CONSTRAINTS, ACHIEVEMENTS AND PROSPECTS OF PULSES BREEDING IN BANGLADESH

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1. INTRODUCTION

Pulses constitute an important component in the farming systems of Bangladesh from the points of view of crop ecology, and human and animal nutrition. At least nine species are grown in various parts of the country. This group of crops covers about 2.5% of the total cropped area, after rice, jute and oilseed and contributes about 1.2% of the gross value product of all crops (Elias, 1987). But their total area, production and even the per hectare productivity have been declining from the early seventies at a considerably fast rate due primarily to their continuous relegation towards more marginal lands and less productive environments (Shaikh, 1977; Shaikh et al.1978)

The decline in total area, production and per hectare productivity of pulses in the country has continued in the following order : 300,000 ha during the 1981-83 period compared to 340,000 ha in the previous five years; 212,000 t in recent years compared to 220,000 t/year during 1973-76 and 675 kg/ ha during the past few years from an average of 735 kg/ha in the mid-seventies (Elias, 1987).

Decline in production with concomitant increase in population has resulted in alarmingly decreased pulse consumption from an approximate 8 gm/ caput/ day in 1974 to about 6 gm at present. This consumption level is absolutely meagre since the recommended daily allowance is 112 gm/ caput/ day (BARC. 1986).Elias (1987) estimated that even a threefold increase in pulse production will only double the per capita availability in view of the projected population increase by the end of the century. This dismal picture of pulse availability fortells an impending nutritional disaster. It will be an almost impossible task to combat this acute problem of malnutrition and protein deficiency.

The imminent national nutritional crisis foretold by Shaikh el al.(1978) has, of course, been a direct consequence of erroneous food production policy (Jabbar, 1987). The food grain biased policy has stunted the overall growth of agriculture itself, let alone pulses. The strategy for self-sufficiency in food grains, meaning rice and wheat, has primarily been responsible for the neglect to pulses. It is, therefore, not surprising that pulses are losing the race with rice and wheat despite the existence of reasonably high yield potential in some of them commensurate with much higher market price. Reduced priority to research in pulses and oilseed legumes prompted Nobel Laureate Borlaug (1973) to confer upon them the title " ugly duckling "and to advocate stimulation of research for speeding up the " slow runners".

However, it will become apparent in the present review that plant breeders of this country have been able to develop / adapt some pulse genotypes which are capable of removing the perception that these are low yielding and high risk crops. What is most necessary now to reap the yield potential of these improved genotypes to the fullest extent, is a fundamental change in the Government policy to research and extension of pulse including provision of input subsidy, price support and farmer training. Otherwise, a serious nutritional crisis, specially for the vulnerable section, is imminent for the already malnourished population. Under the circumstances, we have no option but to warn the policy makers that the very nature and productivity of the nation will be irrepairably damaged unless the trend is averted within the shortest possible time.

II. HISTORY OF PULSE RESEARCH

Most food legumes, of which pulses form a part, have a long history of domestication and conscious or unconscious selection has been continued throughout for improved adaptation and yield. Large seeds, non-shattering pods etc. are thought to be evidence of man-made modifications (Zohary and Hopf, 1973). However, research efforts for pulse improvement in the Bangladesh area are of very recent origin. Research of pulses though initiated during the early fifties but very little progress was made. Most of the efforts were confined to collection and evaluation of local germplasm. A fresh start was made in 1961-62 with the establishment of pulse and oilseed

Division. Screening of local germplasm was carried out during 1961-64 (Islam et al. 1982) and some better ones were recommended for cultivation. A more systematic collection, catalogueing, evaluation through uniformity trials and preservation of local exotic pulse germplasm began at BARI and BINA during the mid-seventies and no worthwhile published report of pulse improvement is available prior to this period (Shaikh 1989). As a consequence of the short period and limited efforts of pulse improvement, each species has only a few recommended and released varieties so far (Table 1: BARC, 1975, Shaikh, 1977, Shaikh et al. 1982, Rahman et al. 1988 and Wahab et al. 1982). Although nine species are listed in the table, breeding work on the five major pulses e.g. chickpea, mungbean, blackgram, lentil and grasspea are being reported and discussed in the review.

Table-1. Common pulses of Bangladesh, their status and number of recommended/ released* varieties of each crop.

