Pearlmillet/Bajra(*Pennisetumtyphoides*)

Bajra popularly known as Pearl millet, cattail millet or bulrush belongs to the family Graminea. The crop is cultivated for grain as well as for fodder in the arid region of Africa and Asia and as a pasture in U.S.A. It is originated in India or Africa. It is grown all over India except Assam and part of northeast India.

Distribution:-

Bajara crop is cultivated in south-west Haryana, Ravalli hills Chambal basin, West Uttar Pradesh plains, Kutch peninsula, Gujarat plains and Kathiawar peninsula. Small area is grown in Andhra Pradesh and Tamil Nadu.

Coarse Cereals-

Bajra, Jowar, maize, ragi, barley and small millets constitute coarse cereals. Area under total coarse cereals was 34.4 m.ha. In 1992-93 production of coarse cereals in 1993-94 is lower than the previous year. The likely production during 1994-95 is reported to be 32 m.t. which would be higher than the previous year. Perhaps a good rainfall year causes more area to be diverted to higher value crops at the expense of area under coarse cereals.

Tamil Nadu has released these varieties in the name of KM-1 (BJ-104) and K-142 (BK-560-230). In addition, Gujarat State has recommended two more hybrids CJ-104(5054A XJ-104) and J-1399(126D2A X J-1399) for commercial cultivation. Both are early maturing (75 days) and are disease resistant under Gujarat conditions. CJ-104 has been evolved at IARI, New Delhi, and J-1399 at Jamnagar centre. However, none of these four hybrids possesses resistance to ergot disease of bajar.

Climate and soil-

The crop has a wide adaptability as it may grow under different day lengths, temperature and moisture stress. Most of the varieties developed in India are photosensitive which helps in growing the crop during monsoon, rabi and arid season. It requires low annual rainfall ranging between 40-50 cm and dry weather. The crop may tolerate drought but cannot withstand high rainfall of 90 cm or above. Light soils of low inherent fertility good drainage, mild salinity are best type for this crop. Crop does not tolerate soil acidity.

Agronomic practices

Seed bed preparation and time of sowing: First ploughing should be done with a soil-turning plough, followed by one or two ploughings with desi or dise plough. Under rain fed areas sowing is done with the first advent of the monsoon while in irrigated areas sowing is done during July to avoid washing of pollen by rains at blooming period in early sown conditions.

Seed rate and method of sowing: Four kg of bajra hybrid seed is enough to sow a hectare. The seed rate can be reduced if the seed bed is well prepared and sowing is carefully done to ensure uniform distribution of seed for a good stand. Seeds should be sown about 1.25 to 2.5 cm deep in rows of 45 cm sprat. The soil should have enough moisture for immediate germination. Wherever possible, direction of rows should be kept east to west to allow the easy penetration of sunlight even to the lower leaves for efficient photosynthesis and carbohydrate manufacture and its translocation to developing grains. This also reduces the pressure of western wind velocity and thus reduces the chances of lodging of the crop. Three weeks after sowing, seedlings should be thinned to keep the plant to plant distance 10 cm apart. Gap filling should be done in patchy plots as early as possible.

Varieties-

NBH-149, VBH-4 developed for Andhra Pradesh, Madhya Pradesh, Gujarat, Maharashtra are capable of producing 14% higher yield.

ICM4-155 gave higher yield than the standard check and adopted for all growing tracts of India.Also H-306, NH-338 and hybrid like MP-204, MP205 have been identified.

Time of Sowing-

Sowing of *kharif* pearl millet should be done with the onset of monsoon i.e. first fortnight of July in north and central parts of the country. First fortnight of October is appropriate time for rabi season in Tamil Nadu. Gap filling should be done by transplanting seedlings after 2-3 weeks of sowing if scanty population exists. In Marathwada area of Maharashtra, dry sowing prior to first monsoon rains is recommended. Summer pearl millet should be sown from 4th to 5th Standard Meteorological Week (SMW) i.e. last week of January to 1st week of February to obtain higher production of summer pearl millet in zone B.

