2. Legumes in Bangladesh

M Matiur Rahman[1], M A Bakr[2], M F Mia[2], K M Idris[3], C L L Gowda[4], Jagdish Kumar[4], U K Deb[4], M A Malek[2], and A Sobhan[5]

Abstract

Food legume crops occupy about 5% of cropped area of Bangladesh but play a significant role in rainfed agriculture. About a dozen legume crops are grown in Bangladesh of which khesari (lathyrus), lentil, chickpea, black gram, mung bean are the major pulses, and groundnut is an oilseed crop. Their cultivation is mainly concentrated in the Gangetic floodplain area. The productivity of these crops is much lower compared to the cereals, and compared to the potential productivity of these legumes, due to various biotic, abiotic, and socioeconomic constraints. Among the biotic stresses, diseases, pests, seed dormancy, and weeds cause significant yield losses. The major diseases are botrytis gray mold, fusarium wilt, and collar rot in chickpea; foot rot, stemphylium blight, and rust in lentil; powdery mildew and downy mildew in khesari (lathyrus); yellow mosaic, cercospora leaf spot, and powdery mildew in black gram and mung bean: and leaf spot, rust, foot rot, and root rot in groundnut. Among the insect pests, Helicoverpa armigera *is a major pest of chickpea and black gram;* Diacrisia obliqua *is a major pest of black gram, mung bean, and groundnut; aphids are common in lentil, khesari (lathyrus), and mung bean;* Euchrysops cnejus, Monolepta signata, *and* Bemisia tabaci *are the major pests of mung bean and black gram. Among the storage pests* Callosobruchus chinensis *infests all pulses except black gram, which is attacked only by C.* maculatus. *Lack of seed dormancy is a major constraint in groundnut and mung bean cultivation. Weeds are a very common problem in all legume crops and in all growing zones. Among the abiotic constraints, drought causes severe yield reduction in some years. Sometimes excess rain and high humidity encourage vegetative growth, in turn leading to high disease and pest incidence and resultant yield loss. Terminal heat stress and rainfall also cause substantial yield loss. In some areas, micronutrient deficiency and soil acidity limit legume cultivation. Among the socioeconomic constraints, low profit, instability of yield, and lack of support price influence the farmers to follow the traditional practices for legume cultivation which inevitably result in poor yields. The area and production of these legume crops are generally declining. The government has consequently launched a Pilot Production Program on lentil, black gram, and mung bean to halt the declining trend. Details of the constraints and the opportunities to fit the legumes in new and diversified cropping systems in Bangladesh are discussed in this chapter.*

1. Regional Agricultural Research Station, Ishurdi, Pabna, Bangladesh.
2. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh.
3. Soil Resources Development Institute (SRDI), Dhaka Regional Office, 803/1 West Kazipara, Mirpur, Dhaka, Bangladesh.
4 ICRISAT, Patancheru 502 324, Andhra Pradesh, India.
5. Agricultural Support Service Program, Khamarbari, Dhaka, Bangladesh.

Introduction

Food legumes, particularly pulses, play a significant role in rainfed agriculture and in Bangladeshi diets. They occupy the second largest cropped area after rice *(Oryza sativa* L.) in the country (5.2% of the total cropped area) (BBS 1993; 1994). The major pulses grown are khesari *(Lathyrus sativus* L.; lathyrus; grass pea), lentil *(Lens culinaris* Medic), chickpea *(Cicer arietinum* L.), black gram *(Vigna mungo* (L.) Hepper), mung bean *(Vigna radiata* (L.) Wilczek), and cowpea *(Vigna unguiculata* (L.) Walp.) and they contribute to more than 95% of total pulses production in the country. Groundnut *(Arachis hypogaea* L.) is the second most important oilseed crop after rapeseed mustard *(Brassica* sp) in Bangladesh, although it is consumed almost entirely as a confectionery product (roasted nut). Other food legumes are also grown in the country but are of minor importance and will not be further discussed here. These include pigeonpea *(Cajanus cajan* (L.) Millsp.), pea *(Pisum sativum* L), faba bean *(Vicia faba* L.), lablab bean *(Lablab purpureus* (L.) Sweet), and soybean *(Glycine max* (L.) Merr.).

Food legumes have traditionally been cultivated under rainfed conditions, usually without any monetary inputs. The productivity of these c rops is low compared to wheat (*Triticum aestivum* L.) and rice. Farmers consider that food legumes do not respond to high inputs of irrigation and fertilizer in the same way as cereals do. Their inherently low yield potential, susceptibility to diseases and pests, and sensitivity to microclimatic changes, contribute to their yield instability. Farmers generally pay little attention to cultivation of pulses, particularly to good quality seed, timely sowing, adequate land preparation, fertilization, weeding, and plant protection. This normally results in very low yields. Since Bangladesh has an acute shortage of food grain production, cereal cultivation receives top priority. With the expansion of irrigation facilities farmers prefer rice-rice or rice-wheat cropping systems and legumes are continuously being relegated to marginal lands. The area and production of some legumes such as lentil, chickpea, and mung bean have decreased over the past decade.

Although some legumes, such as *Sesbania* spp, are cultivated as green manures, there is little quantitative information on these and so they will not be discussed in this chapter.

The objectives of research on legumes in Bangladesh have been to develop improved varieties and new technology packages, and to explore new avenues for these crops in the existing cropping systems so as to halt the declining trend in area and production. In this chapter, the current situation for grain legumes in Bangladesh and the recent trends in area, production, and yield are presented. This information is combined with available physical, biological, and economic databases to explore constraints and opportunities for legumes in the country.

Area, Production, and Yield of Grain Legumes

Distribution of the major grain legumes in Bangladesh is indicated in Figures 2.1-2.6. Cowpea is grown after rainy season rice in Chittagong

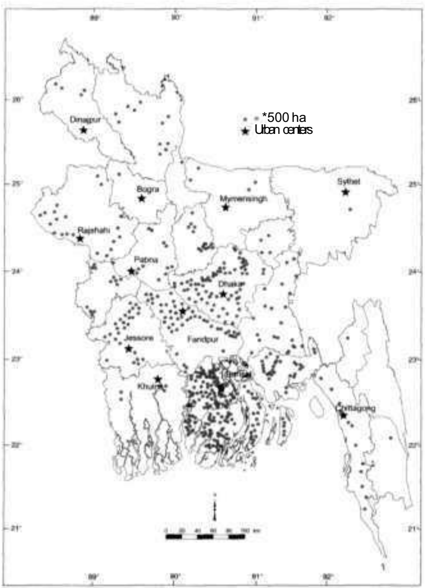

Figure 2.1. Area distribution of khesari (lathyrus) in Bangladesh, 1993-96 (Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh).

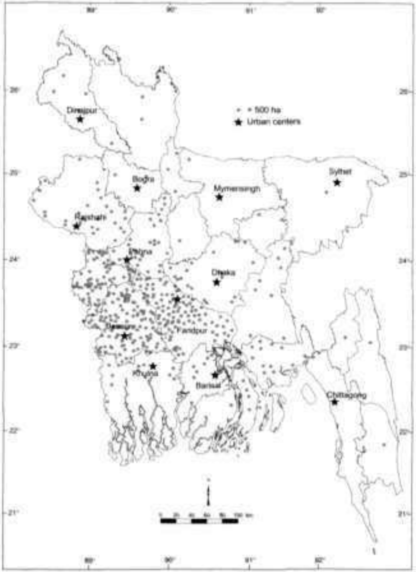

Figure 2.2. Area distribution of lentil in Bangladesh, 1993-96 (Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh).

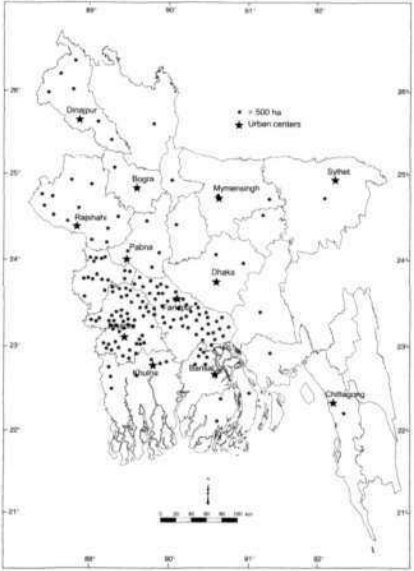

Figure 2.3. Area distribution of chickpea in Bangladesh, 1993-96 (Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh).

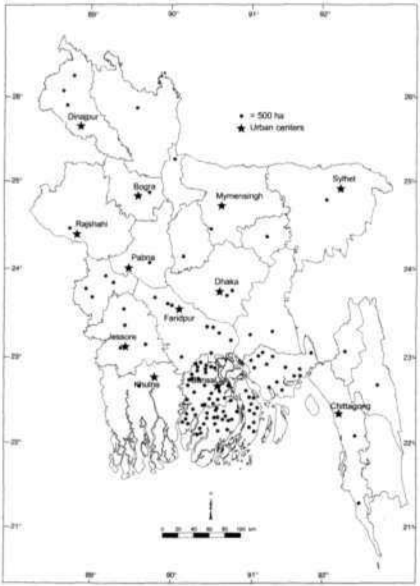

Figure 2.4. Area distribution of mung bean in Bangladesh, 1993-96 (Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh).