Common name	Botanical name	status of production	No. recommended(rec.)/ released(rel.) varietie
Chickpea/ gram	*Cicer arietinum* L.	Major	5 (3 rec. + 2 rel.)
Mungbean	*Vigna radiata*(L.) Wilczek	Major	5 (3 rec. + 2 rel.)
Blackgram	*Vigna mungo* (L.) Hepper	Major	3 (2 rec. + 1 rel.)
Lentil	*Lens culinaris* Medik	Major	3 (rec.)
Grasspea	*Lathyrus sativus* L.	Major	2 (rec.)
Pegion pea	*Cajanus cajan* L.	Minor	2 (rec.)

* Varieties are released by the National Seed Board(NSB). Prior to the establishment of NSB, varieties used to be recommended by the Research Institutes/Directorate of Agriculture.

III. CONSTRAINTS

In attempting to list the constraints for breeding of pulses in Bangladesh the following points emerge as generally applicable to all the species grown.

a. Genetic variability is extremely narrow in the local cultivars and land-races. Each species has only a few varieties/ cultivars and in most cases there is no congnizable variation among them in any character.

b. The varieties/ cultivars are generally low- yielding compared to varieties in other countries although a few newly released ones have reasonably higher yield potential.

c. The species grown are normally wasteful in nature due to improper ratio between total biomass and seed yield portions. This results from plenty of vegetative growth and unusally high rate of flower shedding and / or unfilled pods. Pulses, therefore, have a much lower harvest index than wheat and rice.

d. All the Bangladeshi pulses are of small- seeded type which has a direct bearing upon the lower seed yield.

e. Many of the pulses are required to grow under intercropping/ mixed cropping systems due to various socio-economic and edaphic factors but most of these have not been selected for this purpose.

f. Varieties/ cultivars do not differ in plant types suitable for different agro- climatic regions.

g. Most of the species run the risk of being damaged by early winter rain, late winter rain and early soil drying.

h. The phenology i.e. the development patterns of some pulses have evolved in response to environmental variables rendering them sensitive to photoperiod and temperature. Changes in these factors reduce yield drastically.

In addition to the general constraints to pulse improvement enumerated above, each individual pulse crop has some specific problems listed as under :

<u>Chickpea</u>

a. Yield reduction due to late sowing (December) following harvest of <u>Aman</u> rice. Varieties suitable for such agroecological requirement are lacking.

b. Chickpea yield is also greatly reduced in some seasons by wilt (<u>Fusarium oxysporum</u>), collar rot (<u>Sclerotium rolfsii</u>), root rot (<u>Rhizoctonia solani</u>) and grey mold (<u>Botrytis cinera</u>) diseases and the insect, pod borer (<u>Heliothis armigera</u>) (Shaikh et al. 1981).

<u>Mungbean and Blackgram</u>

a. Asynchronous pod maturity resulting in decreased seed yield per plant (Ahmed et al.1978).

b. Undesirable plant types such as bushy and spreading habits and trailing tendecy under absundant moisture regimes (Shaikh et al. 1982).

c. Yield reduction in photosensitive winter mungbean (600-700 kg/ ha) due to infection with diseases like Cercospora leaf sopt (CLS), yellow mosaic virus (YMV) and powdery mild (PM) (Shaikh et al. 1982) and insects like pod borer (Heliothis armigera). Yield reduction in the photoinsensitive, greenseeded summer mungbean (700-800 Kg/ha) grown in southern part of the country due to indicidence of diseases like YMV, CLS, and insects like pod borer (Euchrysops cneius), leaf beetle (Monolepta signata), stem fly (Agromyja phaseoli) and hairy caterpillar (Diacrisia obliqua) (Rahman et al. 1981).

Lentil

a. Lack of varieties with late sowing potential. Optimum time of sowing for the present varieties is first week of November. But Aman rice/lentil cropping pattern pushes sowing date sometimes upto the end of November with resultant reduced yield.

b. Varieties are susceptible to major diseases like rust (Uromyces fabae) specially the late sown crops and stemphylium blight(Stemphylium sp.). Minor diseases are collar rot, root rot, wilt and bushy stunt.

Grasspea

a. Late sown (end of November) crops suffer from attack of powdery mildew and downy mildew diseases. Aphids, sometimes, reduce yield considerably.

b. High neurotoxin (BOAA) content in the local varieties which is supposed to cause lathyrism in man.

