Pulses (Food Legumes) for Spate Irrigated Farming in Pakistan

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Practical Notes Spate Irrigation

Spate Irrigation Network pakistan

1. Local Production and Import of Food Legumes

Food legumes (commonly known as pulses) are the most important source of vegetable protein in Pakistan. They are cultivated on around 5% of total cropped area. Their use ranges from baby food to delicacies of both the rich and the poor. Because of the population growth, demand for food legumes is increasing rapidly. Currently, the country is importing 0.336 to 0.52 million tons of food legumes worth of Rs. 12.7 to 15 billion per annum based on the last decade data. There is a continuous increase in the import of food legumes.

Major food legumes grown in the country are chickpea, lentil, mung bean and mash beans. There are other summer and winter food legumes such as pigeonpea, cowpea, moth beans, common beans and faba bean. These minor food legumes are grown on small area.

Total area under major food legumes in the country is about 1.5 million ha. Among these food legumes, chickpea is the major winter food legume and mung bean is the major summer legume. Chickpea occupies 73% of the total food legume area with 76% contribution to the total production, whereas mung bean occupies 18% of total area devoted to food legumes contributing 16% to the total pulses production. The black gram and lentil, each are cultivated on 5% of the total area under food legumes and each of them contributes 5% to the total pulses production.

The country is continuously developing varieties with higher yield potential that respond to improved management practices so as to meet the increasing demand of food legumes. Pakistan is deficit in food legumes, as it is importing these legumes since last few decades and imports are increasing continuously. The increase in canal water supplies from 64 MAF to 105 MAF, which is attributable to the storage reservoirs of Mangla, Chashma and Tarbela, which became operational in 1967, 1971 and 1976, respectively (Afzal 1996). The increased water availability resulted in the adoption of high delta crops (cotton, sugarcane, fruits and vegetables) and area under these crops was either reduced or stagnant but the demand was increasing due to rapid growth of population. Share of domestic production in consumption has been declining because of very slow growth of production against considerable increase in consumption. There are many supply as well as demand side factors responsible for the deficit in food legumes. On supply side, low growth of food legumes can be attributed to the following factors:

- Competition of Food Legumes on Water with Cash Crops in the Indus Basin: There has been almost no growth or fractional growth of food legumes in last 30 years (GOP 2006; GOP 2008). Chickpea and lentil being two major food legumes in Rabi season compete with wheat for limited water supplies. Wheat requires 24 MAF of canal water out of total of 31.4 MAF available in Rabi. Very little water is available for other Rabi crops including food legumes. Wheat average yield is 2.45 tons/ha against food legumes yield of 0.429 tons/ha for chickpea, 0.723 tons/ha for mung beans, 0.532 tons/ha for mash beans and 0.480 for lentils (GOP 2008). For such a low yield of 0.43 to 0.723 tons/ha of various food legumes is an indicator that it is difficult for these crops in the Rabi to compete with wheat, except in Spate[1] and Barani areas where wheat cannot be grown economically during the dry years or in droughts. Farmers prefer to grow wheat, as it is not only a staple food but have higher economic returns both from grain and straw.
- Lack of Technological Advancement and In-efficient Machinery: Lack of appropriate technology and in-efficient harvesting and threshing machinery are the major factors contributing to low productivity and losses of mature crop in the field due to shattering. Crop losses at the time of harvesting and during threshing make this crop un-economical. Low productivity of food legumes is largely due to in-appropriate production technology and harvesting and threshing machinery. Even planting machinery is not available to the farmers. The price of food legumes have increased many-fold but due to lack of appropriate technology and machinery it is not economical for the farmers to grow these crops until the potential yield can be increased
- Non-supportive Government Policies: Low production of pulses can be attributed to the neglect of effective policy support for local production and import of pulses. There is little potential to increase the productivity potential of food legumes, whereas introduction of broad beans was not that successful (GOP 2006; GOP 2008). Farmers face lower market prices that dampen down production. Farmers prefer to grow other crops because of sound procurement system. Marketing system should

1) Spate irrigation and farming is locally named as Rod-Kohi in NWFP and Punjab and Sailaba in Balochistan.

not allow importers to exploit local producers, as it is a usual practice of importers to decrease the market prices of imported food legumes as the maturity period of these crops approaches in the country.

2. Can Pakistan be Self Reliant in Food Legumes

Currently, the production gap of food legumes is about 0.5 million tons, as the local production is around 1.0 million tons. Therefore, the current consumption is around 1.5 million tons. Total requirement of food legumes is projected with 2.0% growth rate and production is projected with 4.0% growth rate[2]. Total requirement of food legumes is projected at 2.3 million tons by 2030 while projected level of production is 2.3 million tons and the gap will be zero. Self-sufficiency in food legumes may not be possible in the short run but in the long-term the prospects seem reasonable. The key factor is to increase the area under food legumes outside the Indus basin. Currently, only 1.50 million ha is under food legumes, whereas to achieve self sufficiency at current level of productivity requires an increase in the area to 3.45 million ha.

It is possible to expand the area of food legumes under Spate irrigated areas, where these crops suits well as their water requirement is less than wheat and sorghum and they perform better even in dry spells. There is a large contingent of food legumes that proved to be promising for Spate irrigated areas including lentils and chickpea in Rabi and mung beans, mash beans and moth beans in summers. A number of other non-conventional beans crops can also be added supported by research on food legumes. The opportunities are illustrated as under:

- Water efficient food legumes like lentils, chickpea, mung beans, mash beans and moth beans can be grown in spate areas where wheat and sorghum cannot be grown economically. Currently farmers do mix food legumes (mungbeans, mashbeans) with sorghum but in this mixture seed of high yielding crops is not used. Further instead a mix of sorghum with pulses using broadcast a concept of strip cropping can be used to get better fodders and food legumes.
- Food legumes can be grown in Spate irrigated areas with one deep irrigation before planting and then with rainfall these crops can be matured. In case water is available for additional irrigation, 1-2 extremely light irrigations can help to achieve the potential yield.
- As price of food legumes is fluctuating in the market and there is no assured procurement of food legumes by the public sector in-line with wheat, therefore farmers can be organized in to a cooperative to value add their commodities into pulses and market the pulses to fetch comparatively higher returns.
- Policy support can motivate local farmers for local production of pulses and other by-products.