Sowing time :-

Most appropriate time of sowing is middle or last week of July

Seed rate and Spacing:-

4-5 kg/ha for drilling method

2.5-3 kg/ha for dibbling method

Spacing –

40 –45 cm between rows, 10 –15 cm within rows-in general.

For arid-western plain of Rajasthan, Haryana and Kutch of Gujarat (A1 zone), pearl millet should be planted in rows 60 cm apart, maintaining low plant population of 1.00 to 1.25 lac/ha.

For the area receiving rainfall more than 450 mm (zone A & B), the crop should be planted at the spacing of 45 x 10-15 cm keeping plant population of 1.75 to 2.0 lakhs/ha. Seed rate for the crop should be taken @ 3 to 4 kg/ha for obtaining required plant stand.
The recommended plant stand for pearl millet under normal conditions is 180,000 plants ha^{-1} or 72,000 plants $acre^{-1}$. Under irrigation or high levels of management on highly productive soils, a population of 225,000 plants ha^{-1} (100,000 plants $acre^{-1}$) is recommended. On extremely sandy, droughty soils, a population of about 90,000 plants ha^{-1} (40,000 plants $acre^{-1}$) is desirable.

Seed treatment-

Seed treatment with biopesticides (*Trichodermaharzianum* @ 4g kg^{-1}) or thiram 75% dust @ 3 g kg^{-1} seed will help against soilborne diseases. Seed treatment with 300-mesh sulfur powder @ 4 g kg^{-1} seeds controls the smut disease. For removing ergot affected seeds, they are soaked in 10% salt solution. Seed treatment with metalaxyl (Apron 35 SD) @ 6 g kg^{-1} seed controls downy mildew. Seeds are treated with *Azospirillum* (600 g) and *Phosphobacterium* to enhance the availability of nitrogen and phosphorus.

Nutrient Management-

For hybrid bajra under irrigated conditions following doses of fertilizers may be applied in average soils. The dose may be increased or reduced according to basic fertility of soil. The hybrids usually can stand even heavy doses of fertilizers.

Optimum Fertilizer Doses Needed for Bajra						
Hybrids/ Variety	Nutrients (kg/ha)				Fertilizer (kg/ha)	
	Nitrogen	Phosphorus	Potash	Ammo. Sulphate	Diamond. Phosphate	Muriatic of potash
Irrigated						
Hybrids	60	30	30	300	60	60
Locals	40	20	20	200	40	40
Rain fed						
Hybrids	40	20	20	200	40	40
Locals	30	20	20	150	40	40

Method of fertilizer application

A. First dose: Half the nitrogen and the entire dose of phosphate and potash should be applied in bands along the row 5-7.5 cm away on one side and 5-7.5 cm below the seed at the sowing time. The rest of the nitrogen should be applied in two split equal doses.
B. Second dose: Half of the remaining nitrogen (25 per cent of the total) should be applied 25-30 days after sowing (at the time of thinning).

C. The remaining of the nitrogen should be given again in the bands in the shallow furrows preferably before the emergence of ears. Where moisture is a limting factor, third dose need not be applied. Where deep placement of nitrogen is not possible by fertilizer drills or other methods then all the quantity of fertilizer to be given at the time of sowing should be broadcast in the field one day ahead of the sowing. These should be properly mixed in the soil by desi plough or harrow.

Generally the crop requires low quantity of nutrients. But All India Co-ordinated Millet Improvement Project has proved that new plant types of bajra especially hybrids respond to very high doses of fertilizers.

Under rainfed areas application of organic manures such as FYM or compost helps in increasing the crop yield at the rate of 150-200 quintals/ha 80 –100 kg N:40-50 kgP:40-50kgK is recommended dose for hybrid variety.

Fertilizers are applied in split doses, half of nitrogen, full phosphorus and potash should be basal placed at the time of sowing . The organic manures must be applied 20 days before the sowing of the seeds for full decomposition. One fourth dose of nitrogen should be applied about 30 days and 60 days after sowing.