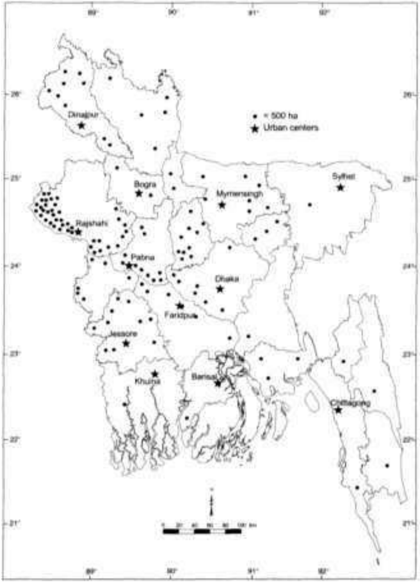

Figure 2.5. Area distribution of black gram in Bangladesh, 1993-96 (Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh).

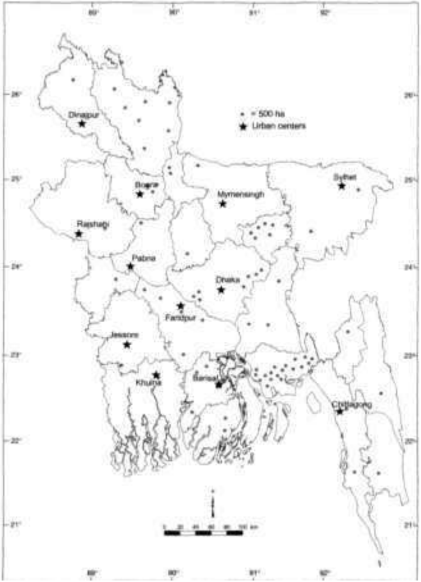

Figure 2.6. Area distribution of groundnut in Bangladesh, 1993 96 (Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh).

Division only. Data have been compiled from various issues of the Year Book of Agricultural Statistics of Bangladesh, published by the Bangladesh Bureau of Agricultural Statistics. For Figures 2.1-2.6, old district boundaries (applicable prior to 1985) are used in area allocation for each crop.

Khesari (lathyrus), lentil, and chickpea are cultivated during winter (rabi or postrainy season; Nov-Mar), and contribute more than 75% of total pulses production. Black gram is grown during rainy season to early winter (Aug-Dec), while mung bean is grown during the rainy season in the northern parts of the country and during late winter (Jan-Apr) in the southern parts. Cultivation of grain legumes is mainly concentrated within the Gangetic floodplains in the northern districts and in some southern districts. Groundnut is produced mainly in winter on residual soil moisture, but is also grown on a small scale on highlands during the rainy season, primarily for seed production. Groundnut cultivation was mainly limited to the central and southern parts of the country but recently its cultivation has been extended to the northern parts.

Trends in area, production, and yield of the principal grain legumes in Bangladesh during 1983/84 to 1995/96 indicate that the area of most crops, in general, has declined or remained static (Fig. 2.7). Yield has similarly remained static, except for lentil where increasing yields have compensated area declines to maintain production levels (Table 2.1).

Agroclimatic Factors Impacting Legume Production

The agroclimatic divisions of Bangladesh are indicated in Figure 2.8 and the soil types in Figure 2.9. Most of the pulses are concentrated in the Gangetic floodplain. Lentil, black gram, and mung bean are grown mainly on high and medium highlands and moderately well to poorly

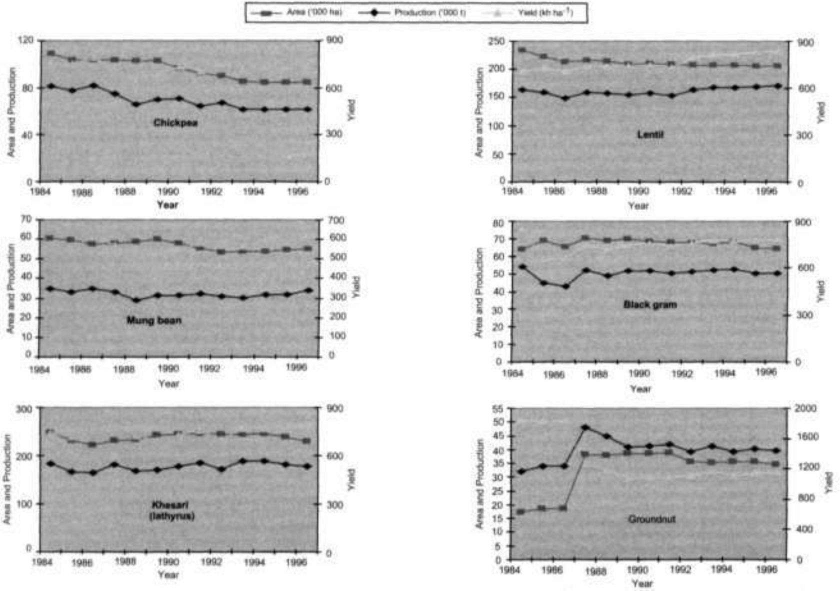

Figure 2.7. Trends in area, production, and yields of the major legumes in Bangladesh during 1983/84 to 1995/96 (Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh).

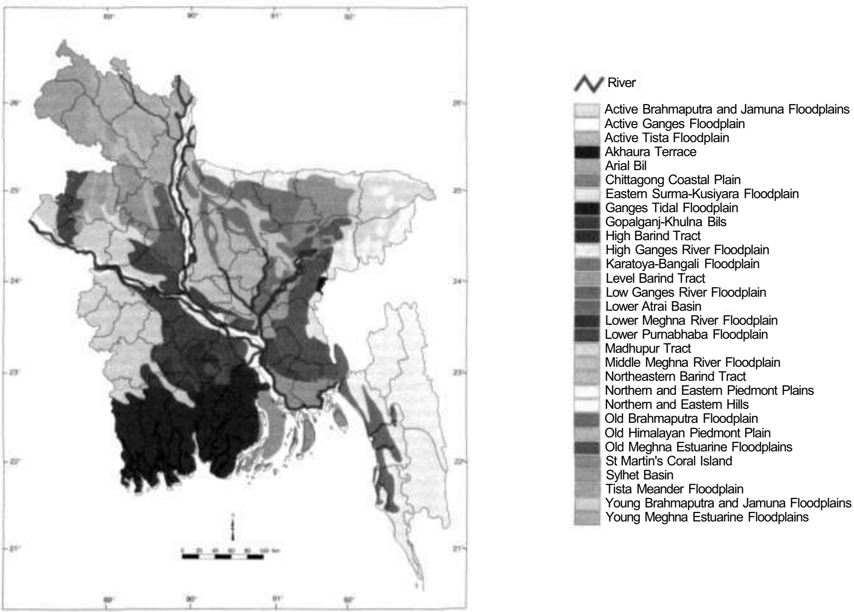

Figure 2.8. Generalized agroecological regions of Bangladesh (Source: FAO 1988).

Table 2.1. Mean area, production, and yield of different grain legumes commonly grown in Bangladesh.

Legume	Period 1: 1983/84-1989/90			Period II: 1990/91-1995/96			Change (%)		
	Area ('000 ha)	Production ('000 t)	Yield (t ha^{-1})	Area ('000 ha)	Production ('000 t)	Yield (t ha^{1})	Area	Production	Yield
Khesari (lathyrus)	233.9	166.0	0.71	243.2	183.0	0.75	4.1	10.2	5.9
Lentil	221.4	157.4	0.71	207.3	163.9	0.79	-6.4	4.1	11.2
Chickpea	107.1	76.9	0.72	91.0	65.6	0.72	-15.1	-14.7	0.5
Pea	20.9	14.0	0.67	18.4	13.8	0.75	-11.7	-0.8	12.1
Mung hean	59.1	32.9	0.56	55.6	31.5	0.57	-5.9	-4.2	1.9
Black gram	71.9	50.4	0.70	67.4	51.6	0.77	-6.2	2.4	9.4
Pigeonpea	6.1	4.2	0.69	5.9	2.9	0.50	-3.6	-30.4	-27.0
Groundnut	33.6	38.0	1.13	36.7	40.6	1.11	9.2	7.0	-1.8

Source: Government of Bangladesh(1995).

drained light-textured soils. Chickpea and khesari (lathyrus) are grown mainly on medium high to low lands and poorly drained heavy-textured soils. Soils of these areas are calcareous and range from loamy to clayey. The available soil moisture ranges from 160 to 282 mm at I m depth (Jashua and Rahman 1983) and pH ranges from 6.5 to 8.0. Availability of phosphorus and calcium are relatively high. Most of the pulses area is located within the K_4, K_5, and K_6, kharif (rainy season) and rabi-growing period zones; but some area lies within K_1, K_2, and K_3 zones (Fig. 2.10; FAO 1988). The length of rabi-growing period in these regions ranges from 105 to 145 days and begins during 12-21 October. These regions receive relatively low annual rainfall of about 1500-2000 mm (Fig. 2.11), with 60-100 mm winter rainfall (Fig. 2.12). They belong to T_3, T_4, and T_5 thermal zones (Fig. 2.13). The cool period (minimum temperature < 15°C) lasts for 50-110 days and normally begins during 20 Nov-6 Dec. Typical seasonal patterns of rainfall, temperature, and humidity in the major pulses growing region are given in Figure 2.14.

