Linking Research and Marketing Opportunities for Pulses in the 21st Century

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The Pulse Economy in the Mid-1990s: A Review of Global and Regional Developments

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Abstract

The world pulse economy seems to have stagnated during the first half of the 1990s after going through a contraction during the 1970s caused by the Green Revolution, and an expansion during the 1980s fuelled by changes in the European Community's (EC) Common Agricultural Policies (CAP) which favored production of pulses for feed. In 1996 world production stood at 57 million MT on 70.5 million ha with an average yield of 809 kg/ha. However, recent vast cutbacks by the Commonwealth of Independent States (former USSR) and reductions in EC feed production following the 1992 CAP reforms in 1993 have been offset by a sustained upward trend in Africa and a remarkable expansion in South Asia. Developing countries produce 71% of the world's pulses. India remains the largest pulse producer with 27% of world production.

Trade in pulses has increased to 14% of world production. This encompasses all pulses and regions, suggesting that trade barriers are being reduced. Imports are still concentrated in Europe, while the most important exporters are Canada, France, China, USA, and Myanmar. The latter has emerged as the largest supplier to South Asia, which it shares with inter-seasonal exports from Australia. Two-thirds of all pulses is used for food, mostly in developing countries, while about one quarter is used for feed, mostly in Europe, CIS, and Oceania (Australia). Since 1980-82, per capita food consumption of pulses declined by 6% in developing countries where relative prices of pulses have gone up while consumption of animal protein is increasing. But developed countries increased their food pulse consumption by 2.3%, if from a low base level.

Price data for pulses remain sketchy. In India, the largest consumer, prices have increased relative to other foods, pushing pulse protein out of the average diet. Declining amounts of pulse protein in developing country diets do not necessarily indicate protein deficiencies, but to a paucity of technological progress in production relative to advances in production of animal protein such as milk and poultry, which have brought down the relative prices of these foods. The same observation, coupled with a relatively strong negative price elasticity of demand for pulses, suggests that there is a significant unmet demand for pulses in developing countries which will not be satisfied at prevailing (high) prices.

Yield variability remains a challenge to a constant, abundant supply at low and stable prices. As most of the food pulses are produced and consumed in developing countries, the limitations to higher and more stable yields need to be addressed, and multi-objective frameworks of farm families need to be taken into account when developing improved cultivars and production methods.

The future of the pulse economy depends on social, dietary, economic, environmental, and infrastructural factors some of which are predictable in the process of economic growth while others -- such as government interventions and scientific breakthroughs or competing crops or protein sources -- are highly unpredictable and could rapidly change the supply or demand situation.

1. INTRODUCTION

Much of this paper is concerned with the aggregates of developing vs. developed countries or world regions, fully realizing that such aggregates conceal much[1]. The paper will not discuss in detail specific

[1] There is some overlap between regions and the level of development, i.e., for the purpose of the pulse economy, we can roughly equate North America, Oceania, CIS, and Europe with the developed countries group, while the remaining regions could be roughly subsumed under the developing countries umbrella. The delineations within Asia are:

South Asia: Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka

East Asia: Cambodia, China, Indonesia, Japan, Korea (2), Laos, Mongolia, Myanmar, Philippines, Thailand, Viet Nam

West Asia: Afghanistan, Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Lebanon, Saudi Arabia, Syria, Turkey, Yemen.

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countries or regions as they are considered in the regional reviews in these proceedings. Our analyses help explain facets of existing pulse economies from which predictions can be made for country groups.

We will refer to India, not simply because our research is done there, but because India is the world's largest pulse producing and consuming country representing 27% and 35% of world production[2], and consumption in 1996. India is also home to more than one-third of the world's poor and is predicted to replace China as the world's most populous nation by the middle of next century (World Bank, 1997).

We first review two similar papers presented at the first and second IFLRC. Next, we present current data from FAO (1997) to summarize developments in production, consumption, and trade. We use the periods 1980-82 to 1989-91 to 1994-96 (or 1993-95, depending on availability of data) for a medium- and short-term analysis. This was necessary to analyse more recent developments as they deviate from the developments in the 1980s. 1989-91 was the final triennium in the analysis of Oram and Agcaoili (1994). This paper also includes a few observations on pulse prices, but no price analyses.

The main part of the discussion revisits issues raised by Agostini and Khan (1988) and Oram and Agcaoili (1994): the protein deficits in the diets of people in developing countries, the supply constraint to pulse markets, and the problem of yield variability.

We felt it necessary to include warm season pulses, particularly pigeonpea *(Cajanus cajan)* and cowpea *(Vigna sinensis, Dolichos sinensis)*, even though the data for them are not as good as for chickpea *(Cicer arietinum)*, dry beans *(Phaseolus spp.)*, dry peas *(Pisum sativum, P. arvense)*, and lentils *(Lens esculenta, Ervum lens)*. As it turns out cowpea has been a star performer, steadily gaining ground in Africa.

At the first conference, Agostini and Khan (1988) reviewed the world grain legume scenario of the 1970s and early 80s when it was coming out of a contraction due to the rapid expansion of cereals. By 1992, when Oram delivered his address at the second conference, the world market had seen the entrance of new players: the EEC producing dry peas for feed to replace soybeans, Turkey exporting chickpea surpluses from a fallow-replacement program, and Australia producing lupins, dry pea, and even chickpeas for export.

The market has continued to change. Lupins and vetches are no longer listed separately among the pulses by FAO. Broad beans are losing significance as the area has been cut-back. The countries of the former USSR have dramatically reduced their pulse production, yet some are emerging as major exporters. The EC countries are making changes in the wake of the Common Agricultural Policy (CAP) regarding support for oilseed crops (1992), cereals and protein crops (including dry pea, faba bean, and sweet lupin) (1993), and other grain legumes (chickpea, lentil, vetches) (1995) which were causing a marked decline in production in 1994 and 1995. Canada, a new entrant, is now fifth among the world's pulse producers (15% of lentils and 10% of dry peas) and by 1995 had become the number one pulse exporter. Myanmar, after the change in government in 1988, has risen to rank fifth among the exporters and has an increasing production of dry beans and pigeonpea. Turkey and Australia, the success stories by the second conference, now rank eighth and ninth, respectively, among net exporters.

2. SOCIO-ECONOMIC SITUATION AT THE TIME OF IFLRC I & II

When Agostini and Khan wrote their paper in 1986, they were looking back at the '70s and the decline in pulse production which had occurred due to lack of government attention which had gone to cereals in the wake of the Green Revolution. They saw a stimulation of the pulse economy in the 80s, including government interest, with Australia appearing as the world's largest lupin producer. 70% of total world production in 1984 came from developing countries, mostly as dry beans, chickpea, and faba bean, while pea and vetches and lupins were the most commonly produced pulses in the developed countries[3]. Of the 48

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[2] India is the largest producer of dry beans (22% of world total), chickpea (74%), lentils (28%), pigeonpea (88%), and "other pulses" (15%). This latter FAOSTAT category includes data for all legumes for which FAO collects data, but that are not listed separately, i.e., vetches *(Vicia sativa)*, lupins *(Lupinus spp.)*, bambara beans *(Voandzeia subterranea)*, and others. FAO also uses "pulses NES" (not elsewhere specified) to describe these. Separate listings exist for dry beans *(Phaseolus spp.)*, broad beans (faba bean) *(Vicia faba)*, chickpeas *(Cicer arietinum)*, cowpeas *(Vigna sinensis; Dolichos sinensis)*, lentils *(Lens esculenta; Ervum lens)*, dry peas *(Pisum sativum; P. arvense)*, and pigeon peas *(Cajanus cajan)*. Data refer to the dry grain only and not to that produced or consumed as a green vegetable.

[3] All data given in this section are taken from the publications reviewed. FAO data may have been revised thereafter.

million tonnes of pulses produced world-wide, 70% went for food, with an average per capita consumption of 6.3 kg in 1983, which had fallen from 7.5 kg in 1969/71 and was seen as stabilizing in the 1980s. Feed uses, which had declined in the 1970s, were picking up, mostly in the USSR and EEC.

Domestic prices for food pulses had risen relative to cereal prices, and while world prices had fallen, they had done so less than prices for other agricultural products. Of the total world production, only 7% was traded, creating an extremely thin world market which was mostly utilized to offset shortfalls in domestic production or dispose of surplus production. This had created highly volatile prices especially for chickpea and lentil. The different pulses also fetched very different prices depending on end use and quality. Beans and peas were becoming more important as were exports of pulses in general, having witnessed an increase in volume of 79% in nearly fifteen years (from 1.9 million MT in 1969-71 to 3.4 million MT in 1984). This development went hand in hand with a reduction in the number of market players and a change in position of the group of developing countries from net-exporter to net-importer status, even though Turkey replaced the U.S. in 1982 as the world's largest pulse exporter.

For the future, Agostini and Khan predicted slow growth in global output with expanding opportunities for exports to developing countries given their inability to satisfy domestic demand as populations grew (eg India) or demand rose (eg Algeria).

The main problem, the authors discussed, was the insufficient availability of protein, especially in the poor countries who could not afford to import pulses - a problem compounded by their demand for pulses, not commonly traded, such as cowpea and pigeonpea. Agostini and Khan also understood the problem of relative, not absolute, pulse prices influencing production and they undertook to calculate some real (i.e., deflated) prices and price deviations.

By 1992 and only six years later, the scenario had changed dramatically. Oram and Agcaoili, found there had been 3.5% growth per annum for the four main cool season pulses during the 1980s, much higher in the developed than the developing countries (8% vs. 1.5%), with increases in yield and area contributing to the trend. Thus, when they reviewed FAO projections from 1986, they found FAO had overestimated output in developing countries while underestimating output in the developed countries. Actual consumption overshot the projections for feed use, while food use had been overestimated. World trade in legumes had vastly increased not only for feed use but also, unexpectedly, as food use for developing countries.

By 1989-91, world production had risen by another 17% since 1984, to 56.2 million MT, with 90% of the total concentrated in 12 countries and as much as 50% grown in India (23%), USSR (17%), and China (10%). The developing countries were still producing the lion's share of pigeonpea, cowpea, chickpea, dry beans, faba bean, and lentil, though their share had declined for six out of nine pulse crops, totalling 63.5% of world pulse production. Dry pea now contributed almost as much as dry beans to world production in pulses, 27% and 29%, respectively. (See Figure 2.)

With total production up, all uses were up, but food use had grown at only 1.3% per annum versus 9.7% for feed. These data could be disaggregated to show that the developed world was using 72% of their share for feed in 1989 (up from 51% in 1980), while the developing world's feed use was 8.5% (up only slightly from 8.2%). While total per capita consumption of food and feed was 16.4 kg in 1989 (up from 8.0 kg in 1980) for the developed countries, per capita consumption for food use only had declined in the developing countries from 7.6 kg in 1980 to 7.2 kg in 1989, mostly due to falling levels of pulse consumption in Asia and Latin America. (Note that Asia represented 54% of the world's total use of food pulses in 1988-90.)

The world market had increased by 1989/90, with 11% of production exported, but it was still a thin market with volatile prices. Peas accounted for 36% of total trade with the EC being the largest importer. The warm-season pulses especially continued to have a low share of the trade. The problem of "unsatisfactory consumption" of food pulses in developing countries pointed out earlier by Agostini and Khan persisted. Oram and Agcaoili postulated a "Year 2000" demand of 49 million MT for developing countries and 4 million MT for food use in developed countries, plus an unspecified amount for feed use in developed countries.

Given the 1992 scenario, Oram and Agcaoili put forward questions to address the postulated protein deficit in developing country diets:

1. How do we deal with yield and area instability in pulses?
2. How do we close the supply/ demand-gap?
3. Are we dealing with a supply or demand constraint?

They suggested the yield and area instabilities were functions of the production systems, use of inputs, and price signals for pulses. The supply/ demand-gap could be closed by increasing area, yield, or both, and also - for individual country deficits - by imports. And production was definitely supply-constrained. According to Oram and Agcaoili, the most promising way to increase supply was to increase yields through technological progress. So the ball was with research, and two of the issues research needed to look at were yield variability and links between socio-economic and technical research.

3. THE CURRENT SCENARIO: 1996

3.1 Production

In 1996, world pulse production stood at 56.8 million MT, down from 58.1 million MT in 1990 (FAO, 1997). This 2.2% reduction occurred despite an increase in area, from 67.4 to 71.0 million ha, which brought the average yield down to 800 kg/ha, from 862 kg/ha in 1990, a 7.8% decrease. However, this single year comparison overstates the downswing.

The more reliable medium-term observations show a growth of 36% for total production between 1980-82 and 1994-96 and a compound growth rate of 2.1% p.a. for 1980 to 1996 (Tables 1 and 2). All the values given in tables 1 to 12, 15 & 16 are calculated from FAO statistics and are for dry grain. The totals in tables 1 & 2 are based on a phenomenal expansion of 3.6% p.a. during the 1980s, followed by near stagnation since 1990. Yields contributed 1.3% p.a. to the growth between 1980 and 1996, while expansion in area accounted for a smaller share of 0.8% p.a. But again, the higher growth rates of 1.2% p.a. for area and 2.4% p.a. for yield occurred during the 1980s. They have since come down to 0.9% p.a. for area and a reduction of 0.8% p.a. in yield during the first half of the 1990s.

