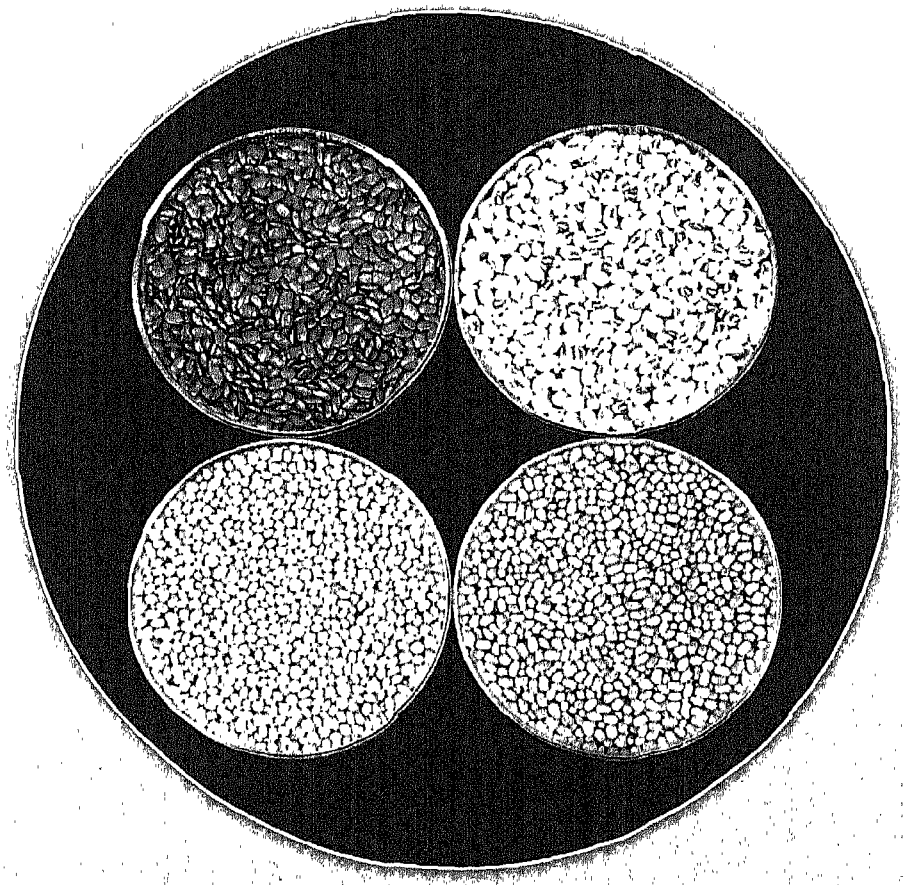
MANUAL FOR SEED PRODUCTION OF ARID LEGUMES



ICAR

All India Coordinated Research Project on Arid Legumes

Central Arid Zone Research Institute, Jodhpur - 342 003

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INTRODUCTION

The Arid Legumes are the most important livlihood source of poor farmers sustaining on resource constraint farmings. These crops are the most stable under fluctuating and hostile fragile agro-ecosystem of Northern-Western dry tracts of India. These crops form the source of food, feed and forage; green manure for conserving soil and soil water etc. Guar gum an export oriented product from guar endosperm was exported to the tune of Rs. 814 crore in 1997-98 towards western countries. Moth bean is a source of daily snacks, and supporting *Dal Bhujia* industries particularly, in Bikaner; and horsegram is a source of homeopathic medicine against kidney trouble. Hence, these crops have great relevance in the regions of low and erratic rains and require least inputs and human care, hence, are the most economic in cultivation. These crops occupy almost 49.6 lakh ha area in India, of which nearly 60.0% (31.0 lakh ha) is occupied by the single state of Rajasthan. Guar and moth bean are the major crops of arid Rajasthan. Cowpea is however, widely grown in almost all arid and semi-arid states from Gujarat in West to Kerala in deep South. Horsegram a crop of semi-arid regions is basically the crop of tribal and hilly plane zones. Karnatka alone occupies almost 34.0% area of this crop. These are the crops grown without agronomic and plant protection inputs. Hence, seed becomes more crucial, initial and basic input for these arid legumes. There is increasing demand of improved seed of these crops as farmers find themselves quite affordable as far seed purchase is concerned. In view to increase more area of these crops and ravel production potential of the lands already occupied by these crops, choice of seed of right quality and location specific at the needed hour becomes all the more important. Hence, ways and means for producing different categories of seed under perfect agrolimatic conditions and appropriate inputs deserve attention. No information on seed production strategies, important varieties in active seed chain and production technologies in a brief are available for Arid Legumes. This manual is, therefore, brought out to supplement all the needed inputs.