Groundnut is cultivated in pockets throughout the country. In the north, duration of the crop is 130-140 days and in the warmer south it is 120-130 days. Groundnut growth and development is inhibited at temperatures below 20°C, and the crop is, therefore, mainly distributed in regions with milder winter temperature (Fig. 2.13).

Constraints to Production of Grain Legumes

Biotic Constraints

Diseases and insect pests (including stored grain pests) are the major biotic constraints to grain legume production in Bangladesh. Weeds and lack of seed dormancy also limit the productivity of some legumes. To date some 93 diseases and 30 insect pests of the six major legumes have been recorded in Bangladesh (Gowda and Kaul 1982; Rahman et al. 1982; Bakr 1994). The important diseases and pests are listed in order of importance in Tables 2.2 and 2.3, respectively. Biotic stresses of the major legumes are briefly discussed.

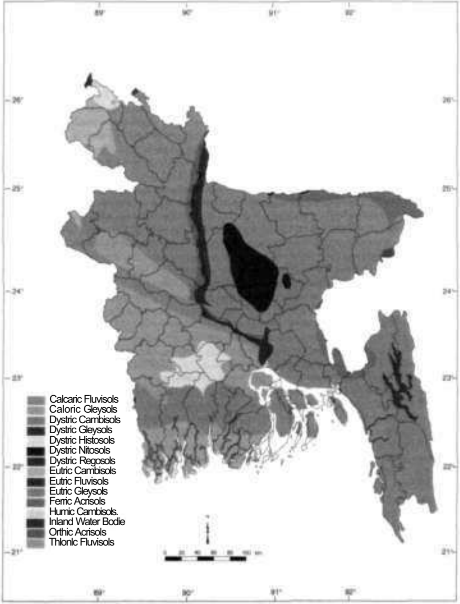

Figure 2.9. Generalized soil types of Bangladesh (Source: FAO 1988).

Diseases

Chickpea. Out of 13 diseases recorded so Far, four diseases, viz., botrytis gray mold (BGM), wilt, dry root rot, and collar rot, are the major ones. BGM and collar rot may cause up to 90% and 84% yield loss respectively (Bakr and Ahmed 1992). All the diseases are widespread over the chickpea-growing zones, but BGM Incidence is low in the Barind tract (Fig. 2.15).

Lentil. Out of 16 diseases, two diseases, viz., stemphylium blight (up to 80% yield loss; Bakr and Ahmed 1993) and rust are the most serious ones. Collar rot and vascular wilt also cause considerable yield loss. Their distribution is almost uniform throughout the country.

Mung bean and black gram. Sixteen diseases in mung bean and 21 in black gram have been recorded. Of these, yellow mosaic, cercospora leaf spot, and powdery mildew are the major ones in both the crops. Recently, sclerotinia blight has also appeared as a major disease. These diseases are evenly distributed throughout the growing zones. Yellow mosaic causes up to 63% yield loss in mung bean (BARI 1984) while powdery mildew causes up to 42% yield loss in black gram (BARI 1987a).

Khesari (lathyrus). Out of 11 diseases recorded, downy mildew and powdery mildew are the major ones. Downy mildew causes up to 12% yield loss while powdery mildew causes up to 23% loss (BARI 1986). Both diseases are evenly distributed across areas where khesari (lathyrus) is grown.

Groundnut. Of the 18 diseases reported, late leaf spot, rust, and sclerotium stem and root rot are considered as major diseases. Late leaf spot causes 30-40% yield loss and rust causes 20-30% yield loss (Ahmed and Ahmed 1994). These diseases are widely distributed throughout the country.

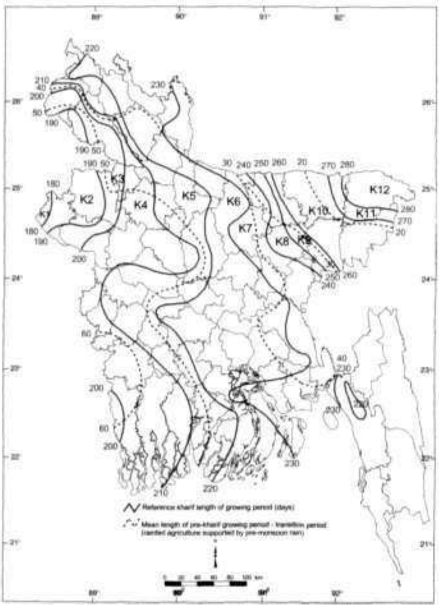

Figure 2.10. Length of growing period map for Bangladesh (Source: FAO 1988).

Generalized moisture characteristics of kharif growing period zones

	Kharif Growing Period		Kharif Humid Period			Rabi Growing Period	
Zone	Days	Period	Days	Period	Excess rainfall (mm)	Days	Period
K1	170-180	27 May 18 Nov	105 115	22 Jun- 12 Oct	600-750	105 -115	12 Oct- 30 Jan
K2	180-190	24 May 25 Nov	115- 130	13Jun- 05 Oct	650-800	11 5125	15 Oct- 12 Feb
K3	190-200	21 May- 02 Dec	115--135	10Jun- 05 Oct	700-1200	115- 135	15 Oct- 17 Feb
K4	200-210	18 May- 09 Dec	125 •145	01 Jun- 05 Oct	700-1200	115- 135	15 Oct- 1 7 Feb
K5	210-220	09 May- 10 Dec	130-160	20 May- 05 Oct	700-1500	120- 140	1 5 Oct- 22 Feb
K6	220-230	03 May- 14 Dec	140-170	17 May- 21 Oct	800-2000[1]	120--145	21 Oct- 02 Mar
K7	230-240	27 Apr- 18 Dec	155 175	10 May- 24 Oct	1200-2500	120-145	24 Oct- 05 Mar
K8	240-250	24 Apr- 25 Dec	165- 175	05 May- 24 Oct	1400-2500	135–150	24 Oct- 15 Mar
K9	250-260	18 Apr- 29 Dec	165- 180	05 May- 27 Oct	1600-2800	135–150	27 Oct- 18 Mar
K10	260-270	12 Apr- 02 Jan	170-190	27 Apr- 27 Oct	1800-4000	135–150	27 Oct- 1 8 Mar
K11	270-280	03 Apr 03 Jan	185- 195	20 Apr- 01 Nov	2500-4000	135- 150	01 Nov- 22 Mar
K12	280-290	27 Mar Of. Jan	195-210	10 Apr- 03 Nov	3000-4500	135 150	03 Nov- 25 Mar

1. Excess moisture of Humid Moisture Period in K6 zone for areas of coastal Chittagong, Sandwip, and Hatiya is in the range 2000- 3000 mm.
2. Rabi periods in K6 zone lor areas of coastal Chittagong, Sandwip, and Hatiya end 10-15 days earlier than elsewhere in the zone.

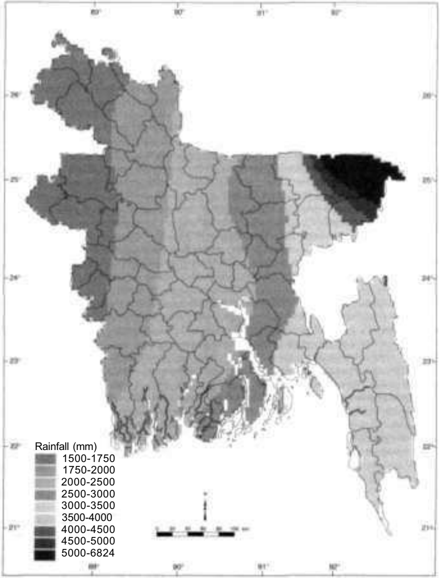

Figure 2.11. Mean annual rainfall for Bangladesh (Source: International Water Management Institute, Colombo, Sri Lanka).