The objective of this practical note is to provide information to the stakeholders about improved varieties and crop management practices so as to maximize yields and quality of food legumes in Pakistan.

3. Production Technology for Food Legumes

Many food legumes are grown for production of pulses and can be grouped in two categories: a) conventional food legumes; and b) non-conventional food legumes. Lentil, chickpea, mung beans, mash beans and moth beans are conventional food legumes and are being grown since historical times. Broad beans, faba beans and other beans are non-conventional crops and are recent introductions at the research level. The recommended production technology for different food legumes in Pakistan (NARC and UAA 2000; NARC 2007) was reviewed and based on the experiences gained under the "National Spate Irrigation Project" the following potential crops have been selected to grow in Spate irrigated areas.

3.1. Chickpea

Chickpea has been the focus of research and development since the inception of systematic research work on food legumes in Pakistan. Major importance to chickpea improvement was attributed because it contributes 70-80% to the total pulses area and production. Thal desert that cannot support/sustain major cash crops due to low fertility and lack of irrigation is well known as home of chickpea. This is because chickpea can perform well under conditions of moisture stress in marginal soils. The drought tolerance in this crop is extremely desirable attribute for moisture deficient areas of the country. The medium fertility, moderate moisture levels, sandy

2) This is an average growth rate from 1990 to 2008

loam soils and moderate winters provide optimum conditions for chickpea cultivation. The study of the production profile reveals swear fluctuation highlighting the problem of instability, which may be attributed to 3 major constraints. Drought or moisture stress and wilt are the twin problems that occur together. The third major constraint to chickpea production is Ascochyta blight.

The major emphasis was placed on these issues and consequently various institutes released 10 blight resistant varieties of Desi chickpea. By the release of these varieties, chickpea captured more area in Pothwar; where chickpea area had reduced to minimal level. Chickpea crop can be introduced in Spate irrigation systems where soils are of light texture and field sizes are small, so that light irrigations can be practiced (Figures 1 and 2).

Disease Resistant High Yielding Varieties for Rainfed and Spate Irrigated Areas

Chickpea blight caused by Ascochyta rabiei has been a major disease constraining chickpea production in the country. This problem caused total crop failure in the early 90s. Pothwar area that has been traditionally a chickpea growing area has become a hot spot for this disease.

Figure 1. Chickpea plantation

Figure 2. Scientists viewing Chickpea in the Travelling Seminar - a routine activity

Progressively the area of chickpea in Pothwar reduced drastically. Realizing the gravity of the problem Pulses program NARC initiated a breeding program aimed at development of blight resistant varieties of chickpea. Food Legumes Programme at NARC released two high yielding disease resistant varieties during 2003 to replace blight susceptible cultivars. Similarly, other varieties are available in the provinces.

Varieties Developed for High Altitudes

The two promising varieties have been selected for comparison of yield potential in Spate irrigation areas in Pakistan (Figures 3 and 4).

The salient features of the two developed varieties (Dasht and Parbat) are:

- Possess a good level of resistance against blight.
- Displayed resistance against multiple isolates of blight pathogen.
- Tolerant to cold.
- Resistant to iron chlorosis.
- Seed quality parameters are comparable with those of released varieties.
- Yield potential is 1.5-2.0 tons/ha on farmers' fields.

Seedbed Preparation

For the cultivation of chickpea light to medium textured soils are appropriate. Fine textured soils are not recommended for its production. In Spate irrigated areas farmers can initiate seedbed preparation, once the ponded water is infiltrated in the soil. Once the soil is in a condition to till, cultivator or harrow can be used and later on planking be done to conserve moisture. In light textured soils only one ploughing is adequate to remove weeds, otherwise in sandy soils ploughing may not be needed and direct seeding can be made.

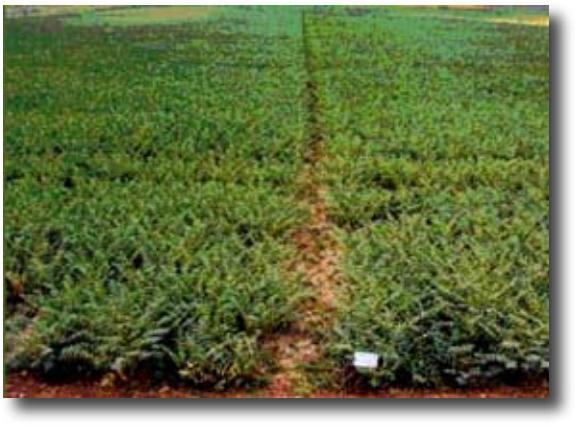

Figure 3. Dasht and Parbat varieties growing side by side in Pothwar

Planting of Chickpea

In Spate irrigated areas, soil fertility is relatively high due to inflow of sediments with the floodwater. Due to the higher availability of nutrients the planting time of chickpea may be delayed so that vegetative growth is not excessive. The planting must be done in line using seed drill. Line sowing helps to have better yield.

1st October to 15th November is the optimum sowing time for these varieties in Punjab and adjustments are needed in other areas.