IV. BREEDING OBJECTIVES

The general breeding objectives of pulses of Bangladesh are as follows:

1. To improve the yield potential of varieties/ cultivars.
2. To develop varieties with resistance to diseases and pests.
3. To improve seed size of varieties / cultivars.
4. To augment nitrogen- fixing capacity of the varieties/ cultivars through incresed nodulation.
5. To develop genotypes with late sowing and/ or early maturing potential.

6. To decrease sensitivity to abundant moisture regimes and to moisture stress conditions prevailing in the drought prone and dryland areas of Barind.
7. To improve nutritional quality characters including increase in protein and sulphur containing aminoacids, improvement of biological availability of protein and also removal of antinutritional factors like flatulence etc.
8. To develop varieties compatible to mixed and inter-cropping systems.

Specific breeding objectives for individual pulse crops are enumerated as under :

Chickpea

1. To breed for varieties resistant / tolerant to wilt, root-rot, collar rot, mold disease and also pod borer.
2. To change seed coat colour from brown to amber like the kabuli type and removal of shrinking seed coat character.
3. To breed for yield stability over years and locations(Gowda and Kaul, 1982).
4. To improve keeping quality of seed for ensuring improved seed viability and a better stand in the field.
5. To breed for salinity tolerance for growing in the southern districts.
6. To select for erect and open plant types for avoiding *Botrytis* attack (Gowda and Kaul, 1982).
7. To develop Kabuli type cultivars for adapting in the North Western dry areas.

Mungbean and Blackgram

1. To develop varieties with resistance to YMV, CLS and PM diseases and pod borer pest.
2. To select genotypes with higher degree of synchrony in pod maturity and determinate type of plant growth.
3. To develop short- duration (60-65 days) and photo-insensitive mungbean varieties for cultivation throughout the year, specially during summer.
4. To develop short duration (70-75 days) and early muturing blackgram varieties.

5. To breed for summer mungbean varieties with improved dormacy and capability of avoiding weather damage.

6. To change seed coat colour in summer mungbean cultivars from green to yellow for consumer preference.

Lentil

1. To breed for varieties with resistance to wilt, stunt, rust and stemphylium blight diseases.
2. To select genotypes with late sowing potential.

Grasspea

1. To develop varieties free from/ with lower content of the lathyrogen factor, BOAA.
2. To breed for resistance/ tolerance to aphids and diseases like powdery mildew and downy mildew.

V. ACHIEVEMENTS

A review of the achievements in the field of pulse breeding in Bangladesh reveals that considerable advancements have occurred in the following aspects (Shaikh, 1989):

a. Components having the highest contribution to yield have been identified.
b. Genetic coefficient of variability in these components and scope for improvement through their selection have been determined.
c. Correlation coefficients among these components have been established.
d. Collection, screening and evaluation of local and exotic gormplasms resulted in selection of improved and adapted lines.
e. Superior lines have been selected through pureline selection.
f. Induction of mutations resulted in selection of superior genotypes with increased yield, resistance to disease, improved nutritional quality, and,
g. Hybridization amo ng different local, exotic and mutant lines yielded many desirable genotypes.

Achievements at BARI

Chickpea

Number of seeds/ pod, pods/ plant and pod weight have been found to have positive and highly significant correlation with yield (Mian and Khan, 1975). Highly significant negative relationships were obtained between pods/ plant and seed size, and seeds/ pod and seed size.

About 200 local and 800 exotic germplasms/ advance lines have been collected and evaluated under natural conditions. One line, ICCL 81248, was released by the NSB in 1987 in the name of Nabin for its better seed quality and higher yield. The yield potential of the variety is presented in Table.2

Table.2 Mean seed weight and yield of Nabin compared to Hyprosola (11 locations : 1982-1986).

Varieties/ lines	100-seed wt. (g)	Seed yield (kg /ha)
Hyprosola	7.1	2046
Nabin	11.6	2784

Two wilt-sickplots (one at Joydebpur and one at Ishurdi) have been developed and all the germplasms are being screened in those wilt-sick plots. Some local and exotic resistance germplasms and 5 advanced lines have been identified. Yield potential studies of these advanced lines over locations are in progress.