Application of 40 kg N + 20 kg P2O5/ha for arid regions and 60 kg N/ha + 30 kg P2O5/ha for semi-arid regions is recommended for sole pearl millet as well as intercropping system. In light soils (sandy loams) the applied nitrogen may be lost due to leaching with heavy rains. So, only about half of the recommended nitrogen dose should be applied at seedbed preparation. The remaining half of nitrogen dose is side-dressed when the crop is 25 days old. On soils which do not leach easily like black soils, all of the nitrogen may be applied during seedbed preparation. Pearl millet seeds are sensitive to fertilizer burn. Do not apply fertilizer in the furrow with the seed or very near the seed in the row after sowing. It should be applied as side dressing Use of biofertilizer (*Azospirillum* and PSB) can economize the N and P fertilizer application.

In zinc deficient soils of the pearl millet growing area of the country, application of 10 kg ZnSO4/ha is recommended. To correct the zinc deficiency in standing crop, spray of 0.2% ZnSO4 at tillering to pre-flowering stage is recommended. Under prolonged dry spell, skip top dressing of N and spray 2% urea. Under excessive rain situation during vegetative phase, additional dose of nitrogen @ 20 kg/ha should be given

Interculture-

Thinning or gap filling is followed at the time of first interculture. Hand weeding is followed to control the weeds or application of Atrazine @ 0.5 kg/ha would take care of most of the weeds.

Irrigation-

Bajra is grown rainfed and crop being drought resistant hardly needs any irrigation, however it is observed that the yield may be significantly increased by irrigating the crop at critical growth stages like maximum tillering, flowering and grain filling stage. Therefore light irrigations and efficient drainage is very essential for bajra production.

Plant protection measures-

a)Insectpests:

Stem bores and grasshoppers are serious pests of bajra controlled by two sprayings with 2 liters of Imedchloropid and grasshoppers may be controlled by dusting the crop with Endosulphan 5 percent.

b) Diseases:

Downy mildew- for controlling this disease seed treatment with fungicide like Dithane Z-78 or M-45 @ 2.0kg/ha in 800-1000 lit. of water.
Smut- Treatment with Ceresan or Thirum @ 1-2 g/kg seeds is effective.
Ergot- Seed treatment with 20% common salt solution followed by washing with fresh water and then treating with Ceresan or Thirum @ 1-2 g/kg seeds is effective.

Harvesting and Storage-

Harvesting and threshing-

The crop is harvested when grains become hard enough and contain moisture. Two methods are adopted for harvesting the crop Cutting earhead

i) from standing crop followed by cutting of remaining plants later.

ii) Cutting of entire plants by sticks and stalking the plants for five days in sun for obtaining grains. Grains are separated either by beating the earheads with sticks or by trampling the ear heads under bullock feet.

Storage-

The separated grains must be cleaned and dried in sun to bring about 12-14% moisture after which the grains may be bagged and stored in a moisture proof store.

Yield-

Irrigated crop yields 30-35 quintals/ha, while un-irrigated crop yield 12-15 quintals/ha

Enhanced utility -

Bajra is also an important fodder and high levels of sugar are being incorporated into the stalks. White grained bajra varieties are now on the verge of release. These should enhance the utility range.

The development of early hybrids such as HHB 67, HHB50 and RHRBH 8609 and composites like WCC 75 have established production of bajra.

Contingency Planning-

To conserve *in situ* rainwater, deep plough the field during summer on heavy soils of Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka and Eastern Rajasthan. A wider row spacing of 60 cm is advocated where rainfall is less than 400 mm. Adopt suitable intercropping system select early maturing hybrids/composite of pearl millet under late onset of monsoon. Keep the crop weed-free by timely weeding. If dry spell occurs immediately after sowing, replant pearl millet in between the existing row or relay cropping may be practiced including short duration oilseed/pulse crops. Under normal onset of monsoon and occurrence of prolonged dry spell during grand growth period of the crop, reduce plant population to the extent of 25 to 40%. Skip top dressing of nitrogen and spray 2% urea. If drought prevails for 2-3 week during pre-flowering to grain setting stage, one life saving irrigation may be given if water is available. Under excessive rains during vegetative phases, additional dose of 20 kg N/ha should be applied.