IMPORTANCE OF SEED

The importance of seed quality in crop production programmes has been recognized since time immemorial and the cultivation of crops began. The seed is initial and the basic input, raising the productivity and quality of crops produce. Improved seed is the only input, which provides maximum return per rupee investment. This has been amply demonstrated by the introduction and development of dwarf and lodging resistant varieties of wheat and rice and the hybrids of maize, sorghum, sunflower, cotton, pearl millet, castor and many vegetable crops. The same is applicable in case of less known crops of Arid Legumes also. The quality seed may increase the crop productivity to the extent of 15-20%. Therefore, there appears no substitute of this input in the crop production programme particularly, for dryland crops.

The importance of seed is far more crucial in crops which are orphan and are cultivated by the small and marginal farmers in fragile agro-eco environment where they can not afford use of costly inputs because of their lower economic status on the one hand and risky growing environmental conditions, on the other. Pulses in general and Arid Legumes, in a particular, belong to this category of crops, which are more prone to agromomic inputs.

QUALITY OF SEED

As stated, importance of quality seed was recognized with the beginning of human civilization. The people were fond of selecting the best plant/ear/panicle for next year's planting. In earlier days, only the good-looking plants and seeds happened to be the sole criterion of quality seed. As the seed science developed the parameters of quality seed also changed. Accordingly, the quality of seed is assessed by such parameters, which include physical and genetic purity, viability, germination, vigour and seed health. The germination does not reflect field performance potential of a seed lot under adverse environmental conditions, the seed vigour as a quality parameter has therefore, gained significance, particularly in grain legumes including Arid Legumes.

Seed vigour is a complex character and for its estimation a number of tests/ parameters have been developed over the years. However, a practical seed vigour test should provide reproducibility of results, which could be easily interpreted and good indication of field performance potential. Another very important component of seed quality is genetic purity, which is generally tested through grow-out test. The released varieties of Arid Legumes appear to have narrow genetic base, thus, making varietal identification a difficult task for quality seed. Seed maturity, time of harvesting and the method of threshing are the other factors, which determine the milling quality of the arid legumes.

CATEGORIES OF SEED

In seed production chain, the following categories are involved.

1. Nucleus Seed

This is the first category in the seed multiplication chain, which is produced by the concerned breeder/institution. The nucleus seed is initially produced from 400-500 individual true to the plant type of the concerned variety. These plants are separately harvested and threshed. The seed of any plant varying in phenotypic traits from the parental variety is rejected. The remaining plants are raised in single plant rows. Again, if any, plant progeny is showing variation/ segregation, the whole progeny is rejected. From the remaining progenies, 400-500 plants are selected for next year's nucleus seed production. Thus, all the left over progenies are harvested in bulk and threshed. The seed obtained from this bulk is called nucleus seed, which is used as the source for breeder seed production.

2. Breeder Seed

This is the progeny of nucleus seed produced by the concerned breeder/institution or the sponsored breeder/Institution. The responsibility of monitoring of this seed production has been assigned to ICAR, involving its Institutes, SAUs and other organizations engaged in research work on Arid Legumes. The seed production plots of this category seed are monitored by the committee comprising of representatives of State Seed Certification Agency, concerned crop Coordinator and member of the Institute producing the seed. The breeder seed is the source of foundation seed.

3. Foundation Seed

This seed is produced by the State Seeds Corporation, National Seeds Corporation, State Farms Corporation of India, State Agricultural Universities and other public/private farms. The seed production plots are duly certified by the concerned State Seed Certification Agency. The bulk of the seed is also produced by the above corporations through progressive farmers. This seed is the source of production of certified seed.