Chickpea hybridization programme of BARI involving local and exotic germplasms was initiated only in 1984-85 and the segregating populations are being screened in the wilt + root rot sickplot at Ishurdi. These wilt resistant materials are in F_5 generation.

Apart from these, some F_5 generation materials and wilt and root rot resistant nurseries received from ICRISAT are also being screened in the wilt sickplots to identify resistant types.

Recently BARI is also trying to develop late sowing potential varieties. Screening for this purpose has been initiated in 1986 mainly on the basis of fast growing habit and yield, and some promising lines have been identified. Disease reaction of these lines are also being tested in wilt-sick plot.

Mungbean

Genotypic and phenotypic coefficients of variability studies by Khanum et al. (1981) indicated considerable good scope for improvement through selection of seed number, seed size and yield. Heritability of these characters were also found to be high. Genetic advance was found to be the highest in yield/ plant. Heritability, GA, GCV and PCV studies by Rahman et al. (1982) showed that the major portion of the total variation was contributed by the genotypic components.

About 1000 exotic and 120 local germplasms have been screened against YMV but none of them was found resistant. However, one tolerant line against YMV has been released in 1983 in the name of " Mubarik " for March/ April sowing in the Mung-Aman rice-rabi cropping pattern. Another moderately resistant variety " Kanty " has been released is 1987 for August/ Sept. planting in the aus/ jute-mung-rabi cropping pattern. Both of these varieties are, of course, green seeded, photoinsensitive, short duration (65-70 days) type (Table-3). Currently, efforts are being made to develop golden seeded photoinsensitive type through modified bulk method and the segregating generations are in different stages of testing. Recently some resistant sources have been identified against CLS which are being used in the crossing programme.

Blackgram

Variability studies in blackgram by Wahab et al.(1981) showed that CV% in height, number of pods/plant and yield/ plant were 27,27 and 39%, respectively. This, of course, indicated a reasonably good scope for improvement through selection. Comparative trials for adaptability and yield potential placed " Baromashi" as the highest yielding genotype(Wahab et al. 1981).It was a single plant selection from the Indian variety, T-9. It is photoinsensitive and produces flowers and fruits almost any time of the year. But winter sowings result in poor yields because it is thermosensitive. It is most suitable for sowing during April-September.

About 3000 local and 500 exotic germplasms have been evaluated for yield and yield contributing characters. The local cultivars are photosensitive. There is variation in crop duration and reaction to YMV but most of them are susceptible to powery mildew disease if planted late. Most of the exotic germplasms were photoinsensitive type having variation in duration, seed size and disease reaction. BARI had identified one short duration (65-70 days) photoinsensitive line (MAK-I) which is awarting release as a variety (BARI, 1985-86). Some genotypes were found to have herterogeneity in plant population from which pure lines are being developed.

Hybridization programme has been initiated to develop short duration high yielding Varieties through increasing pod number and increased seed size. The segregating materials are in different stage of selection.

<u>Lentil</u>

Maximum variability in lentil was observed in pods/ plant(61%) and yield/ plant (51 %)(Doza et al. 1981 and 1982). Moreover, a highly positive correlation (0.76) was found between these two characters. These results indicated that yield may possibly be increased to a considerable extent through selection for pods/ plant.

BARI has later collected and evaluated more than 200 local and about 800 exotic germplasms and advanced lines from India, Pakistan, Syria(ICARDA) etc. Variation among the local germplasms in respect of yield potential, disease reaction, seed size and crop duration is very small. Among local germplasms L-5 was found better in yield and duration (105-110 days) and currently being used as local cheek. The exotic materials are of longer duration and could not produce significantly higher yield that L-5. Moreover, the " Macrosperma" types are very late in maturity and set fewer pods although some of them are rust-free. L-5 is widely adapted in this country and its yield potential(1500kg/ ha) is also reasonably good within our short winter period (110-120 days) but it is suseeptible to rust and <u>Stemphylium</u> blight. Rust can be avoided by early planting and severity of <u>Stemphylium</u> depends, of course, on warm and humid conditions. However, BARI's main effort at present is to make L-5 rust and <u>Stemphylium</u> free and to increase its yield potential by increasing its seed size.

