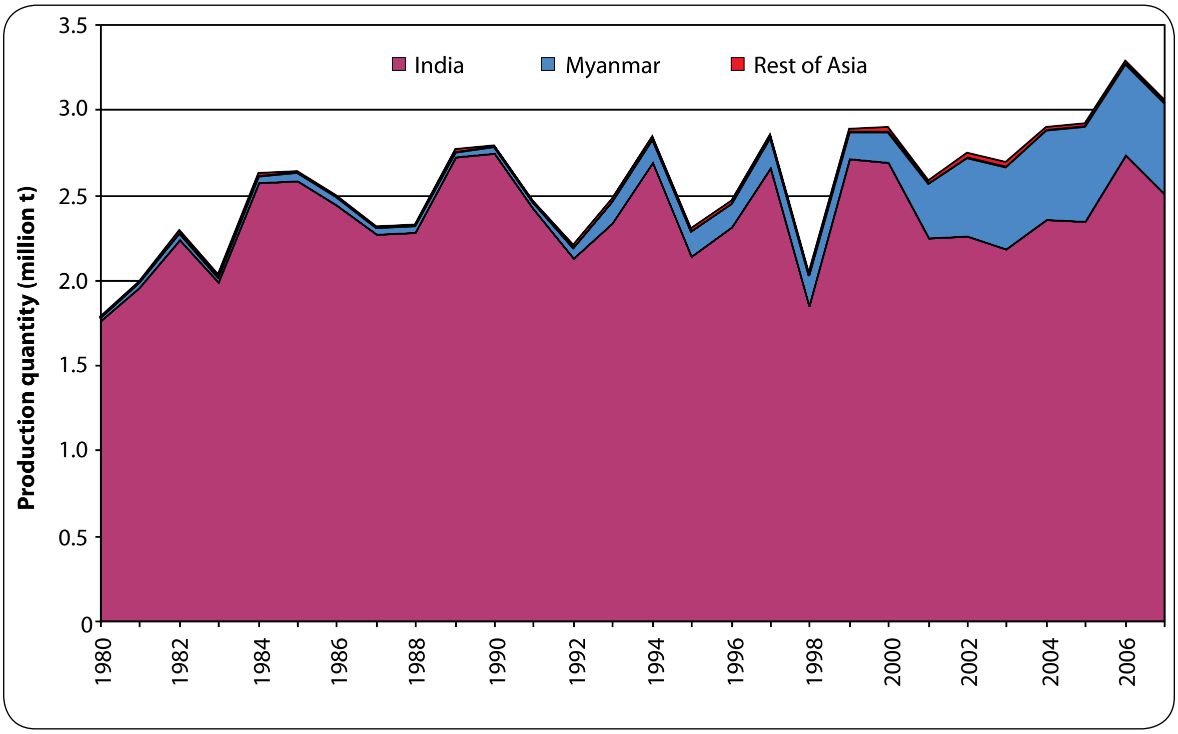


Figure 25. Pigeonpea production trends in Asia, 1980-2007.
Source: FAOSTAT

Utilization

Almost every part of the pigeonpea plant has economic value. Dried mature grains are used as food (split and whole); dry and green leaves as animal feed; and dry stems as fuel-wood, thatching and fencing material. Green pigeonpea – tender pods and/or seeds – are used as vegetable.

The most important use of pigeonpea is its consumption as food (*dal*). Approximately 85% of the global pigeonpea supply is used as food, and 4% each goes for processing and animal feed (Table 7). Further, this pattern of utilization has not undergone any significant change during the last two decades. Since South Asia accounts for a bulk of pigeonpea production and consumption, the global pattern of utilization is influenced by changes in its utilization in South Asia. The pattern of pigeonpea utilization in Africa is not much different.

Table 7. Trends in pigeonpea utilization ('000 t).

	1981-83				2001-03			
Country/region	Total availability	Food	Food manufacture	Other uses[1]	Total availability	Food	Food manufacture	Other uses
World	2,274	1,940	41	293	3,041	2,597	100	344
Africa	124	85	0	39	261	211	0	50
Latin America	28	19	8	0	1	1	0	0
Asia	2,119	1,836	33	251	2,756	2,364	100	292
South Asia	2,086	1,832	5	249	2,339	2,054	10	276
India	2,066	1,819	0	247	2,313	2,040	0	273
Nepal	12	6	5	1	24	12	10	2
Southeast Asia	34	3	28	2	417	310	90	17
Myanmar	34	3	28	2	417	310	90	17

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

There has been an increase in food demand for pigeonpea during the last two decades. Between 1981-83 and 2001-03, global consumption of pigeonpea increased by 34%, from 1.9 million t to 2.6 million t (Table 7). Consumption increased faster in Africa than in Asia. During this period, total consumption increased by 147% in Africa as compared to 29% in Asia.

In India, 88% of the available pigeonpea supply is utilized as food, 5% as animal feed and 3% as seed. Total consumption, however, has not increased much. Between 1981-83 and 2001-03, it increased by 12%, and mainly between 1981-83 and 1991-93.

In Myanmar, three-fourths of the total pigeonpea supply is utilized as food, and its food demand has increased dramatically, from 34,000 t in 1981-83 to 239,000 t in 1991-93 and further to 310,000 t in 2001-03. As a result of disproportionate increase in food demand, its pattern of utilization has also shifted in favor of food; the share of food in total supply gradually increased to 75% in 2001-03 from a mere 10% in 1981-83.

Production Constraints

A number of biotic and abiotic factors limit realization of the true potential of pigeonpea. Ryan (1995) found that the economic loss in pigeonpea production from abiotic constraints is higher than that from biotic constraints. Frequent droughts are a major abiotic constraint to enhancing productivity and production. Waterlogging and salinity are other important abiotic constraints. Frequent droughts in the low-rainfall, semi-arid areas, and waterlogging in the high-rainfall areas cause considerable loss in pigeonpea production. In the semi-arid tropics, pigeonpea is often grown as an intercrop in the rainy season and its reproductive growth occurs on residual moisture left after the harvest of a companion crop. Lack of moisture during the reproductive phase, especially in regions where farmers grow medium-to-long duration varieties, often leads to a situation of terminal drought, affecting crop yield substantially.

Lack of availability of improved seeds/ varieties to farmers is another limiting factor to enhancing pigeonpea production. Seed multiplication and distribution systems are not well-developed. Public sector seed supply is limited and the private sector is not very active in seed production and multiplication. Farmers often use farm-saved seeds for sowing in the next season, which are often damaged by insect-pests during storage. Besides, farmers are not much aware of the availability of new varieties and technologies.

Pigeonpea yield is also severely affected by biotic stresses. Sterility mosaic, fusarium wilt and phythophthora blight are important diseases of pigeonpea. The pod fly (*Melanagromyza spp*.) and pod borer (*Helicoverpa armigera)* are important loss-causing insects, besides storage/postharvest losses due to *Maruca*.

Among socioeconomic constraints, its lack of competitiveness relative to competing crops or companion crops in the intercropping system is important, especially under irrigated conditions. Joshi et al. (2000) estimated that if rice were to be replaced by pigeonpea, farmers would have to sacrifice 49% profit and 76% rice production. However, under rainfed conditions, pigeonpea can grow on low moisture with minimal or no fertilizer application.

International Trade

Available information on international prices and trade in pigeonpea is scanty and incomplete. For several years, FAO trade statistics has not reported pigeonpea imports to India, which accounts for 85%-90% of the global imports. Small quantities are also imported by Mauritius and Trinidad, mainly to meet requirements of ethnic Indians settled there. In 2007-08, India imported 313,000 t of pigeonpea compared to 6000 t in 1999 (GOI various years). Annual imports of pigeonpea to India since 1999 are shown in Table 8.