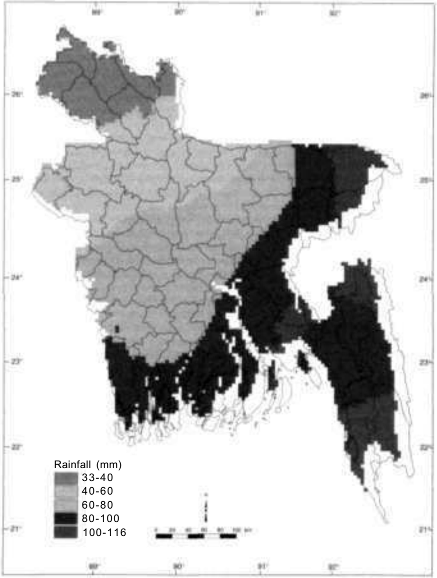

Figure 2.12. Mean winter (Nov-Feb) rainfall in Bangladesh (Source: International Water Management Institute, Colombo, Sri Lanka).

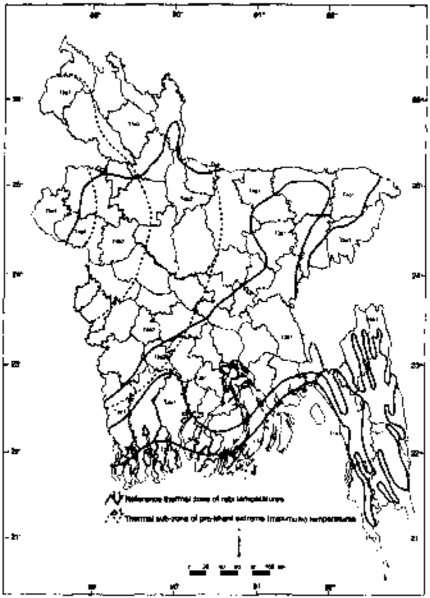

Figure 2.13. Generalized map of thermal resources of Bangladesh (Source: FAO 1988).

Generalized mean temperature characteristics of thermal (T) zones[1]

Thermal zone	Begin period	SD (days)	End period	SD (days)	Length period	SD (days)
			Mean temperatures < 17.5°C			
T1	-	-	-	-	-	-
T2	31 Dec	1	3 Jan	3	4	4
T3	30 Dec	5	4 Jan	5	6	7
T4	26 Dec	6	7 Jan	7	12	10
T5	23 Dec	6	14 Jan	12	22	12
			Mean temperatures <20.0°C			
TI	23 Dec	7	12 Jan	11	20	14
T2	17 Dec	8	14 Jan	10	28	15
T3	14 Dec	8	23 Jan	13	40	15
T4	9 Dec	8	3 Feb	6	56	15
T5	3 Dec	9	11 Feb	15	70	19
			Mean temperature <22.5°C			
TI	1 Dec	7	14 Feb	13	76	19
T2	25 Nov	8	9 Feb	13	77	18
T3	24 Nov	9	18 Feb	9	87	12
T4	19 Nov	8	27 Feb	6	101	15
T5	9 Nov	10	5 Mar	11	117	15

1. Mean of stations occurring in the individual zones.

Generalized maximum temperature characteristics of extreme temperature (e) sub-zones[1]

Extreme temperature zone	Occurrence of maximum temperatures <35°C days	SD	> 35°C days	SD	>37.5°C days	>40°C days
el	353	9	12	9	2	0.1
e2	325	20	40	20	16	2
e3	321	17	44	17	22	6
e4	308	19	57	19	30	10

1. Mean of stations occurring in the individual zones.

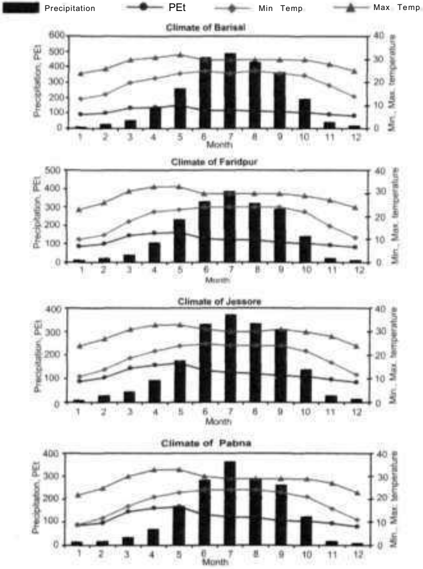

Figure 2.14. Mean monthly precipitation, potential evapotranspiration (PEt), and maximum and minimum temperature in Barisal, Faridpur, Jessore, and Pabna in Bangladesh.

Insect pests

Among the 30 insects recorded many are common pests for several of the legumes (Table 2.3). Aphids are common for lentil, khesari (lathyrus), and mung bean, where they can be a major pest, and for groundnut. *Helicoverpa armigera* Hiibner (pod borer) is a major pest on chickpea and black gram, and can cause up to 90% pod damage in chickpea (Rahman 1989). *Spilosoma (Diacrisia) obliqua* Walker (hairy caterpillar) is a major post of black gram, mung bean, and groundnut. *Euchrysops cnejus* Fab. (hair-streak blue butterfly pod borer), *Monolepla signata* Ol. (monolepta beetle), and *Bemisia tabaci* (whitefly) are the major pests of mung bean and black gram. *Agrotis ipsilon* Hufnagel (cutworm) is a common, major pest of chickpea; and it also attacks lentil and black gram (Karim and Rahman 1991). Thrips are also a major pest in mung bean. Infestation of these pests varies over space and time, depending on weather conditions.

Storage problems

Fungal and insect pest infestations are major constraints in storage and can damage the seed causing loss of seed viability. A total of 15 fungal species were recorded from different pulses. Fungi such as *Aspergillus* spp, *Penicillium* spp, and *Rhizopus spp* are more common in stored grain and increase in severity with an increase in storage period. *Aspergillus flavus* produces aflatoxin, which is the most serious Storage problem of groundnut. Pulses seeds are severely damaged bv bruchids. Two species of this pest, *Callosobruchus chinensis* L. and C. *maculatus* Fab. have been reported to infest all pulses, except black gram which is attacked only by C. *maculatus* (Rahman 1991a).

Seed dormancy

Lack of seed dormancy in the existing cultivars of groundnut, except Virginia types, is a major constraint to groundnut growers. Spanish and

Table 2.2. Recorded diseases of major legumes with casual organisms and their status in Bangladesh.

Crop/Disease	Causal organism	Status
Chickpea		
Botrytis gray mold	*Botrytis cinerea*	Major
Wilt'	*Fusarium oxysporum* f. sp *ciceris*	Major
Collar rot	*Sclerotium rolfsii*	Major
Dry root rot	*Macrophomina phaseolina* (sclerotial state *Rhizoctonia bataticola)*	Major
Alternaria blight	*Alternaria alternata*	Minor
Stunt	Bean (pea) leaf roll virus	Minor
Rust	*Uromyces ciceris-arietini*	Minor
Root-knot	*Meloidogyne javanica, M, incognita, Belonolaimus* sp	Minor
Lentil		
Stemphylium blight	*Stemphylium* sp	Major
Rust	*Uromyces viciae-fabae*	Major
Collar rot	*Sclerotium rolfsii*	Major
Vascular wilt	*Fusarium oxysporum* f. sp *lentis*	Major
Damping-off	*Pythium* sp	Minor
Cercospora leaf spot	*Pseudocercospora cruenta*	Minor
Root-knot	*Meloidogyne javanica; M. incognita*	Minor
Mung bean		
Yellow mosaic	Mung bean yellow mosaic virus	Major
Cercospora leaf spot	*Pseudocercospora cruenta*	Major
Powdery mildew	*Oidium* sp; *Erysiphe polygoni*	Major
Anthracnose	*Colletotrichum lindemuthianum*	Minor
Sderotinia blight	*Sclerotinia sclerotiorum*	Major
Leaf blight	*Leptosphaerulina trifolii; Phoma* sp.	Minor
Nematode disease	*Helicotylenchus* sp; *Hoplolaimus indicus*	Minor
Black gram		
Powdery mildew	*Erysiphe polygoni; Oidium* sp	Major
Cercospora leaf spot	*Pseudocercospora cruenta*	Major
Yellow mosaic	Mung bean yellow mosaic virus	Major
Anthracnose	*Colletotrichum caulicola*	Minor

continued

Table 2.2 *continued*

Crop/Disease	Causal organism	Status
Seed rot and seedling blight	*Macrophomina phaseolina*	Minor
Root-knot	*M. javanica;* M. *incognita; Aphelenchoides* sp	Minor
Target spot	*Corynespora cassicola*	Minor
Leaf crinkle	Leaf crinkle virus	Minor
Leaf blight	*Leptosphaerulina trifolii*	Minor
Khesari (lathyrus)		
Downv mildew	*Peronospora viciae*	Major
Powdery mildew	*Oidium* sp	Major
Leptosphaerulina blight	*Leptosphaerulina trifolii*	Minor
Leaf curl	Leaf curl virus	Minor
Groundnut		
Late leaf spot	*Phaeoisariopsis personata*	Major
Rust	*Puccinia arachidis*	Major
Crown rot	*Aspergillus niger*	Major
Sclerotium stem and root rot	*Sclerotium rolfsii*	Major
Early leaf spot	*Cercospora arachidicola*	Minor
Sclerotinia blight	*Sclerotinia sclerotiorum*	Minor
Rhizoctonia leaf blight/seedling rot	*Rhizoctonia solani*	Minor
Seed rot	*Aspergillus flavus*	Minor

Valencia types arc preferred by farmers because of their short-duration compared to Virginia types. Generally, the main season (rabi or postrainy season) groundnut is harvested during Apr-May, when there is a chance of heavy rain. During this time mature seeds can germinate in the field due to lack of seed dormancy causing a considerable yield loss. This can also be a problem in rainy season groundnut used for seed production. Groundnut seed stored under ambient conditions loses

Table 2.3. Insect pests on major legumes with their nature of damage and importance in Bangladesh.