All the available germplasms are being screended against rust and <u>Stemphlium</u> using susceptible spreader rows. Some resistant lines have been identified against this disease which are being used in the crossing programme since 1985 and the segregating materials are being screened against these diseases. Simultaniously ICARDA has also made some crosses using L-5 and their rust resistant germplasms and supplied F_3 generation to BARI this year. BARI is also receiving ICARDA F_3 populations (LIF_3T-E) regularly but these are mostly late for Bangladesh conditions.

Grasspea

Studies by Begum et al. (1981) involving 190 local germplasm of lentil proved number of pods/ plant to have the highest variability and CV%. Positive correlations were found between seed size and yield, pods/ plant and plant height.

A batch of 260 purelines were screened (BARI, 1987) for BOAA content and two lines were isolated with very low levels (0.1% to 0.5%) of the toxin compared to 0.6 to 1.5%.

From a later collection, 167 local and exotic germplasms were analysed for BOAA content and none of these was found absolutely free from the toxin. It ranged from 0.6-1.20%. Among the local cultivars Jamalpur local and Charbadna produced stable and higher seed yields. Jamalpur is pink flowered with grey seed coat and Charbadna is blue flowered with ash seed coat. The Charbadna type (blue flower) is widely cultivated throughout the country.

Hybridisation programme involving low-toxin lines of grasspea was initiated in India by a BARI scientist and the segregating materials were screened under Bangladesh conditions. These are now at F_6/ F_7 generation. But this character has very poor heritability with strong environmental interaction. However, some low-toxin lines are expected having yield potential and maturity duration at per with the local check.

Table 3. Agronomic characters of the released and potential pulses varieties/lines developed at BARI.

Crops	Variety /line	Days to mature	Plant ht.(cm)	100 seed wt. (g)	Yield (kg/ha)	Time of sowing	Remarks
Chickpea	Nabin	120-125	65-67	11.8	2500-3000	November	Released in 1987
Mungbean	Mubarik	65-75	55-58	3.2	700-800	March	Released in 1983
	Kanti	65-70	50-55	3.2	900-1000	August - September	Released in 1987
Blackgram	MAK-1	70-75	35-38	4.4	1000-1200	March/ Aug.-Sept.	Waiting release
Lentil	L-5	110-115	40-45	1.4	1500-2000	1st week of Nov.	Waiting release

Achievements at BINA

Chickpea

Seed irradiation of the variety Faridpur-1 with 20 kR dose of gamma-rays (Co^{60}) resulted in the isolation of a mutant, M-669 (Shaikh et al. 1978) which had the fortuitous combination of a good many characters (Shaikh et al. 1980).

The mutant is superior to Faridpur-1 in yield and protein content and hence produces about 45% higher protein yield per unit area of land due to its increased seed yield commensurate with the increased protein content (Table 4). It has less branching and a semi-erect plant type thereby making it possible to accommodate an increased population per unit area. It has higher number of pods/plant, seeds/plant and higher harvest index than Faridpur-1. Although its seeds are about 10% smaller in size compared to those of Faridpur-1, but increased number of seeds more than off-set the decreased individual seed weight, thereby increasing its total seed yield (Table 5) (Shaikh et al. 1981, Shaikh et al. 1982 and Shaikh et al. 1983).

Compared to the mother variety, M-669 showed increased field tolerance to pod borer (Shaikh et al. 1981) and Alternaria leaf spots (Shaikh, 1981 and 1982) and also had better symbiosis with local strain No. TLS-2 (Poddar et al. 1980).

The mutant M-669 has been released in 1982 named H Y PRO SOLA (high yield protein sola or high-yielding-high-protein-chickpea (Shaikh, 1983; Shaikh et al. 1985 and Shaikh, 1986). Isozyme similarity and genetic difference studies (Oram et al. 1987) indicated recessive mutant alleles in Hyprosola for small seeds (ssd), long and narrow leaflets(lnl) and early flowering (efl).

Mutants for earliness, disease tolerance, higher number of pods and better plant architecture were isolated from gamma-irradiation of a second batch of Faridpur-1 seeds (Shaikh et al. 1980 and Shaikh 1983). Evaluation of the mutants along with exotic germplasm for yield and agronomic potential over successive generations proved mutant G-299 to be superior to others (Shaikh et al. 1983).

Seed treatment with the chemical mutagen, sodium azide (NaN_3) (Shaikh et al. 1983) resulted in the isolation of mutants with higher number of pods/plant and higher seed yield (Shaikh et al. 1983 and 1985).