Myanmar is the major exporter of pigeonpea, followed by Malawi, Kenya, Uganda and the Dominican Republic. Myanmar accounts for 85%-90% of total pigeonpea imports of India, exporting an average of 235,000 t in 2003-05 (USDA 2005). Myanmar thus plays a decisive role in India's pigeonpea prices. It exports about 55%-60% of its pulses that include pigeonpea, chickpea, green gram, black gram, beans, etc. In recent years, with a ban on export of processed pulses from India, Myanmar has started supplying them in the international market.

Table 8. Pigeonpea trade ('000 t) in India.

Year	Exports	Imports
1999	7	6
2000	7	44
2001	9	354
2002	8	321
2003	12	315
2004	23	238
2005	25	229
2006	NA	NA
2007	NA	313

Source: GOI (various years).
NA= Not available

Trends in Prices

India is the largest producer and consumer of pigeonpea. Its global prices are thus to a large extent influenced by production and price trends in India. Figure 26 shows trends in the real wholesale price index of pigeonpea in India. In general, pigeonpea prices have been fluctuating considerably, declining until 2000 and gradually increasing thereafter. The average price index of all pulses is less volatile but also declining. Their prices, however, rose sharply since 2005.

To examine the competitiveness of pigeonpea production across countries, we compared the behaviour of producer prices of pigeonpea in India vis-à-vis other pigeonpea growing countries, in real terms (at 1983/84 constant US$) in Figure 27. Since the early 1990s, producer prices of pigeonpea have been one of the lowest in Malawi, suggesting that it is more competitive in pigeonpea production than any other country. Though India is the largest producer of pigeonpea, it is not as competitive. Producer prices of pigeonpea in India are

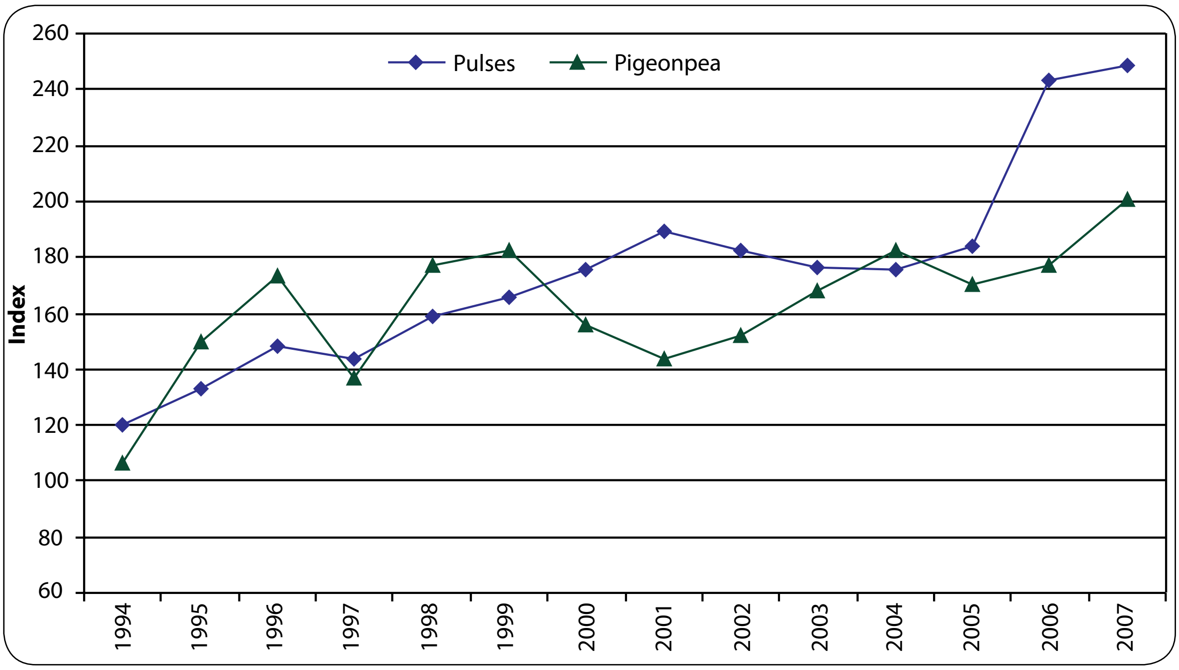


Figure 26. Trends in the real wholesale price index of pigeonpea in India, 1994-2007.
Source: FAOSTAT

closer to that prevailing in Kenya. Within Asia, producer prices are lowest in Bangladesh and in fact very close to prices in Kenya. However, not much area is put to pigeonpea cultivation in Bangladesh because of the pressing concern for producing more of cereals for food security from extremely limited arable land. Average per capita arable land holding in Bangladesh is 0.06 ha (Parthasarathy Rao et al. 2004). In Nepal, producer prices of pigeonpea are lower compared to those in India until 2001.

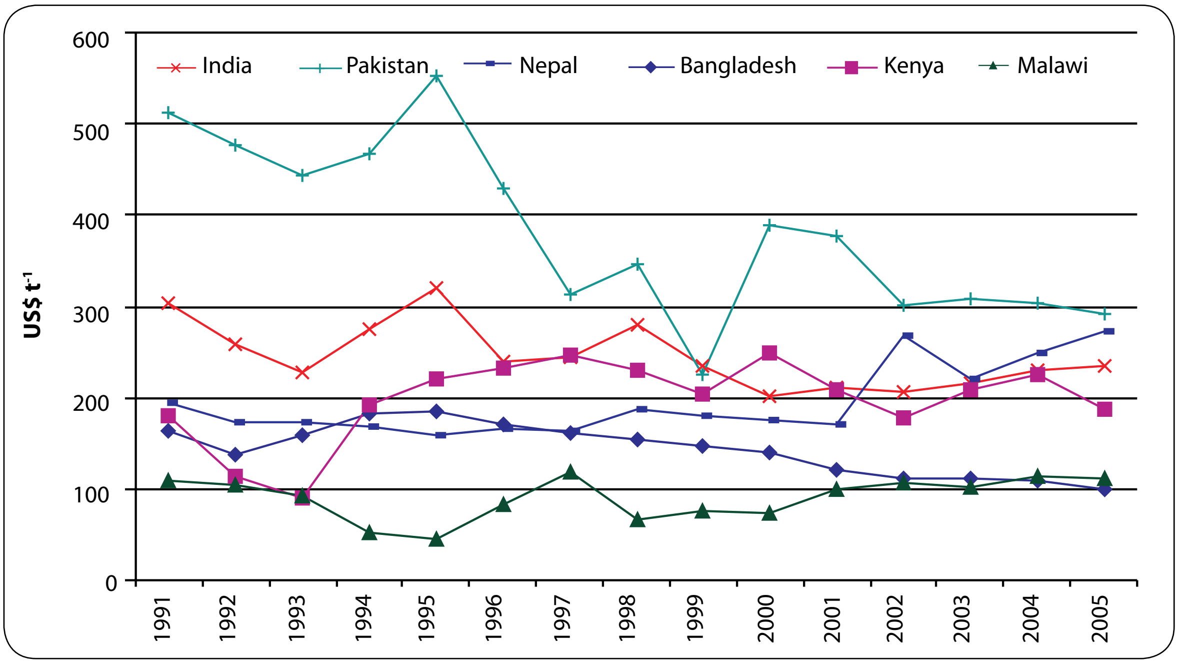


Figure 27. Trends in real producer prices of pigeonpea in major producing countries, 1991-2005.
Source: FAOSTAT

4. Markets, Institutions and Policies

Producer Support Policies

Among developing countries, Myanmar has recently emerged as a major exporter of pulses. This was accomplished through incentives to increase acreage, improved access to fertilizers and farm machinery; and various other policies since 1995. In India, measures to increase production of pulses have met with limited success with area remaining stagnant, yields remaining low and an increasing proportion of domestic demand being met through increased imports. In order to improve pulses production, the Government of India launched a program called the Integrated Scheme of Oilseeds, Pulses, Oilpalm, and Maize (ISOPOM). Under this scheme, new technologies, timely supply of inputs, extension support, remunerative price, marketing infrastructure and postharvest technologies were provided for increasing pulses production. As on 2008, the Project was implemented in 437 districts in 14 States spread across the country. In 2007, under the nationally sponsored National Food Security Mission, sustainable production for pulses was being targeted in 168 districts in 14 major pulse producing states (Ali and Kumar 2009). The program includes quality seed production, integrated nutrient management, integrated pest management, distribution of sprinkler sets, strengthening infrastructure and training and extension services.