Insect pest	Nature of damage	Status
Chickpea		
Helicoverpa armigera Hiibner	Bore into pods and feed on seeds and foliage	Major
Agrotis ipsilon Hufnagel	Cut the young plants	Major
Callosobruchus chinensis L.; C. *tnaculatus* Fab.	Damage seed in storage	Major
Alcidodes collaris Pascoe	Bore into pods and feed on seeds	Minor
Aphis craccivora Koch.	Suck sap from foliar parts	Minor
Pachynerus chinensis	Bore into pods and feed on seeds	Minor
Lentil		
Callosobruchus chinensis L.; C. *tnaculatus* Fab.	Damage seed in storage	Major
Aphis craccivora Koch.	Suck sap from shoots and pods	Minor
Spodoptera exigua Hiibner	Cut the plant or plant parts	Minor
Helicoverpa armigera Hiibner	Bore into pods and feed on seeds and shoots	Minor
Nezara viridula L	Suck sap from shoots and pods	Minor
Black gram		
Spilosorna (Diacrisia) obliqua Walker	Feed on leaves	Major
Helicoverpa armigera Hiibner	Bore into pods and feed on seeds, young stems, and leaves	Major
Agromyza phaseoli	Bore into stem	Major
Callosobruchus tnaculatus Fab.	Damage stored seeds	Major
Monolepta signata Ol.	Feed on leaves	Major
Euchrysops cnejus Fab.	Bore into pods and feed on seeds	Major
Aphis craccivora Koch.; *A. medicagenis*	Suck sap and transmit virus	Minor
Maruca testulalis Gever	Bore into pods and feed on seeds	Minor
Bemisia tabaci Genn.	Suck sap and transmit virus	Minor
Mung bean		
Bemisia tabaci Genn.	Suck sap and transmit virus	Major
Euchrysops cnejus Fab.	Bore into pods and feed on seeds	Major
Agromyza phaseoli	Bore into stems and feed on internal tissue	Major
Aphis craccivora Koch.	Suck sap and transmit virus	Major
Spilosotna (Diacrisia) obliqua Walker	Feed on leaves	Major
Nezara viridula L	Suck cell sap	Minor
Monolepta signata Ol.	Feed on leaves	Major
Callosobruchus chinensis L.; C. *tnaculatus* Fab.	Damage stored seeds	Major
Megalurothrips distalis Karny	Cause flower drop	Major
Khesari (lathyrus)		
Aphis craccivora Koch.	Suck sap from leaves, twigs, and branches	Major
Groundnut		
Spilosoma (Diacrisia) obliqua Walker	Feed on leaves	Major
Odontotermis sp	Feed on pods and underground plant parts	Major
Empoasca kerri Pruthi	Suck sap from foliage of plants	Minor
Scirtothrips dorsalis Hood.	Scrape leaf surface, suck sap; cause leaf curl and stunting of plants	Minor
Anarsia ephippias	Roll young leaves and feed inside	Minor

viability after three months of storage, with complete loss of viability before the next sowing time. Storage techniques have been developed which can help retain 100% viability up to 9-10 months. Well dried seed (7-8% moisture content) preserved in a polythene bag or metal container can retain viability to a satisfactory level (Table 2.4).

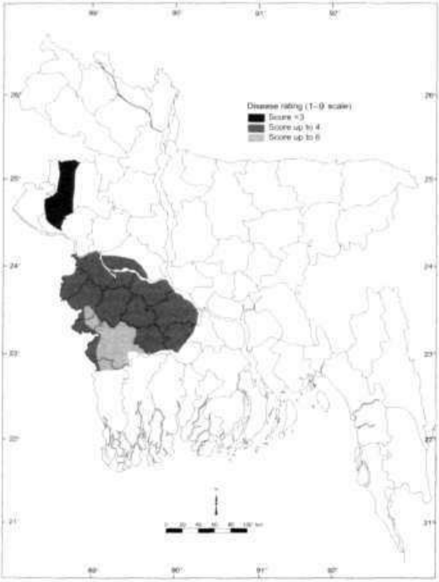

Figure 2.15. Distribution and severity of botrytis gray mold of chickpea in Bangladesh Mean disease severity on a rating scale of 1 9 where 1 is least disease and 9 is most severe.

Table 2.4. Moisture content (%) and germination (%) of groundnut seed of rabi (winter) and kharif (summer) crops stored in different containers for 8 months, Joydebpur, Bangladesh.

	Winter (rabi) season				Summer (kharif) season			
	Moisture content		Germination		Moisture content		Germination	
Treatment	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Earthen pitcher	9.]	11.7	100	0	9.2	9.9	100	89
Tin container	9.1	9.7	100	96	9.2	9.8	100	100
Polythene bag	9.1	10.0	100	99	9.2	9.7	100	100
Gunny bag (jute bag)	9.1	11.8	100	0	9.2	9.9	100	90

Source: Bhuiyan and Quasem (1983).

Seed of the mung bean cultivars used also does not have dormancy and consequently the seed sprouts within the pods if rain occurs at the maturity stage. However, this is not a regular phenomenon.

Weeds

Farmers consider legumes as minor crops and they do not normally weed their legume crops. Hence, weeds compete with legumes and can cause substantial yield losses. Little research has been done in this area. Gowda and Kaul (1982) reported that one hand weeding of a mung bean crop at 20 days is essential otherwise yield reductions will occur. Aziz (1993) reported that grain yield loss due to unrestricted weed growth in a lentil crop was around 25% and the critical period of weed competition ranged from 20 to 30 days after emergence. Several common weeds of legumes are found in farmers' fields in Bangladesh (Table 2.5). These weeds are more or less evenly distributed throughout the growing zones of Bangladesh.

Table 2.5. Common weeds of legume crops in Bangladesh.

Local name	Scientific name	Lentil	Chickpea	Khesari (lathyrus)	Black gram	Mung bean	Groundnut
Mutha	*Cyperus rotundas* L.	Major	Major	-	Major	Major	Major (summer)
Bathua	*Chenopodium album L.*	Major	Major	Major	-	-	Major (winter)
Durba	*Cynodon dactylon* (L.) Pers.	Major	Major	Major	Major	Major	Major
Bindi	*Canvolindus arvensis* L.	Major	Minor	-	-	-	Minor
Dondokalos	*Leucas aspera* Spreng.	Major	Major		-	-	Major
Fashka begun	*Physalis heterophylla* Nees.	Minor	Major	Major	Major	Major	Major
Boon moshure	*Vicia sativa* L	Major	Minor	Minor		-	Minor (winter)
Moshure chana	*Vicia hirsuta* (L) S.F. Grav	Major	Major	Major		_	Minor
Phulkaghash	*Panicum paludosum* Roxb.	-	Minor	Major	-		-
Green foxtail	*Setaria viridis* Beauv.	-	-	Major	Minor	Minor	-
Chhotoshama	*Echinochloa colonum* Link	-	Minor	Major	Minor	Minor	Minor
Chapra	*lileusine indica* Gaertn.	-		Minor	Major	Major	-
Thistle	*Sonchus oleraceus* L.	Major	Major	Minor	-	-	-
Kontanotae	*Amaranthus spinosus* L.	Minor	-	-	Major	Major	Major

Source; M.A Aziz, BARI, personal mmmiiniiation

Abiotic Constraints

A range of climatic and soil factors limit the productivity of both winter and summer food legumes grown in Bangladesh. Among these drought, excess moisture, and adverse temperature and soil conditions are important. As most pulse production occurs in the postrainy season (>80%), the water-holding capacity of the soils is a major factor determining the onset of drought stress.

Drought

The climatic conditions in Bangladesh are variable, particularly during the postrainy (winter) season. In some years very little rainfall occurs during winter and the major legumes [lentil, khesari (lathyrus), chickpea, and groundnut] that are grown on conserved soil moisture suffer from drought stress. Dried-out surface soil hampers proper germination and emergence, especially in case of late-sown lentil and chickpea. Consequently, optimum plant stand cannot be established and thus yields are low (Ahad Miah et al. 1991). The crops can suffer from drought stress during vegetative as well as reproductive phases. This leads to abortion of flowers and young pods and prevents seed filling (Saxena et al. 1994).

