Food Legumes for Nutritional Security and Sustainable Agriculture

Proceedings of the Fourth International Food Legumes Research Conference

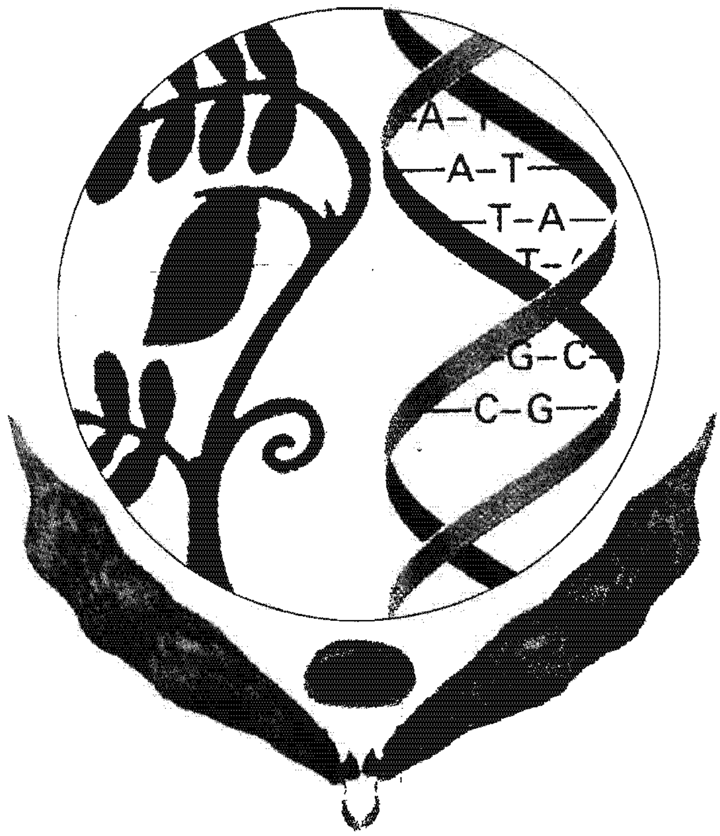
Volume 1

(Invited Papers)

Edited by

M.C. KHARKWAL

Division of Genetics,
Indian Agricultural Research Institute, New Delhi 110 012, India



Indian Society of Genetics and Plant Breeding
New Delhi, India

Food Legumes for Nutritional Security and Sustainable Agriculture

Edited by M. C. Kharkwal

Volume 1

Invited Papers from the Fourth International Food Legumes Research Conference (IFLRC-IV) held at New Delhi, India, October 18-22, 2005.

ISBN 978-81-908995-0-5 (Set)
ISBN 978-81-908995-1-2 (Vol. 1)

Published by The Indian Society of Genetics and Plant Breeding,
P.O. Box 11312, IARI, New Delhi 110 012, India.

Printed in India at M/s. Kamala Print-n-Publish, O 96 New Mahavir Nagar, New Delhi 110 018

Proceedings of the Fourth International Food Legumes Research Conference (IFLRC-IV), October 18–22, 2005, New Delhi, India
M. C. Kharkwal (ed.)

Impact of research and development in food legumes on production and productivity in the last two decades

C. L. L. GOWDA[1*], R. P. S. PUNDIR[1], HARI D. UPADHYAYA[1], M. SEYMOUR[2], MASOOD ALI[3], M. MATIUR RAHMAN[4], X. ZONG[5], S. KHALIL[6], A. M. HAQQANI[7], S. H. SABAGHPOUR[8], AUNG MAYTHAN[9] AND J. K. MLIGO[10]
[1]*International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru 502 324, A.P., India*
[2]*Department of Agriculture, Western Australia (DAWA), Esperance, Australia*
[3]*Indian Institute of Pulses Research, (IIPR), Kanpur 208 024, India*
[4]*Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur 1701, Bangladesh*
[5]*Chinese Academy of Agricultural Sciences (CAAS), Beijing, China*
[6]*Field Crops Research Institute (FCRI), Giza, Egypt*
[7]*National Agricultural Research Centre (NARC), Islamabad, Pakistan*
[8]*Dryland Agricultural Research Institute (DARI), P.O. Box 67145-1, Kermanshah, Iran*
[9]*Central Agricultural Research Institute, (CARI), Yezin, Myanmar*
[10]*International Agricultural Research Institute (IARI), Kilosa, Morogoro, Tanzania*
**Presenting author: c.gowda@cgiar.org*

Abstract

Food legumes include a suite of legume crops grown for human consumption. These include: chickpea (*Cicer arietinum* L.), lentil (*Lens culinaris* Mediks), faba bean (*Vicia faba*), dry bean (*Phaseolus vulgaris* L.), pea (*Pisum sativum* L.), pigeonpea (*Cajanus cajan* L.), cowpea (*Vigna unguiculata* L.), mungbean (*Vigna radiata*) and blackgram (*Vigna mungo* L.). In addition, there are more than a dozen minor food legumes cultivated in many countries, to meet the local preferences for specialty foods, snacks, etc. For all food legumes together, the global trend from 1985-2004 indicated 7.73% increase in area, 20.12% increase in production and 11.49% increase in productivity. The demand for food legumes has doubled in the last quarter century, mostly due to increased population, especially in many developing

M. C. Kharkwal (ed.), Food Legumes for Nutritional Security and Sustainable Agriculture, Vol. 1: 54–71. © 2008 Indian Society of Genetics and Plant Breeding. Printed in India.

countries where the poor people cannot afford buy meat or poultry to meet the protein needs in the daily diets. A study of the area, production and productivity of food legumes in the selected countries (both developed and developing) indicates a mixed trend in terms of increased production of legumes globally. However, the trend is not consistent across countries. Area has drastically reduced in some countries, while in others there are signs of increase in area. Productivity (yield per ha) of food legumes in general has shown an increasing trend over the last two decades. The impact of research and development (R&D) on production and productivity of food legumes in context of regional and global trade is discussed and suggestions have been made for the future R&D efforts to increase the global production.

Introduction

Food legumes play an important role in human nutrition, particularly among the vegetarian population. They are also becoming important as animal feed in developed countries. However, per capita consumption of the food legumes has declined by 6% since 1980-82 in developing countries (Gowda *et al.*, 2000). World human population, which was 5.5 billion in 1994, is likely to be doubled by 2050 (Swaminathan, 1995) that mandates increased production of food legumes. As an integral part of the farming systems food legumes, in rotation with cereals and tuber crops, assist in maintaining soil fertility and the sustainability of production systems (Rego *et al.*, 1996). Owing to higher prices in comparison with cereals, food legumes are increasingly being grown to supplement farmers' incomes. The major food legumes grown worldwide are: dry bean (*Phaseolus vulgaris*), faba bean (*Vicia faba*), pea (*Pisum sativum*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), pigeonpea (*Cajanus cajan*), mungbean (*Vigna radiata*), cowpea (*Vigna unguiculata*), blackgram (*Vigna mungo*), grasspea (*Lathyrus sativus*) and lupins (*Lupinus* spp.). Soybean (*Glycine max*) and groundnut (*Arachis hypogaea*), although classified as oil seeds, also contribute to protein nutrition of human beings and livestock. The trend of area, production and productivity of all food legumes in the world during the last two decades has not shown significant changes (Fig. 1).

Food legume crops have received lesser research attention as compared to the cereal crops. Globally, there are number of institutes that are solely dedicated to single cereal crops, but none on any single food legume crop. Worldwide, food legumes were grown on 68.6 m ha in triennium 2000-02, which reflected a 'mean compound growth rate' of 0.4% (1980-2001). However, the growth rate was higher for production (1.1%) and productivity (0.7%) for the same period, revealing that the research and development (R&D) has definitely made genuine positive impact on yield levels of food legumes (Table 1).

Globally, the R&D impact was more distinct on the productivity of pea followed by lupins, lentil and faba bean. The impact of R&D on pigeonpea was in fact marginally negative (Table 1). In this paper we examine the impact of R&D on area, production and productivity of food legumes in selected countries, as case studies.

Table 1. Mean compound growth rate in area (A), production (B) and yield (Y) of pulses (1980-2001) by region

Crops		Asia[1] (Former)	Africa	Asia[2]	North & Central America	Oceania	South America	World
Beans, dry	A	–0.3	1.9	–0.2	0.7	7.6	–1.2	–0.2
	P	0.4	1.4	–0.3	1.2	10.7	1.2	0.7
	Y	0.7	–0.5	–0.1	0.5	2.9	2.4	1.0
Faba beans, dry	A	–3.7	0.2	2.5	–3.1	13.7	–3.6	–2.3
	P	–2.1	0.5	2.9	–3.7	19.2	0.1	–1.0
	Y	1.7	0.3	0.5	–0.6	4.8	3.8	1.3
Peas, dry	A	–1.3	0.6	2.3	12.5	7.5	–3.6	–1.7
	P	–1.7	–0.1	2.3	13.4	5.4	–1.6	0.6
	Y	–0.5	–0.7	0.0	0.9	–1.9	2.1	2.3
Chickpea	A	0.4	1.4	–0.1	3.3		–8.9	0.6
	P	1.5	1.3	0.5	5.1		–5.4	1.8
	Y	1.1	–0.2	0.6	1.8		3.9	1.2
Cowpea, dry	A	3.4	6.6	11.0	–3.7			6.4
	P	3.7	7.2	12.4	–1.0			6.9
	Y	0.3	0.5	1.3	2.8			0.4
Pigeonpea	A	1.4	3.9	0.3	–0.6		–4.8	1.6
	P	1.1	4.1	1.5	–0.9		–3.2	1.3
	Y	–0.3	0.1	1.1	–0.3		1.7	–0.3
Lentil	A	2.0	0.2	0.3	9.1		–7.7	2.4
	P	2.7	–0.1	–0.4	10.7		–4.8	3.7
	Y	0.7	–0.3	–0.7	1.5		3.1	1.3
Lupins	A	1.8	1.7	–1.4		9.6	6.4	4.1
	P	9.2	3.1	–0.4		11.3	6.2	6.4
	Y	7.3	1.4	1.0		1.5	–0.2	2.2
Pulses (not specified)	A	–1.7	–0.2	–3.6	9.8	2.5	6.2	–1.2
	P	1.0	0.1	2.1	15.3	3.9	8.4	0.9
	Y	2.8	0.3	5.9	5.0	1.4	2.1	2.1
All pulses	A	–0.1	3.5	–0.1	2.5	10.3	–1.4	0.4
	P	0.5	2.7	0.7	4.3	10.7	1.0	1.1
	Y	0.6	–0.8	0.9	1.8	0.4	2.4	0.7

[1]Asian countries before CIS formation; [2]Post CIS Asian Countries

Australia

Lupins: Lupins are dominant grain legume crops in Australia. Three species of lupins are grown in Australia: narrow-leafed lupin (*Lupinus anugustifolius*), albus lupin (*Lupinus albus*) and yellow lupin (*Lupinus luteus*). Narrow-leafed lupin is particularly well suited to acid, coarse textured soils; *albus* to neutral pH, fine textured soils; and yellow lupin has a niche on coarse textured acidic soils with elevated levels of aluminium – known as Wodgil soils.