Minimum Support Prices: The Government of India announces Minimum Support Prices (MSP) for several crops including pulses as a floor price for procurement by government agencies. Despite this, by and large during the last 20 years, the MSP for pulses has remained lower than the market price. In a bid to improve acreage under pulses, the MSP for chickpea and pigeonpea (and for other pulses like lentil, etc.) have been hiked steadily over the years. However, the big push came in 2008-09 when the MSP for pigeonpea was increased by 30% and that for chickpea by 8% over 2007-08 (Figure 28). This is likely to act as an incentive to produce more pulses.

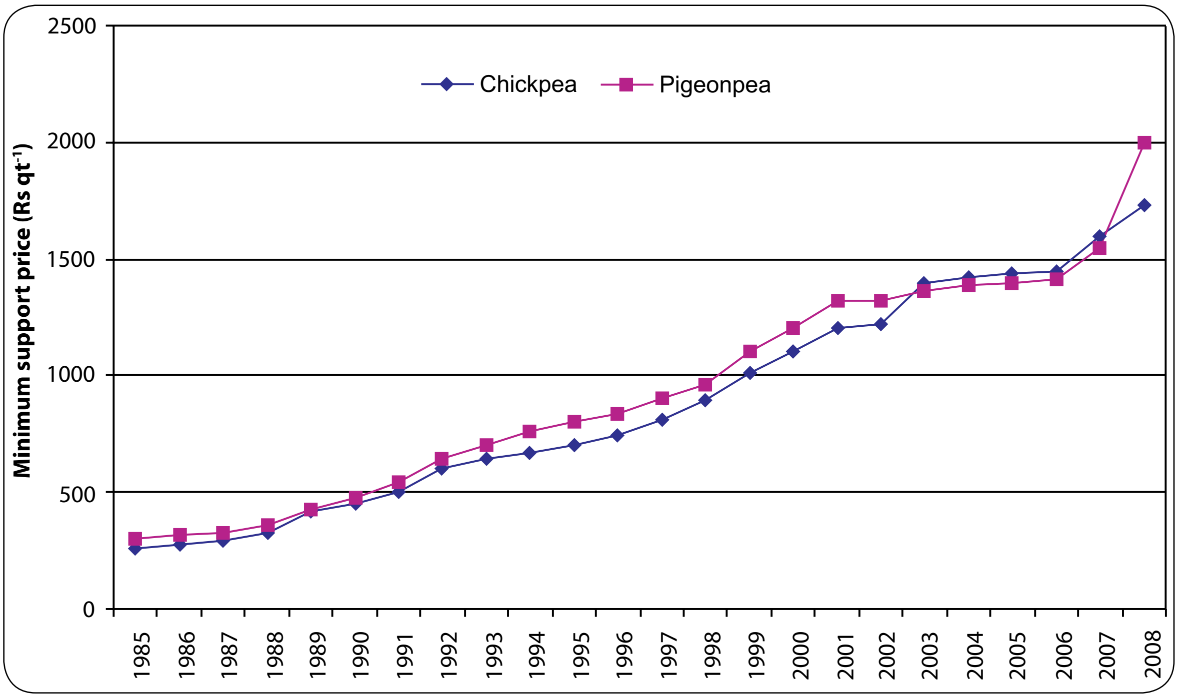


Figure 28. Trends in minimum support prices of chickpea and pigeonpea in India, 1985-2008.

Source: Ministry of Agriculture, data accessed from http://dacnet.nic.in/eands various years.

Marketing of Pulses in India

The traditional private marketing channel is the most prevalent, the simplest channel that originates at the farmer, going on directly to the miller, and finally to the consumer. However, channels where either wholesalers or village traders purchase grain from farmers and then sell it to millers are more popular. In addition, there is another institutional channel called the National Agricultural Co-operative Marketing Federation of India Limited (NAFED) that acts as a nodal agency for procuring grain at MSP. Other agencies, such as the State Trading Corporation (STC), Minerals and Metals Trading Corporation (MMTC) and Project and Equipment Corporation (PEC) have been authorized to import and market pulses. Procurement from major producing states and imports are channeled through these agents to private wholesalers or directly to consumers.

Importers who are licensed to import pulses sell the consignment to a broker, commission agents and middlemen or directly to secondary wholesalers or processors. The brokers and commission agents sell pulses to primary wholesalers, who in turn sell to processors of pulses or to secondary wholesalers. The major portion of the processed pulses from processors goes to secondary wholesalers, and is then sold to consumers through retailers. The secondary wholesalers also sell the pulses to processing units to manufacture flour, puffed and roasted chickpeas. All these products move to consumers via retail markets.

Until recently, the Agricultural Produce Market Committee (APMC) Act in each Indian state required that all agricultural products be sold in government controlled regulated markets. A key impact of this regulation was that private sector processors, wholesalers and retailers were unable to legally integrate their enterprises by purchasing commodities directly from farmers or other sellers, and farmers were unable to legally enter into contracts with buyers[5]. Furthermore, under this system farmers had no incentive to upgrade quality and adopt grade and standards. Recently, these laws have been relaxed in specific states for specific commodities, and the GOI has drafted and recommended new legislation for states that would permit private markets to operate. As a result of a consensus clinched by the Centre, most states have fully or partially amended their Agricultural Produce Marketing Committee Acts on the lines of the Model Act on Agricultural Marketing circulated by the Centre. However, a few states have not implemented the amendments to the APMC Act and its implementation at the ground level is sketchy.

Trade Policies

India has had a liberal policy towards pulses imports during the past two decades. Pulses imports were placed under Open General License (OGL) in 1979, allowing any public or private sector player to import into India without approval or restriction. Import duties on pulses steadily declined during the late 1980s and 1990s. In 1988, the tariff rate was 35%. The duty fell to 10% in 1989 and remained at that level through 1994. In 1995, the tariff was reduced to 5% and was eventually eliminated in March 2000[6]. The reduction in tariffs is despite India's commitment under World Trade Organization (WTO) bound tariff rates at 5% for dry peas and 100% for all other pulse varieties. With the elimination of import duties since 2000, imports of pulses to India have risen from 350,000 tons in 2000/01 to 1.7 million t in 2005-06. In 2007/08, India imported 2.7 million t (Reuters 2008). Chickpea and pigeonpea account for over a quarter of India's pulse imports. In 2009, in a bid to bring down pulses prices, the government allowed public sector parastatals to float international tenders

[5] The Essential Commodities Act (ECA), 1955, allows central or state governments to impose restrictions of movement and storage limits on private traders of cereals, pulses, edible oils, sugar, and other essential commodities. The ECA has not been invoked in recent years owing to the increased availability of foodgrains. The Department of Food & Civil Supplies in respective state governments issues licenses to wholesalers, commission agents and retailers. A wholesaler can stock up to 2000 bags (200 t), a retailer up to 20 bags (2 t), and a commission agent (middleman) can have unlimited stocks, but has to dispose of the stocks within 15 days.

[6] A 5% duty was reinstated in April 2001 and then raised to 10% in March 2002. This has since then been done away with.

to procure pulses in lots of 25,000 t-30,000 t, which further triggered a rise in global prices. Despite a subsidy of 25% - 50% on landed costs of pulses imported by public sector undertakings, domestic prices rose further in line with international market prices (Narang and Gulati 2009).