Table 1. Area, Production and Yield of Total Pulses, Triennium Averages, 1980-82, 1989-91 and 1994-96, by Region

	Area ('000 ha)			Production ('000 MT)			Yield (kg/ha)		
	'80-'82	'89-'91	'94-'96	'80-'82	'89-'91	'94-'96	'80-'82	'89-'91	'94-'96
Africa	9043	11877	12572	5145	6625	7208	569	558	573
East Asia	7573	5993	6641	8282	6942	7807	1095	1152	1175
West Asia	1665	3259	3281	1640	2644	2858	986	811	871
South Asia	25490	26262	27418	11760	14877	16666	462	566	608
L. America + Caribbean	8951	8985	9364	4999	5184	6154	557	575	657
CIS	5167	5484	3165	5392	7594	4178	1060	1372	1307
Europe	2513	3048	2421	2704	7439	6204	1071	2452	2561
N. America	1138	1276	2093	1800	2249	3640	1581	1750	1738
Oceania	286	1524	2054	291	1596	2011	1034	1045	983
World	**61843**	**68421**	**70501**	**42015**	**56160**	**56995**	**679**	**821**	**809**
Developing	52545	56895	60595	31597	36998	40723	601	650	672
Developed	9297	11526	9907	10418	19162	16273	1126	1663	1642

Underlying the world picture are different pictures for country groups. In 1980-82, the "developed countries" accounted for 25% of world pulse production. By 1989-91, their share had risen to 34%. It is now down again to 29%. The fluctuation is due to production shooting up by 8.3% p.a. between 1980 and 1990, to which area expansion contributed 3.2%, and yield increases an amazing 4.9%, bringing their total production up to 19.2 million MT in 1989-91. By 1994-96, total production had shrunk to 16.3 million MT[4]. This contraction occurred at a rate of -3.8% p.a., led by a 2.6% p.a. area reduction, with yields falling at a rate of 1.2% p.a. The average yield in this group is still 1642 kg/ha.

For the "developing countries" group, growth rates have been much more even over the 1980-1996 period. In these countries, production grew at an average of 1.7% during the whole period. This sustained growth came from a 0.94% p.a. expansion in area, and 0.72% p.a. increase in yield. During the 1980s, the growth was led by yields (0.9% p.a.), while an area expansion of 1.5% p.a. has carried the growth since

[4] The triennium averages tend to underestimate the decline of 5 million MT, from 20.3 to 15.3 million MT, between 1990 and 1996.

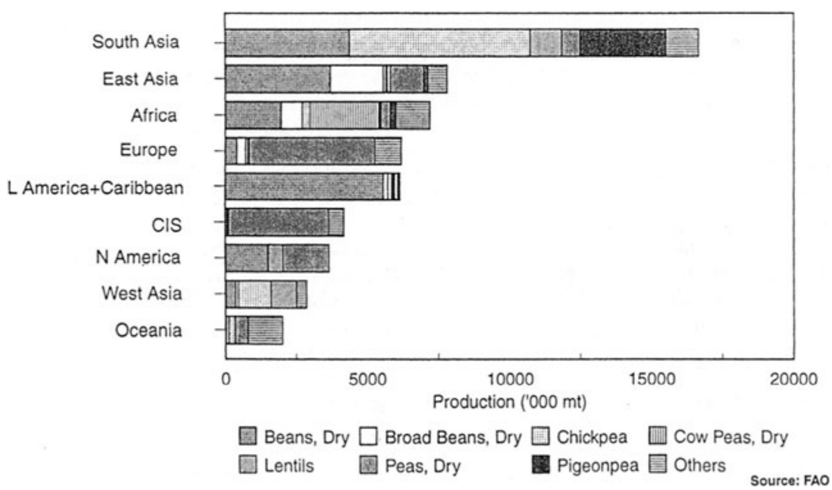
1990. Production in 1994-96 stood at 40.7 million MT on 60.6 million hectares, with an average yield of 672 kg/ha.

Table 2. Growth Rates in Area, Production and Yield of Total Pulses, 1980-96, by Region

	Area Growth Rate (% per annum)			Production Growth Rate (% per annum)			Yield Growth Rate (% per annum)		
	'80-'96	'80-'90	'90-'96	'80-'96	'80-'90	'90-'96	'80-'96	'80-'90	'90-'96
Africa	2.45	3.22	1.12	2.58	3.03	2.22	0.12	-0.19	1.09
East Asia	-1.59	-1.64	3.80	-1.33	-0.57	3.87	0.26	1.09	0.07
West Asia	5.23	8.32	-0.06	4.15	6.76	0.15	-1.03	-1.44	0.21
South Asia	0.35	-0.04	1.29	2.04	2.33	3.13	1.68	2.37	1.83
L. America + Caribbean	0.16	0.50	0.79	1.58	0.20	2.63	1.42	-0.30	1.83
CIS	-3.95	1.64	-10.08	-2.25	5.52	-12.70	1.76	3.82	-2.91
Europe	-0.27	2.79	-3.74	6.44	13.69	-4.41	6.73	10.60	-0.69
N. America	4.96	1.89	10.08	5.77	2.28	9.31	0.78	0.38	-0.70
Oceania	13.97	22.78	5.08	13.90	22.57	4.94	-0.06	-0.17	-0.14
World	**0.80**	**1.18**	**0.85**	**2.07**	**3.63**	**0.07**	**1.26**	**2.41**	**-0.78**
Developing	0.94	0.79	1.48	1.66	1.69	1.84	0.72	0.90	0.35
Developed	0.08	3.22	-2.63	3.13	8.27	-3.79	3.05	4.88	-1.20

Regional Review South Asia was the most important region in production, with 29% of the 1994-96 total, or 17 million MT (Figure 1). There has been an average growth of 2.0% p.a. since 1980, mostly from increasing yields. East Asia, which produces 14% of the world's pulses, or 8.2 million MT, saw its production decline by 1.3% p.a. since 1980, due to area losses of 1.6% p.a. This is mostly attributable to China reducing the area under broad beans (see below). West Asia, with a world production share of 5%, or 2.9 million MT, shows a 4.2% p.a. growth in the medium run. This region had an enormous area increase of 8.3% p.a. during the 1980s, which was somewhat eroded by a yield decrease of 1.4% p.a. during the same period. Since then, slight yield increases have been balanced by very slight area losses to produce a near zero growth. In Latin America and the Caribbean, production was almost stagnant during the 1980s, but has since seen a 2.6% growth per annum, led by yield increases of 1.8% p.a. and area expansion of 0.8% p.a., which resulted in a medium-term growth rate of 1.6% p.a. and a production of 6.3 million MT in 1996, equal to 11% of the world total. This makes the region about as important as Africa, which produces 7.4 million MT, or an eighth of the world total. The medium-term growth rate for Africa has been 2.6% p.a., originating from a 3.2% p.a. area expansion during the 1980s, and a 2.2% p.a. growth rate since. Area and yield increases contribute evenly to the increase.

Figure 1. Regional Production of Pulses, 1994-96 Average



Examining the data for the developed regions, we find that Europe, which produced 11% of the world total in 1996, derived its enormous growth during the 1980s from a 10.6% p.a. yield increase fuelled by changes in the CAP which in 1978 began to give preference to protein crops (Carrouee et al., 1997). The reduction of 4.4% p.a. since 1990 has come mostly from area reductions of 3.7% p.a., which brought total production down to 5.8 million MT, but leaves the region with record yields of 2393 kg/ha. Again, the contraction is attributable to policy changes (Personal Communication, Hubertus Wolfgarten, 1997). In North America, which produces 6% of the world's total, the 5.7% p.a. growth since 1980 has been driven by a 10.1% p.a. area expansion since 1990, much higher than the 1.9% p.a. that accounted for the 1980s growth, and attributable to Canada taking up pulse production. Area under pulses in this region has thus grown from 1.3 to 2.1 million ha between 1990 and 1996. In Oceania, which produced 2.2 million MT or 4% of the world's pulses in 1996, the remarkable growth of 13.9% p.a. has been achieved entirely by area expansion: 22.8% p.a. during the 1980s, and 5.1% since. This is due mostly to Australia entering the global market for pulses.

This leaves the Commonwealth of Independent States (CIS), which produced 3.5 million MT in 1996, down to less than half of their 1990 production of 8.9 million MT. While the growth rate in the USSR had been 5.5% p.a. during the 1980s, with 3.8% p.a. growth from yield increases, and 1.6% p.a. from area expansion, it went down to -12.7% p.a. since 1990, mostly caused by an immense area reduction of 10.1% p.a. Yields fluctuate widely between a 6-year low of 1038 kg/ha in 1991 and a 6-year high of 1647 kg/ha in 1992. At the same time, the CIS lost 54.8 million MT or 30% of their cereal production, and 700,000 MT or 19% of their oilseed production. This immense decline is most likely due to restructuring, and a general economic downturn, which reduced the availability of inputs. Thompson (1997) suggests that the USSR was subsidizing both consumers and producers, leading to a steep decline especially in the livestock sector when the Union dissolved. The CIS and Europe combined, account for all of the contraction in the world pulse economy since 1990.

Major Producers Looking at single countries in 1996, India remained the most important producer (27.0%) followed by China (8.7%) and Brazil (5.0%). Together with France (4.6%), Australia (3.8%), and Canada (3.3%), the top three developed-country producers, the largest six producers in the world account for 52.5% of total production. Ukraine, formerly part of the USSR, which was the second largest pulse producer in 1989-91, occupies rank seven. Even though the broad world production picture has remained intact since the Cairo conference, a comparison with Table 4 of Oram and Agcaoili (1994) shows the changes which have occurred since. They are, the break up of the USSR and the decline in production; India increasing its share of world production as China, Brazil, and France decreased theirs; and Australia and Canada joining the top six producer group, while the United States has dropped out.

The Crops Perspective A comparison with Agostini and Khan (1988, p. 463) shows that concentration of certain pulse crops in one of the two developing/ developed country groups has increased for dry beans (88% grown in developing countries), dry peas (81% grown in developed countries), and cowpea (99% grown in developing countries), while it has decreased for chickpea (96% grown in developing countries), lentil (79% grown in developing countries), and "other pulses" (56% grown in developing countries). Broad bean (87% in developing countries) and pigeonpea (100% in developing countries) are virtually unchanged. (Table 3)

As for distribution of specific pulse crop production, dry beans are still in the lead with 32% of world total in 1996 (Figure 2), largely produced by India (23%), Brazil (16%), and China (9%). The second largest pulse crop with a 22% share is dry peas grown primarily in France (21%), Ukraine (14%), and Canada (10%). Dry beans and dry peas together still account for more than half (54%) of total world production, and they also dominate the world market for pulses, but as dry peas have lost some ground in Europe and the CIS, so has their relative importance.

Chickpea, the number three crop representing 14% of pulses in 1996, also shows an increase in production. India (73%), Turkey (9%), and Pakistan (8%) are the leading producers. "Other pulses" (mostly vetches and lupins for feed) add up to 11% of the world's production[5]. Not surprisingly, the "other pulses" are the least concentrated in any producer country: the top three producers -- India, U.K., and DPR Korea -- together account a quarter of the total, as against the most highly concentrated, pigeonpea, of which 96% is produced by India (88%), Myanmar (4%), and Malawi (3%). This warm season crop has taken over from

[5] In Agostini and Khan (1988), vetches and lupins were dealt with under separate entries. Oram and Agcaoili (1994) had one entry for both crops.

broad beans as the number five, representing six percent of world production[6]. The annual growth rate of 2.8% originates largely in increased area (2.4%). Certain regions, however, have deviated remarkably: East Asia shows a 10.5% growth rate for pigeonpea attributable to expansion in Myanmar, while African yields have grown by 1.4% p.a. (Table 4, 5).