Fertilizer Requirement

Chickpea is a legume. It has nodulation capability which can fix atmospheric nitrogen into the soil, if seed is inoculated with bio-fertilizer using inoculants developed for nodulation of chickpeas. The bio-fertilizers for chickpea are available with NARC and other establishments of PARC. The cost of these bio-fertilizers is Rs. 50 per bag and 3 bags are sufficient to treat seed of 1.0 ha.

High and effective nodulation on the roots of the chickpea is an important agronomic factor for enhanced productivity and fixation of atmospheric nitrogen into the soil. The genotypes are now available with high nodulation capacity and consequently with higher yields.

Fertilization dose of 60 kg/ha of phosphorous is recommended. Foliar application of liquid micro-nutrients (zinc and boron) is suggested based on the recommended dose for soils which are excessively exploited or low in fertility. Normally in Spate irrigated lands there is hardly any deficiency of micro-nutrients.

Plant Density and Population of Chickpea

Optimum seed rate in chickpea is the most important factor for realizing good yields. It has been observed that farmers still use lesser seed rates for chickpea. For chickpea, the optimum plant population for better yield is 670,000 plants/ha. Row spacing of 30 cms is recommended. Seed rate of 62-75 kg/ha is recommended for better harvest for these varieties.

Irrigation

In Spate irrigated areas pre-planting irrigation is essential. Irrigation at flowering is sufficient. In case of adequate rainfall even this irrigation is not needed. Chickpea is the most drought tolerant crop and thus suited well for light textured soils.

Weed Control

Weed control is essential to have higher productivity. The common weed is Pohli, which can be eradicated using: a) deep ploughing of field before seedbed preparation; b) inter-culture during the month of December and January; c) inter-culture between rows using rotary ploughs; and d) application of Tribunil herbicide at the rate of 2.0 kg/ha and dissolving it in 375 to 500 litres of water. The chemical application provides an effective control of weeds if applied after the planting of crop.

Diseases of Chickpea

The common diseases of chickpea and their control are presented as under:

- Blight is a common disease of chickpea. This disease is common during the month of March, when it starts with black spots on leaves, which turns into black circles. Plants slowly get weaker and then ultimately dried. This disease can be controlled with treatment of seed with Tecto or Benlate at a rate of 3 gms/kg of seed.
- Wilt is another disease of chickpea, which normally appears just after the emergence of the crop or after the beginning of the maturity. In this disease the hairs of roots are rotten and plants ultimately dried. It can overcome by treating seed before planting with Benlate at the rate of 3 gms/kg of seed.
- Root Rot is another common disease and it appears in the early stage of growth, where roots are completely rotten and ultimate plants are dried. Seed should be treated with Benlate. The other option is to use chickpea variety which is resistant to root rot. The most important is that excessive wetness or standing water is the root cause of this disease, thus effective drainage is required.
- Seed treatment with Benlate @ 2g/kg of seed is recommended for the eradication of primary inoculums on seed.

Insects and Pests and their Control

The common insects and pests and their control is given as under:

- Chickpea Worm is a common insect and its first attach is in November and December and the second is in March and it normally affect the pods and ultimately the yield. It can be controlled by: a) having deep ploughing before the planting of crop to destroy pupas; b) crop rotation with wheat, barley, rapeseed and mustard; and c) weed control as weeds are the host plants and provide food to the insect. The control is through: a) application of 625 ml of Somisidan or Karatay 205 EC in

250 litres of water (sufficient for one ha) to the field at the time when there is grain formation and worm has attacked the crop. Repeat this process after every 10-15 days.

- Thief Insect is another common insect, which affect the leaves at night time and during day time it is hidden in soil. Application of Furadon 30% granular at the rate of 17 kg/ha at the time of planting be sprayed on the soil.

Current Recommended Crop varieties and their Characteristics

The chickpea varieties released in Pakistan through National testing Programme are listed in Table 1 along with yield potential and main characteristics.

3.2. Lentil

Lentil is the second major winter season food legume after chickpea in Pakistan. It is mainly grown in all the provinces but the two-third area is in Punjab. The area as well as its production has been decreased gradually (almost to 40% mainly due to shift of main lentil area to other crops, weed and disease problems, and non-availability of certified and quality seed of improved varieties). So far, only 9 varieties have been released for use of farmers. Masoor-93 has wider adaptability with high yield potential (3.843 tons/ha) than others. Shiraz-96 is suitable for cold and dry areas of Balochistan. Presently, about 18 research units or institutes are involved in lentil research and development. The lentil hybridization programme is going on at three research institutes. Lentil blight, rust and pea seed-borne mosaic are serious diseases. Weed control, application of basal dose of nitrogen with Rhizobium inoculation, phosphorus, zinc, and optimum seed rate are proved to be highly economical inputs for maximizing lentil production. For enhancement of lentil production in the Spate areas, two approaches are suggested: a) development of improved high yielding, disease resistant, black-spotted, herbicide resistant micro-sperma varieties suitable for marginal areas under drought conditions; and b) bringing more areas under lentil cultivation in Spate irrigated areas (Figure 4). At present, 11 candidate lines of lentil developed by NARC are in national yield testing programme.

Figure 4. Lentil crop at flowering in Spate irrigated areas

Seedbed Preparation

For the cultivation of lentils, light to medium textured soils with low levels of fertility are appropriate. Fine textured soils are not desirable for its production. In Spate irrigated areas, farmers can initiate seedbed preparation, once the ponded water is infiltrated in the soil. Once the soil is in a condition to till, cultivator or harrow can be used and later on planking be done to conserve moisture. In light textured soils, only one ploughing is adequate to remove weeds, otherwise in sandy soils ploughing may not be needed and direct seeding of lentils can be made.