Historically and currently, narrow-leafed lupin grown in western Australia has dominated the lupin industry, producing greater than 80% of Australia's lupins. The success of lupin in western Australia is a model for development of other crops – from the

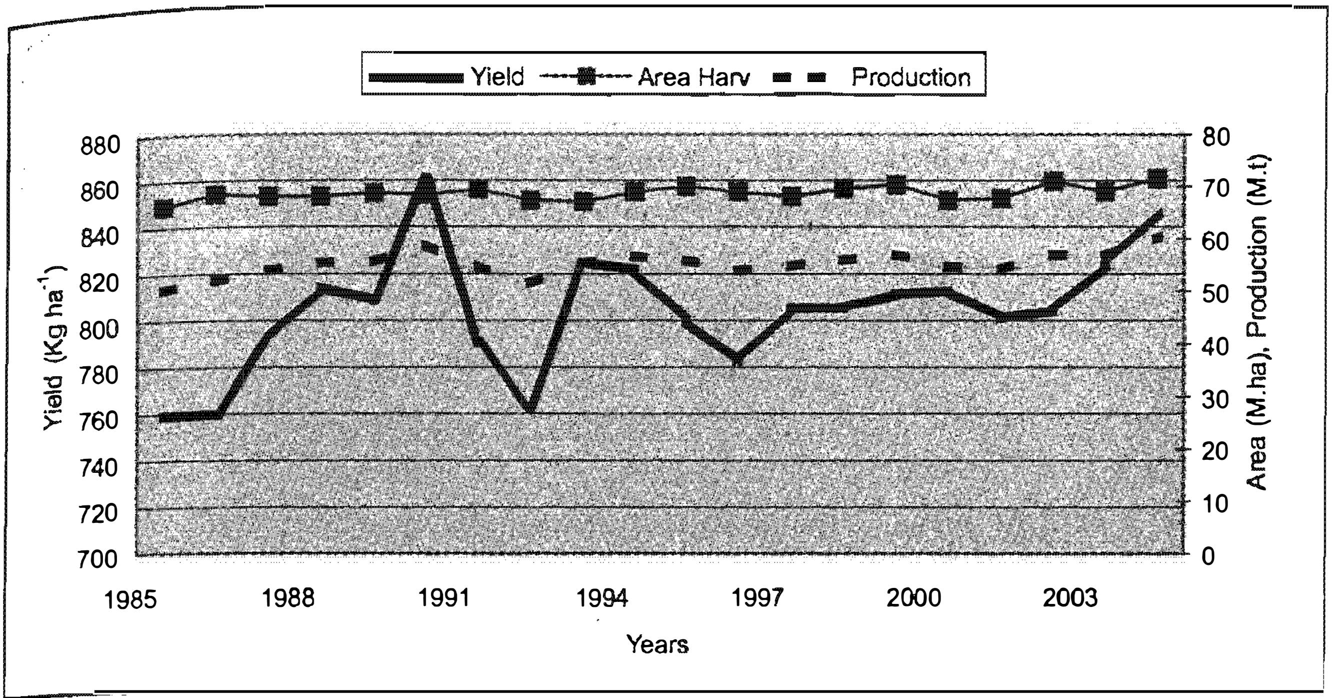


Fig. 1. Area, production and productivbity of all food legumes, worldwide, 1984-2004

domestication of a wild species, through to an extensive and intensive research and development effort on agronomy, pathology, end uses, and marketing, supported by growers and the government over a long timeframe of more than 30 years (Fig. 2). The general increase in yield since 1980 can be equally attributed to both improved varieties and management techniques including the ability of farmers to sow large areas in a short period of time at the beginning of the growing season. In recent years, the area sown to lupins has decreased substantially, from a peak of 1.42 m ha in 1997 to 0.6 m ha in 2004. The decline has been attributed to many factors including: a series of years with lower than average rainfall and delayed starts to the sowing season, reducing sowing opportunities.

In response to the declining production, research institutions and the wider industry are attempting to produce management packages and varieties to tackle the agronomic issues, and to develop higher value end-uses for the grain. Notable initiatives in variety and

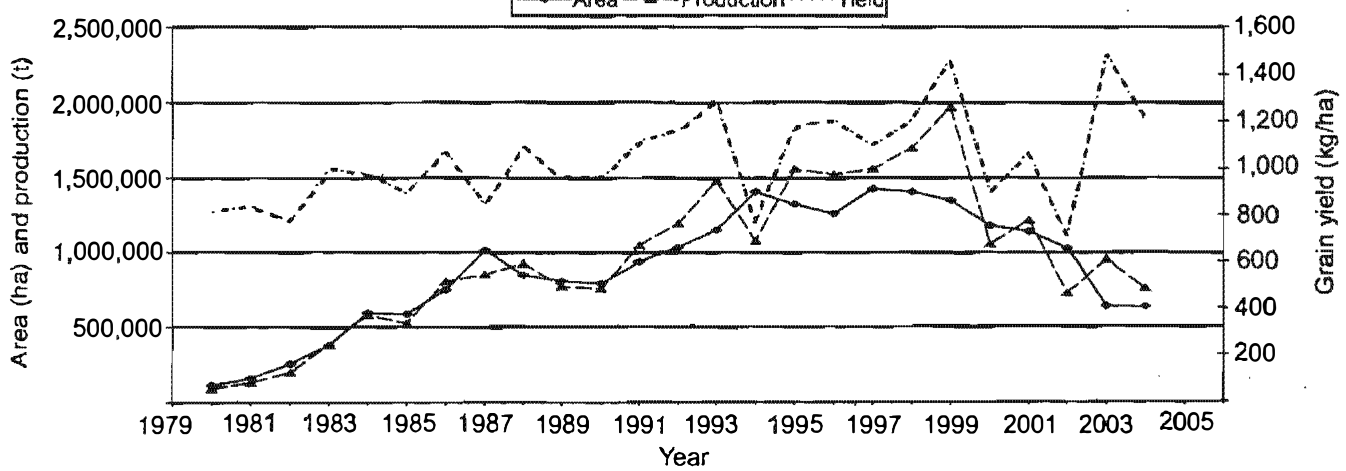


Fig. 2. Lupins area production and productvity in Australia,1980-2004

agronomic development are: breeding and selecting for early-maturing varieties which are less affected by short seasons and allow for non-selective herbicides to be used; increased tolerance to metribuzin which remains an effective herbicide for wild radish control; wide row spacing (>30 cm) to allow for drought proofing in dry environments and shielded spraying using non-selective herbicides to control weeds; continuing the breeding for increased yield and disease resistance, and possibly changes to protein levels and qualities.

Field Pea: Australian production increased during the 1980's as a result of down turns in the wool and wheat markets, and remained over 300,000 ha throughout the 1990's. Since 1994, there has been a declining trend in field pea area in Australia (Fig. 3), attributed to an increasing black spot disease due to close rotations, increase in the area sown to cereals and oilseeds, and a shift to higher value pulse crops (lentil and chickpea) in the favourable regions (e.g. Victorian Wimmera, South Australian Yorke Peninsula and mid-North).

Historically, the Australian field pea industry has been based on varieties with trailing habit, which have broad adaptation to a range of soils and environments, but lodge prior to harvest. Until recently semi-leafless varieties commonly grown in Europe and Canada have performed poorly in Australia. However, semi-leafless varieties with good adaptation to medium and high rainfall zones, and potential for improved harvestability have rekindled interest in field peas. Indications are that the area sown to field pea may increase by 150-250,000 ha by 2006, with most of the increase coming from Western Australia.

Yield and production fluctuations between years are mostly the result of seasonal conditions and the shift in production from field pea to lentil, faba bean, cereals and oilseeds in favourable regions resulting in a greater proportion of the field crops being sown in drier inland areas. Over the last two decades, the field pea yield has had a slight decline, as the area expanded into lower rainfall inland regions and black spot disease limited yield in the medium and high rainfall areas as the level of disease inoculum increased.