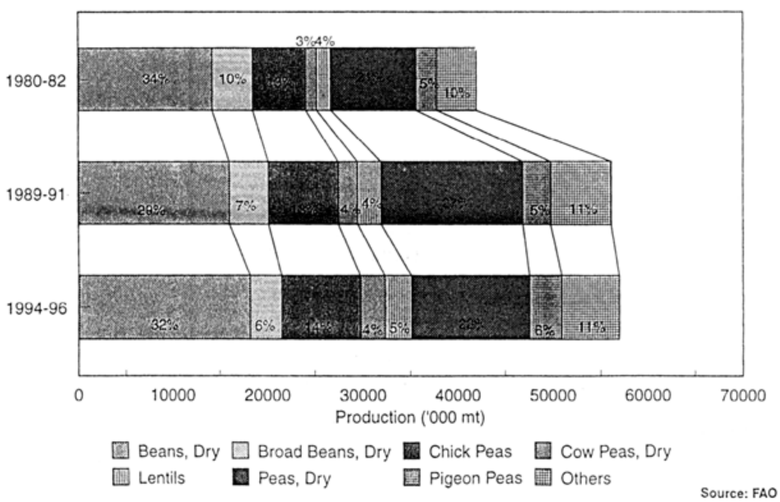
Table 3. Production, as dry grain, of Major Pulses, by Region, 1994-96 Average

	World Prod.	Regional Distribution										
		Africa	Asia			L Amer/ Carib[1]	CIS	Europe	N Amer[2]	Oceania	Developing	Developed
			East Asia	West Asia	South Asia							
	('000 mt)	(% of World Production)										
Beans,	**18,184**	10.9	20.3	2.0	24.1	30.7	*	2.3	8.3	*	88.0	12.0
Peas,	**12,436**	2.7	9.4	*	5.3	*	28.4	35.6	12.9	3.7	18.9	81.1
Chickpeas	**8,247**	3.3	*	13.9	76.9	*	*	*	*	2.6	96.4	3.6
Pigeonpeas	**3,398**	5.8	4.3	*	88.9	*	*	*	*	*	100.0	
Broad Beans,	**3,331**	22.5	56.6	2.9	*	4.6	*	9.6	*	2.8	87.1	12.9
Lentils	**2,816**	2.2	4.0	31.7	39.1	*	*	*	18.2	*	79.4	20.6
Cowpeas,	**2,546**	95.8	*	*	*	*	*	*	*	*	98.7	1.3
Others	**6,037**	19.3	11.0	5.7	19.0	*	8.9	15.3	*	19.9	55.9	44.1
Tot. Pulses	**56,995**	**12.3**	**13.7**	**5.0**	**29.2**	**10.9**	**7.3**	**10.9**	**6.4**	**3.5**	**71.4**	**28.6**

* Regions for which share of world total is less than 2%

1 Latin America & Caribbean 2 North America

Figure 2. Changes in Global Pulse Production by Crop, Triennium Averages



Broad bean is the only pulse crop that has decreased in relative and absolute terms since 1980, down from 10% to 6% of total world production, with a growth rate of -1.6%. This was mostly attributable to area

[6] This data does not include Kenya, which is considered the largest producer in Africa (Muehlbauer et al, 1996).

reductions in China, which fell from 2.3 million ha in 1980 to 1.4 million in 1990 and to 1.1 million in 1996. Cyprus, Israel, and Japan have virtually stopped producing broad beans. This masks a 20.3% annual growth rate in production in Oceania (14.4% p.a. for area, 5.1% p.a. for yield). China (57%), Egypt (13%), and Ethiopia (8%) are the main producers.

Table 4. Compound growth rates (% per annum) of Production of dry grain of Major Pulses, by Region, 1980-96

	World	Africa	Asia			L Amer Carib[1]	CIS	Europe	N Amer[2]	Oceania
			East Asia	West Asia	South Asia					
Beans,	**1.7**	1.7	0.7	3.3	2.4	1.8	0.3	-4.2	1.6	10.7
Peas,	**2.5**	0.8	-5.9	3.6	4.1	1.5	-2.1	13.0	12.7	9.0
Chickpeas	**2.2**	0.9	-0.8	7.8	1.5	-1.4	-	-2.5	-	30.8
Pigeonpeas	**2.8**	2.5	11.3	-	2.6	1.7	-	-	-	-
Broad Beans,	**-1.6**	-1.7	-3.2	0.9	-	-1.1	-	-3.2	0.3	20.3
Lentils	**4.6**	-1.1	40.8	4.2	3.8	0.3	12.4	-6.6	11.7	30.1
Cowpeas,	**6.8**	7.2	7.1	-0.9	-3.3	-0.1	-	5.8	-10.7	-4.1
Others	**2.2**	2.0	2.8	-1.1	0.2	1.7	-3.7	4.2	-	15.1
Tot. Pulses	**2.1**	**2.6**	**-1.3**	**4.2**	**2.0**	**1.6**	**-2.3**	**6.4**	**5.8**	**13.9**

1 Latin America & Caribbean 2 North America

Table 5. Compound growth rates (% per annum) in Yield of Major Pulses, by Region, 1980-96

	World	Africa	Asia			L Amer. +Carib[1]	CIS	Europe	N Amer[2]	Oceania
			East Asia	West Asia	South Asia					
Beans,	**1.3**	0.6	0.5	0.4	1.8	1.5	-2.1	3.2	0.7	1.6
Peas,	**2.6**	0.4	0.02	2.1	2.7	1.4	1.8	3.3	0.1	-2.9
Chickpeas	**1.4**	-0.7	-0.9	-1.4	1.7	2.1	-	-0.3	-	-1.4
Pigeonpeas	**0.3**	1.4	0.7	-	0.2	0.4	-	-	-	-
Broad Beans,	**-0.01**	0.01	2.5	0.8	-	0.4	-	1.7	-2.3	5.1
Lentils	**1.7**	0.4	9.0	-0.7	2.2	2.1	3.9	-0.9	2.1	4.2
Cowpeas,	**2.5**	2.8	2.1	0.7	0.2	4.6	-	-0.7	2.1	-1.7
Others	**1.4**	-0.9	1.7	-0.8	2.2	-3.0	1.9	3.0	-	1.4
Tot. Pulses	**1.3**	**0.1**	**0.3**	**-1.0**	**1.7**	**1.4**	**1.8**	**6.7**	**0.8**	**-0.1**

Source: Calculations from FAO

Lentils and cowpeas account for 5% and 4% of world pulse production, up from 4% and 3%, respectively. While lentils grew at 4.6% p.a., with 2.8% p.a. in area and 1.7% p.a. in yield, cowpeas had the highest global annual growth rate at 6.8%, with 4.1% p.a. in area and 2.6% p.a. in yield. This is mostly attributable to large increases in area (4.4% p.a.) and yield (2.8% p.a.) in Africa. The top producers of this crop are Nigeria (65%), Niger (17%), and Myanmar (2%), while lentil production is dominated by India (28%), Turkey (22%), and Canada (15%).

3.2 Trade

The world market volume[7] in 1995 stood at 8.0 million MT representing 14.2% of world production; the 1993-95 average was 7.6 million MT or 13.4% of production (Table 6). The proportion of production traded is now higher than in cereals, where world trade was 244 million MT, with 12.8% of production traded. The value of all pulse exports exceeded US$ 2.5 billion in 1993-95 (Table 7).

[7] As measured by exports, since export data are usually more reliable than import figures.

Table 6. Imports and Exports ('000 MT) of Total Pulses, by Region, 1980-82 and 1993-95

	Imports		Exports	
	1980-82	1993-95	1980-82	1993-95
Africa	330	786	181	177
East Asia	430	634	434	1734
West Asia	177	248	454	570
South Asia	196	952	9	86
L.America+Caribbean	812	714	300	430
CIS	16	21	39	267
Europe	1055	3608	522	2052
N. America	50	124	970	1692
Oceania	19	24	69	595
World	**3102**	**7130**	**2979**	**7603**
Developing	1731	3050	1373	2988
Developed	1371	4105	1606	4645

Table 7. Trade in pulses by Volume ('000 Mt) and Value ($ Million), 1980-95

Year	Volume of Exports	Growth Rate (%)	Value of Exports	Value in real terms*
1980-82	2,979		1,514	1,514
1985-87	4,659	11.3	1,688	1,261
1990-92	6,522	8.0	2,477	1,383
1993-95	7,604	5.5	2,547	1,194

* Nominal value deflated by 6% per annum

Virtually all pulse crops have seen an increase in export volume (Table 8, 9) as well as in trade as a share of production (Table 10), suggesting that trade barriers are being reduced. The most widely exported crop relative to its production is still lentils, which however, saw only a slight increase. The highest increase in exports has occurred in dry peas, which are now almost as widely traded as lentils, and broad beans, mostly due to the 1974-78 changes in Europe (see Gent, 1994).

Table 8. World Trade in Selected Pulse Crops, 1980-1995

	Exports (Million MT)		
	1980-82	1989-91	1993-95
Beans,	1.4	1.8	2.3
Peas,	0.6	2.5	3.2
Chickpeas	0.2	0.5	0.4
Broad Beans,	0.2	0.5	0.6
Lentils	0.4	0.5	0.7
Total	**2.9**	**6.2**	**7.6**

Table 9. Imports and Exports ('000 MT), of Major Food Grain Legumes, by Region 1980-82 and 1993-95 Averages

	Beans		Peas		Chickpeas		Broad Beans		Lentils		Total Pulses	
	80-82	93-95	80-82	93-95	80-82	93-95	80-82	93-95	80-82	93-95	80-82	93-95
						Imports						
World	**1480**	**1829**	**536**	**2870**	**134**	**467**	**144**	**582**	**354**	**650**	**3102**	**7131**
Africa	116	284	7	43	24	38	5	116	113	145	330	787
East Asia	319	472	38	89	5	6	15	25	13	13	430	634
West Asia	6	18	2	10	35	48	21	20	65	51	177	248
South Asia	119	137	6	216	8	227	-	-	13	106	196	952
L Amer+Carib	522	355	74	120	10	14	-	1	26	101	812	714
CIS	16	-	-	21	-	-	-	-	-	-	16	21
Europe	347	479	390	2356	41	119	102	418	124	227	1055	3608
N America	26	46	12	36	12	14	-	2	1	8	50	124
Oceania	7	12	6	3	-	0.2	1	0.1	0.1	2	19	24
						Exports						
World	**1410**	**2347**	**633**	**3210**	**225**	**441**	**171**	**605**	**369**	**737**	**2979**	**7604**
Africa	61	108	1	6	4	3	39	8	6	16	181	177
East Asia	373	1254	3	33	1	1	15	313	6	57	434	1734
West Asia	15	77	-	1	153	191	26	14	250	260	454	570
South Asia	0.4	1	-	1	1	2	-	-	1	37	9	87
L Amer+Carib	216	327	9	27	64	66	-	1	10	8	301	430
CIS	-	-	38	267	-	-	-	-	-	-	38	267
Europe	66	101	319	1699	2	11	83	197	22	16	522	2052
N America	678	464	201	858	-	8	2	7	75	343	970	1693
Oceania	1	17	61	319	-	162	7	68	-	2	69	595

Table 10. Imports and Exports as a percentage Share of Total Production for Major Pulses, by Region, 1980-82 and 1993-95 Averages

	Beans		Peas		Chickpeas		Broad Beans		Lentils		Tot. Pulses	
						Imports						
	80-82	93-95	80-82	93-95	80-82	93-95	80-82	93-95	80-82	93-95	80-82	93-95
World	**10.4**	**10.5**	**6.0**	**21.2**	**2.4**	**6.2**	**3.4**	**17.8**	**23.7**	**23.1**	**7.4**	**12.6**
Africa	7.5	14.6	2.3	13.1	9.9	13.7	0.5	16.3	156.8	219.0	6.4	11.3
East Asia	11.0	13.9	1.7	8.0	4.8	7.1	0.6	1.4	1715.6	13.0	5.2	8.6
West Asia	2.5	4.9	22.9	89.9	7.9	4.3	24.1	20.1	13.7	5.5	10.8	8.6
South Asia	3.9	3.1	1.7	32.8	0.2	4.0	-	-	2.0	9.7	1.7	6.0
L Amer+Carib	11.9	6.7	67.6	94.9	5.5	10.9	0.0	0.3	45.2	177.3	16.2	12.2
CIS	27.3	-	-	0.5	-	-	-	-	-	-	0.3	0.4
Europe	50.9	121.5	46.1	48.3	45.8	218.2	21.4	125.4	195.5	799.9	39.0	53.8
N America	1.9	3.3	4.1	2.4	-	-	-	11.8	0.5	1.5	2.8	3.7
Oceania	170.4	44.2	4.5	0.5	-	0.1	12.0	0.1	21.3	14.5	6.6	1.1
						Exports						
World	**9.9**	**13.5**	**7.1**	**23.7**	**4.0**	**5.8**	**4.0**	**18.5**	**24.7**	**26.2**	**7.1**	**13.4**
Africa	4.0	5.5	0.4	1.8	1.7	0.9	4.1	1.2	8.5	24.4	3.5	2.5
East Asia	12.9	37.0	0.1	3.0	1.4	1.7	0.6	17.1	765.0	55.9	5.2	23.5
West Asia	6.0	21.4	1.0	5.6	34.3	16.8	30.2	13.5	52.8	28.0	27.7	19.8
South Asia	0.0	0.0	-	0.1	0.0	0.0	-	-	0.1	3.3	0.1	0.5
L Amer+Carib	4.9	6.2	8.6	21.1	37.3	51.6	0.0	0.8	17.3	13.4	6.0	7.4
CIS	-	-	0.8	6.0	-	-	-	-	-	-	0.7	5.2
Europe	9.6	25.6	37.8	40.9	2.5	20.0	17.4	59.0	34.3	57.2	19.3	30.6
N America	49.9	33.0	71.2	58.3	-	-	38.9	48.6	52.1	68.8	53.9	49.9
Oceania	25.7	63.6	47.2	62.7	-	85.2	78.4	66.9	-	17.3	23.8	27.9

Geographically, the highest increases in export shares have occurred in East Asia and Europe, while there have been decreases in West Asia and North America (which still exports half of its production). Europe exports roughly one third of its production[8]. As for import shares, they are still concentrated in Europe and growing (54% in 1993-95, up from 39% in 1980-82), followed by Latin America and the Caribbean (12%,

[8] Data problems exist due to transshipments being counted, e.g. Switzerland, Pakistan, and Macao appear as major exporters.

down from 16%) and Africa (11%, up from 6%). It is interesting to note that South Asia (India), so far not much engaged in exports, has entered the lentil trade, as have Africa and Oceania (Australia), while East and West Asia have pulled out to some extent. The highest import dependency exists in Europe, particularly for lentils. South Asia is said to be a fairly self-contained trade region (Kana, 1997), but their import share has risen to 6% in 1993-95, which translates into a 486% increase in real terms, giving South Asia the position of second largest importing region. Likewise, Myanmar is not only exporting to India, Pakistan, and Bangladesh, but also to Japan, Singapore, Korea, and Malaysia (Kyi, 1996).