Excess soil moisture and humidity

In some years excessive rainfall can occur during winter and this can cause substantial yield loss. If it occurs at an early stage it will encourage excessive vegetative growth leading to lodging, and also encourage development of various leaf and root diseases. If rainfall occurs at the reproductive stage it will not only physically damage the flowers and developing pods/seeds, but also encourage foliar diseases such as BGM in chickpea, rust and stemphylium blight in lentil, downy mildew in khesari (lathyrus), and late leaf spot in groundnut. Some of these diseases can cause complete yield loss in these crops. High rainfall coupled with high humidity also encourages insect pest infestation. In some years when rainfall occurs at the time of crop maturity for rabi crops (Mar-Apr), it affects crop yields due to pod-shedding, seed rotting, and hampering of harvesting and threshing.

Black gram and some mung bean are sown in the late rainy (kharif-II) season (Aug-Dec). The peak months for rainfall are Aug and Sep and so land preparation is difficult during this period and heavy infestation of weeds occurs. Crops may be seriously damaged due to waterlogging, and infestation of insect pests which cannot be controlled effectively through insecticide sprays applied in rainy weather.

Temperature extremes

Low temperatures encountered during Dec-Feb especially towards the north and west of the country (Fig. 2.13), can minimize vegetative growth of both cool and warm season legumes and may delay or reduce podding in crops such as chickpea (Saxena et al. 1988b). A sudden rise in temperature in late Feb in some years severely reduces vegetative growth and pod formation and development of rabi crops, especially of late-sown lentil and chickpea grown in e2T3, e2T4, e3T4, and e4T4 isothermal zones (Fig 2.13). This phenomenon also occurs in other parts of the world (Saxena et al. 1988a; Nene and Reed 1994;Slinkard et al. 1994).

Soil factors

Pulse crops have been traditionally grown in Ganges floodplain soil, although chickpea cultivation is now increasing in the Barind tract, and mung bean in the young Meghna estuarine floodplain (Fig. 2.8). The Ganges floodplain soils are calcareous and alkaline, but older soils are decalcified to a variable depth. Moderately well to poorly drained, loamy to clayey, pale brown soils occur on raised areas. Basin areas have poorly drained, mainly clayey soils with gray to dark gray color. The soils of the Barind tract are mainly imperfectly to poorly drained, brown to gray, loamy to clayey soils. The surface soil is acidic. Young Meghna estuarine floodplain soils are mainly gray and loamy on the raised areas and gray to dark gray loamy to clayey in the basin areas. Soils here are neutral to slightly acidic in reaction. In soils of higher clay content, plow pan formation impedes root development of crops following rice, and thus the ability of those crops to access soil moisture and nutrients.

The organic matter content in the floodplain soils usually ranges from 0.5% to 2.5%, lower in the raised soils and relatively higher in the basin soils. In the Barind tract, it ranges from 0.3% to 1.8% (Idris 1995). Soil analyses conducted by the Soil Resources Development Institute (SRDI 1990-97) suggest that potassium (K), calcium (Ca), and magnesium (Mg) deficiencies are not likely to limit yield of grain legumes in Bangladesh. Phosphorus (P) levels may be marginal and sulfur (S) deficiency would be likely in western and northwestern regions but not in floodplain soils. By contrast to S, soils appear more deficient in zinc (Zn) in the floodplain than in uplifted areas in the northwest. In the Tista floodplain area of northern Bangladesh (Rangpur and Dinajpur), there are increasing reports of boron (B) deficiency limiting yields of lentil and chickpea (BARI 1987b, 1993; Miah 1995).

Socioeconomic Constraints

In Bangladesh, farmer and government priority is given to production of cereals such as rice and wheat, or to cash crops. Farmers consider that legumes are very sensitive to microclimatic variation and to diseases and pests, and thus high and stable yields cannot be ensured.

Therefore, they consider them as risky crops, even if they are potentially remunerative, and give low priority to their optimum husbandry. The major socioeconomic constraints related to legume production in Bangladesh are discussed.

Low profit and high risk

Lack of high-yielding varieties of legumes, analogous to those for rice or wheat, is an important consideration to the farmers. Traditional landraces continue to be used and it is thus not surprising that yields have generally not increased over time (Fig. 2.7). Although market price of grain legumes is generally increasing relative to other grains, the benefitxost ratio is low and ranges from 1.03 to 3.38 on full cost basis (Hossain 1993).

Input use

Farmers have experienced that use of irrigation and fertilizers encourages excessive vegetative growth of legume crops, which ultimately results in poor pod set and low yield. Therefore, they do not use inputs, conduct plant protection measures, or practice weeding. The prices of fertilizers, insecticides, and fungicides are relatively high and increasing which discourage their use for risky crops like legumes.

Lack of cash and credit

Most of the farmers do not have enough cash on hand to buy quality seeds or inputs, even if they intended to. Credit facilities are not available for legume crops in the same way that they are for other crops such as rice, cotton (*Gossypium* sp), and sugarcane (*Saccharum officinarum* L.) (Hossain 1993).

Lack of support price and marketing

Pulses are generally more susceptible than other crops to stored grain pests. As a result farmers cannot store their produce for long and hence they sell it immediately after harvest. There is neither a definite marketing channel nor a government support price for legumes. The traders buy the grains from the farmers at a low price. About 74% share of the profit goes to traders and only 26% to the farmers (Elias 1991).

Traditional cultivation practices

Farmers follow traditional cultivation practices for legumes in Bangladesh, because improved methods of cultivation (such as line sowing and use of inputs) cannot assure them of a high yield. Although prices of legumes are much higher than other competing crops, profitability seems to have little influence on production decisions. On the contrary, production with minimum cash inputs seems to be the aim (Elias 1991). So, unless improved technologies can be demonstrated on farmers' fields to ensure high and stable yields, it will be extremely difficult to change traditional cultivation practices for legume crops.

Consumer preference

All the pulses are not equally liked by the consumers all over Bangladesh. Hence the price is determined by the consumers' preference as well as total production. The present ranking of pulses on the basis of price is as follows: mung bean > lentil > chickpea > black gram > khesari (lathyrus). Some pulses are regionally preferred; for example, black gram is preferred by most of the people of northwestern Bangladesh and hence it is not widely grown in other parts of the country. The price of groundnut is more or less stable throughout the year. Its marketing is also channelized in the same way as pulses.

Role of Legumes in Cropping Systems

As irrigation facilities become available, farmers shift to predominantly rice-rice or rice-wheat cropping systems (RWCS). However, there is increasing concern about the long-term sustainability of cereal monocropping systems. It is generally considered undesirable to indefinitely continue with these systems. Legumes are considered as ameliorative crops from the point of view of sustainability to break continuous cropping with cereals. Soil aggregation, soil structure, permeability, fertility, and infiltration rate are reported to improve with the inclusion of pulses in the cropping system (Yadav et al. 1997). Grain legumes can add 20-60 kg ha^{-1} residual nitrogen (N) to the succeeding crop (Kumar Rao et al. 1998). Therefore, legumes in general can play a vital role in sustainability of agroecosy stems.

In Bangladesh, pulses are grown in different cropping systems. The major ones are presented in Table 2.6 and discussed below.

Lathyrus

Khesari (lathyrus) is cultivated as a relay crop with main season rice (*aman* rice) in the medium-low and lowlands. It is broadcast on the saturated soils by the end of Oct to mid-Nov, about 15-20 days before the rice harvest. It is the hardiest crop among pulses and can thrive under both excess moisture and extreme drought conditions. It has no major disease or insect problems, stable yields, and negligible input cost. It is difficult to replace khesari (lathyrus) by any other crop under the situation in which it is presently cultivated. Most of the land planted to this crop would have remained fallow after rice had there been no khesari (lathyrus). However, it is reported that if it is consumed as a staple food (one-third of the daily calorie intake) continuously for 2-3 months, it may cause lathyrism, a paralytic disease of the limbs of humans.

Lentil

Lentil is mostly grown in the upland rice (aus)/jute (*Corchorus capsularis* L.)-fallow-lentil cropping pattern, and is usually sown by mid-Nov. But some lentil is also grown in the broadcast *aman* rice-lentil cropping pattern, where it is sown during the later part of Nov and is considered as a late-sown crop. Apart from these patterns, lentil is commonly cultivated as a mixed crop with mustard (*Brassica* sp) and as an intercrop with sugarcane in the northern part of the country where it is sown during early Nov.

Chickpea

Chickpea is grown on relatively heavier soils under the *aus* rice/jute-fallow-chickpea cropping pattern, where it is sown in Nov and covers about 60% chickpea area. About 35-40% chickpea is grown in the *aman* rice-chickpea cropping pattern, where it is sown in Dec (Rahman and Mallick 1988) as a late-sown crop. Apart from these systems, chickpea is cultivated as a mixed crop with linseed (*Linum usitatissimum* L.), barley *(Hordeum vulgare* L), and mustard and as an intercrop with sugarcane.