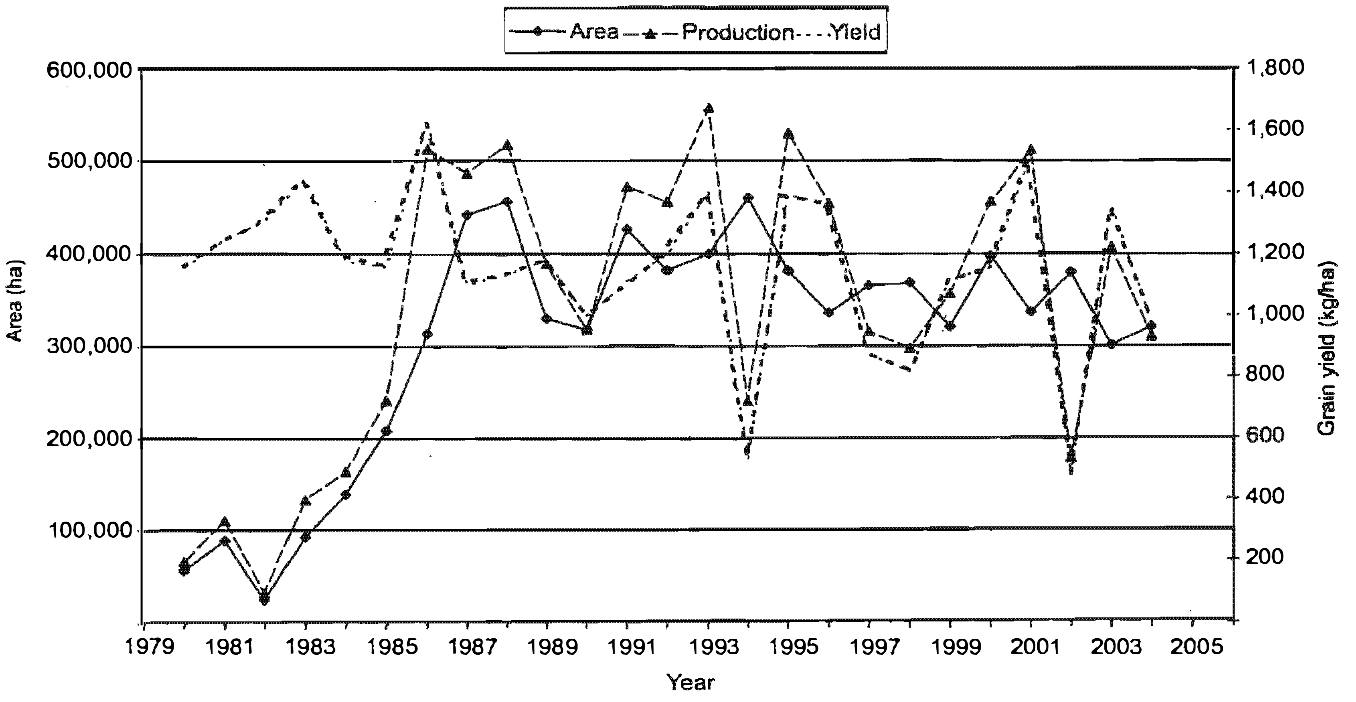


Fig. 3. Field pea area, production and productivity in Australia, 1980-2004

Lentil: Lentil production in Australia has been centred on the Wimmera region of Victoria, which often produces >90% of Australia's lentil crop. The area sown to lentil in Australia continually increased to 165,000 ha in 2002, as result of the release of improved cultivars more suited to Australian conditions and strong agronomic and industry support from both the government and private organizations (Fig. 4). To achieve the target of 430,000 ha by 2010, improvements need to be made in many crop characteristics including improved early vigour, resistance to ascochyta and botrytis diseases, higher plant height and reduced lodging.

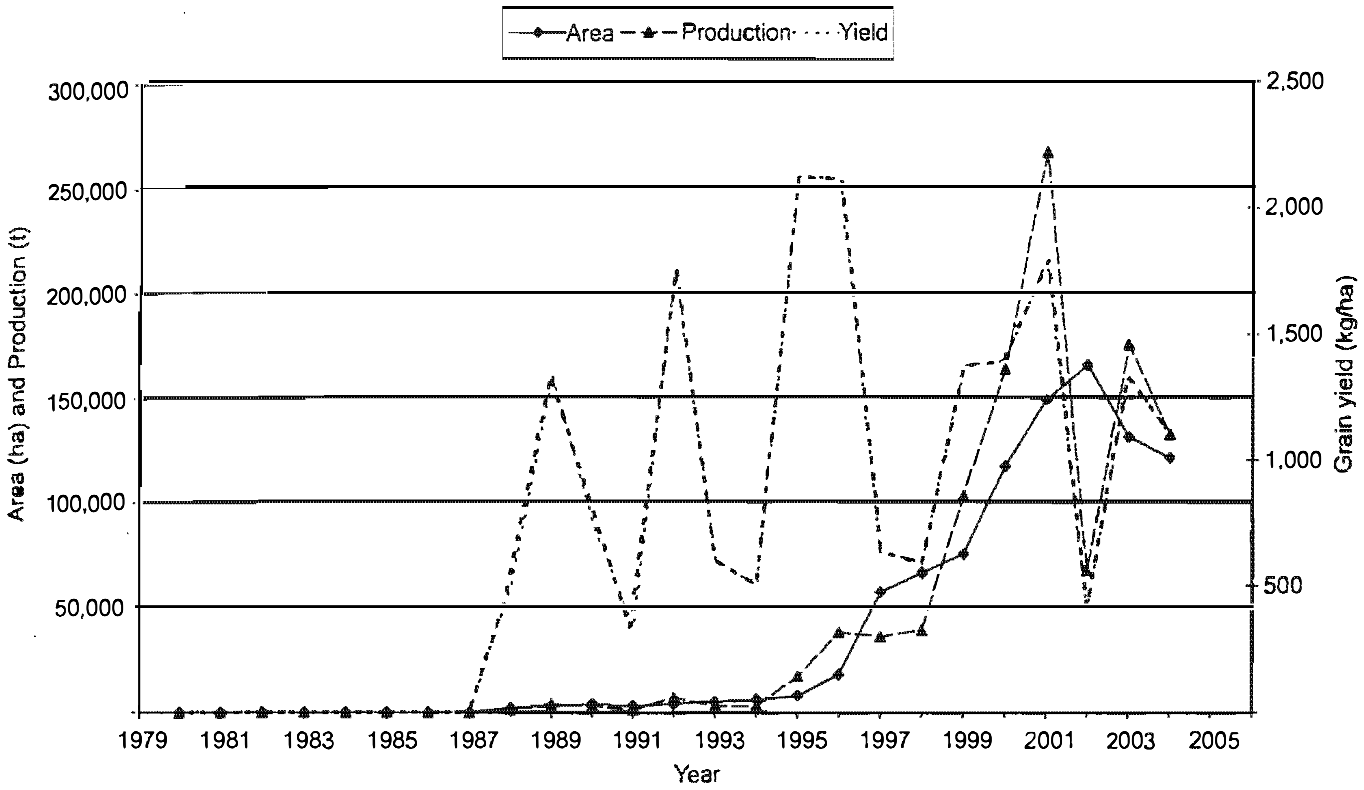


Fig. 4. Lentils area, production and productivity in Australia, 1980-2004

Experience has shown that the yield of lentil fluctuates widely from year to year. Years with low yield (< 650 kg ha^{-1}) can be attributed to dry conditions (1993, 94, 98 and 2002); and waterlogging (in 1991) or wet conditions at podding (in 1997) resulting in botrytis infection, lodging and pod loss. As the area has expanded, the fluctuations in yield have normalised somewhat to the range of 0.5-1.5 t ha^{-1}. Lentil remains a profitable crop at 0.5 t ha^{-1} yield.

Faba Bean: The area sown to faba bean in Australia has had a general upward trend since 1980, with a current area of 202,000 ha (Fig. 5). The main areas of production have been the southern states of South Australia and Victoria. The increase in area sown to faba beans is due to the confidence of growers in controlling chocolate spot (*Botrytis fabae*) and ascochyta (*Ascochyta fabae*) as a result of improved varietal resistance and better management practices. In addition, faba beans are now most commonly grown in higher rainfall regions and are less exposed to drought than some of the more widely grown grain legume crops.

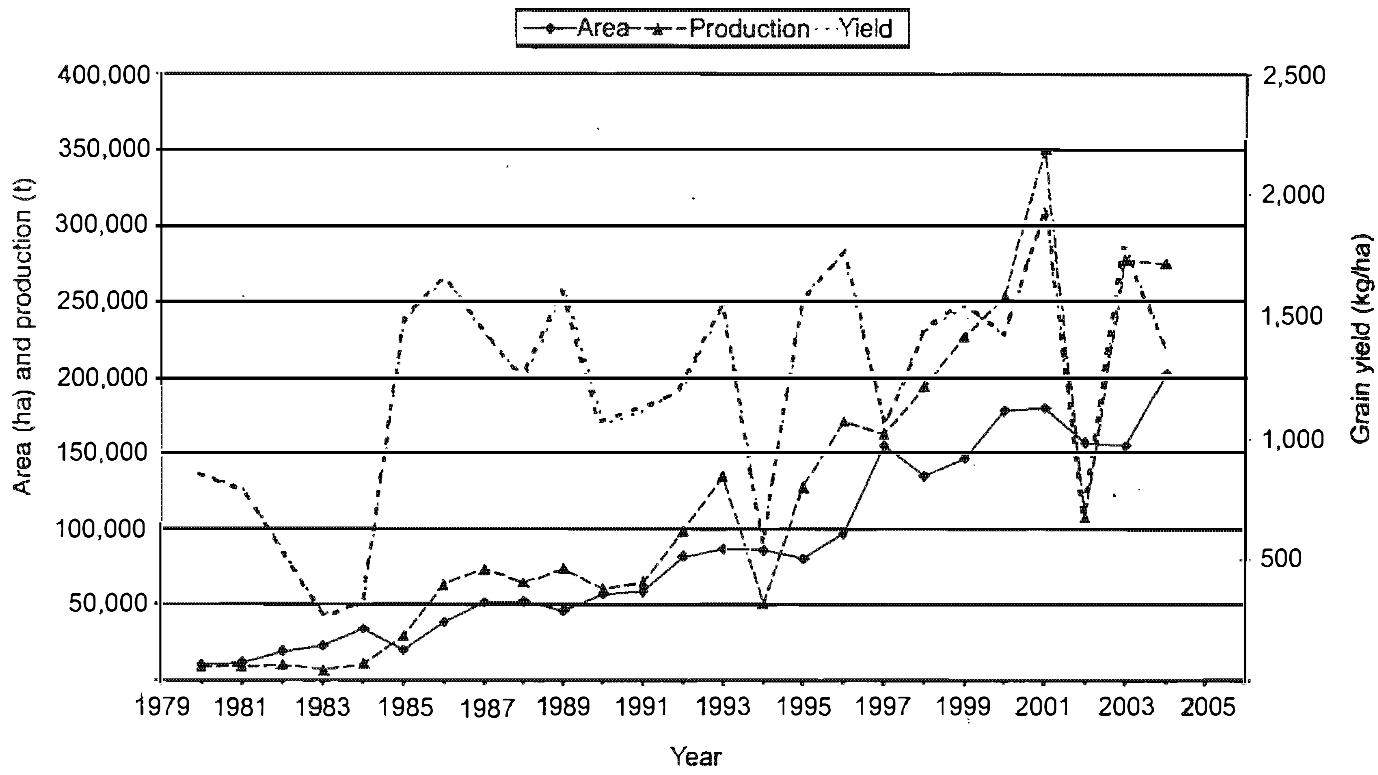


Fig 5. Faba bean area, production and productivity in Australia, 1980-2004

Fluctuations in yield from year to year mostly reflect the occurrence of very dry years. Since 1993, average yield has been slowly increasing, attributed to a greater proportion of the crop being produced in the reliable rainfall regions in Victoria and South Australia; an increase in the ability of farmers to sow their crop quickly at the beginning of the season, and a reduction in the incidence and severity of foliar diseases (*Botrytis fabae*, *Ascochyta fabae* and *Uromyces vicia-fabae*) due to improved varietal resistance and more timely applications of fungicide.