In 1993-95, dry peas were the most important pulse crop traded by volume (3.21 million MT or 42%) followed by dry beans (2.35 million MT or 31%) (Table 8). The dry beans trade was valued at 1.11 billion US$ as opposed to dry peas at US$ 715 million, illustrating the higher valuation of food (beans) vs. feed (peas) use. The lentil trade was 0.7 million MT (US$ 280 million). The total average value of all legumes exported in 1993-95 was 2.55 billion US$, nominally up from 1990-92 by 700 million US$, but down in real terms (Table 7).

3.3 Utilization

Looking at consumption (Table 11), the total world production is split into roughly two-thirds for food (62% in 1993-95, up from 59% in 1989-91, but still down from 69% in 1980-82), while about a quarter goes to feed (27% in 1993-95, markedly up from 19% in 1980-82 and down from 29% in 1989-91), and the remaining tenth is used for seed, waste, and stockholding (11% in 1993-95 and 1989-91, down from 13% in 1980-82).

Table 11. Food & Feed Use of Total Pulses, by Region, 1980-82 and 1993-95 Averages

	Average Quantity ('000 MT)						Share of total Pulse Utilization (%)					
	1980-82			1993-95			1980-82			1993-95		
	Food	Feed	Other	Food	Feed	Other	Food	Feed	Other	Food	Feed	Other
World	**28677**	**7819**	**5358**	**34517**	**15400***	**6200***	**68.5**	**18.7**	**12.8**	**61.5**	**27.4**	**11.0**
Africa	4233	119	817	5852	99	1285	81.9	2.3	15.8	80.9	1.4	17.8
East Asia	6122	1198	855	5168	1102	732	74.9	14.7	10.5	73.8	15.7	10.5
West Asia	959	159	221	1771	360	413	71.6	11.9	16.5	69.6	14.2	16.2
South Asia	9761	972	1197	13696	1294	1494	81.8	8.1	10.8	83.1	7.8	9.1
L Amer+Carib	4671	67	586	5402	29	636	87.7	1.3	11.0	89.0	0.5	10.5
CIS	771	3645	955	374*	3811*	651*	14.4	67.9	17.8	7.7	78.5	13.6
Europe	1398	1491	443	1716	5924	645	42.0	44.7	13.3	20.7	71.5	7.8
N America	735	18	88	1229	251	232	87.4	2.1	10.5	71.8	14.7	13.5
Oceania	28	150	39	88	723	194	12.8	69.3	18.0	8.7	72.0	19.3

* estimated

The aggregate figures conceal differing trends in the regions. Africa, South Asia, and Latin America and the Caribbean, for example, consume over 80% of pulses as food in the form of soft cooked beans in gravy eaten over rice or cassava; cleaned split pulse *dhals* eaten with rice; and whole cooked beans, respectively. The shares have gone down for Africa and up for South Asia and Latin America/ Caribbean. However, due to absolute increases in consumption over the past 15 years, the compound growth rates for food consumption have been 2.7%, 2.3%, and 1.1%. Feed use has declined for Africa (-2% p.a.) and Latin America and the Caribbean (-5.4% p.a.)[9], and increased in South Asia (1.7% p.a.) (Table 12).

East and West Asia and North America use between 70% and 74% of their consumption for food, with the trend pointing down, and between 14% and 16% for feed, with the trend going up. Again due to differences in the totals between these regions, the growth rates have been -1.5%, 5.1%, and 4.3%, respectively, for food consumption. Feed use declined slightly in East Asia (-0.3% p.a.), but increased sharply in West Asia (6.8% p.a.), and dramatically in North America (24% p.a.).

[9] Note that the large growth rate here, as in the case of feed use in Oceania, reflects a very low base level and is thus not significant in the overall scenario.

Table 12. Change (Compound growth rates) in Utilization of Pulse Products, by Region, 1980-95

	food	feed	other*
Africa	2.71	-2.03	4.15
East Asia	-1.52	-0.26	-1.50
West Asia	5.06	6.80	5.20
South Asia	2.31	1.66	1.60
L Amer + Carib	1.07	-5.43	0.67
CIS	-4.49	4.40*	-
Europe	1.40	11.61	2.07
N America	4.29	23.96	8.22
Oceania	7.33	11.11	12.26
World	1.50	7.97*	2.02*

* including seed, waste and industrial use

The regions with the highest feed use -- above 70% and trends sharply up -- are parts of the former USSR (now CIS), Europe (dominated by the EC), and Oceania (dominated by Australia). Compound growth rates for these three have been -4.5%, 1.4%, and a very high 7.3% for food use, and 4.4%, 11.6%, and 11.1% for feed use, respectively.

Examining pulse utilization rates in selected developing countries and their development over the past 15 years, only China (East Asia) shows a marked departure from the "food" group (above 70% food use), yet its new proportions (53:35 food:feed ratio) still keep it well out of the "feed" group. Colombia, Brazil, and Mexico (Latin America) and Indonesia, Malaysia, and Thailand (East Asia) all show negligible proportions of their pulse use in feed, and their food pulse shares are all above 80%. Turkey (West Asia) increased the proportions of both food and feed uses to 59:23 (from 56:20) as other uses declined.

As for per capita consumption of pulses and pulse products for food, the world average has fluctuated between a low of 5.8 kg per annum for the year 1992 and a high of 6.6 kg in 1983, around a slowly declining trend. Although aggregate consumption of food pulses at the global level rose by 1.5% per annum between 1980-95, per capita consumption declined over the entire period by 2.8%. This disaggregates into per capita consumption figures fluctuating between 2.7 kg and 3.1 kg for the developed countries group, with a 2.3% growth in per capita consumption over the entire period. Per capita consumption for the developing countries group declined by 6% over the 15-year period, with consumption fluctuating between 7.9 kg and 6.7 kg per annum. One explanation for these developments is the saturation of developed country diets with animal protein so that other foods are slowly becoming more desirable, whereas total protein consumption in developing countries is still shifting away from pulse and cereal protein towards animal protein, when affordable.

4. REVISITING THE MAIN RESEARCH QUESTIONS

4.1 Protein Deficiencies in Developing Country Diets

While it is understood that animal protein will replace cereal and pulse protein in the human diet as incomes go up or relative prices change[10], researchers are still postulating shortages of pulse protein in developing country diets, as indicated by declining, or at best stable, per capita consumption figures (Agostini and Khan, 1988; Gowda et al., 1997). While this may be true for very poor countries and poor segments of advancing developing countries, we hold that for the most part, the reduction in pulse consumption has not contributed to a deteriorating protein nutritional status. As shown below, the data appear to substantiate this view.

Pulse Protein Overrated? Although pulses are an inexpensive source of protein (Pachico, 1993), their protein status is probably overrated. Walker (1987) cites three reasons. First, most of the nutritional

[10] For a detailed analysis of pigeonpea protein in Indian diets, see Mueller et al. (1990). They found that "the objective of maximizing protein consumption would be achieved not by buying more protein-rich pigeonpea, but by buying more low-protein cereals. As a consequence, the contribution of pigeonpea to total protein consumption would fall when both budget constraint and minimum pulse requirement were relaxed" (p.467).

evidence indicates that protein deficiencies are rare in poor urban and rural households in Asia. Deficiencies related to lack of calories, vitamins, and minerals are more common. Secondly, other studies have shown that a threshold amount of calories must be ingested before additional protein can be efficiently absorbed. So for energy deficient individuals, it is calories and not protein that is required. And finally, more than dietary concerns or cost of nutrients, taste preference influences food intake. Thus, even traditionally pulse-consuming societies will add vegetables, milk and dairy products (vegetarian), eggs, and seafood and meat (non-vegetarian) to their diets, and increase the share of preferred pulses, at the expense of "basic" pulses.

Competing Protein Source. Technological progress benefits products at different rates and other protein-rich foods can become relatively cheaper than pulses. For example, the use of pharmaceuticals in the poultry industry has made it possible to produce eggs and chicken on much less land, with labor-saving techniques, leading to lower prices. Fish and prawn farms are becoming alternatives to "traditional agriculture". Milk production per cow has vastly increased through breeding programmes using artificial insemination. All these technologies have been adopted by developing countries, leading to lower prices of animal protein in those products, which are acceptable to populations which observe dietary restrictions, such as vegetarians. At the same time, pulse prices have increased relative to other foods. Table 13 gives values for India.

Table 13. Expenditure and Own Price Elasticities for Selected Commodities of Consumption in India

	Expenditure elasticity		Own price elasticity	
	Model I[1]	Model II[2]	Model I[1]	Model II[2]
Rice	0.049	0.384	-0.250	-0.46
Wheat	-0.075	0.382	-0.185	-0.60
Pulses	0.283	0.647	-0.518	-1.07
Milk	0.435	1.100	-0.637	-0.66
Meat, Fish & Eggs	0.770	0.890	-0.878	-0.56

1 Kumar et al (1994) 2 Radhakrishna and Ravi (1990)

If our hypothesis is true, we can expect the following developments in protein intake per capita for developing countries:

a) an increase in the total,

b) the shares of cereal and pulse protein first increasing and later declining, or at least stabilizing, and the share of animal protein increasing, over time, at a rate determined by changes in relative prices, changes in income and dietary preferences, and

c) a reduction in intake of the less-preferred pulses, to the benefit of more highly valued ones, and

d) greater fluctuation of all the figures for poorer countries who rely less on imports and government programs to buffer their food economies, and for countries which produce mostly for their own consumption.

For protein-saturated (mainly developed) countries, we expect alternative uses of pulses such as in convenience foods (e.g., frozen foods, take-outs, semi-prepared foods, snack foods) and specialty foods (e.g., vegetarian dishes in otherwise non-vegetarian cultures, "natural" foods), and a gradual decline in protein from animal sources for reasons of health.

Visual Evidence We have chosen graphs depicting average daily per capita intake of protein from cereal, pulses, and animal sources over a 25-year period to support our hypotheses. Figure 3 shows the world per capita intake of all protein increasing over time, from 56 g/day in 1970 to 63 g/day in 1995, a 12.5% increase. At the same time, intake of protein from cereals increased moderately from 30 g to 33 g per person per day (10.0%) as against a 23.8% increase - from 21 g to 26 g - for dietary protein from animal sources, while pulse protein intake declined from 5 g to 4 g, by 20%. Thus, the protein composition was 54% cereal, 9% pulse, and 38% animal protein in 1970 as against 52% to 6% to 41% in 1995[11].

Figures 4 and 5 disaggregate the world picture into developed vs. developing countries. In the developed countries, total protein intake increased over the period, from 83 g to a peak of 90 g in 1990, and has been declining since, to 86 g in 1995. At the same time, cereal protein has been fairly stable, as has been pulse

[11] This assumes only negligible amounts of protein from other sources such as oilseeds and nuts, which does not hold true for countries which consume large amounts of soybean in their diet.

protein at 2 g per day. Protein from animal sources increased from 1970 to the peak in 1990, and has since declined. For the developing countries as a whole, per capita protein from all sources has gone up by 20%, from 45 g in 1970 to 56 g in 1995. Cereal protein contributed 30 g in 1970 and 34 g in 1995, while pulse protein contributed 6 g and 4 g, respectively. Animal products contributed 10 g to the total in 1970, as against 18 g in 1995, an 80% increase. To compare the two groups, the total protein intake in developing countries was 54% of that of developed in 1970, and 65% in 1995. Progress has clearly been made.

Asia (East, South, and West) is home to countries with different dietary preferences, natural endowments, and income levels. Japan is a rich, industrialised, densely populated, protein-saturated country with a highly protected farm sector; Myanmar, a small, poor, agrarian country newly emerging as a pulse exporter; and Turkey, a fairly large country at the top end of the developing country scale, which emerged as a major chickpea producer and exporter in the 1980s. India, with a per capita income of US$ 320 in 1994 and largely producing for its own population, shows a slowly increasing daily per capita intake between 49 g in 1970 and 52 g in 1995.[12] A largely vegetarian country, India had 33 g of daily protein from cereals in 1970, as against 35 g in 1995, and 10 g and 8 g from pulses, respectively. Dispelling some notions about the strictly vegetarian Indian diet, animal protein stood at 6 g in 1970 and overtook pulses for the first time in 1980, and has been consistently above pulse protein since 1988, reaching 9 g in 1995 (Figure 6).