4. Certified Seed

This type of seed is supplied to the farmers for raising their commercial crops and is produced from duly certified foundation seed mostly at the farmers' fields under the supervision of State Seeds Corporations. Similar to foundation seed, this is also certified by the State Seed Corporation Agency.

SEED PRODUCTION INDENTS

All the agencies dealing with the seed business like NSC, SFCI, State Departments, Private sectors etc., place their requirement of breeder seed to the Department of Agriculture and Cooperation (DAC), Govt. of India as indent. All the indents received are compiled by DAC and a consolidated indent is submitted to ICAR for arranging the breeder seed production (BSP). The ICAR proceeds for breeder seed production of the indented varieties through different agencies including ICAR Institutes / SAUs

BSP 1

Based on DAC indent of breeder seed received from the Council, the Project Coordinator (Arid Legumes) formulates BSP 1 following detailed discussion with breeders and seed producing agencies during Annual Group Meet/Workshop. The proforma includes details on crop, varieties, Institute/breeder responsible for producing the breeder seed, DAC indent quantity, allocation and name of indentors etc. The proformae are sent to the concerned breeders well in time.

BSP 2

BSP 2 proforma is submitted to PC (Arid Legumes) by the concerned breeder/ breeder seed producing agencies after sowing of breeder seed production plots. The proforma gives details like name of the variety, quantity targeted, area sown, expected production, field location, date of sowing, expected fortnight for inspection by the monitoring team, expected date of harvest and expected date of seed availability.

BSP 3

The BSP 3 proforma is submitted to the PC (Arid Legumes) after completion of inspection of breeder seed plot by the monitoring team. The monitoring team comprises concerned breeder and representatives from NSP, NSC and State Seed Certification Agency. The proforma includes name of the variety, area sown, authority date of BSP 1, date of sending BSP 2 and the report of the monitoring team (with signatures from all members).

BSP 4

The BSP 4 proforma is issued by the breeder/agency undertaking the breeder seed production after harveting, threshing, cleaning and grading the breeder seed. The proforma gives details about name of the variety, quantity of breeder seed to be produced, quantity of the breeder seed actually produced and the comments of the monitoring team.

BSP 5

After lifting the breeder seed by the concerned indentors, this proforma is submitted by the breeder/breeder seed producing agencies to the PC (Arid Legumes). The proforma also highlights the left over quantity of seed and the responsible agencies.

SEED STANDARDS

For production of foundation and certified seed which ultimately have to reach to the cultivars' fields purity has to be carefully monitored and maintained. There may be several types of admixtures which may deteriorate quality of the seed hence, their quantity have to be kept below the threshold level as per seed act standards. Similarly, maintenance of isolation distances and the number of inspection by the monitoring and Seed Certification Committees are important factors, which need to be addressed as per the following table.