Chickpea: The area sown to chickpea in Australia had a general increasing trend until 1998. The arrival of ascochyta blight (*Ascochyta rabiei*) in the late 1990's led to a substantial reduction in the crop to areas where ascochyta was not as prevalent (northern NSW and southern Queensland) or where the costs of fungicides could be justified due to reliable yields (Wimmera and mid north of South Australia). In other regions such as Western Australia, chickpea has virtually disappeared.

During 1998-2002 production mirrored yield, and since 2002 production has mirrored the declining area sown to chickpeas. Variability in yield in a long season crop such as chickpea is to be expected, however its good tolerance to drought conditions and farmers choosing their better soil types for the crop has seen the average yield of chickpea over the 25 years around 0.9 t ha^{-1}, and median 1 t ha^{-1} (Fig. 6). If farmers did not have to spray fungicides these would be quite profitable yield levels. An active breeding program throughout Australia has led to marked improvements in ascochyta resistance, and the industry is set for resurgence in the near future.

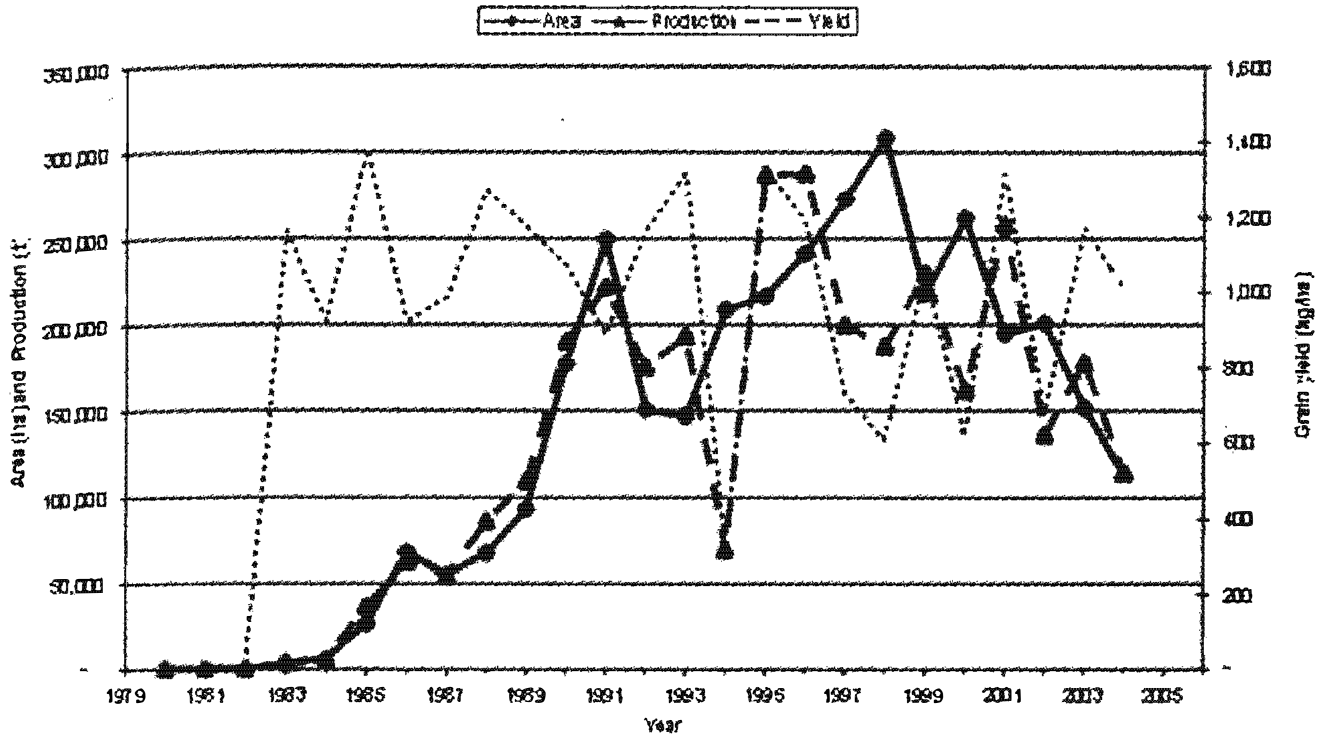


Fig. 6. Chickpea area, production and productivity in Australia, 1980-2004

Bangladesh

Food legumes area and production have reduced drastically in 2003/04 compared to 1983/84. The area has reduced from 729,000 ha in 1983/84 to 448,000 ha and production from 527,000 to 344,000 tones during the same period. The main reasons behind the decline of food legume production are excess humidity and fog during flowering period (February), and incidence of diseases and insect-pests due to excess humidity and rains.

Chickpea: Chickpea area and production have shown drastic reduction over the years (1983/84: 113,000 ha and 87,000 t; 2004/05: 17,000 ha and 16,000 t). However the yield remained almost unchanged (Fig. 7). The drastic reduction occurred due to botrytis gray mold (BGM) disease and damage due to pod borer, *Helicoverpa armigera* (Rahman 2000). Farmers in the traditional area have almost given up chickpea cultivation and the gap has been filled by boro rice (winter rice). On the other hand, the western part of Bangladesh called Barind area is relatively dry and less humid and chickpea has shifted to that area. Chickpea area in Barind has increased from about 2000 ha in 1983/84 to about 10,000 ha in 2002 due to adoption of short duration and wilt resistant varieties. Recently, with the expansion of irrigation facilities in Barind under the 'Barind Multipurpose Development Authority', the scope of expansion of chickpea in that area is becoming limited. However it may be possible to rehabilitate the crop if improved short-duration and BGM resistant varieties could be developed.

Lentil: The average productivity of lentil has increased considerably since 2000. This was primarily due to introduction of improved high-yielding varieties such as BARI Masur-3 and BARI Masur-4 under the 'Pilot Production Program on Lentil, Mungbean and Black gram (1997-2002)'. About 30% area under traditional lentils has been replaced by the modern varieties. The rust and the stemphylium blight are the main yield reducers of lentil in

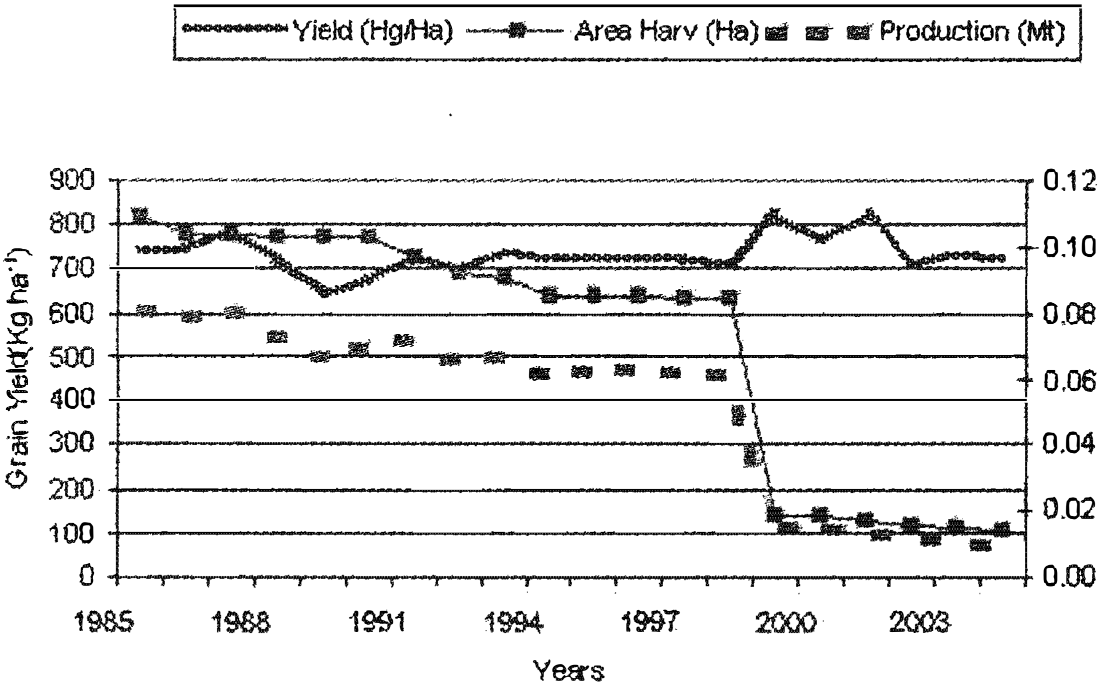


Fig. 7. Chickpea area, production and productivity in Bangladesh, 1985-2004

Bangladesh and currently, the Bangladesh Agricultural Research Institute is developing resistant varieties in collaboration with ICARDA.