China, with a per capita income of US$530 in 1994 was the world's second largest net exporter of pulses in 1995. It shows a strong growth in per capita protein intake, a very large increase in animal protein, and pulse protein declining from 5 g to 1 g per day (Figure 7).

Latin America Brazil had a 1994 per-capita-income of US$ 2970. It belongs to a group of meat and pulse-consumers and shows little volatility in its relatively high protein intake, which rose from 52 g in 1970 to 65 g in 1995 (Figure 8). Cereals accounted for 36% of the daily protein intake in 1970-72, but by 1995 this share had fallen to 31%. (Actual consumption rose, however.) Pulses contributed 13 g in 1970-72 and have since declined to 10 g in 1995. Animal products contributed 20 g in 1970-72 and the share has since gone up to 35 g in 1995.

Africa Nigeria is a large pulse growing country with a per capita income of only $260. The protein intake has been low and highly volatile (Figure 9). Animal protein has seen no expansion since 1985. Cereals have contributed most to the total, while pulses have fluctuated widely. It appears that pulses have since 1985 served to replace a share of animal products in the diet.

North America The U.S.A. are an excellent example of a protein-saturated exporter (Figure 10). Per capita income is a very high US$ 25,880. Pulses are produced for export as well as home consumption, driven by several pulse-eating ethnic groups. Only in the last year, has protein intake from pulses risen in the USA, from 2 to 3 g/day per capita[13].

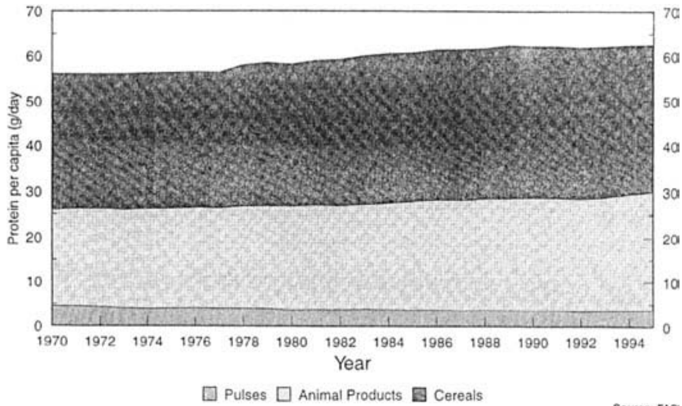
4.2 Supply vs. Demand Constraint

Why has per capita consumption of pulses declined in developing countries? Is there a lack of supply so that demand can not be met (supply constraint), or are consumers not interested in purchasing more pulses (demand constraint)? India may serve again as an example. Radhakrishna and Ravi (1990) and Kumar et al. (1996) have estimated expenditure and price elasticities of demand for various food commodities, i.e., they have shown how much of a change in consumption will occur with a one percent increase in the price of that commodity (own price elasticity) or a one percent increase in total household expenses (expenditure elasticity). In a demand-constrained pulse economy, we would expect very low or negative expenditure elasticities, and likewise low price elasticities - i.e., an inelastic demand, which will not react to income or price changes.

[12] Note that the peaks and valleys are due to whole figures in the database.

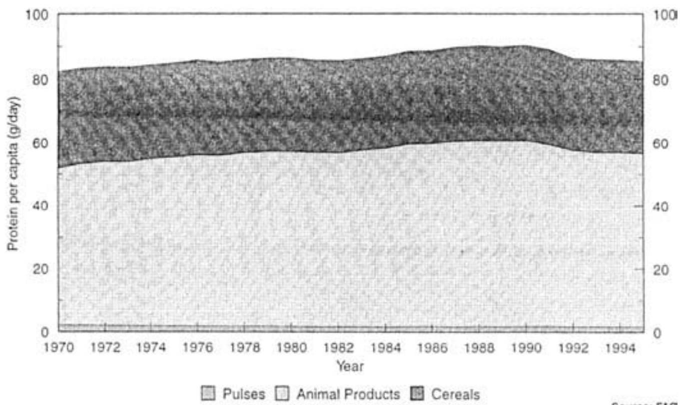
[13] Values are rounded off to the nearest whole number in the FAO data for the USA.

Figure 3. Protein Consumption from Various Sources, 1970-94
World



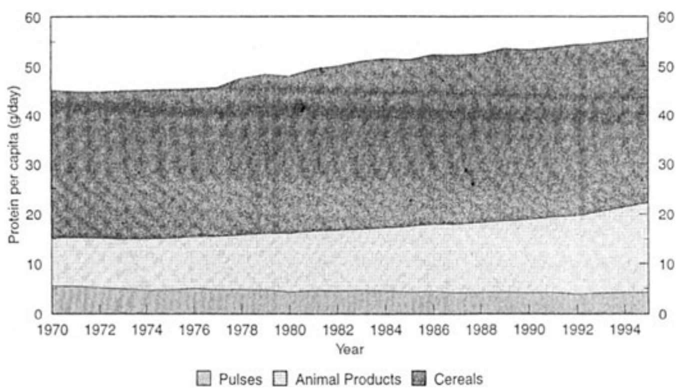
Source: FAO

Figure 4. Protein Consumption from Various Sources, 1970-94
Developed Countries



Source: FAO

Figure 5. Protein Consumption from Various Sources, 1970-94
Developing Countries



Source: FAO

Figure 6. Protein Consumption from Various Sources, 1970-94
India

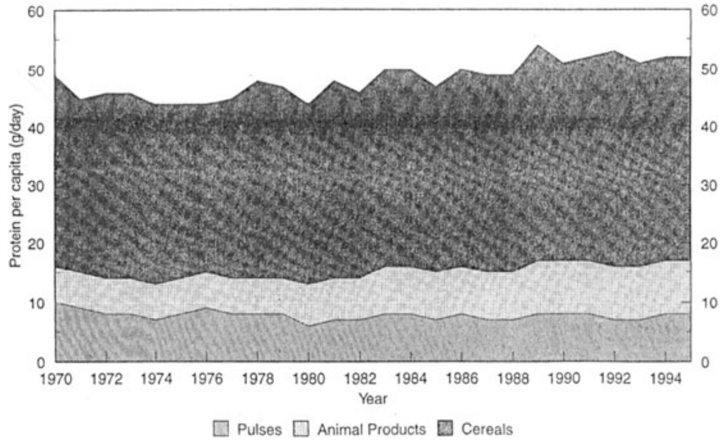


Figure 7. Protein Consumption from Various Sources, 1970-94
China

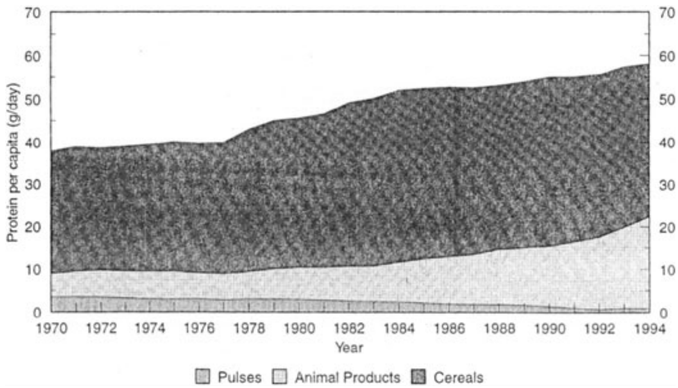


Figure 8. Protein Consumption from Various Sources, 1970-94
Brazil

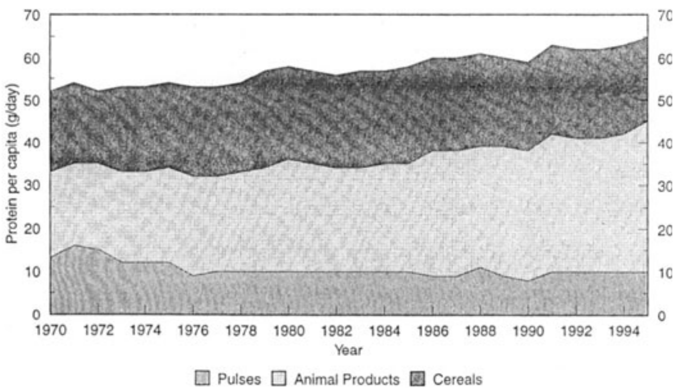


Figure 9. Protein Consumption from Various Sources, 1970-94
Nigeria

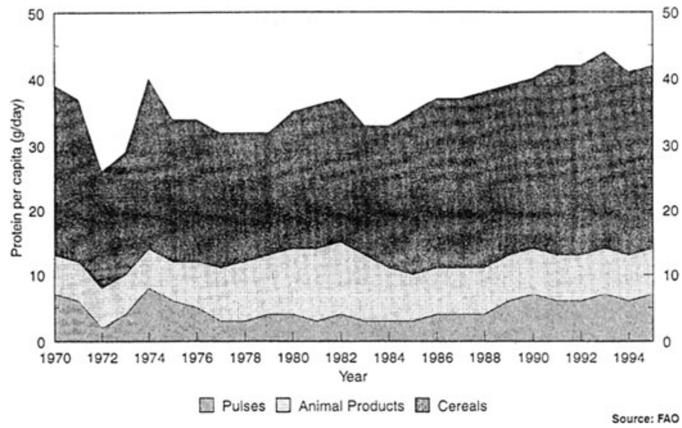
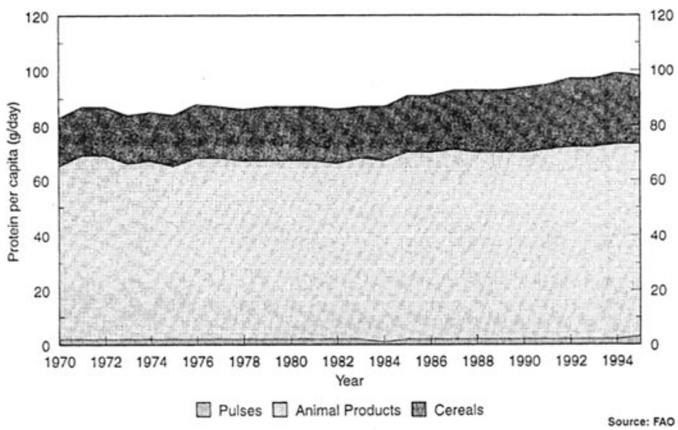


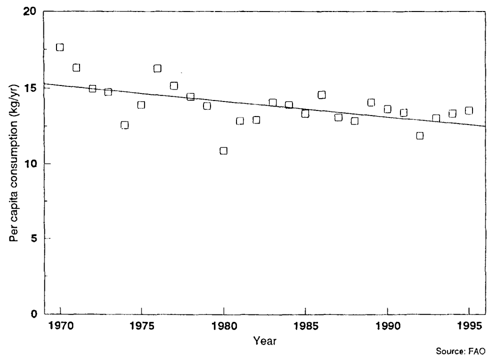
Figure 10. Protein Consumption from Various Sources, 1970-94
USA



Elasticities In both studies, expenditure elasticities of demand for pulses are higher than for rice and wheat, but lower than for milk and meat, indicating that as incomes go up, Indian consumers buy relatively more pulses than cereals, but less pulses than animal products. (Table 13) Price elasticities of demand for pulses are higher than for the cereals in both studies. For meat and milk, the outcome is not quite clear, as Kumar et al. (1994) estimate lower price elasticities of demand for pulses, while Radhakrishna and Ravi (1990) give higher elasticities for pulses. In either case, a one percent increase in pulse price leads to a 0.5% to 1.1% reduction in pulse consumption, which points very clearly to a supply constraint.

Using their estimated elasticities and assuming a 5% p.a. income growth and a 1.9% population growth rate, Kumar et al. (1994) have estimated growth in demand for pulses in India at 3.3% p.a. to the year 2010, which is comparable to a 1.1% increase in per capita consumption. Past trends do not bear out this prediction. Figure 11 shows a steady decline in consumption in India since 1970 from 16.3 to 13.3 kg per capita per annum. This is curious, as real incomes in India rose throughout the period. The only reasonable explanation for the reduction in consumption is the high growth in prices of pulses observed during this period.

Figure 11. Total Pulse Consumption in India, 1970 to 1995



Pulse Prices Too High Table 14 brings together changes in production, per capita availability, and real prices for selected pulses as well as "all pulses", wheat, rice, and milk. Pulses as a group registered a higher growth rate in price than wheat, rice, and even milk. Falling real (deflated) prices for wheat and rice attest to the impressive gains in productivity through technical change in these crops over the period during which per capita availability of wheat increased by 50%, and that of rice by 17%. At the same time, real prices of wheat and rice fell by 29% and 16%, respectively. Technological improvements in the dairy sector tell the same story: Gains in productivity through improved breeds and management resulted in an 85% increase in milk availability per capita in India over the 25-year period, while real prices rose by a mere 4%. By comparison, "all pulse" prices increased by almost 30%.