On the export front, though a small player, India removed packaging restrictions of 5 kg for export of pulses in 2002, thus making exports free without any restrictions. However, in 2006, due to domestic shortages, the government banned export of pulses. The ban was extended to mid-2007 and was withdrawn amidst protests from exporters.

5. Outlook for Chickpea and Pigeonpea

Model Description

In this section, we examine the possible future scenarios for chickpea and pigeonpea in terms of likely changes in area, production, yield, consumption and trade in major Asian countries growing these crops vis-à-vis the world. For this purpose, we used the IMPACT model developed by the International Food Policy Research Institute (IFPRI). The model was expanded in coverage of crops and geographical area by ICRISAT and IFPRI to include important dryland crops like millets, sorghum, chickpea, pigeonpea and groundnut and to include countries in the semi-arid tropics.

The model simulates the behavior of a competitive world agricultural market for crops and livestock, and is specified as a set of food producing units (FPU) that can be aggregated to 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 agricultural sub-models are linked through trade in a non-spatial way, such that the effect on country-level production, consumption and commodity prices is captured through net trade flows in global agricultural markets. Demand is a function of prices, income and population growth. Growth in crop production in each country is determined by crop 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, nonagricultural 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 to food production, demand and trade at various spatial scales – from river basins, countries or regions to the global level over a span of 25 years.

The version of the model used for this paper is the IMPACT-Water model with a base year 2000 [a three-year average of 1999-2001 FAOSTAT (http://www.faostat.fao.org) data] with projections to the year 2020.

Plausible Futures and Alternate Scenarios

Within the IMPACT-WATER model, there are several principal "drivers" that underlie the dynamics of agricultural production and consumption growth over time. The primary macro-economic drivers are income and population, which jointly determine the dynamics of per capita income for each country, which is a major determinant of food 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 over time, which reflects improvements in agricultural technology and growth potential that can be realized over time. Other important policy relevant variables to consider are those which directly affect the market prices of the commodities – such as the 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 within the business-as-usual baseline scenario, 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 chickpea and pigeonpea in Asia requires a careful analyses of the assumptions of baseline business-as-usual conditions for several technological, socioeconomic and policy factors, and a comparison of how this may change if other plausible technological, policy options and development pathways were to be followed. In this paper, we examine the following changes in key "drivers" from baseline scenarios:

- A 25% increase (and decrease) in yield growth rates for chickpea and pigeonpea in India
- A 25% higher income growth rate in India
- Raising protection levels for chickpea and pigeonpea in India
- A 25% increase in pigeonpea yield growth in Myanmar.

For each of the alternative scenarios, the following outcome indicators have been examined and compared with the baseline projections in 2020:

- 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 the above scenarios, deviations in the key selected outcome indicators from the baseline projections in 2020 are compared, for chickpea (Table 10 and Figure 29) and pigeonpea (Table 12 and Figure 30). Such a comparison provides a better understanding of the potential responsiveness of these crops to important technological, socioeconomic and trade-related changes.

Outlook for Chickpea

Business-as-usual Scenario

Given the current levels of technology, water availability, per capita income and demand conditions, projected forecasts for production, demand and net trade in chickpea are presented in Table 9. The model forecasts that India's production is set to increase from 5 million t in 2000 to nearly 10 million t in 2020. Despite this, India's imports will increase substantially from the 2000 levels owing to increased demand. Increased exports from both Australia and North America are also forecast. Myanmar's demand for chickpea is forecast to increase as well, and the domestic production will not be sufficient to meet this. Therefore, its imports will rise, creating a trade deficit of 102,000 t in 2020. World prices of chickpea are projected to increase gradually from 2000, peaking between 2015 and 2017 and gradually tapering off in 2020, eventually settling at a little over \$ 620 t^{-1} (at 2000 prices) (Figure 29).

Table 9. A business-as-usual scenario for chickpea ('000 t).

	Production		Demand[1]		Net trade	
Country/region	2000	2020	2000	2020	2000	2020
North America	343	617	160	193	106	348
Africa	329	1,169	409	662	-78	510
Tanzania	24	87	19	32	5	55
Ethiopia	160	734	159	302	1	431
Asia	6,907	12,447	7,228	14,205	-277	-1,714
Iran	225	351	167	189	56	160
Turkey	547	1,060	454	544	89	511
India	5,263	9,900	5,470	10,813	-200	-906
Myanmar	90	136	90	239	0	-102
Oceania	217	521	13	16	225	526

1. Includes food, feed and other demand.

A 25% Increase in Yield Growth in India

If the current growth rate in chickpea yield were to accelerate by 25% in India, by 2020 chickpea production is likely to increase by 8% in India, 5.5% in Asia and 3% in the world. Chickpea yield in India would be higher by 12% from the baseline projection, reaching close to 2 t ha^{-1}. Under this scenario, chickpea area would however decline by 3% from the baseline scenario. Despite yield and production increases, India would continue to be a net importer but its imports would be less by 54% compared to the baseline scenario. Exports of major exporting countries in Africa, North America and Oceania would decline (Table 10). Global chickpea prices would decline by almost US$ 100 t^{-1} in 2020 compared to the baseline scenario (Figure 29). However, per capita chickpea consumption would increase by 2.5% in India and also in several other countries due to decline in global chickpea prices.

A 25% Decrease in Yield Growth in India

Since India is an important chickpea producing and consuming country, we tried to look at an additional scenario where chickpea yield growth in India would be less by 25% than the base year growth rate. This is definitely not a plausible scenario but will provide an indication of its implication for global chickpea production and trade. Under this scenario, chickpea production in India would decline by 38% in 2020 from the baseline scenario as yield declines by close to 59%. Area under chickpea would however increase by 25% from the baseline scenario, partly compensating for the yield decrease. India would have a net trade deficit of 4.2 million t. The higher import demand from India would trigger area expansion in major chickpea growing regions leading to increase in production there. Much of this increase in production will be used to meet the import demand from India. This is reflected in increase in net trade values for Africa, WANA, North America and Oceania. Per capita consumption would decline in India and also several other countries since global production of chickpea would decrease by 16%. Global chickpea prices would more than double in 2020 compared to the baseline prices.

Increasing Trade Protection Measures in India

Increase in trade protection would have no significant impact on chickpea area, production or yield in India. Imports to India would, however, decline and hence net trade deficit would be less. India would still have a trade deficit of 0.64 million t in 2020. Per capita consumption would decline by 2% while it will increase marginally in a few other Asian countries. This is because world market prices will be lower compared to the baseline scenario.

A 25% Higher Income Growth in India

If per capita income in India were to grow at 25% higher than the baseline growth rate, by 2020 chickpea production in India would increase by 6% compared to the baseline scenario due to the higher demand. The additional chickpea production would come from a combination of area and yield increases. The increase in production, however, will only partially bridge the supply-demand gap; hence imports are slated to increase by 48% in 2020 from the baseline scenario. Net trade deficit would increase to 1.34 million t compared to 0.91 million t in the base year. Exports would increase from WANA and North America and to a lesser extent from Africa and Oceania. World market prices will be higher by US$ 150 t^{-1}.

Table 10. Forecast values for chickpea production, yield, area and net trade under different scenarios.