Important standards for producing foundation and certified seed of Arid Legumes

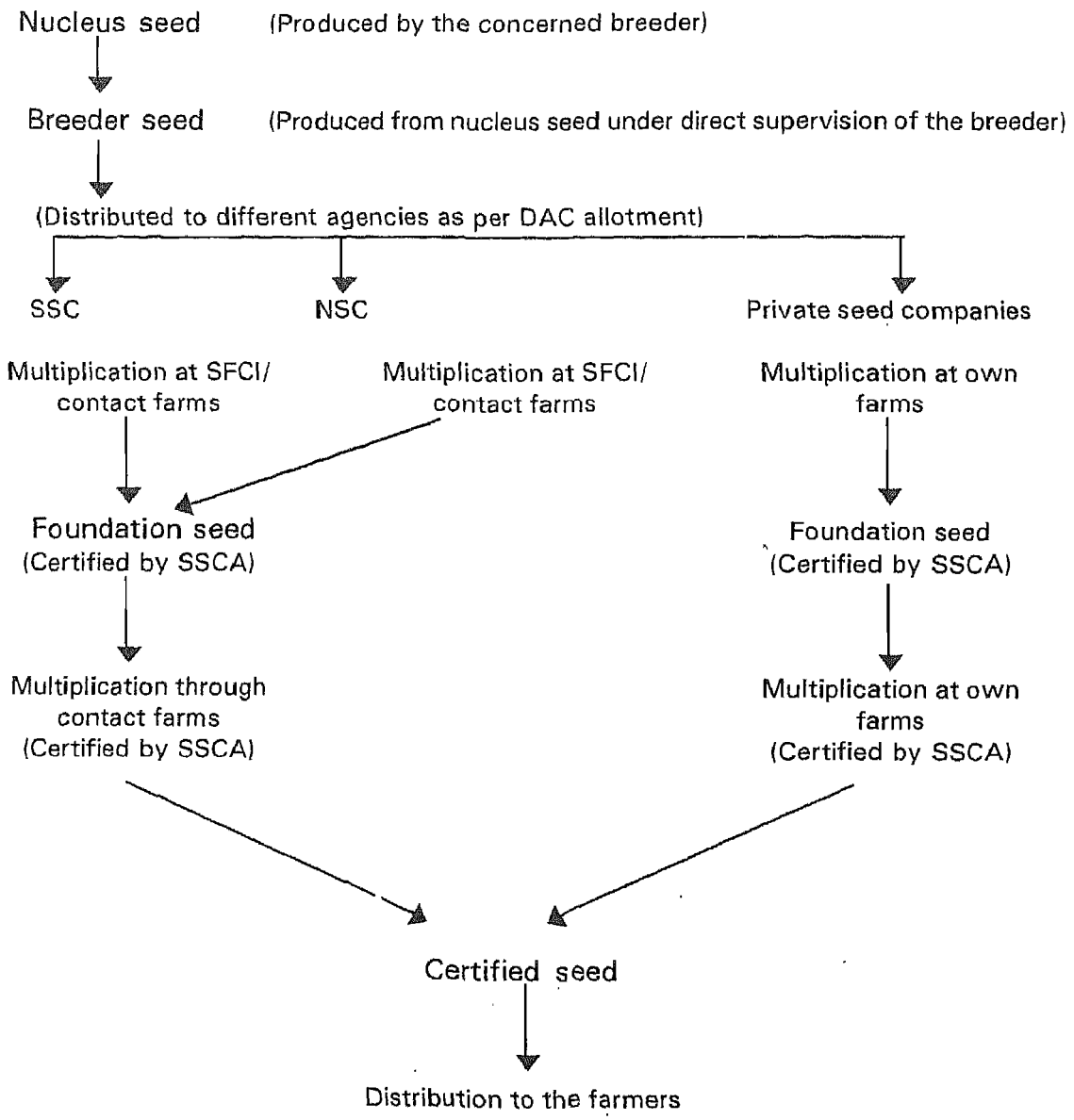
Criteria	Foundation seed	Certified seed
Minimum number of inspections	2	2
Isolation distance (m)	10	5
Off-type plants (%)	0.10	0.20
Plants affected by disease (%)	0.10	0.20
Genetic purity of seed (min. %)	98.0	98.0
Seed of other distinguishable varieties	5/kg	8/kg
Inert matter (max. %)	2.0	2.0
Total weed seeds (max.%)	none	8-10/kg
Other crop seeds (max. %)	none	8-10/kg
Germination % (min.)	75-80	75.0
Moisture content (max. %)		
a. under vapour proof container	8.0	8.0
b. under ordinary container	9.0	9.0

SEED PRODUCTION NETWORK

Before green revolution era, the seed production in the country was poorly organized. Few public (National Seeds Corporation, State Farms Corporation of India and Departments of Agriculture in States) and private seed producing organizations were engaged in the seed production. Vegetables, ornamental and horticultural and flowering plants used to get priority. The seed production programme was lacking recognized norms, procedures and certification. The production was attempted without indents from the user community. During eighties when the Indian Council of Agricultural Research (ICAR) launched National Seeds Programme (NSP) through World Bank support, the systematic seed production programme was initiated. Sufficient infrastructure for seed production was created through this support in the ICAR Institutes, States Agricultural Universities, N.S.C., SFCI, State Seed Corporations, State Seed Certification of Agriculture and by the private seed companies. Infrastructure facilities including development of foundation seed production farm, creation of irrigation facilities, construction of cold storage rooms for buffer stocking the seed, provision of seed processing equipment and machinery, seed planters, harvesters and threshers, equipping of seed testing laboratories were created. The breeder seed production (BSPs) units and Seed Technology Research (STR) units were established at SAUs and ICAR Institutes, where core staff was provided. The seed production network has thus, strengthened so much, that India has become largest seed production network in the world, so much so that, it is helping neighbouring countries in providing quality seed of the important crop varieties suitable to them.