Black Gram

Black gram is a relatively hardy pulse crop. It is generally sown in Aug-Sep on well-drained medium-high or highlands after harvest of *aus*

Table 2.6. Major cropping patterns of grain legumes in Bangladesh.			
Crop	Cropping pattern[1]	Land type	Remarks
Khesari (lathyrus)	B. *aman* rice-khesari relay (Apr-mid-Nov) (Nov-mid-Mar)	Medium lowland, clay loam, clay soil	Broadcast khesari seeds before rice harvest
	T. *aman* rice-khesari relay (Apr/May-Aug) (mid-Nov-Mar)	Medium, high-medium, lowland, clay loam, clay	Broadcast khesari seeds before rice harvest
Lentil	*Aus* rice/jute-fallow-lentil (Apr/May-Aug) (Aug-Oct) (Nov-Feb)	Highlands, loamy soil	Optimum sowing; major pattern
	B. *aman* rice-lentil (May-Nov) (late Nov-mid-Dec)	Medium highland, clay loam/loam soils	Late sowing
	Sugarcane + lentil (Oct/Nov) (Nov-Feb)	Hlighlands, loamy soil	Companion crop, sown along with sugarcane
Chickpea	*Aus* rice/jute-fallow-chickpea (Apr/May-Aug) (Aug-Oct) (Nov-Apr)	Highlands, clay loam soil	Optimum sowing; major pattern
	Aus rice + B, *aman* rice-chickpea (May-Nov) (Dec-rnid-Apr)	Medium highlands, clay loam to clay soils	Late sowing
	T. *aman* rice-chickpea (Jul-Nov) (Dec-mid-Apr)	Medium lowlands, clay soil	Late sowing
Black grain	*Aus* rice/jute-black gram (Apr/May-Aug) (late Aug-Dec)	Highlands/medium highlands, river basin (after flood), sandy loam, silty	Major pattern
	Aus rice-black gram-mustard/wheat/lentil/sugarcane (Apr-Aug) (Aug-Nov) (Nov-Mar)	Highlands sandy loam to clay loam	Short-duration black gram
Mung bean	*Aus* rice-*T. aman* rice-mung bean (Apr-Jul) (Aug-Dec) (Jan-Apr)	Silty loam to clay loam	Southern belt (65%) mung bean
	Winter crops-mnng bean-*T. aman* rice/vegetabie.s (Nov-Mar) (Mar-Jun) (Jul-Dec)	High/medium highlands, sandy to silty loam	Northwestern Bangladesh (5%)
	Aus rice/jute-mung bean-winter crops (Apr-Aug) (Aug-Nov) (Nov-Mar)	Well drained highlands, sandy to loam soil	Green-seeded, short-duration mung bean
	Aus rice/jute-mung bean-fallow (Apr-Aug) (Sep-Dec) (Jan-Feb)	High-medium highlands, sandy loam to clay loam soil	Golden-seeded, long-duration mung bean
Groundnut	*Aus* rice/jute-fallow-groundnut (Apr-Aug) (Aug-Oct) (Nov-Apr)	High-medium highlands, sandy loam to silty loam	Major pattern
	Groundnut-fallow-winter crops (Apr-Aug) (Sep-Oct) (Nov-Apr)	High-medium highlands, sandy loam to silty loam	Minor pattern

1. B - Broadcast; T = Transplanted.

rice in the *aus* rice-black gram-fallow cropping pattern. Short-duration black gram (small seeded called *thakrikalai*) is cultivated in the *aus* rice-black gram-rabi crops cropping pattern where sowing is completed within Aug. The Bangladesh Agricultural Research Institute (BARI), Joydebpur, Bangladesh has released one variety, Barimash, for this cropping pattern and a few more are in the pipeline.

Mung Bean

About 65-70% of the mung bean crop is grown in the *aman* rice-mung bean-aws rice cropping pattern in the southern part of Bangladesh. In these areas the crop is sown in Jan/Feb and harvested in Mar-Apr. About 5% of the mung bean crop is grown in the northwestern part of the country in the winter crops-mung *bean-aman* rice cropping pattern. This crop is sown in Mar and harvested in Jun. The remaining 20-25% of mung bean is cultivated in the central part of the country in the *aus* rice/jute-mung bean cropping pattern. Varieties for this pattern are photoperiod-sensitive and golden seeded (*sonamung);* they are planted in Aug and harvested in Dec. This pattern, however, is gradually being replaced by rabi crops such as wheat, mustard, and potato *(Solatium tuberosum* L.).

Groundnut

Groundnut is mostly grown in the *aus* rice-groundnut cropping pattern or as a monocrop in the riverbed areas (*chaur).* It is sown in Oct-Nov and harvested in Mar-Apr. A small portion of groundnut (mostly for seed purpose) is sown in Apr-May and harvested in Aug-Sep in the groundnut-winter crop cropping pattern.

National Policies and Emphasis on Legumes Production

The population of Bangladesh, as per the World Bank projection, will cross 132 million by the year 2000, 153 million by 2010, and 173 million by 2020 (BARC 1995). The current production of pulses is 0.532 million t (BBS 1997). If the present rate of per capita consumption of about 12 g day^{-1} (which itself is only one-third of the world average) is to be maintained in the year 2010, the demand for pulses is expected to be 0.672 million t. This means the total production of pulses needs to be increased by about 28% by 2010 over the present production, with an average annual growth rate of 2.19%.

The Government has given priority for pulses production policy. It launched the Crop Diversification Programme (CDP) with the assistance of the Canadian International Development Agency (CIDA) in 1990 to augment pulses, oilseeds, and tuber crops production in the country. This program is expected to continue up to the year 2000. The themes of the CDP are: (1) increase area and production through utilization of fallow lands or periods; (2) introduction of new cropping patterns with increased cropping intensity, through introduction of new varieties and technologies; and (3) increase consumption and marketing. To achieve these goals the CDP has supported several components such as:

- Strengthening research for development of suitable high-yield technology packages.
- Seed production of improved varieties through the Bangladesh Agricultural Development Corporation (BADC).

- Strengthening of extension services through training and demonstration programs to familiarize farmers with the latest production technology.

The CDP has strengthened linkages among the research institutes [BARI and Bangladesh Institute of Nuclear Agriculture (BINA)], Department of Agricultural Extension (DAE), and BADC to achieve their common goals. In addition, the Government launched a special project called "Pilot Production Project on Lentil, Black gram and Mung bean" in 1996-97 which will continue up to 2000. The main objectives of this project are to extend improved varieties and production technologies of these crops among the farmers to increase their area and production. BARI is implementing the project in collaboration with BINA, BADC, DAE, and the Institute of Postgraduate Studies in Agriculture (IPSA).

Prospects for Increased Production and Use of Legumes

There are good prospects for increased legume production in Bangladesh. The additional production can be achieved by. (1) increased productivity through adoption of improved varieties and cultural practices; and (2) increased area through utilization of fallow lands and introduction of new cropping patterns. The list of the newly released varieties of the major grain legumes is given in Table 2.7. These varieties produced higher yields compared to the existing varieties at research stations and farmers' field demonstrations.

Some of the potential technologies and new cropping patterns incorporating legumes for additional production are discussed.

Table 2.7. Pulses varieties recommended or released in Bangladesh.

Crop	Variety	Year of release/registration
Lentil	Barimasur 1 (Uthfala)	Released in 1991
	Baritnasur 2	Released in 1993
	Barimasur 3 (BLX-8405-36)	Registered in 1996
	Barimasur 4	Registered in 1996
Chickpea	Hyprosola	Released in 1981
	Nabin	Released in 1987
	Barirhola 2	Released in 1993
	Barichola 3[1]	Released in 1993
	Binachola 2	Released in 1994
	Binachola 4 (ICCL 85222)	Registered in 1996
	Binachola 5 (RBH 228)	Registered in 1996
	Binachola 6 (ICCL 83149)	Registered in 1996
Khesari (lathyrus)	Barikhesari 1	Registered in 1995
	Barikhesari 2 (No. 8603)	Registered in 1996
Black gram	Barimash	Released in 1990
	Barimash 1	Released in 1994
	Barimash 2 (BMAX-90233)	Registered in 1996
	Barimash 3 (BMAX-90235)	Registered in 1996
Mung bean	Mubarik	Released in 1982
	Kanti	Released in 1987
	Binamung 1[2]	Released in 1992
	Binamung 2[2]	Released in 1994
	Binamung 3 (BMX-842243)	Registered in 1996
	Binamung 4 (BMX-841121)	Registered in 1996
	Binamung 5 (NM-92)	Registered in 1997
Cowpea	Barifaion 1	Released in 1993
	Barifalon	Registered in 1996
Groundnut	Dhaka 1	Recommended
	DC 2	Recommended
	Jhinga badam	Recommended
	DM 1	Recommended
	ICGS(E) 55	Released in 1995

1 For Rarind only.
2. For Kharif-1.
Source: S e e d Certilualum A , G.MJW, BannUlrsh

Lentil

Most of the local cultivars suffer from rust and stemphylium blight especially under late planting conditions. The loss caused by these diseases may be minimized by early planting (first week of Nov). Yield of lentil may be increased significantly by early planting with a higher seed rate to achieve a plant stand of 333.3 plants m^{-2} (Ahlawat et al. 1982, 1983; Saxena et al. 1983).