Planting of Lentils

In Spate irrigated areas soil fertility is relatively high due to inflow of sediments with the floodwater. Due to the higher availability of nutrients the planting time of lentil may be delayed so that vegetative growth is not excessive. The planting must be done in line using seed drill. Line sowing helps to have better yield. The recommended planting dates are middle of October to middle of November for Punjab and Sindh provinces, whereas for NWFP and Balochistan the recommended planting period is the month of October. If lentil is planted early then the excessive vegetative growth can reduce the yield, whereas late plantings are more liable to insects and pests.

Fertilizer Requirement

Lentil is a legume. It has nodulation capability which can fix atmospheric nitrogen into the soil, if seed is inoculated with bio-fertilizer using inoculants developed for nodulation. The bio-fertilizers for lentils are available with NARC and other establishments of PARC. The cost of these bio-fertilizers is Rs. 50 per bag which is sufficient to treat seed of one acre.

Table 1. Chickpea varieties released in Pakistan through National Testing Programme

Variety	Year of Release	Institution	Yield Potential (Kg/Ha)	Main characteristics
Sheenghar	2000	GRS, Karak	1800	Drought and blight tolerant, bold seeded, high yielding
Punjab-2000	2000	AARI	2500	Desi, high yielding, bold seeded, tolerant to ascochyta blight, resistant to shattering.
Balkasar	2000	BARI	2500	Desi, high yielding, medium seeded, tolerant to ascochyta blight
Venhar	2000	BARI	2500	Desi, high yielding medium seeded, resistant to ascochyta blight
Dashat	2003	NARC	2500	Desi, high yielding medium seeded, resistant to ascochyta blight
Parbat	2003	NARC	2500	Desi, higher yielder than dashat medium seeded, resistant to ascochyta blight
KK-2	2003	GRS, Karak	2000	Desi, drought tolerant, medium seed size
Thal-2006	2006	AZRI, Bhakkar	2500	Bold seeded, drought and blight tolerant, highly responsive to irrigation.

High and effective nodulation on the roots of the lentils is an important agronomic factor for enhanced productivity and fixation of atmospheric nitrogen into the soil. The genotypes are now available with high nodulation capacity and consequently with higher yields.
Fertilization dose of 60 kg/ha of phosphorous is recommended. Nitrogen is not recommended otherwise vegetative growth will affect the productivity.

Plant Density and Population of Chickpea
Optimum seed rate in lentils is the most important factor for realizing good yields. It has been observed that farmers still use lesser seed rates for lentils. Row spacing of 30 cms is recommended. Seed rate of 45 kg/ha is recommended for better harvest from these varieties.

Irrigation
In Spate irrigated areas pre-planting irrigation is essential. Irrigation at the flowering stage is adequate. In case of adequate rainfall this irrigation may not be needed. Lentil is drought tolerant crop and thus suited well for light to medium textured soils.

Weed Control
Weed control is essential to have higher productivity. The common weeds can be eradicated using: a) deep plouging of field before seedbed preparation; b) inter-culture after 40-45 days since planting of lentils; and c) application of Tribunil herbicide at the rate of 2.0 kg/ha and dissolving it in 375 to 500 litres of water, which is sufficient for one ha. The chemical application provides an effective control of weeds if applied after the planting of crop.

Diseases of Lentils
The common diseases of lentils and their control are presented as under:

- Rust is a common disease of lentils. This disease occurs after flowering, where yellow spots are observed on the leaves, which later on changes to brown and ultimately black circles. Sometime similar spots occur on pods and stems. The Rust can be controlled by: a) adopting disease resistant varieties; b) destroy and safely dispose the affected plants; c) use disease free seed; and d) planting at right time because delayed planting is susceptible to disease infestations.
- Blight is another disease of lentil, which normally appears in high rainfall areas and thus it is normally not witnessed in Spate irrigated areas except in extremely wet years. In this disease the stems, leaves and pods are having brown or black spots. It can overcome by: a) use of healthy seed and treating it before planting with Benlate at the rate of 3 gms per kg of seed; b) after the harvest destroy safely the affected plants; and c) following crop rotation.
- Stem Rot is another common disease and it

affects the stem and then plant dry. White fungus is witnessed on the affected parts of the plant. The control is only through crop rotation by avoiding continued plantation of lentils in the same field.

- Root Rot is another common disease which is caused by fungus and it affects the root and then root breaks down in to pieces and ultimately root is dead. It can be effectively controlled by adopting crop rotation.

Insects and Pests and their Control

Worm is a common insect and its attach is normally observed in March and April. It normally eats leaves, young stems and pods and then crop is ultimately affected resulting in reduced yield. It can be controlled by the application of 625 ml of Somisidan or Karatay 205 EC in 250 litres of water to the soil at the time when insect attach the plants. If there is no control then repeat application of recommended insecticide after 10-15 days.

Recommended Varieties for Different Areas

The National Pulses Progarmme of NARC has recommended different varieties for irrigated and non-irrigated areas including varieties suitable for various Spate irrigated areas. The details are given as under:

- For Punjab recommended lentils varieties are: Local lentil and Mansara 89;
- For NWFP recommended lentil variety is Masoor 93;
- For Sindh recommended lentil varieties are: Malka Masoor and Masoor 93; and
- For Balochistan recommended lentil varieties are Masoor 85, Masoor 93 and Shiraz 96.

Comparison of Highland Variety Developed for Spate Irrigated Areas (SHIRAZ-96)

The comparison of two varieties namely Shiraz-96 and Balochistan Local is presented in Table 2. The major characteristics of Shiraz-96 and the details of the approval process are given as under:

- Pedigree: ILL5865 (ILL470xILL1334);
- Approval: Balochistan Seed Council in December, 1996;
- Variety registration: Federal Seed Certification and Registration in March, 1997; and
- Recommended area: All highlands (>1000 m altitude) areas of Balochistan.

Current Varieties of Lentils and their Characteristics

The lentils varieties released in Pakistan through National testing Programme are listed in Table 3 along with yield potential and main characteristics.