Almost all the major states in the country have established State Seed Corporations for production and marketing of seeds of improved varieties and State Seed Certification Agencies for controlling the quality of the seed through certification. Besides, the public seed producing organizations, the growth of the private seed companies have also been phenomenal. The private seed companies are, however, mostly involved on hybrid seed production and are least involved in the seed production of self-pollinated crops including Arid Legumes. Even the public seed producing organizations attach least priority for seed production of these legumes. This resulted in poor distribution of improved varieties among the farmers and the rate of seed replacement has been far below the recommended norms of more than 5.0% per year.

SEED PRODUCTION NETWORK IN INDIA



TARGETED QUANTITY OF SEED

For future planning, maintaining buffer stock and for catering the need of sprut in area of arid legumes in newer, non-traditional areas and in common adapted zones, it is of paramount importance to frame out long term contingent plan of seed production. Accordingly for next 12 years, keeping the seed replacement rate of almost 10% following tables may suggest approximate quantity of different category of seed that would be required in India. In case, we are able to produce desired and targeted quantity of seeds whole Arid Legumes area (49.5 lakh ha) could be flooded with improved seeds, hence grain yield could be increased by about 15-17% without providing additional agro-inputs.

Targeted quantity of different categories of guar seeds in India

Year	Area (m ha)	Breeder seed requirement (q)	Foundation seed requirement (q)	Certified seed requirement (q)
2004	3.27	54.5	1635	49050
2005	3.59	59.8	1795	53850
2006	3.94	65.6	1970	59100
2007	4.33	72.16	2165	64950
2008	4.76	79.33	2380	71400
2009	5.23	87.16	2615	78450
2010	5.75	95.83	2875	86250
2011	6.32	105.3	3160	94800
2012	6.95	115.8	3475	104250
2013	7.64	127.3	3820	114600
2014	8.40	140.0	4200	126000
2015	9.24	154.0	4620	138600

Seed rate 15 kg ha^{-1}, multiplication ratio 1: 30, seed replacement rate 10.0%

Targeted quantity of different categories of moth bean seed in India

Year	Area (m ha)	Breeder seed requirement (q)	Foundation seed requirement (q)	Certified seed requirement (q)
2004	2.18	17.79	622.8	21800
2005	2.40	19.59	685.7	24000
2006	2.64	21.55	754.2	26400
2007	2.90	23.67	828.5	29000
2008	3.19	26.04	911.4	31900
2009	3.50	28.57	1000.0	35000
2010	3.85	31.42	1100.0	38500
2011	4.23	34.53	1208.5	42300
2012	4.65	37.95	1328.5	46500
2013	5.11	41.70	1460.0	51100
2014	5.62	45.80	1605.7	56200
2015	6.18	50.44	1765.7	61800

Seed rate 10 kg ha^{-1}, seed multiplication ratio 1: 35

Targeted quantity of different categories of cowpea seed in India

Year	Area (m ha)	Breeder seed requirement (q)	Foundation seed requirement (q)	Certified seed requirement (q)
2004	0.20	12.0	600	30000
2005	0.22	13.2	660	33000
2006	0.24	14.4	720	36000
2007	0.26	15.6	780	39000
2008	0.28	16.0	840	42000
2009	0.30	18.0	900	45000
2010	0.32	19.2	960	48000
2011	0.34	20.4	1020	51000
2012	0.36	21.6	1080	54000
2013	0.38	22.8	1140	57000
2014	0.40	24.0	1200	60000
2015	0.42	25.2	1260	63000