Maize(*Zea Maize*)

Southern Mexico

Production = America – 185mt
Asia - 107mt
Europe – 66 mt
Africa - 30 mt
India 5.69 million lone productions
6.25 million ha. Area
UP, Bihar, M.P, Rajasthan, Punjab 75% of production

Classification

1. Dent corn : (Z. Maize indentatasturt)
    - Dent formation on the top, yellow/white color.
    - Dent because of rapid drying & shrinkage of soft starch.
    - Mostly U.S.A.
2. Flint corn: (Z.M indurata strut)
    - Discovered in Europe, Early Maturity
    - Round at top Hard kernels
    - Europe Asia, C.America, Main var. of India.
3. Pop corn : (Z.M evertasturt)
    - New world (America)
    - Mainly used in pop con confection.
    - The kennels are flowery in the middle, surrounded by hard (flint) Outer Layer.
4. Flour corn: (Z.M amylaceasturt)
    - Kernel are soft, no dent.
    - Oldest type of maize grown in U.S.A,S-Africa
5. Sweet corn : (Z.M sacchuratasturt)
    - Sugar & start are major part of endosperm
    - After Maturity kernels become wrinkled
    - Green cobs picked up for canning /table purpose.
    - Mainly grown in N-half of U.S.A.
6. Pad corn (Z.M tunicata Strut)
    - Kennel Enclosed in pod.
7. Waxy Corn (Z.M CerabinaKulesh)
    - Waxy in appearance
    - 78% aymlopectin& 22% amylose
    - Origen China, Waxy Hybrid developed in U.S.A

Waxy pod corn lesser in importance commercially and gong out of cultivation.

Ecophysiology:

- Lot of sunshine & warm climate.
- Ar. Temp. 20-24c· Night >14C
- Maize is Not drought tolerant dry periods during flower formation fertility reduced yield .

Soil:

- Maize is adopted to all types of soils through well drained, fertile and deep soil are ideal for maize

  PH Range = 7.5to 8.5

  Best soil = sandy loam – ph range 5.5-8.0

Preparation of field:

- One deep summer Ploughing after harvest of Rabi.
- In light soil one Ploughed + Planking
- Heavy soil, three ploughing
- In heavy Rain fall area furrow making crop sown on ridge.

Time of Sowing:

Kharif - on set of monsoon

North - Eastern hills	First week of marl
North-W hills	April last to early may
Peninsular	May – June
Indo Gangatic plane and AP	Mid June to Mid July

Rabi:

End of Oct. to Mid of Nov

Spring:

Jan last to first fortnight of feb.

Seed Rate:

60-75 X 25-30 cm

Plant density 55000 -70000 plants

Method of sowing:

1. Broad casting
2. Dibbling Method
3. Drilling Method
4. Hill sowing
5. Sowing the seed behind the plough.

Fertilizes & Manures:

25t/ha FYM

100-120: 60:40

N= 1/3,1/3,1/3 (sowing, Knee height, tasseling stage) for production of 1 tone crop, plant uptake 24 kg N, 4kgP, 23kgK.

Water Management :

- Most critical period → seedling stage, knee height, flowering (tasseling&silking stage)grain filling.
- Crop sensitive to water logging
- Irr. at 25-30% available Moisture.
- 50% of irri. at short period of 30-35 days after tasselling
- The vegetation period of H.Y.V. is long 140 day or more. At least 500mm of rain should fall during this time.

Harvesting & threshing:

Cobs are picked at maturity when grain should be hard & yellow or brown in color

Grain is separated from cobs by maize Sheller

Use :

Food, fodder, silage, fuel, beverage.

Corn Strove

30% of total nutrient in the corn plant commonly used in mixed with soil and manure.