Region/country	Production		Yield		Area		Net trade	
	Scenario value in 2020 ('000 t)	Change over baseline (%)	Scenario value in 2020 (kg ha^{-1})	Change over baseline (%)	Scenario value in 2020 ('000 ha)	Change over baseline (%)	Scenario value in 2020 ('000 t)	Change over baseline (%)
A 25% increase in yield growth in India								
Africa	1,093.2	-6.5	1,258.2	-2.3	868.8	-4.3	405.5	-20.5
North America	575.6	-6.7	1,770.1	-2.2	325.2	-4.7	294.4	-15.3
Latin America	579.9	-6.9	3,014.3	-2.1	192.4	-4.8	409.1	-10.3
Europe	89.8	-7.1	1,053.1	-1.5	85.2	-5.8	-138.2	-16.1
Asia	13,125	5.4	1,597.9	9.3	8,213.8	-3.5	-1,456.4	15
South Asia	11,833.8	6.9	1,631	10.6	7,255.6	-3.3	-1,694.8	17.7
India	10,708.1	8.2	1,969.6	12.4	5,436.7	-3.8	-418.2	53.8
Southeast Asia	129.6	-4.8	957.3	-1.7	135.4	-3.2	-125.4	-15.3
Oceania	487.7	-6.3	1,890.1	-1.5	258	-4.9	492.7	-6.4
World	15,954.1	3.1	1,604.2	7	9,945.3	-3.7	–	–
A 25% decrease in yield growth in India								
Africa	1,711.8	47	1,450	14.2	1,180.5	28.8	1,189.5	134.9
Northern America	905.9	49	1,996	13.4	453.9	31.5	691.7	102.7
Latin America	962.3	50.6	3,519.2	13.3	273.5	32.9	816.8	72.1
Europe	148.4	53.1	1,151.8	9	128.9	40.5	-7.1	93.8
Asia	8,423.2	-31.3	801.5	-44.1	10,509.4	23	-3,462.5	-99.6
South Asia	6,443.5	-40.9	701.9	-51.5	9,180.7	21.9	-4,520.6	-117.9
India	5,004.6	-48.7	706.4	-58.9	7,085.2	24.9	-4,047.6	-339.1
Southeast Asia	180.8	33	1,069.7	10.4	169.1	20.5	-11.3	89.3
Oceania	768.4	45.7	2,109.3	9	364.3	33.8	776.7	45.7
World	12,924	-15.5	1,000.9	-32.1	12,912.7	24.4	–	–
Increasing trade protection measures in India								
Africa	1,128.1	-3.5	1,272	-1.2	886.9	-2.3	453.9	-11
North America	594.7	-3.6	1,788.3	-1.1	332.5	-2.5	319.1	-8.2
Latin America	599.7	-3.7	3,045.3	-1.1	196.9	-2.6	430.6	-5.5
Europe	92.9	-3.8	1,060.4	-0.8	87.6	-3.1	-129.2	-8.5
Asia	12,394.1	-0.4	1,462.3	0	8,476	-0.4	-1,575.7	8.1
South Asia	11,062.3	-0.1	1,475.7	0.1	7,496.5	-0.1	-1,864.1	9.5
India	9,917.2	0.2	1,751.8	0	5,661.2	0.2	-644.9	28.8
Southeast Asia	132.7	-2.6	965	-0.9	137.5	-1.7	-117.5	-8.1
Oceania	502.9	-3.4	1,903.4	-0.8	264.2	-2.7	508.2	-3.4
World	15,315.2	-1	1,494.7	-0.3	10,246.1	-0.8	–	–

Continued...

Continued...

Region/country	Production: Scenario value in 2020 ('000 t)	Production: Change over baseline (%)	Yield: Scenario value in 2020 (kg ha^{-1})	Yield: Change over baseline (%)	Area: Scenario value in 2020 ('000 ha)	Area: Change over baseline (%)	Net trade: Scenario value in 2020 ('000 t)	Net trade: Change over baseline (%)
A 25% Higher Income Growth in India								
Africa	1,244.4	6.4	1,319.1	2.4	943.3	3.9	608.4	19.4
North America	658	6.6	1,850	2.3	355.7	4.3	397.4	14.3
Latin America	664.3	6.7	3,150.2	2.3	210.9	4.3	499.1	9.5
Europe	103.3	6.9	1,085.2	1.5	95.2	5.3	-104.1	12.6
Asia	13,191.3	6	1,500.8	2.6	8,789.7	3.3	-1,953.8	-14
South Asia	11,726.3	5.9	1,514.4	2.7	7,743.3	3.2	-2,394.2	-16.2
India	10,516.4	6.2	1,795.6	2.5	5,856.6	3.6	-1,342.3	-48.2
Southeast Asia	142.7	4.8	991.2	1.8	144	2.9	-95	12.6
Oceania	553.6	6.3	1,948.1	1.5	284.2	4.7	559.5	6.3
World	16,418	6.1	1,537.1	2.6	10,681	3.4	–	–

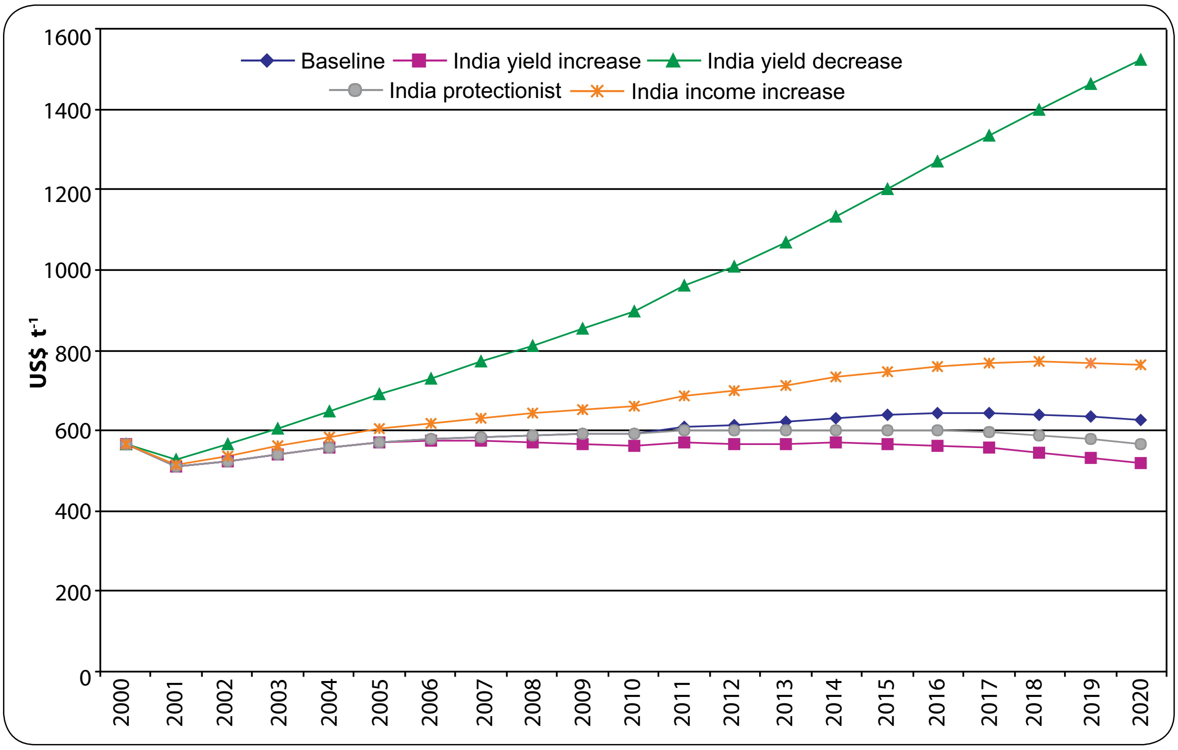


Figure 29. Forecast trends in global chickpea prices under different scenarios, 2000-2020.

Outlook for Pigeonpea

Business-as-usual Scenario

Table 11 shows start and end year values of production, demand and net trade in pigeonpea for Africa and Asia. Given that current levels of yield growth, per capita income growth and demand structures remain the same, Africa is set to increase its exports of pigeonpea as production increases faster than domestic demand. Pigeonpea production in India is also set to increase from 2.6 million t in 2000 to 4 million t in 2020, but the net trade situation is set to worsen due to faster growth in demand. In contrast, the net trade position of Myanmar is set to improve, settling at a trade surplus position. The world price of pigeonpea is set to increase from 2000 to 2020. However, the model indicates that the prices of pigeonpea will grow faster after 2010 (Figure 30), eventually settling at \$610 t^{-1} in 2020 (at 2000 prices).