Table 14. Production, Per Capita Availability, and Price Indices of Selected Foods in India, 1970-72 and 1994-96

	Production ('000 MT)			Per capita availability (kg/yr)			Real-price indices (1970 = 100)		
	Triennium Average		Growth	Triennium Average		Growth	Triennium Average		Growth
	70-72	94-96	(%)	70-72	94-96	(%)	70-72	91-93	(%)
Wheat	23445	62742	167.6	44.6	67.2	50.8	94.8	67.2	-29.1
Rice	62269	120338	93.3	110.3	129.6	17.4	99.0	82.6	-16.4
Milk	21373	60948	185.0	38.9	72.0	85.1	108.0	111.8	3.5
Chickpeas	5275	5730	8.6	9.3	6.2	-33.1	101.3	141.3	39.5
Pigeonpeas	1803	3000	66.4	3.2	3.2	1.6	99.8	135.9	36.2
Lentils	390	792	103.1	0.7	0.9	35.2	120.0	138.4	15.4
Mungbean	595	1459*	145.3	1.1	1.7*	60.1	112.2	129.0	14.9
Blackgram	601	1675*	178.5	1.1	1.9*	82.2	126.6	115.0	-9.2
All Pulses	11446	15143	32.3	20.1	16.8	-16.6	106.0	136.6	28.9

* Based on 1990-92 triennium average

As for differences between pulse crops, chickpea and pigeonpea, which account for well over half the pulse production in India, have registered real price increases of 40% and 36% since 1970, more than any other food group. This dampenend any positive effects from rising incomes. Surprisingly, this rise in price had little effect on production. Throughout the 70s and 80s, the profitability of oilseeds and cereals rose relative to pulses; the former due largely to rising prices (Ashok Gulati, personal communication, 1997), and the latter by lowering per-unit cost of production through irrigation and adoption of improved cultivars. More than anything else, the lack of a technological breakthrough in pulses and slow growth in productivity (yields increased by a mere 0.6% per annum between 1970 and 1995) led to the shortfall in production in India. Because of import restrictions and the generally higher level of prices paid for imported pulses (world market price plus tariffs ranging between 35% and 20%, more recently 10%), per capita availability fell steadily at the rate of 0.7% p.a., or 16.6% over the period.

These findings clearly support a supply-constrained situation in India with respect to pulses. Demand does not appear to be limiting, as implied by the high expenditure elasticity of demand and high (negative) price elasticity of demand for most pulse crops. Population and income growth ensure a healthy long-term demand for this commodity in India, assuming prices can be kept down.

Can Supply Keep Up? In order to simply maintain per capita availability of pulses in India, production would have to increase at the rate of population growth, i.e., slightly less than 2% p.a. Production increases may occur from increases in area or yield. In the past, the area under pulses has remained stagnant while yields have increased by only 0.6% p.a. Yields in India currently average 610 kg/ha. Assuming no expansion in area, an increase of 1.9% p.a. to the year 2010 would require an additional 245 kg/ha, raising yields to 855 kg/ha. To achieve the required 3.3% p.a. aggregate growth in consumption estimated by Kumar et al. (1996), yields would have to increase to nearly 1000 kg/ha. Only a significant breakthrough in research and its rapid adoption would permit such an advance in India. New technologies exist, but much needs to be done to assess their potential and in identifying on-farm constraints that may limit their uptake.

The above scenario assumes that pulses will continue to be grown primarily on the land now allocated to them, i.e., the more marginal areas. A shift in government policy, resulting in a change in their price, relative to cereals and/ or oilseeds, could alter the situation dramatically. But as shown above, higher pulse prices have a major adverse effect on domestic demand. This brings out the major challenge for pulse research: How to close the gap between existing supply and unmet demand? In other words, what can be done to increase supply at a rate that would make pulses "cheaper"? Oram and Agcaoili (1994) suggested five possible solutions, the most promising being to increase productivity through technological change. They pointed out that "current pulse yields in most countries are both low and highly variable", which leads us to an analysis of yield variability. In an earlier paper, Muehlbauer et al (1996) indicated that technological progress in germplasm development for pulses was promising to alleviate multiple stresses in some pulses, thus making them more adaptable to adverse growing conditions. Later in this paper we discuss the possibility of closing the gap through imports.

4.3 Yield Variability

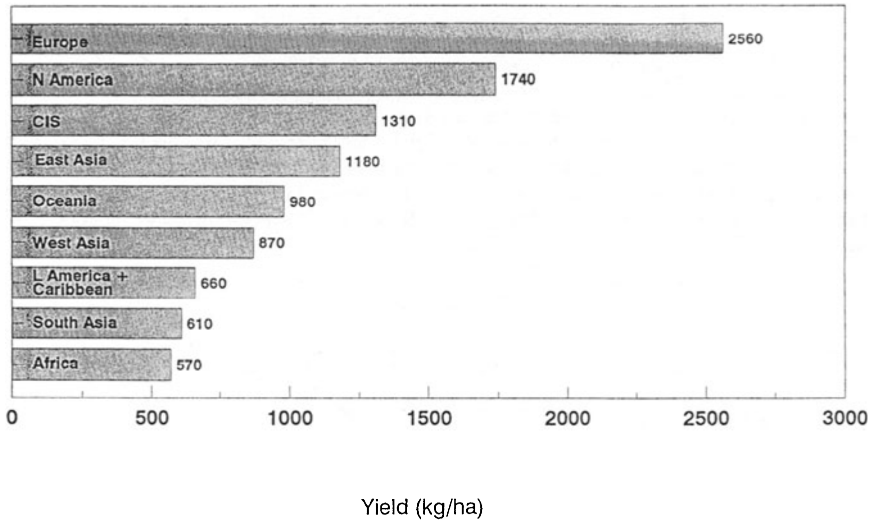
Productivity is defined as output relative to input use, without consideration of cost. However, output is most often measured relative to that input factor which is in shortest supply -- typically land. Thus, crop productivity is often measured as yield. As sustainability concerns are broadening the interpretation of legume productivity (see Byerlee and White, 1997), other measurements of productivity may need to be defined. This leaves unaffected the extreme output variability noted by Agostini and Khan (1988, p.464-465) and Oram and Agcaoili (1994, p.35-36). We undertake a closer look at this phenomenon.

4.3.1 Yield Variation between Regions

To understand pulse production and outputs, one must consider the basic systems in which they are grown. This also provides an indication of the factors in short supply.

Figure 12 shows the yield levels in each of the major growing regions of the world. Yields in Europe and North America are triple and double the world average of 810 kg/ha. Adding CIS and Oceania, the developed countries achieve yields of 1640 kg/ha as opposed to 670 kg/ha for the developing countries (Africa, Asia, and Latin America and the Caribbean). Which factors account for these differences?

Figure 12. Total Pulse Yields, Regional Averages, 1994-96



Climate/Soil: Most of the developed countries are in the temperate zone, where lower temperatures and longer days during summer provide an environment conducive to high yields. Evapo-transpiration is lower, and moisture stress is not as frequent in these environments. In the tropics or sub-tropics where most developing countries are located, double cropping is a common practice in systems which include pulses, which tends to reduce the individual yields of each crop. -- There is a low rainfall in much of the tropical rainfed area and terminal heat/drought stress and poor, highly degraded soils occur, particularly in Africa. Short-duration pulse varieties would be one answer to the challenge faced by producers in developing countries (Kumar et al., 1996).

Subsistence: Agricultural production continues to have a subsistence objective in many of the developing countries, as opposed to the highly commercial production of developed countries, especially those who do not protect their farmers from world competition. Where farmers produce primarily for the market, they adjust factors of production in response to relative prices, i.e., productivity for all factors would be higher in such systems. Where employment opportunities exist outside of agriculture, labor productivity will be much higher than in subsistence agriculture, and all limiting factors will be used to produce as much as possible for the market. Farmers in a subsistence situation will exert less effort in raising yields if the meeting of household production targets, which change little from year to year, is the objective.

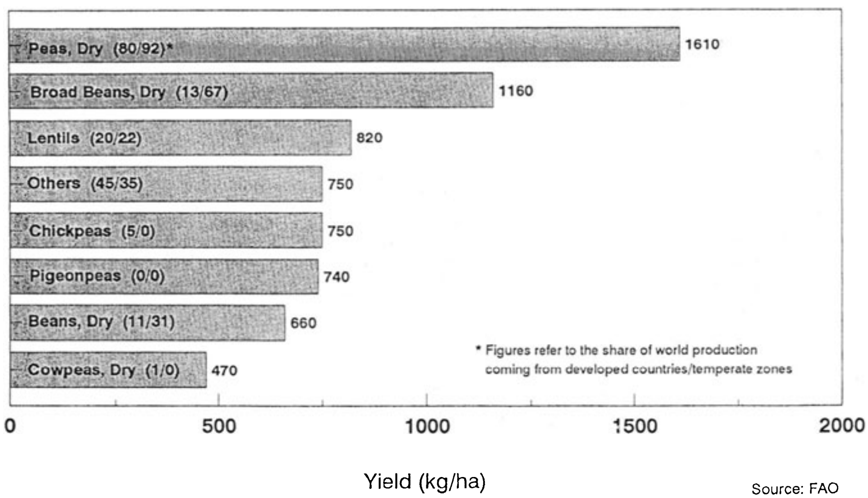
By-Products: Producers in developing countries often have a need for non-grain by-products (Kelley et al., 1996; Kelley et al., 1993). For pulses, this includes fodder (e.g., cowpea, pigeonpea, lentil) or fencing (pigeonpea). Grain yield would then be only one of several objectives, and lower (grain) yields would be the opportunity cost of meeting multiple objectives.

Level of Development/ Infrastructure: The general level of development determines the support for agriculture indirectly in terms of infrastructure, and more directly as income support. Better infrastructure provides easier access to inputs such as seed, fertilizer, pesticides, mechanization, and credit. It also means more highly developed markets, better transport, and information services. All this translates into higher yields not only for pulses, but all crops. In addition, research investments -- public and private -- are higher in developed countries (Gowda et al., 1997). Where economies mature, agriculture releases labor into higher-paying occupations, which puts pressure on governments to provide "parity" for the remaining agricultural population, leading to agricultural support policies. These are in place in many developed countries (e.g., EC and other European countries, Japan) or were until recently (e.g., USA, New Zealand, CIS), which can have a direct effect on pulse yields[14] (e.g., dry peas in France). Agriculture in developing countries, on the other hand, is often net-taxed (Gulati and Sharma, 1995). Where policies have been favorable to agriculture, cereal crops such as wheat and rice have benefited often at the expense of pulses and coarse cereals (Gulati and Sharma, 1997).

4.3.2 Yield Variation Between Pulse Crops

Average global yields for specific pulse crops are shown in Figure 13. Dry peas, 80% of which are produced in developed countries, register the highest average yields at 1.6 t/ha. More than any other pulse crop, dry peas, whether grown in developed or developing countries, appear to have comparatively higher yields. This is illustrated in Table 15 where dry pea yields are higher than "total pulses" yields in virtually every region. In West Asia, for example, yields of dry peas are almost 2 t/ha, compared to the region's average total pulse yield of 0.9 t/ha. This points to a *crop-specific effect* underlying variations between regions which may partly result from "more sophisticated research attention" afforded certain (usually non-tropical) pulses (C Johansen, personal communication, 1997).

Figure 13. Average Global Yields for Specific Pulse Crops, 1994-96



Broad beans are the next highest yielding with 1.2 t/ha most of which is produced in East Asia mainly China. Much of the crop area is in the temperate zone. A similar type crop-specific effect is also evident for broad beans, but more difficult to tease out because of the obvious regional (temperate climate) effect. Yield levels of lentil, chickpea, pigeonpea, and dry beans are roughly similar -- 820 to 660 kg/ha, and the vast majority of these is produced in developing countries. Cowpea, grown almost exclusively in Africa, a particularly disadvantaged region in the warm tropics, has the lowest yields at 470 kg/ha.

[14] If there is no upper limit to total payments, producers will increase non-land inputs to achieve higher output. In the case of set-aside requirements, it is usually the poorest land which is set aside, thus leading to an increase of average productivity across the remaining cropped land.

As already discussed in Section 4.3.1, differences in pulse crop yields at the global level can be explained in part by regional effects[15]. Nevertheless, there also appear to be crop-specific effects, as the data in Table 15 illustrate for dry peas and broad beans.

Table 15. Average yields (kg/ha) of Major Pulses by Region for the period 1994-96.

	World	Africa	Asia			L Amer + Carib	CIS	Europe	N Amer	Oceania
			East Asia	West Asia	South Asia					
Beans,	**660**	700	1,030	1,340	430	640	1,140	900	1,810	640
Peas,	**1,610**	680	1,540	1,950	830	860	1,350	4,030	1,950	1,100
Chickpeas	**750**	560	660	740	760	1,220	-	580	-	970
Pigeonpeas	**740**	730	630	-	750	730	-	-	-	-
Broad Beans	**1,160**	1,230	1,730	1,860	-	710	-	1,820	610	1,100
Lentils	**820**	600	1,150	920	880	750	930	670	1,260	1,050
Cowpeas	**470**	460	690	970	-	710	-	2,890	900	400
Others	**750**	480	990	820	510	880	1,190	1,840	-	950
Tot. Pulses	**810**	**570**	**1,180**	**870**	**610**	**660**	**1,320**	**2,560**	**1,740**	**980**

4.3.3 Yield Variations within Regions over Time

As geography and type of pulse crop influence yield levels, so does development over time as expressed in growth rates. More than the other two measures, yield growth reflects variable inputs. Of greatest interest to scientists are the medium- and long-term growth rates which reflect technological progress and/ or rates of return on inputs. Table 16 shows yield growth rates of total pulses for the period 1980-1996.