3.3. Mungbeans

Mungbean is one of the important Kharif food legumes. It is also grown during spring season mainly in southern Punjab and Sindh provinces. Punjab is the major mungbean growing province that alone accounted for 88% area and 85% of total mungbean production. Cultivation is concentrated in the districts of Layyah, Bhakkar, Mainwali and Rawalpindi. Although it is grown in different cropping patterns, about 75% cultivation follows mungbean-wheat cropping pattern. The improvement of mungbean had been limited until late 70s due to the selection from land races which were of trailing types. Research on this crop like other pulses gained momentum in mid 80s when National Coordinated Pulses Research Program was started at the federal level by PARC in collaboration with provincial research institutes. This program, through provision of funds to partners, short term and long-term trainings, exchange of germplasm and/or research material with National and International Research Institutes and evaluation of new improved lines, strengthened research improvement of cultivars of pulses. From 1985-86 to date about ten improved varieties have been released. With the development of short duration and uniform maturing varieties, mungbean can be fitted in various cropping systems.

Among the major constraints weeds, insect damage and lack of seed production are the most important ones. Research activities on mungbean have mainly been focused on the development of high yielding varieties with wider adaptability, resistant to diseases like mungbean yellow mosaic virus and Cercospora leaf spot, early maturity and insensitivity to photo period.

Mungbeans are extensively cultivated in Pakistan, but their full yield potentials are not being realized. There are several constraints including climatic conditions, adaptation of varieties, disease and insect problems, and poor crop management practices.

Table 2. Major traits of improved and local variety of Lentils for spate irrigated area of Balochistan

Traits	Shiraz-96	Balochistan Local
Potential biomass yield (tons/ha)	5.00	4.00
Potential seed yield (tons/ha)	1.60	1.00
Avg. biomass yield (tons/ha)	4.33	1.40
Avg. seed yield (tons/ha)	1.15	0.40
Seed size (g/1000 seed wt.)	35	12
Cold tolerance (°C)	-18	-19
Drought tolerance	Produces seed in <100 mm precipitation	Produces seed in >100 mm precipitation
Disease Resistance - Fusarium wilt - Ascochyta blight	 Resistant Tolerant	 Susceptible Susceptible
Protein contents (%)	17	16
Cooking time (minutes)	30	29
Cotyledon colour	Red	Red
Testa colour	Smooth	Black-spotted

Table 3. Lentil varieties released in Pakistan through National Testing Programme

Variety	Year of Release	Institution	Yield Potential (Kg/Ha)	Main characteristics
Shiraz-96	1996	AZRI, PARC	2200	Selection from ICARDA genetic material, cold and drought tolerant, suitable for arid highlands of Balochistan, rarely black-spotted/ smooth testa, red cotyledon, medium seed size (28 g/1000 seed weight), long maturity.
Masoor-2002	2002	NIAB	1600	Evolved from a cross between Precoz and Masoor-85, early maturing, medium seed size, black-spotted testa, red cotyledon, lodging susceptible, medium yield, suitable for late planting after cotton.
Masoor-2004	2004	ARI, DIK	2000	Selection from exotic germplasm provided by NARC, suitable for the lowlands of NWFP after rice crop and irrigated areas, black-spotted testa, red cotyledon, medium seed size (25 g/1000 seed weight), medium maturity. Susceptible to A. blight.
Rattakulachi 2004	2004	ARI, DIK	2000	Selection from exotic germplasm provided by NARC, drought tolerant, suitable for arid lowlands of NWFP, black-spotted testa, red cotyledon, medium seed size (25 g/1000 seed weight), medium maturity. Susceptible to A. blight.
NIA-Masoor-05	2005	NIA, Tandojam	2200	Mutant of Masoor-85, suitable for irrigated areas of Sindh, black-spotted testa, red cotyledon, medium seed size (25 g/1000 seed weight), medium maturity. Susceptible to A. blight.
Masoor-2006	2006	NIAB	2000	Mutant of ILL 2580, suitable for Punjab, black-spotted, red-cotyledon, medium seed size (25 g/1000 seed weight), medium maturity, tolerant to A. blight and rust. Lodging susceptible.

* *Source: NARC 2007.*

Varieties

Mungbean is an ancient and well-known crop in Pakistan. It is often included in rice or wheat-based cropping systems in the tropics and subtropics. For example in Spate Irrigated areas, mungbeans are commonly grown along with sorghum for dual purposes – fodders and grains. The traditional mungbean varieties under cultivation in Pakistan are often inferior because seed of improved varieties is not available to farmers. They are late maturing, they require a long harvesting period, they are low yielding, and they are susceptible to diseases. The short duration, early maturing and uniform in maturity are now the breeding objectives and such varieties are being developed and seed is multiplied for availability to farmers.

ICRISAT and AVRDC have developed several superior lines for production in the tropics and subtropics. These lines mature early and uniformly high yielding, and disease-resistant. Pakistan has benefitted from the germplasm developed by ICRISAAT and AVRDC.

Early (55-65 days) and uniform maturing mungbeans easily fit into multiple cropping systems. The harvesting cost is also reduced due to uniform maturity.

Pakistan has released early maturing cultivars using germplasms from international and national sources. AVRDC-improved mungbeans have been named and released directly, or used as parents in breeding programs of different countries. Examples of such varieties are Pusa Vishal (India), NM-92 (Pakistan) and Er Lu No. 2 (China).

Field Preparation

In addition to the use of improved varieties, suitable production technology is also important for achieving higher productivity. At the establishments of NARS (National Agricultural Research System) of Pakistan, higher productivity is achieved by adopting the following suggested production technologies and best management practices. According to the local condition of Spate irrigated areas, one can make modifications wherever required. Growing mungbean after rice is a best practice. Avoid planting mungbean after mungbean or cabbages because toxic residues and disease organisms from the previous mungbean or cabbage crops may affect the following mungbean crop adversely.