Table 4. Protein content, protein yield per unit area of land and important amino acid contents in Hyprosola and Faridpur-1*

	Hyprosola Mean ± SE[a]	Faridpur-1 Mean ± SE
Protein content (%)	22.5 ± 0.5	18.5 ± 0.4
Seed yield (kg/ha)	2290	1922
Brotein yield (kg/ha)	515.3	355.6
Increase in protein yield		
Absolute (kg/ha)	159.7	-
Percentage	45	-
Amino acids (g/16 g N)	Mean ± SD[b]	Mean ± SD
Lysine	7.44 ± 0.01	8.05 ± 0.40
Methione	1.56 ± 0.04	1.60 ± 0.04
Cysteine	1.61 ± 0.13	1.61 ± 0.04

[a]SE : Standard error; [b] SE : Standard deviation

* after Shaikh et al. 1982 & Shaikh et al. 1988.

Table 5. Comparison of various agronomic characters of Hyprosola with the mother variety, Faridpur-1*

Characters	Faridpur-1	Hyprosola
Height (cm)	50-55	45-50
No. of branches/plant	± 9	± 7
Maturity (d)	155	145
No. of pods/plant	± 80	± 92
No. of seeds/plant	125	155
1000 seed weight (g)	± 85	± 75
Harvest index (%)	33	40
Colour of mature fruit	Dull	Shiny
Population (plants) possible/acre	70 000 ± 5000	80 000 ± 5000

* after Shaikh et al. 1980 & Shaikh et al. 1982.

Mungbean

Correlation studies with 70 strains of mungbean revealed positive and significant correlation of number of pods and branches with yield/plant (Ahmed et al. 1981). Other characters having the strongest positive influence on yield are number of branches (Shamsuzzaman et al. 1983) and seed size specially in summer mungbean (Ali and Shaikh, 1986).

Two cycles of single plant selections from one local collected germplasm helped in the development of one improved line, Acc. MB-55 (Ahmed et al. 1981). This line is resistant to Cercospora leaf spot and tolerant to MYMV. It produces, on average, around 35% higher yield (Table 5 & 6) than the recommended variety, Kishoregonj (Shaikh & Ahmed 1987). Its seeds are about 25% higher than those of Koshoregonj (Ahmed et al. 1978).

Experiments throughout a complete year with 60 local and exotic germplasm through fortnightly sowings of all accessions grouped then in three categories such as "real summer", "modified summer" and winter types. These lines can be selected for sowing almost throughout the year. Moreover, some of these are of short-duration type and fit well between two major crops (Begum et al. 1980; Begum et al. 1983; and Shaikh, 1986).

A mutant hybrid MB-246 (Mutant X V5197) produced significantly higher yield in most locations and years (Shaikh and Ahmed, 1987). Adaptation trial over a few years have shown MB-246 and the AVRDC entry V 2272 to be reasonably free from MYMV and both have higher pod number and yield than the recommended cultivar.

Screening and evaluation of 52 gamma-ray induced mutants along with collected germplasm of mungbean (Shaikh et al. 1978, Ahmed et al. 1978) revealed the highest CV% in no. of pods and yield/plant. The accessions showed varying degrees of tolerance to diseases and synchrony in pod maturity. The grades of disease reaction of these breeding materials have been thoroughly studied (Jalaluddin and Shaikh, 1981, Jalaluddin et al. 1985 and Hussain et al. 1981). Some of those materials have also altered plant architecture and synchrony in pod maturity (Shaikh 1982 and Shaikh et al. 1985).

Gamma-irradiation of MB-55 and MB-56 resulted in the isolation of 19 true-breeding mutants with characters like dwarfness, erectness, shiny and large-podded, bold-seeded, synchronously maturing and higher yielding (Shaikh et al. 1982). Erect and synchronous type mutants were selected following sodium azide (NaN_3) treatment of MB-55 seeds (Shaikh et al. 1983).

Blackgram

Biometrical studies revealed that number of pods/plant had the highest significant positive correlation with seed yield followed by number of inflorescences/plant. Similarly number of pods/plant was also significantly and positively correlated with number of inforescences/plant (Majid et al. 1981 and Majid et al. 1982).