Table 16. Yield Growth Rates (% per annum) of 'Total Pulses', 1980-96 and 1990-96, by Region

Region	1980-96	1990-96
Africa	0.12	1.09
East Asia	0.26	0.07
West Asia	-1.03	0.21
South Asia	1.68	1.83
L. Amer +Carib	1.42	1.83
CIS	1.76	-2.91
Europe	6.73	-0.39
N. America	0.78	-0.70
Oceania	-0.06	-0.14
World	**1.26**	**-0.78**
Developing	0.72	0.35
Developed	3.05	-1.20

Overall, developed countries achieved the highest growth in yields of 3.1% per annum, compared to less than 1% per annum for the developing countries. Europe had an impressive 6.7% annual growth rate due mainly to strong support policies, but made possible by higher inputs. Yields stagnated in Africa, East Asia, and Oceania, and shrank in West Asia. North America had a slight growth, while South Asia and Latin

[15] For example, average yields for dry beans are low for the developing country regions (Africa, South Asia, Latin America/Caribbean), moderate for East Asia (of which much is temperate), and high for North America. The case of lentils is similar, though not as dramatic. For chickpea, where the major producers are located in tropical climates under low rainfall conditions, Oceania (primarily Australia, which is a developed country) has yields roughly 30% higher than South and West Asia, pointing to a developed country (infrastructure) effect. Pigeonpea yields are low relative to other pulse crops and they are grown exclusively in developing countries.

America and the Caribbean increased their yields by about 1.5% per annum. The factors accounting for the inter-regional differences are related to[16]:

a) level of development/ infrastructure (see 4.3.1. above)

b) crop-specific effects (see 4.3.2. above)

c) changes in cropping pattern: Pulse crops are being pushed into more marginal lands and this fact in sometimes reflected in declining, static, or slow-growing yields, e.g., chickpea in India (Kelley and Parthasarathy Rao, 1994) or sorghum in many parts of Africa (ICRISAT/FAO, 1997). Alternatively, as crop area expands into better endowed regions due to price changes, average yields can grow without technological change, which would be visible in a high correlation between yield increase and area increases.

d) Statistical anomaly: Area reductions (increases) in countries where pulse yields are above (below) the regional average will have a depressing (inflating) effect on yield growth rates even without any changes in the other countries' yields.

e) Base-yield level: All other factors being equal, growth rates will tend to be higher the lower the base level. Of course, low base yields are highly correlated with the developing region effect, and hence this effect may be difficult to tease out.

4.3.4. Yield Stability

Variability in yield is a major source of production instability and merits close investigation. In this analysis the coefficient of variation (CV) in yields is used as a measure of yield variability. The CV around the trend[17] was calculated for major pulse crops for each of the world regions using yield data from 1980 to 1996. Only the CVs for pulses which have at least 2% of the world share in any region are listed (Table 17).

Table 17. Pulse Yield Variability (as CV %) between 1980 and 1996 for Major Pulse Crops, by Region (1980-96)

	World	Africa	Asia			L Amer +Carib	CIS	Europe	N Amer	Oceania
			East Asia	West Asia	South Asia					
Beans	2.9	3.3	7.8	**	6.4	8.1			6.5	
Peas	10.8		9.8				19.6	8.3	10.3	17.3
Chickpeas	6.8			7.7	8.6		-		-	24.8
Pigeonpeas	6.1			-	7.0		-	-	-	-
Broad Beans	9.8	9.7	10.7		-		-	11.4		37.4
Lentils	6.4			13.4	5.7				19.3	
Cowpeas,	10.7	11.3					-			
Other	7.9	6.6	2.7		4.2			12.8	-	14.0
Tot. Pulses	4.0	4.1	6.9	7.6	4.6	7.1	18.3	12.2	6.2	14.4

*CV (coefficient of variation) was calculated after detrending the yield data using linear estimation.

*Blank cells indicate the region's share was less than 2% of world production.

At the global level, dry peas, cowpeas and broad beans have the largest CV values (10.8%, 10.7%, and 9.8%, respectively), indicating that these crops exhibit the greatest yield variability. The source of this instability can be ascertained from the table where yields of dry peas in CIS are shown to be extremely variable (CV = 19.5%), as they are in Oceania (CV = 17.3%). They are more moderate in Europe (8.3%) and N. America (10.3%). The high CV in CIS probably reflects the seemingly wild swings in production--due to area and yield changes--throughout the 80s and first half of the 90s, but particularly the latter. High CVs in Oceania are generally characteristic of that region due to great weather variability. Additionally, Oceania is, with respect to pulse geographic area, relatively small, compared to other regions (South Asia, Africa, etc.),

[16] It is beyond the scope of this paper to attempt to econometrically model differences in current yield levels, yield growth rates, or yield variability over time for pulses. We simply indicate those factors thought to be most relevant.

[17] That is, the standard error of regression divided by the mean, i.e., a de-trended CV. This is almost identical to the Cuddy-Della Valle index (Singh and Byerlee, 1989).

and there is less scope for smoothing out the fluctuations in yield from one sub-region to another, as for example in South Asia, or even within India.

The high CV for cowpeas suggests that year to year yield variability on this low input crop is probably strongly influenced by climatic events, rainfall mainly, in Africa. Note as well the relatively high CV for broad beans in Africa (9.7%), another low input pulse crop of which only a small amount is grown, mainly in Egypt. Dry beans have the lowest CV of any pulse crop, 2.9%. However, this is very likely due to the fact that "dry beans" includes numerous species and year to year variability in one species is averaged out by the others.

Yield stability is influenced by factors such as climate, irrigation, degree of commercialization, political and economic instability, and geographic coverage. Table 18 illustrates a few of these points. For instance, the CV of yields for chickpea and pigeonpea are higher in Rajasthan, an arid region, compared to Madhya Pradesh, a higher rainfall region. The CVs at the all-India level are lower compared to the individual states as India has a large geographical coverage, so that the variations in yield tend to average out.

Table 18. Yield Variability, (as coefficients of variation) for Selected Crops in India and Australia*

	Chickpea	Pigeonpea	Wheat
All-India	7.7	8.5	3.4
Madhya Pradesh(Semi-arid)	7.4	16.8	6.1
Rajasthan (Arid)	13.9	45.2	12.9
Australia	25.0		18.0

*CV (coefficient of variation) calculated after detrending the yield data. Data for chickpea and wheat: India, M.P. and Rajasthan, 1980-94. Pigeonpea: India and M.P., 1980-94; Rajasthan, 1980-92. Data for Australia for wheat from 1980-96 and for chickpea, 1983-96.

Source: Government of India, Agricultural Statistics at a Glance, 1994

The more market-oriented a farm economy, the more responsive its output will be to product and input prices. This may lead to large year-to-year fluctuations compared to production in countries where the crop is grown largely for subsistence. Figure 14 illustrates the case of India and Australia. Chickpea production in Australia roughly follows the trends in market price, while chickpea production in India appears almost unrelated to price. Thus the CVs in Table 18, which are considerably higher for Australia than for India, may also be explained by level of commercialization. Climatic variability in Australia probably contributes significantly as well, as does the narrow range of crop geographic area.

Finally, political, social, and economic instability probably play a role in variability in yields, i.e., high CVs, as characterized by the CIS since the early 1990s.

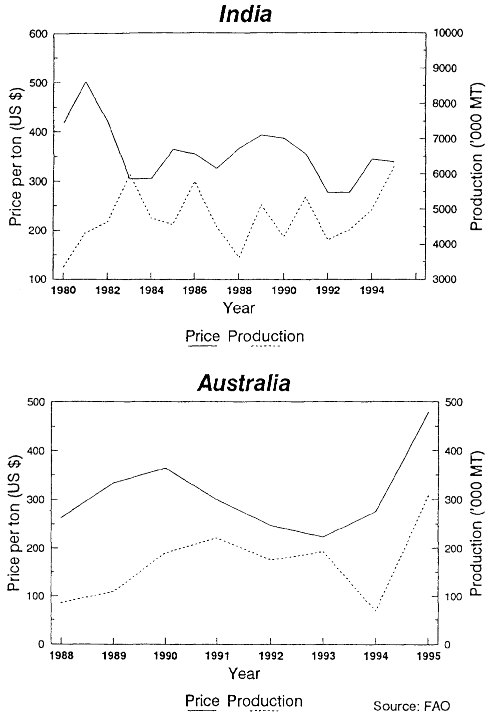
5. POINTS TO PONDER WHEN HAZARDING PREDICTIONS

The world market for pulses has been strongly influenced by unexpected developments over the past 15 to 25 years. These range from advances in competing crops such as Green Revolution cereals and soybean, and competing foods such as milk, meat, and vegetables, over government policies as varied as soyameal replacement in the EC (Gent, 1994), withdrawal of rail rate subsidies in Canada (Thompson, 1997; McVicar et al., 1997), and change of whole political systems (break-up of the former USSR and an export regime for Myanmar, formerly Burma), to technological progress in pulse production such as fallow replacement in Turkey (Acikgoz et al, 1994) and new methods of cultivar selection (Muehlbauer et al., 1996), to advances in pulse utilization (such as the semi-prepared pulse-based convenience foods and extruded snack foods now appearing on supermarket shelves in Indian cities), to name just a few. Byerlee and White (1998) discuss some of the more complex issues in pulse production systems.

The reversible (policies) as well as irreversible (technological progress) changes in the pulse economy have had a marked impact on market volumes and players, as discussed in Section 3 above. Many of the changes were unpredictable, and we believe they are likely to occur again in other forms in the future. Scientists concerned with world food issues have been waiting for technological breakthroughs in pulse production. The question of if, when and how there will be a "Green Revolution in pulses" continues to be discussed (Muehlbauer and Kaiser, 1994.) Therefore, we are unlikely to produce correct medium-term predictions for any market details. Only five years after Agostini and Khan's paper (1988), Oram and

Agcaoili (1994) dismissed FAO predictions, and any predictions based on production trends during the late 1980s did not hold for the early 1990s.

Figure 14. Chickpea Production and Prices



What we can discuss are the factors which will influence pulse production and markets. Oram and Agcaoili (1994) provided a list to which we have added other factors (Table 19).

Table 19. Factors Affecting Pulse Demand and Supply

		Demand	Supply
Social	Population growth	+	
	Migration/Tourism	+	
	Urbanization/Convenience foods	?	
	Concern for the poor	?	?
Dietary	Health Concerns	+/-	
Economic	Currency convertibility		+
	Import substitution	-	+
	Free Trade	+	-/+
Agricultural/ Environmental	Sustainable systems		+
	Reduced chemicals		+/-
	High cost of production	-	-
	Yield Variability		-
Infrastructural	Research investments		+
	New Uses	+	
	Transportation	+	+
	Intelligence/Communication	+	+

Source: Adapted from Oram and Agcaoili, 1994

Social factors:

* Population growth, especially in India and China, will not have as strong an impact on demand as assumed earlier given the decline in per-capita consumption of pulses in those nations. Even though consumption of animal protein has gone up in both cases, the growth rate for feed use of pulses in their respective world region have been relatively low: 1.7% for India, and 0.3% for East Asia.

* Migration and tourism, have caused ethnic foods to become available all over the world. These activities are also introducing pulse-based dishes from South Asia and Latin America to affluent populations in developed countries. This is illustrated by the fact that Trinidad and Tobago, with a large population of ethnic Indians, boasts the world's highest pigeonpea yields of 1,620 kg/ha. The U.S.A., which is home to many immigrants from Latin America and South Asia, and also to a fast food chain called *Taco Bell* which offers Latin American bean dishes, has just seen an increase in the per capita intake of protein from pulses from the long-term level of 2 grams per day to 3 grams per day[18]. It would not surprise us to see a fast food chain emerge which offers Indian food.