Prepare the field by plowing, harrowing and leveling. Application of fertilizer is recommended based on soil analysis and availability of soil nutrients. As Spate irrigated areas are normally having medium to high fertility therefore lower doses of fertilizers are recommended. Furthermore, mungbeans is a food legume therefore, application of inoculums for seed treatment can help to fix atmospheric nitrogen into the soil. For Spate irrigated areas a fertilizer at the rate of 60 kg/ha of phosphorous is recommended. The fertilizer can be broadcasted and incorporated into the soil before planting.

Crop Establishment and Management

The best management practice is to plant seed on raised beds in two rows per bed, spaced 45 cm apart. Seed rate varies with seed size and the season. It is usually 20 kg/ha in spring and autumn, and 16 kg/ha in summer. The number of plants maintained per meter row length is 20 in spring and autumn, and 15 in summer.

Weedicides such as alachlor at 1.5 kg/ha in summer and autumn; and chloramben at 2.5 kg/ha in spring are applied as a pre-emergence spray to control weeds. Hand weeding at about 40 days after planting is beneficial.

Irrigation is required depending upon weather, soil and field conditions. As the pre-sowing Spate irrigation is of higher amount, therefore first irrigation may be required after 15 days if water is available. One to two light irrigations after emergence can mature the crop. Generally, no irrigation is needed in Spate irrigated areas during the rainy season except when drought occurs. Practice inter-tillage by hand or cultivator once or twice to promote healthy plant growth.

Diseases and their Control

The information regarding diseases of mungbeans and their control is largely drawn from NARC and UAA (2000), where diseases of food legumes are discussed in detail.

Cercospora leaf spot (CLS) commonly attacks mungbeans in the monsoonal climates. The disease is recognized by the appearance of leaf spots that are circular to irregularly shaped with grayish white centers and reddish brown to dark brown margins. It can cause yield losses of up to 58%. The losses due to CLS disease can be avoided by planting resistant cultivars. Crop debris and weed hosts should also be removed at the time of planting. When susceptible cultivars are planted, spray with fungicides such as Dithane M 45. The recommended varieties NCM 7, 10, 11 and 68and VC 2764 may be grown.

Powdery mildew occurs under cool temperature (20-26 °C) and is favored by cloudy weather. It can cause up to 40% yield loss. In the early stage the disease appears as light yellowish irregular spots on leaves which turn brown quickly. A powdery mass grows over the spots covering the entire leaf surface. The control of disease can be made by: a) planting of disease resistant cultivars; b) spray anti-fungal spray of Dithane

M-45 or Antracol at a rate of 0.2% solution; and c) use early maturing crop cultivars like Mash-93 and Mash-97.

Yellow Mosaic Virus is the most serious problem of mungbeans in the country. Planting of yellow mosaic virus resistant varieties is the best control measure. This is caused by a white fly therefore, control of fly is essential. The control can be made by: a) application of Dimicron or Azertovene or Metasystox at a rate of 10 litre per ha by diluting it in 750 to 1000 litres and minimum two applications; b) eradicate the affected plant materials; c) burn the diseased plants to destroy the virus; and d) cultivate improved cultivars of NIAB-98, NIAB 25-121, NCM 209, NIAB 19-19and NIAB 21-21.

Leaf Crinkle is a disease caused by a virus which stays inside the seed and cannot be seen with naked eye or ordinary microscope and is caused by movement of aphids. The leaves are crinkled and ultimately result into complete loss of production. The control is made by: a) using virus free and healthy seed; b) destroy the affected leaves; c) control of aphids which cause leaf crinkle; and d) use disease resistant varieties.

Root and Stem Rot is another disease of mungbeans common in dry areas and with the infestation of this disease loss of upto 60% is common. Initially the colour of leaves turns to yellow and then leaves start dye back. The black spots can be witnessed on the stem of dried leaves and named as Sclerotia. The root is also having signs of rot. The disease is caused by a fungus named as Macro Phomina phaseolina and stays alive on the diseased plants. It can be controlled by: a) treating mungbeans seed with 2 gms of Benlate per kg of seed; b) crop rotation by avoiding continued cultivation of mungbeans in a given field; and c) cultivating disease resistant varieties.

Mung Anthracnose is a serious disease and it appears on all parts of plants but mostly it affects leaves and pods. Initially deep white spots are witnesses and the periphery of these spots is shining pinkish. The plants ultimately die back. The disease is severe in wet and cooler climates. It is caused by a fungus named as Collerotri chum lindemuthianum and it survive on the plant or inside the seed. The control can be made by: a) use of healthy and disease free seed; and b) application of Daconil and Tecto-60 through spraying the crop but it is costly.

Bacterial Leaf Spot is another disease of mungbeans. It can be witnessed on leaves where circular spots having moisture and later on turned to brown. The disease infestations ultimately dry the leaves and then they shed even before maturity. The disease is caused by Xanthomonas phaeoli especially in a tropical environment. The control can be made by: a) by treating the seed with solution of Streptomycin Sulphate (50 ppm concentration) by dipping for 30 minutes; and b) use of healthy and disease free seed.

Insect Pest Management

Bean fly is the most important insect pest of mungbeans. It causes significant damage during the seedling stage. The adult flies are too tiny and cannot be recognized easily. The beanfly maggots feed inside the plant stem and their damage cannot be seen from the outside. Mungbeans must be protected against bean flies. Monocrotophos or omethoate or dimethoate can be sprayed at 3, 7, 14, 21, 28, and 35 days after emergence. The first three sprays are very important and must not be delayed.