Gamma-irradiation of 50-90 kR (60_{Co}) yielded 17 mutants with varying characters like altered plant architecture, disease resistance, synchrony in pod maturity, earliness and bolder seed size (Majid et al. 1981, Shaikh 1981, Shaikh and Majid, 1982). One of these, M-23 is erect, determinate and its pods are more upright compared to the horizontally/downward borne pods of the existing varieties. A higher number of plants unit area of land can be accommodated for obtaining higher yields due to its compact growing habit (Shaikh et al. 1982). Another mutant M-25 is moderately reisitant to CLS and ZMV and is also higher yielding than both B-23 and B-10 (Shaikh et al. 1983, Shaikh et al. 1985 and Shaikh, 1987).

Lentil

Simple correlation, path coefficient analysis and multiple correlation studies in lentil indicated that number of pods/plant, branches/plant and plant height were the three main contributors to yield (Islam and Shaikh, 1978).

Mutation induction in the variety Mukdia-15 was achieved by applying 30-60 kR doses of 60_{Co} gamma-rays. Characters like pod number and protein content were altered (Shaikh et al. 1978). A few phenotypically incognizable mutants were isolated on the basis of higher seed yield from a segregating population following treatment with NaN_3 + gamma rays (Shaikh, 1985). These are under further trials.

Grasspea

Variability studies involving 16 local and 8 exotic grasspea cultivars by Shaikh et al. (1985) revealed a narrow range for days to maturity and number of seeds/pod. However, variations for number of pods/plant, seed size and yield/plant were quite pronounced. BINA accessions L-6 and L-14 had the highest yield/plant.

Treatment of grasspea seeds of BINA Acc. No. 1 with 2, 3, 4 and 5 mM solutions of NaN_3 resulted in the isolation of 32 mutants and six mutant families from the M_2 progeny rows of M_1 plants (Ali et al. 1986). The mutants were selected on the basis of changed plant type, leaf variations, earliness and flower colour. The mutant families showed early flowering and pigmented pods.

Simple correlation and path-coefficient analysis were conducted from the data generated from the mutants and mutant families for identifying the causes of association to improve the selection criteria. Number of pods/plant showed the highest CV% followed by seed yield/plant in both the mutant groups. Plant height, numbers of branches and pods/plant were the main yield determinants in both groups according to the simple correlation computations. But as per path-coefficient analysis, number of pods/plant and plant height were the main yield determinants in the mutants and mutant families, respectively. From these results it was concluded that for improving seed yield in grasspea, number of pods/plant and plant height should be given importance in selecting superior lines among the mutants and mutant families, respectively.

Biochemical screening of 20 cultivars of both local and exotic origin by Dutta et al. (1981) revealed a range of 26-30% protein and 0.22 to 2.00% neurotoxin, BOAA (B-(N)-Oxalyl-Amino-Alanine). There was no correlation between protein and BOAA content.

Another study on the relationship among various characters (Islam et al. 1986) revealed that seed weight varied from 40-67 gm. Protein and BOAA percent ranged from 24.5 to 31.4 and 0.22 to 2.08, respectively. Significantly positive correlation was present among seed size and protein content but a negative relation was found between seed size and BOAA content. No correlation was obtained between protein and BOAA contents. These results indicated that it may be possible to develop low-neurotoxin varieties of grasspea by hybridizing bold-seeded and low-neurotoxin genotypes with small-seeded and high-neurotoxin ones and by selecting for bold seed size. A hybridization program in this line resulted in the isolation of a few plants with bigger seed size, higher protein content and moderate amounts of BOAA. These are under further trials.

VI. PROSPECTS

In pulses, average and potential yield of the existing cultivars are smaller than those of the cereals. Breeding efforts have been small compared to cereals. Success in genetic improvement is also very small mainly because of (i) narrow genetic base of the existing cultivars, (ii) extreme specificity of adaptation which leads to the use of exotic germplasms in the breeding programme and selection from their derivatives ineffective, (iii) emphasis on breeding for yield which is not at all a reliable criterion for selection. The yield contributing characters like pods/plant, seed/pod, branching, seed size etc. sometimes show significant positive correlation with yield but these have poor heritability and large non-additive genetic component and, therefore, are of little utility in selection for higher yield. Nevertheless, Smithson and Roberts (1987) reported that increased seed size (within certain limit) and increased fruiting nodes through increased branching may be useful criteria in selection for higher yield.