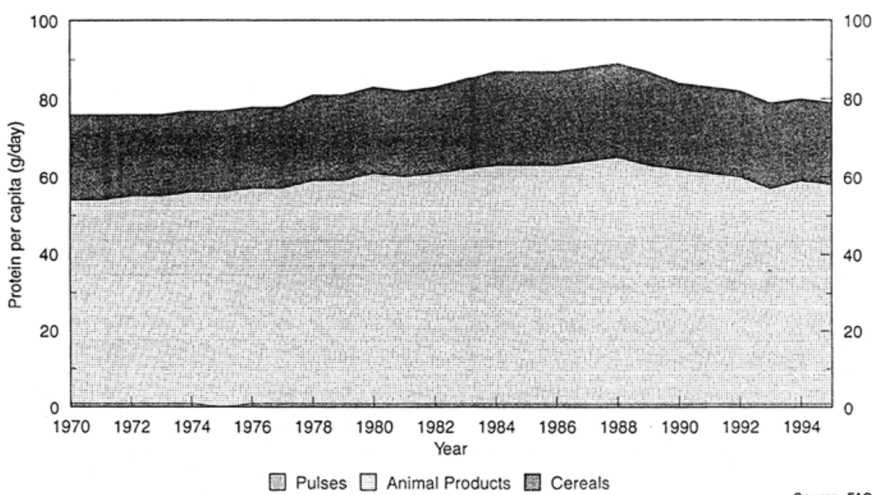
* Urbanization, while reducing the importance of traditional pulse dishes, contributes to acceptance of non-traditional pulse preparations which arise out of imports, inter-regional trade, and new cultivars. It also gives rise to a demand for convenience foods, especially since dry pulses require long cooking times. In India, "Ready-to-mix" pulse preparations are fast entering supermarkets; in the U.S., pulses are sold frozen (Oram and Agcaoili, 1994); and Nestle Lanka is using mung beans in infant meals (Kana, 1997).

* A concern for the poor is behind much of the aid to developing countries, and is behind aid targeted specifically to small farmers in poorly endowed environments. This could influence investments in pulse research increasing production as well as alternative rural development which would take the poorest soils out of production.

Dietary factors:

- Health concerns in protein-saturated countries are not as yet showing up as an increase in pulse consumption. However, there has been a decline in consumption of all protein, corresponding to the decline in animal protein, in Germany, which has an affluent and health-conscious population and many "new" vegetarians (Figure 15).

Figure 15. Protein Consumption from Various Sources, 1970-94
Germany



Source: FAO

[18] The change occurred in 1995 (FAOSTAT, 1997). Many countries report only whole numbers in this statistic, which leads to distortions.

* Reduced meat consumption can be expected to lower the demand for feed pulses; a trend which is concealed by the agricultural policies promoting feed pulse utilization in Europe, which has the world's highest growth rate for feed use.

Economic/ political factors:

* The alternative to producing domestic pulse requirements is to meet them through imports. Trade has played a minor role in many developing countries in the past, but is likely to become more important if domestic policies on trade and exchange rates are changed. Pakistan, for example, has opened its markets to pulse imports at the expense of domestic production (Kyi et al., 1997). How readily consumers take to imported commodities will depend on their quality and price.

Exchange rates are extremely important to agriculture. Myanmar's export expansion followed a devaluation of the kyat (Kyi, 1997). In India, full convertibility of the rupee would benefit domestic pulse producers who would not only gain from higher prices as imports became more expensive, but also improve their competitive position relative to oilseeds.[19]

* Import substitution in the EC was the driving force behind the pulse expansion in Europe discussed above. A reversal will further reduce the size of the world feed pulse economy, but will re-open markets for non-EC imports.

* The World Trade Agreement (Uruguay Round of GATT) "reduced and bound domestic agricultural subsidies" to lay open trade distortions and encourage a higher degree of free trade, which allows agricultural production to move to locations of comparative advantage and which decreases instability in the world markets. The U.S.A. made sweeping changes in their 1996 farm legislation; the EC passed one agricultural reform packet in 1992 and is discussing further changes to a system of direct income support (Thompson, 1997).

Agricultural/ environmental factors:

* Pulses are beneficial to cropping systems (Byerlee and White, 1998). As a result of concerns about sustainability, pulses may be made integral to international aid for agricultural development and also to new income support measures in the EEC.

* Penalties for high-input of fertilizers in Europe would reduce production costs of pulses there.

Infrastructural factors:

* Research investments in pulses have been relatively low, and more so in developing countries (Gowda et al, 1997). More funds could direct more research attention to technological breakthroughs in pulses, which would bring down their prices and increase supply and demand.

* "New Uses" would also benefit from research attention and could open up new markets for pulses as such programs have done elsewhere, e.g., biodegradeable plastics and ink from maize in the U.S.A.

* Transportation is crucial to market development and trade. Breakthroughs in this area would have a high impact on the pulse economy.

* Information and communication are important to efficient market development and trade. With increased trade in pulses and an integration of the markets for developed and developing countries, we should expect higher investments in market research and marketing efforts all over the world.

6. Summary and Conclusions

The expansion in the pulse economy of the 1980s and present stagnation are in fact a "bubble" largely based on only two regions, the USSR and the EC, where agricultural subsidies created a supply of dry peas which was utilized domestically as feed with the help of a second set of subsidies to processors (EC) (Hubertus Wolfgarten, personal communication) or as a direct subsidy to the livestock industry (USSR) (Thompson, 1997). With the break-up of the USSR and the reforms to the CAP, the bubble burst. We would assume the world pulse economy to return to a scenario of slow, but steady growth in production and consumption of pulses for food (mostly in developing countries, but also for select quality in developed countries) and feed (mostly in developed countries). Trade will play an increasingly important role in the pulse economy, and the sophisticated marketing techniques of developed country exporters can be expected to have an impact on developing country markets, particularly if coupled with improvements in infrastructure.

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[19] Pulse producers switched over to soybean, rape/ mustard, sunflower and groundnut as a result of the 1986 Technology Oilseeds Mission set up to reduce imports of edible oils (Ashok Gulati, personal communication). We would expect edible oils to be imported if India would open up the markets.

Protein deficiency in developing-country diets is not directly related to declining per capita intake of pulse protein. We have shown that people in all but the poorest developing countries are consuming increasing amounts of protein from animal sources in addition to cereals. Even in India, animal products have overtaken pulses as a source of protein in the human diet. However, pulse consumption would increase considerably if their price came down.

A review of the supply/demand balance for India points to a supply-constrained situation for pulses, at least in the short to medium term. Declining consumption of pulses is related to slow growth in productivity, rendering pulses relatively less profitable than competing crops. This has resulted in production shortfalls and a subsequent rise in real prices, pushing pulses which exhibit price elasticities of demand between -0.5 and -1.1 further out of the diet.

Yield variability, a major problem in the pulse economy, is influenced by factors such as climate (especially rainfall), political, social, and economic instability, access to irrigation, degree of commercialization or price responsiveness, and geographical coverage. A coefficient of variation can be constructed for comparisons between pulses produced in different regions. It might also help in defining strategies to assure greater stability in world food supply.

International and interregional trade is becoming a major factor in the world pulse economy as markets are opening up, allowing production to begin to move to the relatively "best" location, promising higher welfare to all market participants. At the same time, concerns for sustainability are being built into the development and agriculture policy agenda. For pulses, this may imply a re-focusing on the more poorly endowed, rainfed environments and the need to re-define productivity of pulse systems in terms of a factor that may well prove to be scarcer than land: water.

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References

Acikgoz, N., Karaca, M., Er, C. and Meyveci, K. 1994. In: *Expanding the Production and Use of Cool Season Food Legumes.* pp 388-98 (eds F.J. Muehlbauer and W.J. Kaiser). Kluwer Academic Publishers.

Agostini, B.B. and Khan, D. 1988. In: *World Crops; Cool Season Food Legumes*, pp 461-82 (ed R.J. Summerfield). Kluwer Academic Publishers.

Byerlee, D. and White, R. 1998. In *Proceedings IFLRC-III: Linking Research and Marketing Opportunities for the 21st Century.* (ed. R. Knight) Dordrecht: Kluwer Academic Publishers (in press).

Carrouee, B., Gent, G.P. and Summerfield, R.J. 1997. In *Proceedings IFLRC-III: Linking Research and Marketing Opportunities for the 21st Century.* (ed. R. Knight) Dordrecht: Kluwer Academic Publishers (in press).

FAO (Food and Agriculture Organization of the United Nations). 1997. FAOSTAT Production, Utilization and Trade Tapes.

ICRISAT and FAO. 1997., FAO Commodities and Trade Division and the Socio-Economics and Policy Division, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Gent, G.P. 1994. In: *Expanding the Production and Use of Cool Season Food Legumes.* pp 361-66 (eds F.J. Muehlbauer and W.J. Kaiser) Kluwer Academic Publishers.

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 Xuxiao. 1998 In *Proceedings IFLRC-III: Linking Research and Marketing Opportunities for the 21st Century.* (ed. R. Knight) Dordrecht: Kluwer Academic Publishers (in press).

Gulati, A. and Sharma A. 1997. *Agricultural Trade Liberalization and Efficiency Gains - An Analysis of Major Indian Crops.* NCAER/ICRISAT study. Unpublished Report.

Gulati, A. and Sharma, A. 1995. *Subsidy Syndrome in Indian Agriculture. Economic and Political Weekly, September 30.*

Kana, N.L. 1997. *Pulses Trade Study. Paper presented at the Regional Workshop on Market Prospects of Upland Crops in Asia,* in Bogor, Indonesia, 25-28 February.

Kelley, T.G., P. Parthasarathy Rao, E. Weltzein R. and M.L. Purohit 1996. *Experimental Agriculture*: 32 (2): 161-172.

Kelley, T.G. and P. Parthasarathy Rao 1996. In *Adaptation of Chickpea in the West Asia and North Africa Region* pp. 239-254 (eds N.P. Saxena, M.C. Saxena, C Johansen, S.M. Virmani, and H. Harris.). ICRISAT/ICARDA, 1996.

Kelley, T.G. and P. Parthasarathy Rao 1994. *Economic and Political Weekly*: 29 (26): 89-100.

Kelley, T.G., Parthasarathy Rao, P. and Walker, T.S. 1993. In *Social Science Research for Agricultural Technology Development: Spatial and Temporal Dimensions.* pp. 88-105 (ed Dvorak K.) CABI, London.

Kumar, P. 1996. *Market Prospects for Upland Crops in India.* Working Paper No. 20. The CGPRT Centre, November 1996.

Kumar, J., Sethi, S.C., Johansen, C., Kelley, T.G., Rahman, M.M., and Van Rheenen, H.A. 1996. *Indian Journal Dryland Agriculture Research & Devolopment.* 11(1), 28-32.

Kyi, H. 1996. *Production, Consumption and Marketing of Selected Pulses in Myanmar.* Unpublished Report, Yangon, July 22.

Kyi, H., Mruthyunjaya, Khan, N.A., Liyanapathirana, R. and Bottema, J.W.T. 1997. *Market Prospects for Pulses in South Asia: International and Domestic Trade.* Working Paper 27, The CGPRT Centre, Bogor, Indonesia.

McVicar, R., Slinkard, R.E., Vandenberg, A. and Clancey, B. 1998. In *Proceedings IFLRC-III: Linking Research and Marketing Opportunities for the 21st Century.* (ed. R. Knight) Dordrecht: Kluwer Academic Publishers (in press).

Mueller, R.A.E., Parthasarathy Rao, P., and Subba Rao, K.V. 1990. In *The Pigeonpea* (ed Nene, Y.L.), UK: CAB International.

Muehlbauer, F.J., Johansen, C., Singh, L., and Kelley, T.G. 1996. *Crop Improvement - Emerging Trends in Pulses.* Paper presented at the 2nd International Crop Science Conference in New Delhi, November.

Oram, P.A. and Agcaoili, M. 1994. In: *Expanding the Production and Use of Cool Season Food Legumes.* pp 3-49 (eds F.J. Muehlbauer and W.J. Kaiser). Kluwer Academic Publishers.

Pachico, D. 1993. In Trends in CIAT Commodities, 1993. Working Paper No. 128, July. CIAT.

Pala, M., Armstrong, E., and Johansen, C. 1998. In *Proceedings IFLRC-III: Linking Research and Marketing Opportunities for the 21st Century.* (ed. R. Knight) Dordrecht: Kluwer Academic Publishers (in press).

Parthasarathy Rao, P. and Von Oppen, M. 1987. pp. 54-63 In *Food Legume Improvement for Asian Farming Systems:* Proceedings of an International Workshop, 1-5 September, 1986, Khon Kaen, Thailand (Wallis, E.S. and Byth, D.E. eds) Canberra, Australia: ACIAR

Radhakrishna, R. and Ravi, C. 1990. *Food Demand Projections for India.* Hyderabad, A.P., India: Centre for Economic and Social Studies.

Roberts, E.H. 1994. In: *Expanding the Production and Use of Cool Season Food Legumes.* pp 983-8 (eds F.J. Muehlbauer and W.J. Kaiser). Kluwer Academic Publishers.

Singh, U., Williams, P.C. and D.S. Petterson. 1998 In *Proceedings IFLRC-III: Linking Research and Marketing Opportunities for the 21st Century.* (ed. R. Knight) Dordrecht: Kluwer Academic Publishers (in press).Singh, A.J., and Byerlee, D. 1989. Indian Journal of Agricultural Economics

Thompson, R.L. 1997. *Presidential Address,* XXIII International Conference of Agricultural Economists, Sacramento, California, USA, 10 August.

Walker, T.S. 1987. In *Food Legume Improvement for Asian Farming Systems*: pp. 208-10 Proceedings of an International Workshop, Khon Kaen, Thailand (eds Wallis, E.S. and Byth, D.E.) Canberra, Australia: ACIAR.

World Bank. 1997. *World Development Indicators.* The World Bank, Washington, D.C.