Aphids usually occur on mungbean. If you notice unusually high aphid populations (over 20 insects/plant), spray an insecticide such as dimethoate once a week until aphids are eradicated.

Mungbean is also infested by **pod borers**. When infestation of pod borers is very severe over large areas of your field, spray chlorpyrifos or fenvalerate at weekly intervals, until the infestation is controlled.

Mungbean is sometimes attacked by **stink bugs**. If you observe unusually high populations of this pest (3-4 insects/meter row) uniformly over an entire field when pods are still green, spray with fenvalerate or deltamethrin at weekly intervals until the infestation stops.

Bruchids, commonly called pulse beetles or cowpea weevils, attack mungbean both in field and storage. But the greater losses occur in stored grains. The nutritional quality of the grains deteriorates because of bruchid infestation rendering them unmarketable. To control bruchids: clean storage area properly, dry seeds well, and apply non-toxic chemicals such as vegetable oils. For large-scale storage, fumigation with phosphine or other suitable fumigants can be adopted. Always follow the label directions whenever using any pesticides.

Varieties Released in Pakistan

The mungbeans varieties released in Pakistan through National Testing Programme are presented in Table 4.

Table 4. Mung bean varieties released in Pakistan through National Testing Programme

Variety	Year of Release	Institution	Yield (Kg/Ha)	Main characteristics
NM 121-25	1985	NIAB	1250	Medium maturity, determinate, tolerant to yellow mosaic, small seeded, shining seed, released through mutation breeding.
NM 19-19	1985	NIAB	1200	Medium maturity, determinate, tolerant to yellow mosaic, small seeded, shining seed, released through mutation breeding.
NM 20-21	1985	NIAB	1150	Early maturity, determinate, tolerant to yellow mosaic, small seeded, shining seed, susceptible to cercospora leaf spot.
NM 13-1	1985	NIAB	1100	Early maturity, determinate, tolerant to yellow mosaic, small seeded, shining seed, susceptible to cercospora leaf spot.
NM 51	1991	NIAB	1500	Early, bold seeded, dull seed color, tolerant to cercospora leaf spot.
NM 54	1991	NIAB	1600	Early, bold seeded, dull seed color, tolerant to cercosproa leaf spot.
NM-92	1993	NIAB	1800	Early, bold seeded, shiy colour, tolerant to cercosproa leaf spot and yellow mosaic virus
NM-98	1998	NIAB	1500	Medium bold seeded, high yielding and yellow mosaic tolerant
Chakwal Mung-97	2000	BARI	1500	Small seeded, shiny green colour, resistant to leaf virus and yellow mosaic virus. Suitable for cultivation in Pothwar region.
AEM-96	1997	NIA	1300	Small seeded, shiny green colour, resistant to leaf virus and yellow mosaic virus. Suitable for cultivation in Sindh
NM-2006	2006	NIAB	2000	Bold seeded, high yielding and yellow mosaic tolerant
Chakwal Mung 2006	2006	BARI, Chakwal	1500	High yielding, drought tolerant and yellow mosaic tolerant
AZRI-Mung-06	2006	AZRI, Bhakkar	1800	Bold seeded. Non shattering, short duration, disease tolerant, high yielding

* *Source: NARC 2007.*

3.4. Mashbeans

Mash or black gram belongs to family Leguminosae. Mash occupies an important position in Pakistan's agriculture. It grows on marginal lands of Spate irrigated areas where other crops perform poorly. Being leguminous, it demands less nitrogenous fertilizer, and fits well as source of protein (25-32%). The worldwide yield of mash (including Pakistan) is very low because mostly indigenous land races are cultivated and also because the crop is often grown on marginally fertile lands with insufficient water. In Pakistan, mash is the least researched crop among pulses despite its high nutritive and economic value due to which its area and production decreased continuously. The lack of suitable and high-yielding varieties and basic information about production technology are major inhibitors. Therefore, research on mash improvement aims at development of high yielding varieties with resistance to diseases.

Varieties Developed

Three varieties namely NARC MASH-1, NARC MASH-2 AND NARC MASH-3 have been developed, which are of short duration (60 to 85 days) and relatively uniform in maturity (Box I).

Varieties Released

The varieties of mashbeans released during the last decade are presented in Table 5.

Mashbeans Nodulation

High and effective nodulation on the roots of the mashbeans is an important agronomic factor. This trait can be exploited in the breeding programs

Box 1: Major characteristics of improved varieties of Mashbeans released by NARC

NARC Mash – 1
Year of release: 1993
Duration: 80-85 days
Plant type: Glabrous and semi erect
Disease reaction: Resistant to Yellow Mosaic Virus
Cultivation areas: Islamabad, Rawalpindi, Sialkot, Norowal & NWFP
Yield potential on farmers' fields: 1500 - 2000 Kg/Ha

NARC Mash – 2
Year of release: 1993
Duration: 70 - 75 days
Plant type: Semi erect
Disease reaction: Resistant to Yellow Mosaic Virus
Cultivation areas: Islamabad, Rawalpindi, Sialkot,Narowal, Gujrat & NWFP
Yield potential on farmers' fields: 500-2000 kg/ha

NARC Mash – 3
Year of release: 1993
Duration: 60 - 65 days
Plant type: Erect
Disease reaction: Resistant to Yellow Mosaic Virus
Cultivation areas: Islamabad, Chitral, Mansehra, Swat, Rawalpindi, Dir & AJK
Yield potential on farmers' fields: 1000-1500 kg/ha

* *Source: NARC 2007.*

Table 5. Mash beans varieties released in Pakistan through National Testing Programme

Variety	Year of Release	Institution	Yield Potential (Kg/Ha)	Main characteristics
Mash-88	1988	AARI	1800	Medium maturity, semi-erect, high yielding, tolerant to yellow mosaic.
Mash-1	1993	NARC	2000	Medium maturity, semi-erect, high yielding, tolerant to yellow mosaic.
Mash-2	1993	NARC	2000	Early maturity, semi-erect, high yielding yielding tolerant to yellow mosaic
Mash-3	1993	NARC	1600	Extra early, erect, high yielding, tolerant to yellow mosaic, suitable for rain-fed areas.
Mash-97	1997	AARI	1650	Early maturity, semi-erect, high yielding tolerant to YMV.