A 25% Increase in Yield Growth in India

Under this scenario, pigeonpea production in India in 2020 will be greater by 5.3% compared to the baseline production (Table 12). Increase in production will come from yield improvements while area will decline marginally. Increase in production will be reflected in Asia's total production. Owing to a decline in pigeonpea production in Myanmar from business-as-usual value in 2020, world pigeonpea production would be higher by only 2.9% in 2020. This is because Myanmar would cut down on pigeonpea production due to reduced import demand from India. The net trade deficit for India would decline by 12% due to a decline in imports. Pigeonpea exports from Africa and Myanmar would decline, reducing their net trade surplus. Pigeonpea prices would decline by US\$ 60 t^{-1} in 2020 (Figure 30). Per capita food demand would go up in all major consuming countries.

A 25% Increase in Yield Growth in Myanmar

A 25% higher yield growth in Myanmar would lead to a 12.5% increase in pigeonpea production in Myanmar but this will not impact much on production in Asia or the world. Global prices of pigeonpea would decline marginally by US\$ 20 t^{-1}. However, exports from Myanmar would increase with a small increase in imports to India.

A 25% Higher Income Growth in India

Under this scenario, pigeonpea production would increase in all major growing countries in Asia and Africa to meet India's growing demand. Production increase would be driven by a combination of area and yield increases. Imports to India would increase by 16% in 2020 as compared to baseline imports. Africa

Table 11. A business-as-usual scenario for pigeonpea ('000 t).

	Production		Demand[2]		Net trade	
Country/region	2010[1]	2020	2010	2020	2010	2020
Africa	482	841	264	352	155	427
Kenya	117	203	62	62	55	141
Malawi	128	224	97	124	31	100
Uganda	145	254	105	151	41	103
Asia	3,606	4,576	3,692	4,967	-172	-476
India	3,251	4,016	3,484	4,652	-233	-636
Myanmar	329	532	185	282	65	172

1. Production, demand and net trade estimates are reported for the year 2010 as data for 2000 is inaccurate.
2. Includes food, feed and other demand.

and Myanmar would be the main exporters and their net trade balance would be on the rise. Global pigeonpea prices will be at an all time high of US$ 700 t^{-1} in 2020. Per capita pigeonpea consumption in India would be higher by 6% from baseline consumption.

Increasing Trade Protection Measures in India

Under this scenario, there will be a marginal impact on pigeonpea production in India. Production will decline by 5.5% in Africa and 3.3% in Myanmar because under the protectionist policy, imports to India would decline by 16.9%. Consequently, exports from Africa and Myanmar would decline as reflected in their net trade surplus. Per capita consumption would increase in Africa and Myanmar, while it would decline in India.

Since India is a major producer of chickpea and pigeonpea, changes in yield and income growth in India impact production not only

Table 12. Forecast values for pigeonpea production, yield, area and net trade under different scenarios.

	Production		Yield		Area		Net trade	
Region/country	Scenario value in 2020 ('000 t)	Change over baseline (%)	Scenario value in 2020 (kg ha^{-1})	Change over baseline (%)	Scenario value in 2020 ('000 ha)	Change over baseline (%)	Scenario value in 2020 ('000 t)	Change over baseline (%)
A 25% increase in yield growth in India								
Africa	806.1	-4.2	1,039.7	-1.6	775.3	-2.7	374.4	-12.3
Asia	4,776.0	4.4	1,238.6	6.4	3,855.9	-1.9	-419.2	11.9
South Asia	4,257.6	5.3	1,249.7	7.4	3,406.9	-2.0	-567.8	12.3
India	4,229.9	5.3	1,251.5	7.4	3,379.9	-2.0	-554.2	12.9
Southeast Asia	518.5	-2.5	1,154.5	-0.9	449.1	-1.6	148.6	-13.5
World	5,670.2	2.9	1,209.4	5.1	4,688.7	-2.1	–	–
A 25% increase in yield growth in Myanmar								
Africa	834.1	-0.9	1,052.9	-0.3	792.2	-0.5	416.2	-2.5
Asia	4,616.4	0.9	1,178.8	1.3	3,916.2	-0.4	-464.3	2.4
South Asia	4,018.2	-0.6	1,160.9	-0.2	3,461.2	-0.4	-700.5	-8.2
India	3,989.9	-0.6	1,161.9	-0.2	3,433.8	-0.4	-688.5	-8.3
Southeast Asia	598.2	12.5	1,314.6	12.9	455.0	-0.3	236.2	37.5
World	5,541.2	0.6	1,162.4	1.0	4,766.9	-0.4	–	–
A 25% increase in income growth in India								
Africa	888.2	5.6	1,081.6	2.4	821.2	3.1	495.6	16.1
Asia	4,771.4	4.3	1,184.9	1.8	4,026.9	2.4	-549.5	-15.5
South Asia	4,222.0	4.4	1,185.5	1.9	3,561.4	2.5	-749.4	-15.7
India	4,192.4	4.4	1,186.5	1.9	3,533.4	2.5	-740.4	-16.4
Southeast Asia	549.4	3.3	1,180.2	1.3	465.5	2.0	199.8	16.3
World	5,755.1	4.5	1,172.5	1.9	4,908.6	2.5	–	–
Increasing trade protection measures in India								
Africa	795.4	-5.5	1,034.7	-2.0	768.8	-3.5	358.2	-16.1
Asia	4,529.2	-1.0	1,158.9	-0.4	3,908.2	-0.6	-401.8	15.5
South Asia	4,014.8	-0.7	1,159.8	-0.3	3,461.5	-0.4	-543.1	16.1
India	3,987.3	-0.7	1,160.9	-0.3	3,434.7	-0.4	-528.8	16.9
Southeast Asia	514.4	-3.3	1,151.4	-1.1	446.7	-2.2	141.4	-17.7
World	5,411.7	-1.8	1,143.2	-0.7	4,734.0	-1.1	–	–