Mungbean: Mungbean area continuously declined till 1999-2000, but has now started increasing. The increase in area, production and yield were mainly due to: (i) development of short duration (~60 days), yellow mosaic virus resistant, photo-in sensitive high yielding varieties and (ii) Introduction of these varieties in the summer season after harvest of winter crops when crop competition is much less.

The reduction of winter mungbean has been compensated by summer mungbean crop, catalyzed by the 'Lentil, Mungbean and Blackgram Pilot Project', where seeds of improved varieties, fertilizers and training was given to farmers. During the project period (1997-2002) mungbean area was over 45,000 ha in summer season and 45% area has been replaced by new varieties. Replacement of traditional varieties directly contributed to yield increase.

China

The government of China opened the domestic and international market for food legumes from 1991 and the prices increased considerably. The free market and research on genetic resources and breeding have led to the increase in area, production, and productivity of food legumes during the past 15 years. About 21 food legume crops are cultivated in China, and the most important are: faba bean (1.339 m ha), pea (1.136 m ha), dry bean (1.205 m ha), mungbean (0.7 m ha), adzuki bean (0.3 m ha) and cowpea (0.2 m ha).

The increased market demand and enhanced exports of food legumes have triggered higher market prices, which has resulted in increased public and private support to research and development. This has led to the development of new crop varieties and better cropping management packages leading to wider adoption of the new crops and varieties by the farmers.

An area increase of about 10% annually is witnessed in crops like faba bean, pea, dry bean, and mungbean in the last decade. However, area has shown a declining trend since 2002. Pigeonpea crop is spreading more rapidly. With the new varieties introduced from ICRISAT, the area under this crop has doubled in the last six years. With the adoption of improved varieties and agronomic management, production of food legumes is likely to increase depending on demand from domestic and export market.

Egypt

Faba bean, lentil and chickpea are the main food legumes grown for dry seed for human consumption and animal feed in Egypt and for their role in crop rotation in cereal-based systems.

Faba Bean: Most distinct yield reducers of faba bean in Egypt are chocolate spot, rust (*Uromycis fabae*), faba bean necrotic yellow virus (FBNYV), faba bean yellow mosaic virus (FBYMV) and the broomrape (*Orobanche crenata*). Six varieties (developed jointly by Egyptian national program and ICARDA) with resistance to chocolate spot and rust and having high yield potential were released to the farmers in Nile Delta and northern parts of the newly reclaimed land in the western desert (Khalil *et al.*, 1996). Concurrently, four high-yielding varieties that had resistance to broomrape were developed (Khalil *et al.*, 1994). The improved packages that included integrated control of various diseases and plant parasites has stabilized production of faba bean (Fig. 8).

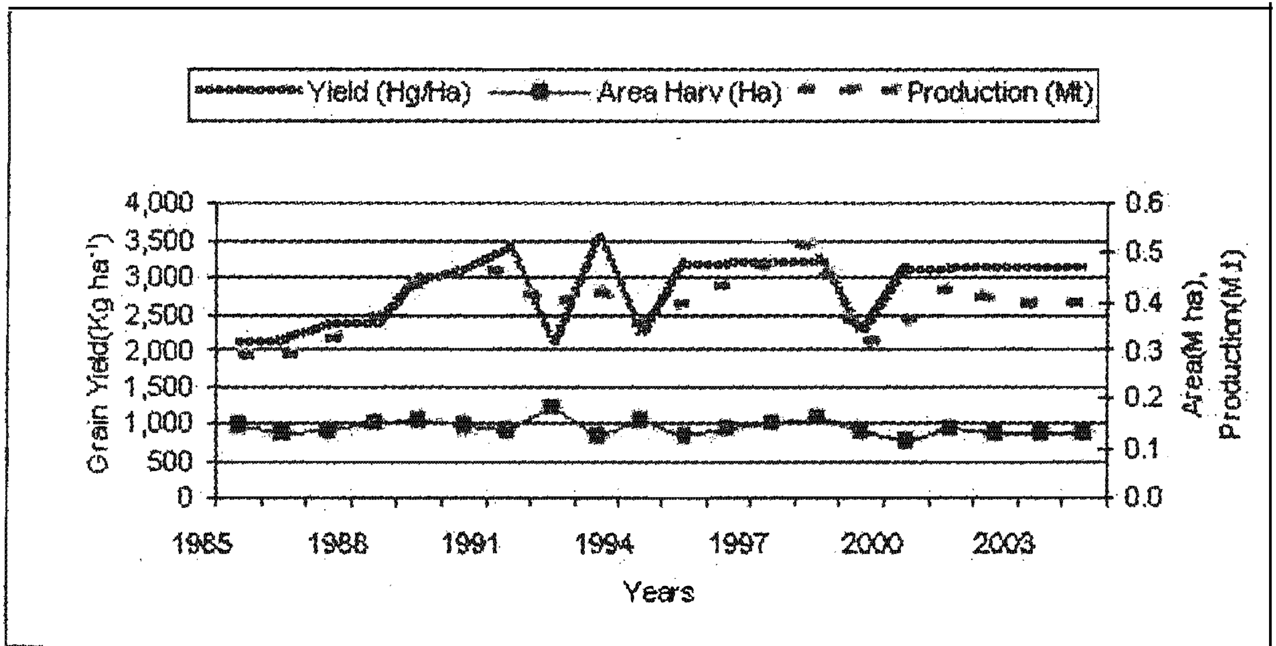


Fig. 8. Faba bean area, production and productivity in Egypt, 1985-2004

Lentil: The improved agronomic package including the improved varieties (Giza 370 in the Nile Delta, Giza 9 in Upper Egypt, under flood irrigation system, and Sinai 1 in North coast of Sinai, under rain-fed condition), chemical control of downy mildew disease, weed control, irrigation, fertilization and recommended seed rate showed that the improved package gives better yield than farmers' practice. The technology is being transferred to the farmers to i crease area, production and productivity. However, low prices of the imported lentil is upsetting morale of the farmers.

India

I the post-green revolution period, expansion of rice and wheat cultivation relegated the food legumes and coarse cereals to marginal lands. Consequently, the area under food legumes has remained almost static at about 22-23 m ha during 1971 to 2000 with a marginal regional shift towards central and southern zones of India, which are characterized by short growing period due to terminal moisture stress and risi g temperature at maturity for most winter legumes. Expa sion of pulses in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan and Tamil Nadu states is the testimony of this phenomena where area under pulses increased from 13.92 m ha in 1971 to 17.27 m ha in 2000; whereas in northern states like Bihar, Haryana, Punjab, Uttar Pradesh, West Bengal and Orissa, area has reduced from 8.03 m ha in 1971 to 5.22 m ha in 2000 (Table 2), giving way to rice in rainy season and wheat in postrainy season.

Table 2. Patten of the shift of area under food legumes within India during the last three decades

Crop	Region[1]	Area (m ha) 1971-75	1996-2000	Gain/loss
Chickpea	AP, GS, KS, MS, MP, OS, RS	3.86	6.03	+2.17
	BS, HS, PB, UP, WB	3.60	1.44	–2.16
Pigeonpea	AP, GS, KS, MS, OS	1.18	2.35	+1.17
	BS, MP, PB, UP, WB	1.53	0.93	-0.60
Mungbean	BS, KS, MS, PB, RS, TN, UP	0.99	1.94	+0.95
	AP, MP, OS, WB	1.08	0.82	-0.26
Urdbean	AP, GS, KS, MS, RS, TN, UP	0.96	2.03	+1.07
	BS, MP, OS, WB	1.36	0.83	-0.53
Lentil	BS, MP, UP, RS	0.65	1.29	+0.64
	WB, MS	0.14	0.06	-0.08
Pea	MP	0.09	0.19	+0.10
	UP	0.56	0.44	-0.12
All food legumes, countrywide		21.95	22.29	0.54

AP = Andhra Pradesh, BS = Bihar, GS = Gujarat, KS = Karnataka, MP = Madhya Pradesh, MS = Maharashtra, PB = Punjab, OS = Orissa, RS = Rajasthan, TN = Tamil Nadu, UP = Uttar Pradesh, WB = West Bengal

Chickpea: I recent years, the area u der chickpea has been reduced to half in northern states owing to cultivation of wheat and rice. However the crop has gained area in southern states. The country's average productivity of the crop has remained nearly constant over the years. However, there is an increasing trend in area and production in southern states, catalyzed by availability of short duration, wilt resistant, and high-yielding varieties (such as ICCC 37, ICCV 10, ICCV 2, KAK 2, Vijay, Vishwas, Phule G 5, Gujarat Gram 2, JG 74 and JG 315), which can escape terminal drought (Fig. 9). The dramatic increase in productivity due to adoption of short-duration varieties is evident in many southern states. For example, the productivity in Andhra Pradesh has increased from < 400 to > 1200 kg ha^{-1} in the past 20 years (Fig. 10). In addition, developments of short-duration *kabuli* varieties such as ICCV 2 and KAK 2 receive increased price in market and have become popular with the farmers because of high profits.