Seed rate 15 kg ha^{-1}, multiplication ratio 1: 50

Targeted quantity of different categories of horsegram seeds in India

Year	Area (m ha)	Breeder seed requirement (q)	Foundation seed requirement (q)	Certified seed requirement (q)
2004	1.80	12.7	510	20400
2005	1.98	14.85	594	23760
2006	2.17	16.2	651	26040
2007	2.38	17.8	714	28560
2008	2.61	19.5	783	31320
2009	2.87	21.5	861	34440
2010	3.15	23.6	945	37800
2011	3.46	25.9	1038	41520
2012	3.80	28.5	1140	45600
2013	4.18	31.3	1254	50160
2014	4.59	34.4	1377	55080
2015	5.04	37.8	1512	60480

Seed rate 12 kg ha-1, multiplication ratio 1: 40

Technology for Quality Seed Production

Guar

Seed Source

Nuclear seed : Concerned breeder and the institution, where from variety was developed

Breeder seed : Authorized breeder seed producing centre, where from variety was developed

Foundation/certified seed : Authentic sources

Soil type : Well drained, sandy loam to loam soils

Optimum planting time : 15-30 July

Seed rate : 15-20 kg ha-1, may depend on soil moisture and sowing time

Spacing : Early, unbranched type: 30 cm inter-row

Medium late branched type : 45 cm inter-row

Seed treatment : Captan/thiram/bavistin 3 g kg-1 seed

Fertilizer : 15-20 kg N, 30-40 kg P_2O_5 per ha.

Weed management: Keep the field free of weeds at least upto 30-35 days of sowing. Pre-plant soil incorporation of basalin/treflan 1.0 kg a.i. ha-1 in light and 1.5 kg-1 in medium textured soils.

Insect management

1. For checking aphids, leafhopper, sucking pests, spray of 0.05% malathion 50 EC may be done.
2. For checking leaf perforator, *Dichomeris ianthes* pod borer, *Helicoverpa armigera*, spray of 0.07% Endosulfan 35 EC may be done two times at interval of 10 days.

Disease management

1. Bacterial leaf blight: Seed treatment with 100 ppm streptocycline, followed by foliar application (2 sprays) of Streptocycline (150 ppm) + Blitox (0.2%) may be attempted.
2. Alternaria leaf spot: Spray with Mancozeb or Captafol @ 1.5 kg ha-1 at 40-50 days after planting the crop, may be done.
3. Root rot complex: Seed treatment with Vitavax (2 g kg-1) and Bavistin (2 g kg-1) is recommended.

Cowpea

Source of seed

Nucleus seed	:	Concerned breeder/Institute from where the variety originated
Breeder seed	:	Authorized breeder seed producing centre from where the variety originated
Foundation/certified seed	:	Authentic source (s)
Soil type	:	Well drained loam soil
Optimum planting time	:	10-30 July (kharif), 15 Oct. to 15 Nov. (rabi) in Southern India
Seed rate	:	20-25 kg ha^{-1} (grain purpose)
Spacing	:	30-45 and 8-10 cm inter and intra-row, respectively
Seed treatment	:	Carbendzin or Thiram 3 g/kg seed
Fertilizer (kg/ha)	:	15-20 N : 30-40 P_2O_5 : 40-50 K_2O
Weed management	:	Fluchloralin or Triflurolin @ 0.75 kg a.i. may be incorporated in the soil before planting of the crop.

Insect-pest management	:	• Soil application of Carbofuran or Phorate @ 1-1.5 kg/ha at sowing for the control of sucking pests. • One or two spray of Monocrotophos @ 0.04 % or Phosphamidon at pod initiation stage against sucking pests. • Spray of Endosulphan @ 0.07% or Quinolphos @ 0.05% or Alanycarb @ 0.06% against pod borer. • Dusting with Endos han or Quinolphos @ 1.5% against pod borer. • One or two spray ... Malathion or Metasystox @ 500-600 ml/litre water for control of white fly.
Disease management	:	Seed treatment with Emidachloprid (70 W.P.) @ 5g/kg seed helps in controlling YMV spread.