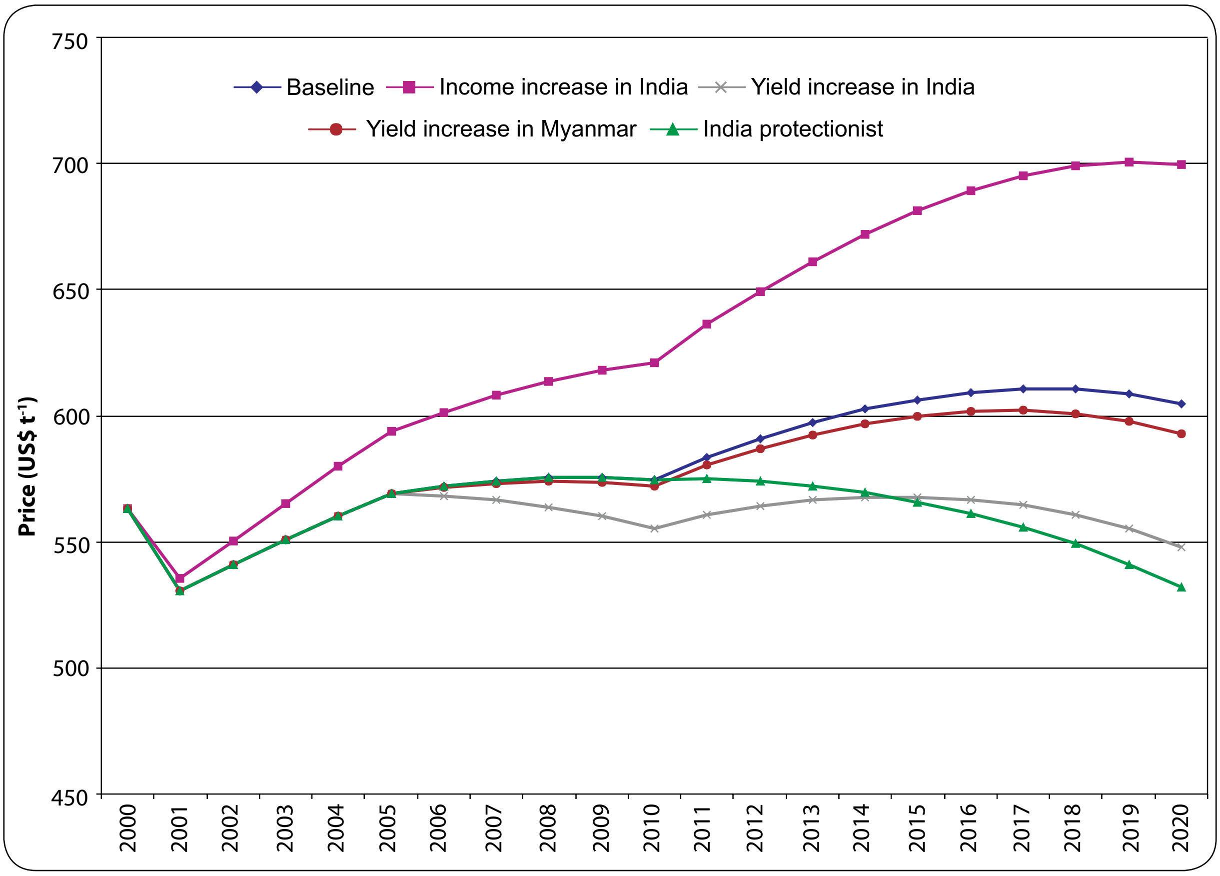


Figure 30. Forecast trends in global pigeonpea prices under different scenarios.

in India or Asia but also globally across main growing regions. Between the two crops, changes in chickpea yield due to improved technology leading to faster growth in yield or increase in demand due to higher income growth are more pronounced for chickpea than for pigeonpea. Policies related to these crops in India would thus have to be keenly observed by countries growing them. The bottom-line is that despite yield increases (25% higher growth rates compared to baseline scenarios), India would continue to be a net importer of both chickpea and pigeonpea. Changes in yield level of chickpea in other South Asian countries and pigeonpea in Myanmar would have a minor regional impact in Asia and not much globally.

6. Conclusions and Implications

Supply-Demand Balance

Demand for pulses in Asia has been growing and this trend will continue well into the future. Domestic production of pulses in major pulse growing countries has been stagnating due to a combination of policy-induced emphasis on production of fine cereals and the prevalence of low-yielding pulses varieties. In Asia, patterns of production and utilization of pulses, chickpea and pigeonpea in particular, are overwhelmingly influenced by India because of its status as a dominant producer and consumer in the region. In 2005-07, India contributed about half to Asia's total pulses production and accounted for 53% of the total demand. India's domination in chickpea and pigeonpea production is even more pronounced; in 2005-07 it accounted for two-thirds of the global and three-fourths of Asia's chickpea production. Likewise, it accounted for over 72% of the global and 81% of Asia's pigeonpea production.

Chickpea and pigeonpea yield levels in Asia have been low, around 760 kg ha^{-1} for chickpea and 749 kg ha^{-1} for pigeonpea in 2005-07, largely owing to their low yields in India – 801 kg ha^{-1} for chickpea and 715 kg ha^{-1} for pigeonpea. Chickpea yields in developed countries are much higher – 1.1 t ha^{-1} in Australia and 1.3 t ha^{-1} in Canada. Pigeonpea yields in Myanmar are higher at 962 kg ha^{-1}.

Trade statistics indicate a demand-supply imbalance for pulses in Asia. While the quantum of pulse exports from Asia increased five-fold between 1981-83 and 2005-07, overall the region remains a net importer, importing 5 million t and exporting 2.5 million t in 2005-07. Moreover, the imports have increased over time, largely due to increasing imports by India and Pakistan. Owing to increased import demand, countries that traditionally did not grow pulses are significant exporters now. For example, Australia and Canada emerged as important exporters of chickpea in the mid-1990s, whereas Myanmar currently dominates the pigeonpea export market.

Demand and supply projections for chickpea and pigeonpea under the business-as-usual scenario for India and Asia corroborate the fact that in the near future, domestic production is unlikely to catch up with growing demand. If current trends in per capita income and production were to continue, by 2020 India's demand for chickpea and pigeonpea would increase to 10 million t and 4.7 million t, respectively, worsening India's net trade situation. Increasing consumption, coupled with stagnant domestic production and open import policies, will further worsen India's net trade deficit. Even in scenarios which posited an increase in yield growth rates in India, the net trade position registers only a very small improvement. Demand for chickpea and pigeonpea is also projected to increase in Africa, although increase in production there would more than offset increase in demand, resulting in Africa becoming a net exporter of both crops.

Overcoming Supply-side Constraints

In India, as in some other Asian countries, the crop growing domains for chickpea as well as pigeonpea are moving from favorable towards marginal environments characterized by low and erratic rainfall, leading to increased uncertainty in their production.

The expanding food and feed demand for pulses suggests that there are considerable opportunities to expand the pulses sector in Asia. This can be harnessed by overcoming supply-side constraints through generation and diffusion of appropriate technologies for different production environments, and appropriate market and trade policies. Developing traits for drought resistance, breeding for shorter duration and other crop management practices need to be emphasized. Investment in water efficient technologies, such as mulching, drip irrigation and so on should also be emphasized, in order to optimally utilize scarce resources.

A majority of the cultivars grown in India are the open pollinated varieties, and farmers frequently use self saved seeds. While the public seed sector has in the past placed less emphasis on multiplication and distribution of pulse seeds, low profit margins and low replacement rates keep away the private seed sector. The public sector, therefore, needs to be more proactive in seed production and distibution. Further, alternative seed systems, such as village seed banks at a local level need to be developed and promoted.

Policy Support

On the policy front, most Asian countries have in the past emphasized on increasing production of rice and wheat for food security, by offering attractive price and input support policies at the expense of coarse cereals, pulses and oilseeds. Prices of pulses were kept depressed through domestic price controls and liberal trade policies in order to protect consumer interests. Further, the lack of trade restrictions implies that the Indian farmer has to compete with cheaper imports from Australia, Canada and Myanmar. This has led to a stagnation in area and production, worsening the pulses trade deficit. Policies to increase competitiveness of pulse crops in India by providing producer subsidies or by strengthening the price support structure would ensure that their cultivation increases. Coupled with low productivity in general, most pulse crops have lost their competitive edge over other crops grown under similar agro-climatic conditions. Hence, to improve production of pulses, there is a need to improve their profitability by promoting high yielding varieties and ensuring competitive prices.

Additionally, recent years have seen wide fluctuations in pulse prices owing mainly to speculative/pre-emptive purchases by state boards in response to anticipated shortfalls in domestic demand. A coherent long-term import policy would enable the prices, both domestic and international, to be more stable while providing adequate imports to meet domestic demand.

Marketing of pulses in Asia, especially India, also serves as a bottleneck in expanding production. The traditional marketing systems with a number of intermediaries, lack of quality grading mechanisms and uneven price transmission continue to dominate the Indian pulse marketing system. Implementation of market reforms is skewed and various price asymmetries exist along the marketing chain. Developing and formalizing institutions which would enable the confluence of farmers, processors and consumers of chickpea and pigeonpea would go a long way in increasing the attractiveness of pulse cultivation.

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Annexures

Annexure 1. Regional production, yield and demand for pulses, 1981-83 to 2005-07.

	Production (million t)		Yield (kg ha^{-1})		Demand (million t)	
Regions	1981-83	2005-07	1981-83	2005-07	1981-83	2005-07
World	**45**	**59**	**707**	**818**	**45**	**55**
Developed countries	11	15	1,147	1,767	–	–
Developing countries	34	44	628	695	–	–

Annexure 2. Global growth rates (%) in production and yield of pulses, cereals and oilseeds, 1981-2007.