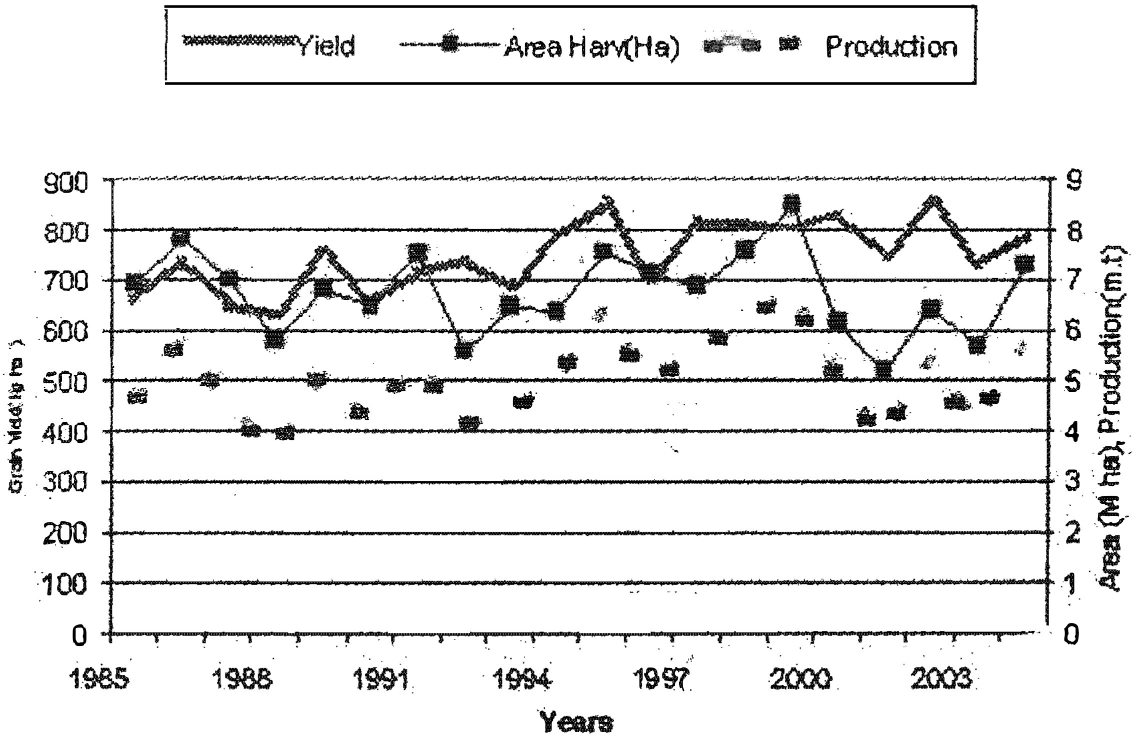


Fig. 9. Chickpea area, production and productivity in India, 1985-2004

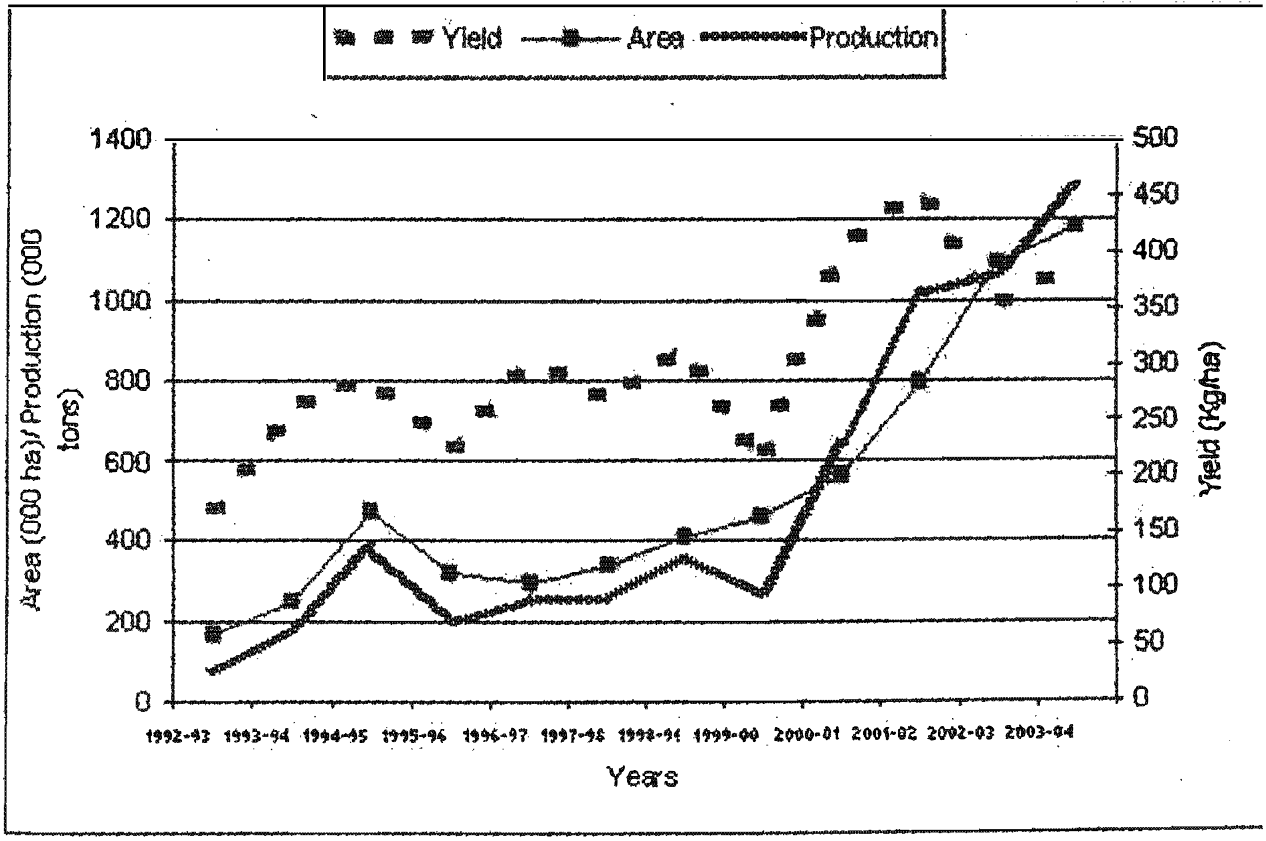


Fig. 10. Chickpea area, production and productivity in Andhra Pradesh, India, 1992-2004

Pigeonpea: Pigeonpea has lost area in northern states owing to the popularity of wheat, rice, and sugarcane. The short duration varieties originally targeted for pigeonpea-wheat rotation in northern states, also found favour in southern states because of certain advantages over the prevalent medium duration cultivars such as ability to escape drought and suitability in the existing cropping systems. The development of wilt and sterility mosaic disease resistant varieties like Maruthi, Asha, BSMR 376 and BSMR 853 have helped in further expansion of the area under pigeonpea in southern states, namely, Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, Orissa and Karnataka. However, the total area under the crop across the country has been static (Fig. 11).

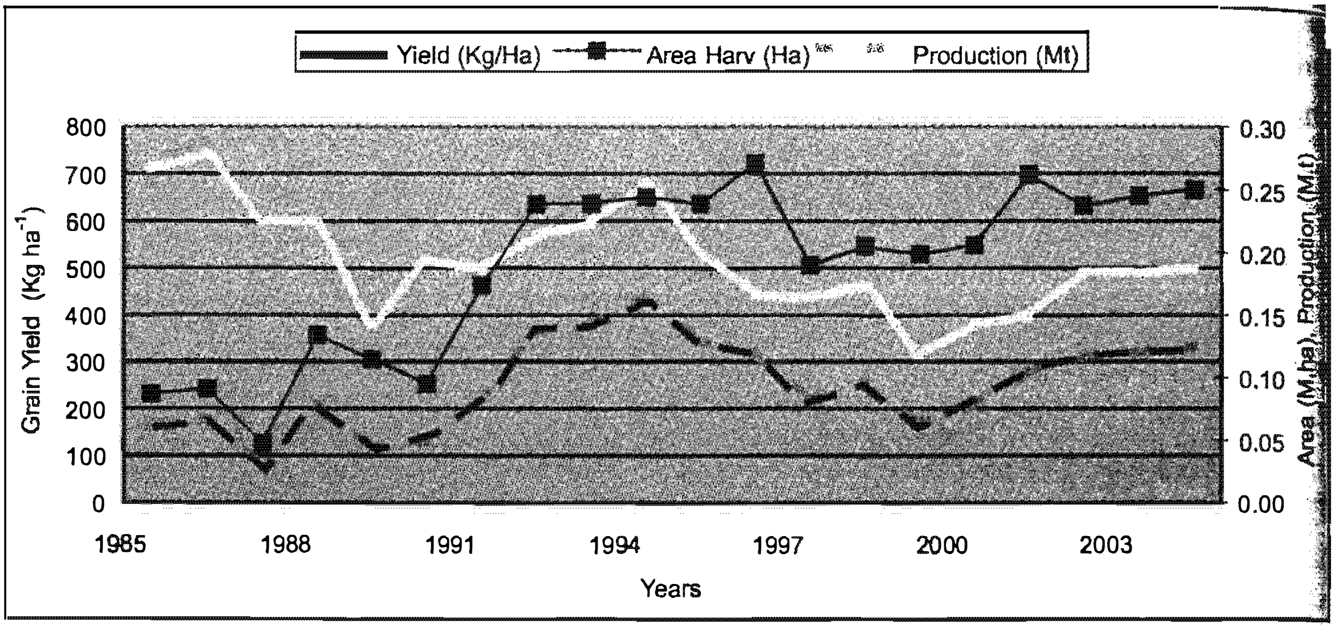


Fig. 11. Pigeonpea area, production and productivity in Andhra Pradesh, India, 1992-2004

Mungbean and Urdbean: Development of short duration varieties with synchronized maturity and resistance to yellow mosaic virus in mungbean (PDM 11, PDM 54, Samrat, Vishal, SML 668, ML 267, HUM 2 and Pant M 2) and urdbean (Pant U 19, Uttara, PDU 1 and UG 218) has paved the way for their introduction as catch crops during spring and summer seasons in a wide range of intensive cropping sequences. These varieties have caught the imagination of farmers and consequently, the area under spring urdbean and mungbean is gaining ground in Indo-Gangetic Plains, particularly in Punjab, Haryana, Rajasthan, Uttar Pradesh, Bihar and West Bengal. Efforts are underway to further reduce the crop duration of mungbean varieties to 50-55 days so as to avoid pre-monsoon showers. LBG 17 is a new, short- duration and powdery mildew resistant urdbean variety and much popular in Andhra Pradesh. Commercialization of this variety in rice fallows of Andhra Pradesh has contributed to area expansion and higher yields from 410 kg ha^{-1} on 0.22 m ha in 1981/82 to 576 kg ha^{-1} on 0.42 m ha in 1999-2000. About 0.5 m ha additional area has been brought under urdbean cultivation in Andhra Pradesh, Karnataka, and Tamil Nadu since 1970-71 (Table 2).