However, the preponderence of non-additive genetic variation for most yield components and the specific nature of adaptation suggest the need to consider approaches which involve the incorporation of features such as resistance to diseases and pests and tolerence to physical stress factors. The prospects for more stable yield and strategies to achieve them will vary due to the environments, physical stress factors, available genetic stock and existing cropping patterns. Where desirable genetic variance does not exist in the germplasms for any specific character, mutation breeding may serve as a tool to create such variability.

Chickpea

Chickpea yield potential of as high as 4800 kg/ha has been recorded in Bangladesh (BARI, 1983-84). But even with inputs this yield can not be guaranteed because of its high sensitivity to microenvironments, tendency to excessive growth in favourable conditions, and more susceptibility to diseases and pest.

The inherent unstability of chickpea has both pathological and physiological origin. Eight chickpea diseases have been reported (Ahmed et al. 1981, Fakir, 1983) and their distribution and importance are principally determined by rainfall, temperature and humidity. Among them occurance of collar rot, wilt, root rot, and Botrytis are severe and more common. Resistance source against wilt and root rot have been obtained and are being utilised in crossing programme but resistance are still lacking for collar rot and Botrytis. Therefore, more effort should be diverted to identify or create resistance against these. Like-wise other biotic stresses such as inadequate soil moisture affects germination, growth and podding etc. especially under late-planting conditions after rice. Therefore, the vast fallow area after rice harvest may be utilised if late sowing potential varieties having ability to germinate under limited moisture, having fast growth habit and tolerance to higher temperature are developed.

Thus, incorporation of resistance to wilt, root rot, collar rot, Botrytis and Heliothis as well as tolerance of drought into adapted genetic background will help in producing larger yield and to stabilise production of chickpea.

Mungbean

Mungbean is a unique crop for its shorter duration which can be fitted as catch crop in the gap period between kharif and rabi season which otherwise remain fallow. Pulses area is reducing day by day which is not possible to increase but still there is a scope to increase total pulse production involving mungbean in the above pattern. Moreover, mungbean plants can add substantial amount of green manure if ploughed down after havest of pod. Hence, attention should be paid for top canopy bearing habit

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during selection for easy harvest and later ploughing down of the plants.

The most limiting factor for poor mungbean yield today is probably the YMV disease. Efforts should further be strengthened to develop YMV resistant varieties. Varietal development programme may also be undertaken against pod borer.

Blackgram

Blackgram has better prospects for its more stable and better yield, better adaptibility to stress environments, like water logging, environmental hajards, less disease and insect problems. Currently much of the blackgram area is being taken up by rabi crop which can be recovered by short duration varieties suitable for aus/jute-blackgram-rabi cropping pattern. However, during this time (August/September) conventional land preparation is difficult due to heavy rain. Hence, varieties should be developed utilising the fodder type genotypes (grown under zero tillage along the road sides) which can be grown under minimum tillage condition. Late planting as relay crop with aman rice or post flood situation will continue in this country and for these situations powdery mildew resistant thermo-insensitive varieties are necessary.

Lentil

Most of the cultivars have been derived from selection within heterogenous population and the progress through this approach is very limited due to the small diversity available in these population; (Muehlbauer et al. 1987). For further improvement vigorus mutation induction, hybridization and selection against specific stress conditions is inevitable. All standard breeding techniques are appropriate but pedigree method may be more advantegious for simply inherited characters.

For Bangladesh condition, a variety of 110-120 days duration, resistant to rust and stemphylium blight disease, having 1000 seed weight around 20 grams and a yield potential of 2-2'5 t/ha.

Grasspea

Grasspea is probably the hardiest pulse crop grown as relay crop with minimum inputs (only cost of seed) and occupying the largest area which would otherwise remain fallow. It is the number one pulse crop in area and production (BBS, 1986) and mostly consumed by human beings (although a small quantity of grain is fed to animals). Its cultivation has not reduced despite a huge campaign against it by the nutritionists about its relation with lathyrism. It is a matter of educating the people rather than discouraging its cultivation. Methods of cooking and safe consumption patterns are available now. Side by side, genetic detoxification is possible through development of toxin-free varieties as has been shown in this review.

Grasspea is such an easy crop that farmers are not going to leave it as also happened in India despite government's ban on its cultivation. It is a crop which will survive on its own merit in Bangladesh.

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