Moth bean

Seed source

Nucleus seed	:	Concerned breeder and the Institution, wehere from the variety originated
Breeder seed	:	Authorized breeder seed producing centre, where from the variety orginated
Foundation/certified seed	:	Authentic source
Soil type	:	Well drained sandy loam soils
Optimum planting time	:	15-30 July
Seed rate	:	10-15 kg ha-1
Spacing	:	Early maturing: 30-35 cm and for medium late maturing varieties : 40-50 cm inter row spacing.
Seed treatment	:	Carbendzin/thiram 3 g kg-1 seed.
Fertilizer	:	Basal dose of 15-20 kg N, 30-40 kg P_2O_5 ha^{-1}.
Weed Management	:	Fluchloralin@1.0 kg ha-1 ai pre-plant incorporation
Insect-pest Management	:	Jassids and white flies can be controlled by spraying monocrotophos/dimethoate@ 0.03% or lindane@0.01%. Thrips and white flies can be controlled by dust of melathion (5.0%) @ 25 kg ha-1.

Disease Management :

1. YMV can be controlled by spraying monocrotophos (0.04%) or rogor (0.2%), at 35-40 days of sowing the crop.
2. Bacterial leaf spot disease can be controlled by three sprays of Blitox (0.03%) or streptocycline (0.01%).

Horsegram

Seed source

Nucleus seed	:	Concerned breeder, where from the variety originated
Breeder seed	:	Authorized breeder, where from the variety originated
Foundation/certified seed	:	Authentic source/person
Soil type	:	Poor, light sandy, well drained soils with low inputs
Optimum planting time	:	Tamil Naidu : Second fortnight of October
		Karnataka : Mid July to mid August
		Maharashtra : Mid June to mid July
		Rajasthan : Mid July to end of July
Seed rate	:	25-30 kg ha^{-1}
Spacing	:	30-35 cm between rows
Seed treatment	:	Thiram/Carbendzin 2-3 g ha^{-1} seed
Fertilizer	:	20 kg N + 25 kg P_2O_5 + 10 kg K_2O

Disease Management

1. Anthracnose: Spray of the field crop by Carbendazin with 0.1% conentration.
2. Powdery mildew: Two spray of Calixin (0.05%).
3. Leaf spot: Spray with Mancozeb (0.2%)

Insect-pests:

1. Pod caterpillar: Spray the crop with Nuvan/ Monocrotophos@2ml l^{-1} water
2. Leaf hopper, pod fly: Spray dimenthate 30 EC (0.05%)

Seed Storage

The success of seed production programme also depends on efficient packing and seed storage for maintenance of high seed germination and vigior from harvest until planting is done. Seeds of cowpea and moth bean are particularly highly prone to store-grain pests and deterioates fast if not stored properly. Hence, proper care has to be taken while storing the seed. The harvested seeds are severely infested by two imporant bruchids viz; *Callasobrunchus chinensis* and *Callasobrunchus maculates* under storage condition. The peak damage is generally observed from April to September. The beetles are carried to the stores from the field along with the grain. It has been observed that the damage during the storage is quite serious. The control of bruchids may be done both in field and stores. The pods should be harvested and threshed as soon as possible on maturity. The Seeds should be dried and the moisture content must be kept below 10%. The damage can be prevented in storage by using suitable insectricides/fumigants. The seed treatment with neem leaves and edible oil keep the seeds free from the infestation of pulse beetle. Some studies conducted earlier revealed that the oilcakes and leaf extracts may be used to protect the grains from the pulse beetle damage.

Important Varieties in seed chain

Many promising varieties have been developed during past decade. However, varieties being indented regularly are few. Hence, careful and adequate quantity seed of these varieties deserves priority. For instance, in case of guar RGC-936, RGC-197, RGC-1002, RGC-1003, HGS-365 and HG-563; in case of cowpea GC-3, C-152, RC-101, V-585 and V-240; in case of moth bean RMO-40, RMO-257, RMO-225, FMM-96, RMO-435 and CAZRI Moth-1 and in horsegram AK-21 and PHG-9 etc., are regularly indented. Details of these varieties are given in following Tables.