Iran

In Iran, chickpea, lentil, dry bean, mungbean, cowpea and faba bean are the major food legumes that occupied 985,000 ha in 2003, which is 8.2% of the country's cultivated area. Chickpea occupies 66.3% and lentil 23% of the area under food legumes.

Chickpea: Chickpea was cultivated on 653,000 ha in Iran during 2003. Average productivity of the crop is 410 kg ha^{-1}, which is low. Recently two chickpea varieties, namely, Hashem and Arman, having erect growth habit and resistance to ascochyta blight and fusarium wilt have been released. With new varieties and improved cultivation practices including (i) minimum soil tillage to overcome the loss of moisture during land preparation and sowing, (ii) managing a plant population of about 33 plants m^{-2}, and (iii) sowing of spring/summer crop as early as possible to take advantage of available soil moisture, the average farm yields have been increased.

Lentil: The crop was cultivated on 227,000 ha in Iran during 2003. However, the production is not adequate to meet the country's demand. On average, lentil productivity is 468 kg ha^{-1} (Fig. 12), which is low. The low productivity is due to prevalence of local varieties and traditional cultivation practices followed by the farmers. Recently an improved variety, Gachsaran, which has erect growth habit and resistance to ascochyta blight and wilt, has been released. However, the new technologies are yet to be adopted by the farmers. With disease resistant and high yielding varieties and improved agronomic management, yield levels are expected to increase in the near future.

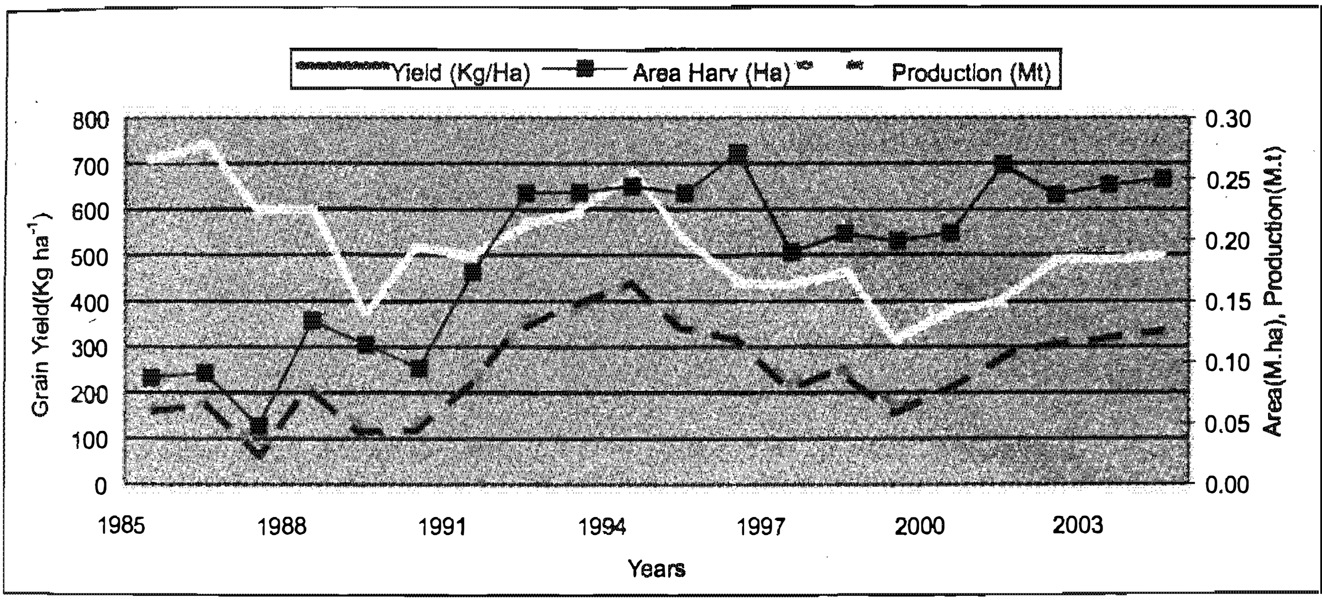


Fig. 12. Lentils area, production and productivity in Iran, 1985-2004

Myanmar

In Myanmar, urdbean, mungbean, chickpea and pigeonpea are most important components of the cropping systems. During 2004, chickpea and pigeonpea were cultivated on 208,000 and 540,000 ha land, respectively. Case studies of chickpea and pigeonpea in Myanmar are given below:

Chickpea: The chickpea area is confined to the central dry zone covering the Sagaing, Mandalay and Magwe divisions. The Myanmar national program and ICRISAT have been working in close collaboration for development and identification of suitable chickpea varieties. As results of this collaboration, Schwe Kyehmon (in 1986), Yezin 3, Yezin 4 (in 2000) and Yezin 5 and Yezin 6 (in 2004) have been released. The present average yield of chickpea in Myanmar (1.1 t ha^{-1}) is about 25% higher than the global average yield, due to adoption of improved varieties (Fig. 13).

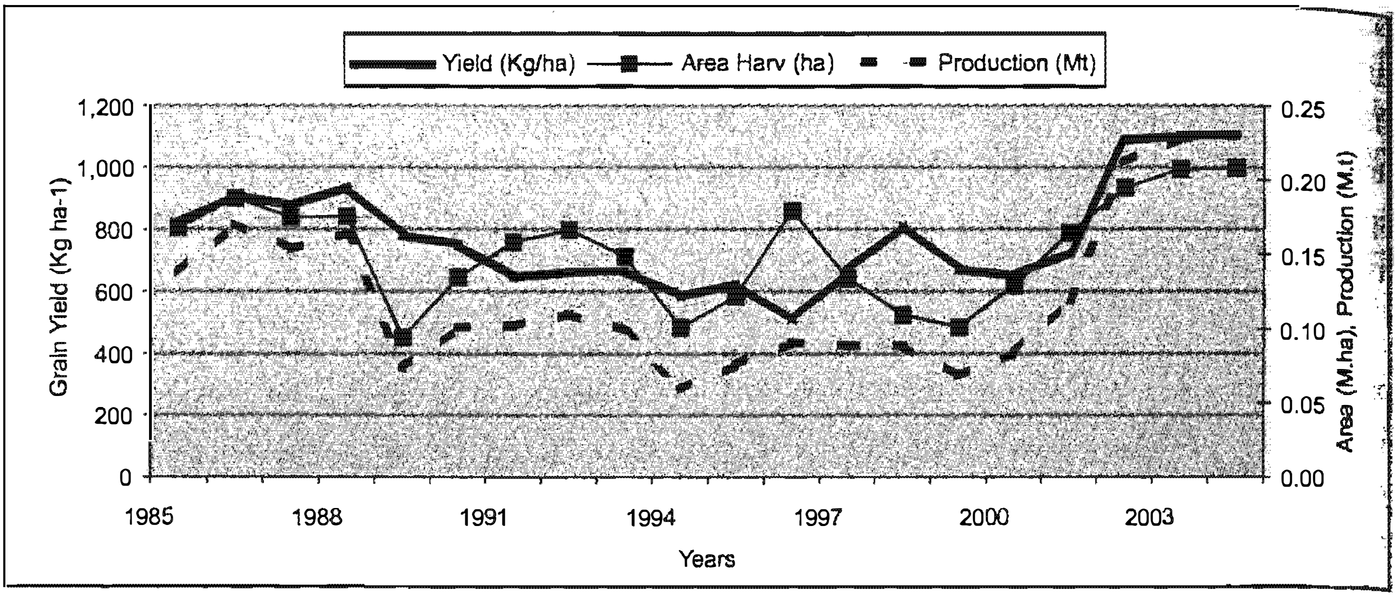


Fig. 13. Chickpea area, production and productivity in Myanmar, 1985-2004

These short duration wilt resistant chickpea varieties, particularly Yezin 3 and Yezin 4, have been a boon to the farmers of Myanmar. Many farmers switched from wheat to chickpea because cultivation of short-duration chickpea varieties was more remunerative than wheat in short growing environments under rainfed conditions. Yezin 3 being a kabuli type fetches higher price than the desi varieties, as it is exported to India. There has been a phenomenonal adoption of this variety in Myanmar during the past four years. During 2002-2003, 60% of the chickpea area in Myanmar was under Yezin 3 and about 10% under Yezin 4. Due to these varieties, the chickpea area has doubled, the production has tripled and the yield has increased by 50% during the past 5 years.

Pigeonpea: Pigeonpea area is increasing in Myanmar very rapidly. Area under the crop has increased from 54,000 ha in 1980-82 to 247,000 ha in 1996-98 with annual compound growth rate (ACGR) of 10.6% (1981-98), which is a spectacular growth compared to 1.6% for the whole world. The yield potential has also increased steadily (ACGR of 0.8%: 1981-98), which too is a spectacular progress compared with ACGR of the whole world (-0.6%) for the same period (Joshi *et al.*, 2001). Most of the increase in pigeonpea production is due to area expansion. However, adoption of short and medium duration, high-yielding varieties has also contributed to the success of pigeonpea in Myanmar (Fig. 14). Higher market prices due to export demand have also resulted in increasing the area and production of food legumes in Myanmar.