Corn Fodder

1% of domestic corn acreage is cut for fodder, gazed or hogged off some corn is cut and fed green. The feeding of corn fodder is popular in the semiarid as well as in the northern border section where corn often fails to mature grains. Such stalks are more palatable & higher in protein than when they have produced mature ears.

Corn Silage:

Cut the crop when kernels are in the glazed stage and dented which is before a serious loss of leaves occurs. The yield may be 20% less if the corn is ensiled when only half of the Kernal are dented.

Corn harvested for silage because of drought stress, from soil high in nitrates and low in Mn may subject cattle to nitrates poisoning (Grass tetany) which some time is fatal to live stock.

Rabi Maize :

The main reasons for low production of *Kharif* maize are as fallow.

1. Cultivation of low yielding local variety.
2. Cultivation under Rain fed condition.
3. Use of in-adequate quantity of fertilizer.

4. Losses due to vagaries of nature.
5. Cultivation with traditional method.
6. Cloud weather → less sunshine period→less Photosynthesis.
7. High temp. →more photo respiration→ loss of water
8. High humidity and high temp → high pest attack.
9. More average moisture→ more weeds competition.
10. Delayed sowing & different in maintaining optimum plant population.

Reason for higher yield in *Rabi*:

1. Favorable weathers condition.
2. Timely sowing
3. Proper establishment of plan stand
4. Efficient fertilizes utilization.
5. Effective water management
6. Better weed management
7. Reduced pest & diseases problem
8. Better post harvest management
9. Favorable grain-strove ratio
    - Hight in Rabi is shorter than kharif
    - More in Northern part
    - More prolific

Production technology of Rabi Maze :

Choice of varieties –

Use of high fertilizes responding genotypes

Yield potential 6-8 tlha

High starch Variety is grown → Ganga-5, Deccan -103, Pratap, manjari

Planting time

In North – second fort night of Oct- mid Nov.

In Punjab, Hariyna → temp low at time of sowing → crops own on Ridge, sowing should be done on the southern side of the east west ridge.

Transplanting of maize:

- Mostly in N.W Eastern plan
- Trans planning is done in second for high of Jan.
- Nursery should be sown between 21-30 Nov.
- For 1 ha – 25kg seed & 1/10ha of land
- RxR = 20-22cm, FYM = 1.5-2 t/ha
- Fertilizer :: 7.5 : 2.5 : 3
- Pre Emergence herbicide Atrazin 1kg/ha
- Planning on Ridge gives high yield than flat

- Istirrigation immediate after Transplanting.
- IIndirr. 8-10 day Transplanting.

Fertilizes management:

120: 60: 40

N=1/4, 1/2, 1/4, (sowing Knee height, emergence of Flag leaf stage0

Weed management:

Broad –leave weed common =Atrazin 1Kg/ha, 1-2 inter culture operation

Irrigation

In heavy soil a moisture level of 30% during the vegetative stage of 70% during the reproductive stage of grain filling period is desirable.

Four to six irrigation is needed in Rabi crop .

Two irrigation up to flowering, 20-25 days interval

One irrigation at the time of flowing

Two irrigation after flowering

One irrigation grain felling stage

Inter cropping

Sort duration varieties → pea, rajma, beans

Oil seed crop→ soybean, linseed

Yield of maize in intercropping equal to pure crop

Shots duration varieties are best for intercropping.

Folder maize:

- Imp. because it is quick growing.
- It can safely fed at any stage of growth
- Grown hole year

Agronomy:

Same as cereal & Rabi maize.

Varieties:

The hybrids, composites and open pollinated var. are used for folder production, Ganga -5.

Sowing Time:

North → End of feb. – early march

South → four to five crop raised → max yield sep- Oct sown crop

Spacing:

25-30 x 10-15 cm

Seed Rate:

40-50 to 60-90 depend upon varietiesr. Thin stemmed is preferred

Crop Mixture:

Mixture with abually legume

Legume increase →Crude Protien

Summers season mixed with bajra, sweet sudan or MP chari.