* *Source: NARC 2007.*

of mashbeans to develop genotypes with high nodulation and consequently with higher yields. A fair amount of costly fertilizer can be saved in this way. Promising genotypes of mashbeans have been screened for their nodulation behavior.

Field Preparation

In addition to the use of improved varieties, suitable production technology is also important for achieving higher productivity. At the establishments of NARS (National Agricultural Research System) of Pakistan, higher productivity is achieved by adopting the following suggested production technologies and best management practices. According to the local condition of Spate irrigated areas, one can make modifications wherever required. Growing mashbeans in kharif season is a best practice. Avoid planting mashbeans after mashbeans or mungbean or cabbages because toxic residues

and disease organisms from the previous mashbeans, mungbeans or cabbage crops may affect the following mashbeans crop adversely. Prepare the field by ploughing, harrowing and leveling. Application of fertilizer is recommended based on soil analysis and availability of soil nutrients. As Spate irrigated areas are normally having medium to high fertility therefore lower doses of fertilizers are recommended. Furthermore, mashbeans is a food legume therefore; application of inoculums for seed treatment can help to fix atmospheric nitrogen into the soil. For Spate irrigated areas a fertilizer at the rate of 60 kg/ha of phosphorous is recommended. The fertilizer can be broadcasted and incorporated into the soil before planting.

Crop Establishment and Management

The best management practice is to plant seed on raised beds in two rows per bed, spaced 45 cm apart. Seed rate varies with seed size and the season. It is usually 20 kg/ha in spring and autumn, and 16 kg/ha in summer. The number of plants maintained per meter row length is 20 in spring and autumn, and 15 in summer. Weedicides such as alachlor at 1.5 kg/ha in summer and autumn; and chloramben at 2.5 kg/ha in spring are applied as a pre-emergence spray to control weeds. Hand weeding at about 40 days after planting is beneficial. Irrigation is required depending upon weather, soil and field conditions. As the pre-sowing Spate irrigation is of higher amount, therefore first irrigation may be required after 15 days if water is available. One to two light irrigations after emergence can mature the crop. Generally, no irrigation is needed in Spate irrigated areas during the rainy season except when drought occurs. Practice inter-tillage by hand or cultivator once or twice to promote healthy plant growth.

Figure 5. Multi crop spate field - Moong beans and sorghum.

Diseases of Mashbeans

The information regarding diseases of mashbeans and their control is largely drawn from NARC and UAA (2000), where diseases of food legumes are discussed in detail.

Powdery mildew occurs under cool temperature (20-26 °C) and is favored by cloudy weather in the southern areas of Pakistan. It can cause up to 40% yield loss. In the early stage the disease appears as light yellowish irregular spots on leaves which turn brown quickly. A powdery mass grows over the spots covering the entire leaf surface. The cause of this disease is Erysiphe polygon fungus. The control of powdery mildew can be made by: a) planting of disease resistant cultivars; b) spray anti-fungal insecticide of Dithane M-45 or Antracol at a rate of 0.2% solution; and c) use early maturing crop cultivars like Mash-93 and Mash-97.

Cercosphora Leaf Spot is a common disease in Punjab and it happens before the maturity of the crop. The signs are circular brown spots on leaves with periphery of pinkish brown, which affect the pods. The disease is more severe in wet monsoonal climates. The disease is caused by a fungus and can be controlled by: a) destroying the affected parts of plant safely; b) anti-fungal sprays of Diathane M-45 or Bavistin at the rate of 0.5 kg of insecticide in 1000 litres of water per ha; and c) use of disease resistant cultivars.

Stem and Root Rot is another disease of mashbeans common in dry areas. The disease infestation can cause a loss of up to 60%. Initially the colour of leaves turns to yellow and then leaves start dye back. The black spots can be witnessed on the stem of dried leaves and named as Sclerotia. The root is also having signs of rot. The disease is caused by a fungus named as Macro Phomina phaseolina and stays alive on the diseased plants. It can be controlled by: a) treating mungbeans seed with 2 gms of Benlate per kg of seed; b) crop rotation by avoiding continued cultivation of mashbeans in a given field; and c) cultivating disease resistant varieties.

Yellow Mosaic Virus is the most serious problem of mashbeans in the country. Planting of yellow mosaic virus resistant varieties is the best control measure. This is caused by a white fly therefore, control of fly is essential. The control can be made

by: a) application of Dimicron or Metasystox at a rate of 10 litre per ha by diluting it in 750 to 1000 litres and minimum two applications; b) eradicate the affected plant materials; c) burn the diseased plants to destroy the virus; and d) cultivate improved cultivars of mashbeans.

Leaf Crinkle is a disease caused by a virus which stays inside the seed and cannot be seen with naked eye or ordinary microscope and is caused by movement of aphids. The leaves are crinkled and ultimately result into complete loss of production. The control is made by: a) using virus free and healthy seed; b) destroy the affected leaves; c) control of aphids which cause leaf crinkle; and d) use disease resistant varieties.

Figure 6. Harvested moon bean crop

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Colofon

This note was prepared by Shahid Ahmad. The Practical Notes series is prepared as part of the strengthening of the Pakistan Chapter of the Spate Irrigation Network, supported by World Bank and Royal Netherlands Embassy.

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