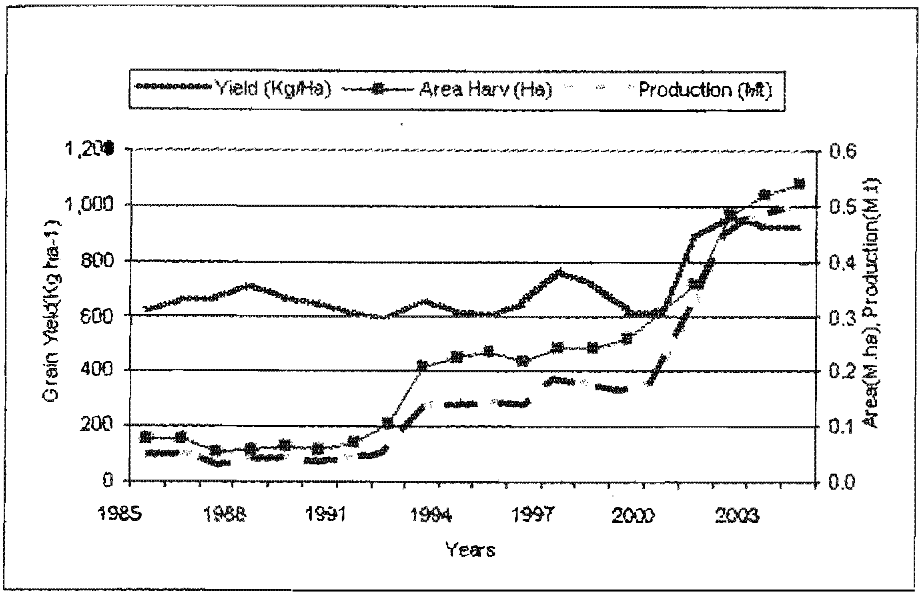


Fig. 14. Pigeonpea area, production and productivity in Myanmar, 1985 to 2004

Pakistan

Chickpea, lentil, mungbean, and urdbean are major food legume crops in Pakistan. Food legumes occupy about 1.5 m ha, however, the productivity is low (0.5 t ha^{-1}). The main reasons for the low productivity are that the government has given all encouragement and support to the R&D of cereals, fiber and sugar crops and very little to the food legumes. The food legumes have been relegated to very marginal conditions.

In 1980, a Cooperative Research Program on Pulses (CRPP) involving four provinces was initiated. A strong linkage was established at the national and international levels to coordinate pulses research in the country. Under the umbrella of CRRP, more than 30 varieties of chickpea, lentil, mungbean, and urdbean were released. Improved production technologies were also developed and being disseminated among the farmers. However, the results have not been as desired (Fig. 15). There has been some breakthrough due to expansion in area

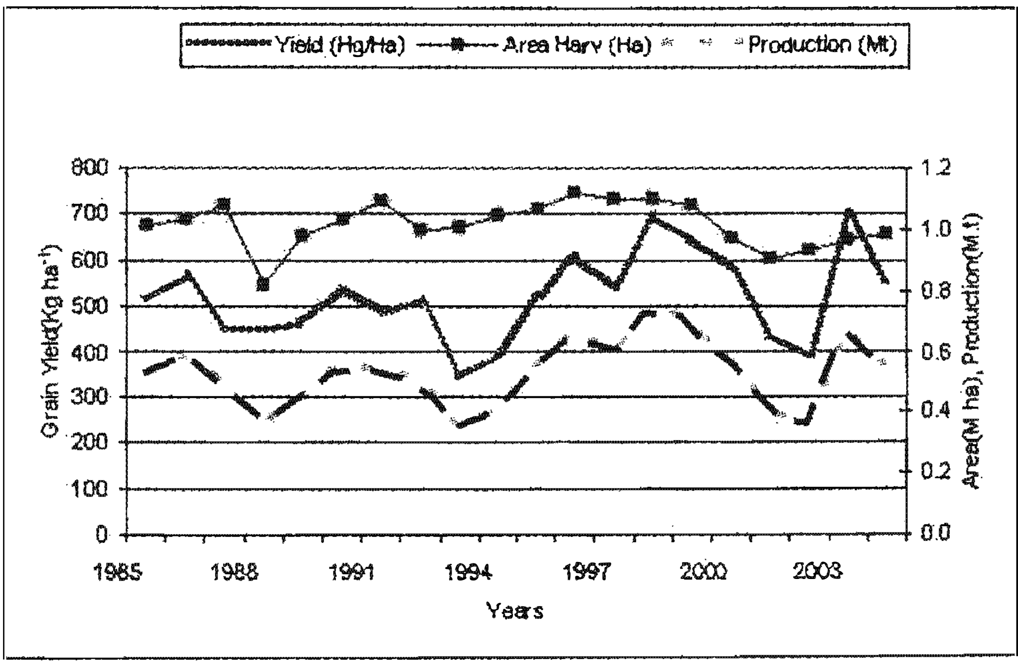


Fig. 15. Chickpea area, production and productivity in Pakistan, 1985-2004

under mungbean. Country is self sufficient in supply of desi chickpea too. For other food legumes, namely, lentil, urdbean and kabuli chickpea, country depends heavily on imports.

There are good prospects of increasing production of food legumes in Pakistan, if farmers adopt improved crop varieties and the management practices. Support price for the crop can also help in stabilizing production. All these could become a reality with genuine interest and support by the scientists, extension workers, policy makers, and the government.

Tanzania

Food legumes crops are the essential components of cropping systems in Tanzania. The main food legume crops of Tanzania are dry bean, cowpea, pigeonpea, mungbean, chickpea and bambara nut. Considering all the food legumes together, the area increased from 502,270 ha (1982) to 641,800 ha (2001) showing a gain of 27%. The gain for productivity was 56.5% (680 to 1064 kg ha^{-1}), and for production 100% (341,930 to 682,951 tones) during the same period. This was largely due to the technical support from international centers, namely, ICRISAT (chickpea and pigeonpea), CIAT (dry bean) and IITA (cowpea). During this period, 14 dry bean, four cowpea, three pigeonpea and two mungbean varieties were released. Adoption of high yielding and wilt resistant pigeonpea varieties has resulted in increased productivity from 620 kg (in 1985) to >720 kg ha^{-1} in 2004. Favorable market prices spurred by the exports have also led to increase in area and production.

Concluding Remarks

There has been marginal increase in production and productivity of food legumes globally in the last two decades. However, spectacular increases in production and productivity have been recorded in several regions in many countries across different continents. Most increases in productivity (yield per hectare) have occurred due to: (i) high yielding varieties with insect-pest and disease resistance, (ii) short duration varieties that avoid terminal drought and match with available crop duration and soil moisture, (iii) better management of weeds, pests and diseases, (iv) improved agronomic management, (v) new farm machinery for efficient sowing and harvest, (vi) improved seed multiplication and supply systems, and (vii) innovative policy support from the government. An increasing world population will create a huge demand for food legumes in the near future. However, the production is not keeping pace with the demand. Several national programs are marginalizing food legumes. in terms of R&D input and the support prices, in comparison to the cereal crops. For enhancing production and productivity as well as for the sustainability of the agricultural systems, it is important that individual countries increase support to R&D, extension and the seed systems in national programs. National governments should increase investments in research and development to avoid costly imports in the future. Funds could also be generated through levies on crop growers, marketing boards, processing industry and export councils, which has been found to be successful in countries such as Australia (Gareau *et al.*, 2000). Developing countries should also collaborate with each other and with regional and international institutes to access information, material, and technology. Regional fora, networks, and R&D consortia will play a critical role in material and technology exchange.

Nevertheless, responsibility also lies with scientists, extension workers, NGOs and the private sector. Scientists have to tailor input responsive and physiologically efficient crop varieties and develop cost-effective production technologies. Governments, NGOs and private sector should establish viable seed systems to ensure supply of quality seed of improved varieties to farmers, even in remote areas. All these could be achieved in phased manner provided the policy makers and the governments extend full support.

References

Gareau, R.M., Muel F. and Lovett, J. 2000. Trends in support for research and development of cool season food legumes in the developed countries. p. 59-66. *In* Knight R. (ed.). Linking Research and Marketing Opportunities for Pulses in the 21st Century. Kluwer Academic Publishers, Dordrecht.

Gowda, C.L.L., Ali, M., Erskine, W., Halila, H., Johansen, C., Kusmenoglu, I., Mahmoud, S.A., Malik, B.A., Meskine, M., Rahman, M.M., Sapkota, R.P. and Zong, X. 2000. Trends in support for research and development of cool season food legumes in the developing countries. p. 47-58. *In* Knight R. (ed.) Linking Research and Marketing Opportunities for Pulses in the 21st Century. Kluwer Academic Publishers, Dordrecht.

Joshi, P.K., Parthasarathy Rao, P., Gowda, C.L.L., Jones, R.B., Silim, S.N., Saxena, K.B. and Jagdish Kumar. 2001. The world chickpea and pigeonpea economies: Facts, trends and outlook. ICRISAT, Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 68 pp.

Khalil, S.A., Saber, H.A., El- Hady, M.M., Amer, M.I., Mahmoud, S.A. and Abou-Zeid, N.M. 1996. Utilization of genetic resources in developing new faba bean (*Vicia faba* L.) cultivars, Pp. 47-54. *In* Wolfgang Bertenbriter & Mohamed Sadiki (ed.), Premier Seminaire du Rseau Marghrebin de recherche sur Feve (Remafeve, Acts Edition, Rabat, Morocco, 24 -27 May 1995, Rabat.

Khalil, S.A., Saber, H.A., El-Sherbeeny, M.H., El-Hady, M.M. and Saleeb, S.R. 1994. Present state of *Orobanche* breeding in Faba bean in Egypt. p. 455-464. *In* Pieterse A.H., Verkleij J.A.C. and ter Borg S.J., (ed.). Biology and Management of *Orobanche*: Proceedings of the Third International Workshop on *Orobanche* and related *Striga* Research. Royal Tropical Institute, Amsterdam, Netherlands.

Rahman, M.M., Baker, M.A., Mia, M.F., Idris, K.M., Gowda, C.L.L., Jagdish Kumar, Deb, U.K., Malek, M.A. and Sobhan, A. 2000. Legumes in Banglades. p. 5-34. *In* Johansen C., Duxbury J.M., Virmani S.M., Gowda C.L.L., Pande S. and Joshi P.K. (ed.). Legumes in rice and wheat cropping system of the Indo-Gangetic Plain-Constraints and opportunities. ICRISAT, India and Cornell University, USA.

Rego, T.J., Nageswara Rao, V. and Kumar Rao, J.V.D.K. 1996. Presented at the Workshop on Residual Effects of Legumes in Rice-Wheat cropping systems of the Indo-Gangetic Plains, 26-28 Aug 1996, ICRISAT Asia Center, Patancheru-502 324, Andhra Pradesh, India.

Swaminathan, M.S. 1995. Issues in Agriculture, No. 7, Washington D.C., U.S.A.: Consultative Group on International Agricultural Research.