	Production			Yield		
Regions	1981-95	1996-2007	1981-2007	1981-95	1996-2007	1981-2007
			Pulses			
World	**1.7**	**1.0**	**0.9**	**1.0**	**0.7**	**0.6**
Developed countries	3.3	-0.8	0.4	3.6	0.1	1.5
Developing countries	1.0	1.7	1.2	0.2	1.1	0.6
			Cereals			
World	**1.3**	**1.1**	**1.2**	**1.5**	**1.3**	**1.5**
Developed countries	-0.2	0.8	0.2	2.0	1.5	1.9
Developing countries	2.4	1.3	1.9	1.5	1.2	1.4
			Oilseeds			
World	**3.9**	**4.4**	**4.1**	**2.2**	**2.4**	**2.3**
Developed countries	2.0	2.7	2.6	1.5	1.3	1.3
Developing countries	4.9	5.2	4.9	2.7	2.9	2.8

Annexure 3. Regional exports and imports of pulses ('000 t).

	Exports		Imports	
Regions	1981-83	2003-05	1981-83	2003-05
World	**3,107**	**9,046**	**3,228**	**9,261**
Developed countries	**1,580**	**5,445**	**1,231**	**3,090**
Developing countries	**1,527**	**3,600**	**1,997**	**6,171**
Africa	171	335	336	1,244
Asia	1,048	2,784	935	3,971
South Asia	25	519	288	2,673
Southeast Asia	334	844	87	234
Europe	608	1,740	1,159	2,712
Latin America	307	481	726	956
North America	891	3,105	52	349
Oceania	80	600	20	29

Annexure 4. Area, production and yield of chickpea in India by district, 2002-04.

State/district	Area ('000 ha)	Yield (kg ha^{-1})	Production ('000 t)
Madhya Pradesh	**2,620**	**870**	**2,279**
Sagar	213	652	140
Vidisha	205	877	180
Guna	191	670	128
Damoh	173	590	102
Narsinghpur	142	910	129
Rajasthan	**868**	**700**	**607**
Ganganagar	188	407	77
Churu	136	351	48
Bikaner	89	815	72
Jhunjhunu	73	878	64
Sikar	60	1,019	61
Maharashtra	**825**	**569**	**469**
Osmanabad	97	392	38
Parbhani	70	514	36
Ahmednagar	59	496	29
Akola	54	574	31
Aurangabad	53	557	30
Uttar Pradesh	791	944	746
Hamirpur	168	807	136
Banda	165	847	140
Jhansi	121	946	115
Jalaun	73	1,113	82
Fatehpur	46	1,131	52
Karnataka	**426**	**460**	**213**
Gulbarga	132	690	91
Dharwad	91	257	23
Bijapur	84	429	36
Belgaum	43	330	14
Raichur	42	348	15

Annexure 5. Regional growth rates (%) in chickpea area, yield and production.

Country/region	Area		Yield		Production	
	1981-95	1996-2007	1981-95	1996-2007	1981-95	1996-2007
World	**0.44**	**-0.89**	**0.75**	**0.55**	**1.19**	**-0.34**
Developed countries	**6.80**	**-1.38**	**2.77**	**2.54**	**9.76**	**1.13**
Europe	-4.65	-4.75	0.64	2.31	-4.04	-2.56
North America	NA	25.43	NA	-0.77	NA	24.46
Oceania	42.40	-5.15	-1.40	2.15	40.41	-3.11
Developing countries	**0.31**	**-0.86**	**0.69**	**0.46**	**1.00**	**-0.41**
Africa	1.08	0.18	-1.17	2.49	-0.10	2.68
Latin America	-2.71	-2.94	3.21	-1.62	0.41	-4.52
Asia	0.33	-0.89	0.73	0.45	1.06	-0.44
East Asia	NA	8.55	NA	3.63	NA	12.48
China	0.00	8.55	0.00	3.63	NA	12.48
South Asia	-0.20	-1.05	0.70	0.27	0.51	-0.78
India	-0.93	-0.96	1.20	0.09	0.27	-0.88
Pakistan	1.00	-0.78	-1.23	1.07	-0.24	0.27

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Country/region	Area 1981-95	Area 1996-2007	Yield 1981-95	Yield 1996-2007	Production 1981-95	Production 1996-2007
Bangladesh	-2.42	-19.32	-0.31	0.54	-2.72	-18.88
Nepal	-5.22	-7.34	0.09	1.90	-5.13	-5.58
Southeast Asia	-2.46	6.06	-3.05	7.36	-5.43	13.86
Myanmar	-2.85	6.06	-3.68	7.36	-6.42	13.86
West Asia	8.05	-0.67	-0.44	0.42	7.57	-0.26
Turkey	7.82	-2.79	-1.01	1.14	6.73	-1.68
Iraq	7.35	11.61	-2.67	-0.03	4.49	11.57
Syrian Arab Republic	0.64	0.47	-0.07	1.39	0.57	1.86
Yemen	NA	-4.86	NA	6.68	NA	1.49
Israel	5.61	1.42	2.22	1.52	7.95	2.96

NA = Data not available for the time period.

Annexure 6. Area, yield and production of pigeonpea in India by district, 2002-04.

State/district	Area ('000 ha)	Yield (kg ha^{-1})	Production ('000 t)
Maharashtra	**1,063**	**668**	**710**
Osmanabad	151	549	83
Yavatmal	128	823	106
Akola	94	808	76
Amravati	94	870	82
Aurangabad	87	441	38
Karnataka	**536**	**454**	**243**
Gulbarga	344	461	159
Bijapur	28	244	7
Raichur	27	270	7
Chitradurga	13	652	9
Andhra Pradesh	**477**	**410**	**196**
Guntur	68	527	36
Mahabubnagar	57	395	23
Kurnool	45	412	18
Adilabad	40	337	14
Anantapur	36	204	7
Uttar Pradesh	**371**	**1,013**	**376**
Mirzapur	28	771	21
Banda	26	1373	36
Aligarh	25	800	20
Allahabad	22	1,420	31
Hamirpur	17	1,077	18
Madhya Pradesh	**315**	**740**	**234**
Sidhi	32	470	15
Betul	23	668	16
Chhindwara	23	1,380	32
Raisen	21	649	14
Narsinghpur	21	1,380	29

Annexure 7. Regional growth rates (%) in pigeonpea area, yield and production.

	Area		Yield		Production	
Country/region	1981-95	1996-2007	1981-95	1996-2007	1981-95	1996-2007
World	**2.01**	**1.32**	**-0.91**	**0.78**	**1.08**	**2.11**
Developing countries	**2.01**	**1.32**	**-0.91**	**0.78**	**1.08**	**2.11**
Africa	4.81	2.10	0.04	1.58	4.86	3.72
Latin America	2.31	-2.50	0.27	1.00	2.59	-1.53
Asia	1.76	1.27	-0.97	0.70	0.78	1.99
South Asia	1.46	0.23	-0.97	0.02	0.48	0.25
India	1.31	0.10	-1.03	0.17	0.26	0.27
Nepal	2.58	-1.96	0.74	1.57	3.34	-0.42
Bangladesh	0.26	0.27	-4.15	2.06	-6.20	0.21
Pakistan	-28.53	NA[1]	2.14	NA	-18.30	NA
Southeast Asia	10.30	11.58	0.46	4.49	10.81	16.58
Myanmar	11.32	9.81	0.39	4.27	11.75	14.49
Philippines	NA	34.24	NA	5.86	NA	42.10

1. Time series data are not available for all countries and regions for the time period under study, either owing to a lack of data in FAOSTAT or because pigeonpea was not produced in the country. As such growth rates cannot be calculated. In these cases, we have used NA to signify this.

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ICRISAT Science with a human face

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.

ICRISAT is headquartered in Hyderabad, Andhra Pradesh, India, with two regional hubs and four country offices in sub-Saharan Africa. It belongs to the Consortium of Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

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ISBN: 978-92-9066-530-4 Order code: BOE 049 98-2010