Important varieties of arid legumes involved in active seed chain at the national level.

Name of variety	Year of release	Days to maturity	Yield potential (kg ha-1)	Major characteristics
				Guar
RGC-471	1987	90-100	1200-1400	Branched, medium maturing.
RGC-197	1988	105-110	1000-1200	Unbranched, late maturing, good for intercropping.
RGC-936	1994	85-95	1000-1200	Branched, early maturing, widely adapted
HGS-365	1998	85-90	1100-1200	High yielding with high gum content (32.0%), suited to dry tracts of Haryana and surroundings.
RGC-986	1999	110-115	800-950	Late maturity, resistant to bacterial leaf blight disease, adapted to all arid areas.
RGC-1003	1999	90-95	900-1200	Branched and bushy habit, adapted to all arid and semi-arid areas, gum content almost 30-31%
RGC-1002	2000	90-95	900-1000	Branched type, high endosperm content (35.37%), adapted to arid and semi-arid well-drained areas.
HG-563	2001 (State release)	90-95	1800-2000	Branched, pubescent with smooth leaves, early maturing.
RGC-1017	2002	92-95	850-1200	Less susceptible to BLB, PM and RR diseases, adapted to all guar growing zones of India.

				Moth bean
Maru moth-1	1989	80-85	500-550	Semi spreading type, lesser susceptibility towards *Cercospora* leaf spot, used for mixed cropping.
RMO-40	1994	62-65	600-800	Early maturing, erect type, synchronously maturing, resistant to drought and YMV, short heighted variety, 30-32% den sity.
RMO-257	1997	64-67	600-800	Semi-erect growth habit gives 18-20 q fodder yield ha^{-1}, bears 3-6 branches/plant, less YMV infection.
FMM-96	1997	58-60	500-700	Extra early variety, short statured, erect growth habit syn chronous maturity.
CAZRI Moth-1	1999	75-80	500-560	Semi-erect type, profuse bearing, seed protein 24-25%, showing field tolerance to YMV
RMO-225	1999	62-65	600-800	Semi-erect type, grain color light brown, escapes drought and YMV infection, fodder yield 17-20 q ha^{-1}.
RMO-435	2001	64-67	600-700	Escapes drought, has resistance to YMV in field conditions, semi-spreading growth habit, may yield 10-12% higher over RMO-257. Leaves are broad with dark green color.
				Cowpea
C-152	1985	105-110	600-800	Field resistance to viral disease, suitable for mix cropping and as a cover crop in plantation crops.
RC-19	1993	60-65	900-1000	Moderately tolerant to CYMV synchronous maturity with earlyness
V-130	1993	90-100	1000-1100	Resistant to CYMV, white seeded.
V-240	1997	90-100	900-1200	Tall, erect, creamy white seeds, field resistance to major diseases addapted to NWPZ of India.
V-585	1997	90-100	800-1000	Tall, erect, creamy white seeds, field resistance to major diseases.

GC-3	1997	90-95	550-1150	Early maturity, tall medium trailing small thin pods, resistant to CYMV suited to arid, semi-arid and humid areas of Gujarat and South zone of India.
KBC-2	1998	95-105	600-1250	Semi-determinate with tendency to tendril, light brown seed color, resistance to rust. Agro-climatic zones 4,5 & 6 of Karnataka.
Vamban-1	1998	90-100	900-1000	Bold and light brown colored seed.
RC-101	2001	85-90	700-1050	Early maturity, determinate, non-viny, white seeded for Rajasthan State.
			Horsegram	
Maru Kulthi	1989	700-800	600-700	Resistant to disease and drought.
PHG-9 (state released)	1997	90-100	550-1250	Dry areas of south zones, thick foliage, semi spreading, tolerant to powdery mildew and BGM.
Palem-1	1998	110-115	600-700	Suited to A.P. conditions
Palem-2	1998	105-115	650-750	Suited to A.P. conditions
AK-21	1999	850-900	510-1000	Early maturity suited to North-West India.
Paiyur-2	1999	100-105	500-700	Suitable for September-October planting in groundnut-horse gram-gingerly cropping sequence.