Chickpea

Most of the traditional chickpea area is concentrated within the Gangetic floodplains. Yield stability is very low due to sporadic yield losses caused by various diseases, mainly BGM. On the other hand most of the 0.8 million ha land of the high Barind area in northwestern Bangladesh remains fallow in the winter months after harvest of local transplanted *aman* rice (Raisuddin and Nur-E-Elahi 1984). Experiments indicate that yields of more than 1 t ha^{-1} can be harvested if chickpea is planted by early November (Table 2.8a, b). In this case, the local long-duration rice cultivars need to be replaced by short-duration varieties such as BR 1, BR 14, and IR 50. The relatively less humid climate in the Barind area is not favorable for BGM infestation, which is a major threat to chickpea in the traditional areas. If only 10% of the Barind could be brought under chickpea cultivation, it may double the chickpea production in the country (Kumar et al. 1994). Similarly, lands remain fallow after harvest of transplanted *aman* rice in some parts of eastern Bogra, Rangpur, and Dinajpur districts. The soils are silty loam with high soil moisture-holding capacity. Chickpea grows vigorously on these soils but sets fewer pods. On-station studies indicate that chickpea yield of more than 1 t ha^{-1} can be obtained by applying 0.5 kg B ha^{-1} (Table 2.9). If parts of these areas are brought under chickpea cultivation, total area and production of this pulse crop could be greatly increased (Fig. 2.16).

Table 2.8a. Grain yields of modern rice varieties and following rabi (postrainy season) crops in Barind, Bangladesh.

Rice variety	Rice date	Grain yield (t ha^{-1}) 1988	1989	Mean	Rabi crops	Grain yield (t ha^{-1}) 1988/89'	1988/90	Mean
BR 14	23 Oct-7 Nov	4.58	4.21	4.39	Chickpea	0.77	0.81	0.79
					Lentil	0.21	0.45	0.33
					Mustard	0.46	0.76	0.61
					Linseed	0.38	0.70	0.54
BR 1	11-25 Oct	4.17	2.93	3.55	Chickpea	0.66	1.04	0.85
					Lentil	0.31	0.30	0.31
					Mustard	0.55	0.50	0.53
					Linseed	0.31	0.44	0.38
BR 11	7-23 Nov	5.00	4.71	4.85	Chickpea	0.30	0.30	0.30
					Lentil	0.14	0.43	0.29
					Mustard	0.22	0.32	0.27
					Linseed	0.21	0.52	0.37

Table 2.8b. Grain yield of kabuli and desi chickpea lines planted after rice harvest in Barind, Bangladesh.

Line	Grain yield (t ha^{-1}) 1988/89	1989/90	Mean
ICCL 83007 (kabuli)	2.07	1.63	1.85
1CCL 83008 (kabuli)		1.65	
Rajshahi Local (desi)	1.61	1.98	1.60
Nabin (desi)	2.16	1.82	1.99

Source: OFRD (1989. 1990).

Black Gram

One of the major upland cropping patterns of the northern districts is *aus* rice-fallow (Aug-Oct)-winter crops. If this fallow period of 80-90 days could be utilized to grow short-duration pulses such as mung

Table 2.9. Effect of boron on the yield and other characteristics of chickpea at Rangpur, Bangladesh in 1992/93.

Boron applied (kg ha^{-1})	Plant height (cm)	No. of pods plant[1]	No. of seeds pod^{-1}	100 seed weight (g)	Grain yield (kg ha^{-1})
0	44.3	1.0	0.7	9.7	11
0.5	44.8	32.9	1.3	12.8	1025
1.0	46.0	33.5	1.3	12.8	1157
1.5	46.2	35.4	1.3	12.9	1213
2.0	44.2	35.3	1.3	12.9	1188

Source: BARI (1993).

bean or black gram, a large area could come under pulses without disturbing the existing cropping pattern. BARI has released a short-duration (60 days) black gram variety, Barimash, which is tolerant to yellow mosaic and fits well into this pattern provided sowing is completed by the end of Aug (Table 2.10). The major cropping pattern with black gram is *aus* rice-black gram-fallow. In this pattern farmers cannot grow winter crops after black gram due to lack of moisture for sowing of the winter crops. However, short-medium-duration pigeonpea can be grown as a mixed crop or intercrop. Black gram is harvested in Dec when pigeonpea attains a height of about 60 cm and begins to flower. Thus pigeonpea does not affect the black gram yield. However, insect pest damage is the major constraint to pigeonpea, which can be managed by careful need-based insecticide sprays. If this cropping system is extended, a large area can be brought under pigeonpea, which otherwise would remain fallow.

Mung Bean

About 30% of the country's mung bean is cultivated during Aug-Dec in the *aus* rice-mung bean cropping pattern. These are golden-seeded mung bean [*sonamung*] having long-duration (about 90 days) and low productivity. The area under this pattern is being replaced by other winter crops such as wheat and mustard. If the long-duration mung cultivars are replaced by short-duration varieties, e.g., Kanti, it will be possible to grow winter crops after mung. The major upland cropping pattern of the northern districts, i.e., *aus* rice-fallow-rabi crops can be replaced by aus rice-mung bean-rabi crops. (Table 2.10). Thus, it would be possible to bring a large area under mung bean cultivation, which otherwise remains fallow.

BARI also tried to introduce mung bean in early summer in the winter crop-mung bean (May-Jun)-aman rice cropping pattern. This pattern is feasible under irrigated conditions when sowing must be completed by Feb/mid-Mar (Rahman 1991b). In these patterns if mung bean plants are plowed down after the harvest of pods, considerable organic matter and fixed N will be added to the soils.

Table 2.10. Yield increase, net return increase, and cost-benefit ratio of the *aus* rice-mung bean/black gram-winter crops pattern over the existing *aus* rice-fallow-winter crops pattern in Bangladesh.

	Yield increase (%)		Net return increase (%)		Cost-benefit ratio	
Cropping pattern	1987	1988	1987	1988	1987	1988
Aus rice-mung bean-wheat	15	17	62	131	1.04	1.05
Aus rice-mung bean-mustard	36	34	101	139	1.15	1.16
Aus rice-mung bean-lentil	32	30	63	78	1.64	1.91
Aus rice-black gram-wheat	19	19	90	123	1.16	1.01
Aus rice-black gram-mustard	46	44	133	145	1.33	1.19
Aus rice-black gram-lentil	37	29	74	53	1.79	1.90

Source: Aziz and Rahman (1991)

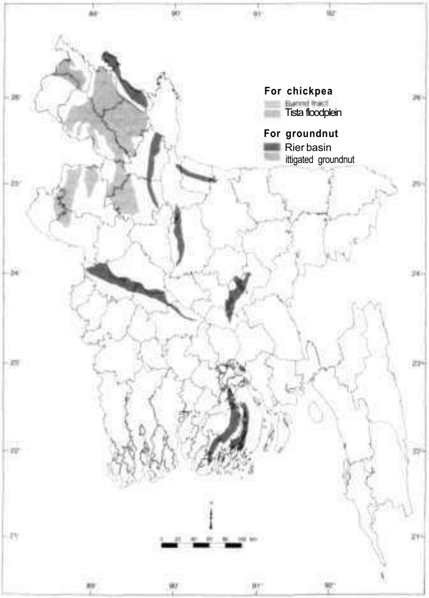

Figure 2.16. Potential area for expansion of chickpea and groundnut in Bangladesh.

Groundnut

Groundnut is facing considerable competition from other crops in the existing cropping patterns due to its long-duration and low productivity. However, there is potential for expansion of the postrainy season (main season) groundnut in *chaur* (river basin) lands without much competition from other crops. These areas are found in Lalmonirhat, Gaibandha, Sirajganj, Jamalpur, Tangail, Kustia, Faridpur, Dhaka, Narayanganj, Munshiganj, Narsingdi, Noakhali, Potuakhali, and Bhola districts. Parts of Thakurgaon, Panchagahar, and Nilphamari districts, in the northwest region of the country, are suitable for irrigated groundnut cultivation during winter and rainfed cultivation during summer (Fig. 2.16).

Conclusion

The productivity of legume crops in Bangladesh is low and unstable due to various biotic and abiotic constraints and as such their area and production are declining due to low profitability compared to other crops such as rice, wheat, and sugarcane. However, there is some scope of increasing the area and production of these crops if the appropriate technologies are followed for their cultivation and also if they are fitted in various niches of rice, wheat, and sugarcane cropping systems, as discussed above. Better linking of research and extension efforts is needed to achieve this.

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