Manuring:

15-25 t/ha FYM

N= 1/2, 1/2, (1/2 at sowing, ½ six week after sowing)

Irrigation:

60-65 cm water

Not be low than 65% of field capacity

Irrigation after every 10-15 days.

Harvesting:

Between 50-80 days of growth

Yield:

20-25 t/ha – summer session

45-55 t/ha – wet session

Digestibility:

DM	=	57-61%
CP	=	22-67%
NFF	=	45-83%
CF	=	39-72%

Sorghum

Origin :

India & Africa

Area &Production :

Third in respect to area (rice then wheat) India

80% as Rain fed

Main crop of India ,Chaina, Africa, America .

Production :

Maharashtra
Karnataka 25%
A.P 12%
Rajasthan
Gujarat
Total = 90% of total production

Eco physiology :

Tem =15c to 40 C, optimum 27-28c
Rain fed = 400- 1000 mm (40-45 F min for germination)
Both, Rabi % Kharif crop
36to38% production in Rabi Season

Sorghum is drought tolerant and can be cultivated with substantilly less rain fell than maize. The drought to tolerance is based on a low transpiration rate, on the dense and deep reach root system and on it's ability to stop all growth metabolism in time of severs dryness (dormancy abiosis). Early ripening cultivars have the least need for moistureand can be growth with only 200-300 mm rain. It is sort day plant but few new cultivars will also flower in long dag periods.

Soil :

Medium and deep black soils are suitable for →kharif
Black soils alone, more moisture retention→ Rabi
In loam and lighter soils sorghum is an irrigated summer crop (Jan. to April)
Ph =5 - 8.5
With stand salt and alkali soils.

Seed Rate & spacing:

7-8 kg/ha by hybrid seeds
45 cm R X R , 15cm P X P
3-4 cm Depth

2 lakh plant population

Seed bed preparation :

First ploughing = M.B plough
2^{nd}& 3^{rd}ploughirg = Desiplongh
2 to 3 harrowing and Planking

Time of **sowing**:

Normal kharif = June – July
Late kharif = Late aug. – Early sep.
Rabi = mid sep. – med oct
Summer = Jan- Feb.

Normal Kharif :

Under Rain fed condition during kharif sowing should be done at the onset of the first monsoon shower or slightly ahead where irrigation facility is available from the middle of June to the first week of July. Sowing must be completed in those pleas where early sowing get caught with late monsoon at harvest and reduce the train quality sowing should be delayed accordingly. sowing done in the first week or the middle of July avoids washing of pollen by rain blooming.

Late Kharif :

Area – khammam, Warangal, karimnagar, Kurnool in AP and surat in Gujrat.

Sowing in late aug. to early Sept. This area is wholly rain fed, therefore early maturing hybrid such as CSH-1,2,3,4 should be grown.

Rabi:

Area →Traditionally → Deccan plateau covering→Mah.Kar., AP

It constitutes nearly 1/3 of total jawar area

sowing →second fort night of sep. → mid oct.

Rabi jawar in black cotton soil grows entirely on the moisture retained in the soil.

Summer :

In T.N &the rives project areas of AP &Kar. 37 to 38.8 kg/ha yield reduction per day in kharif, rain fed with progressive delay of 7,14,21, days from onset of first monsoon shower.

Fertilizes Application:

Rain fed sorghum responds very well to 25-30 kg of N/ha and irrigated crop requires 90-100kg, based on soil test, P and K can be applied, N fertiliser application has to be regulated on judging the stand of crop .

Application of FYM 10T/ha improves the moisture retaining capacity & microbial activity in the soil in addition to supplying plant nutrients.

For tall varieties 45 kg P2O5/ha is required.

Inter culture:

Weeds are removed be howing twice 25 D.A.S.

Herbicide spraying 1kg propazin or 0.5kg atrazien in 1000 li. of water as pre emergence.

Irrigation:

For Kharif =500-600 mm

Hot weather =600-700 mm

Three irrigation is applied – 1) →30 DAS, 2) → Foot stage, 3)→ Green filling

For Kharif seedling & Flowering is most critical.

Behavior of Nutmeats in plant :

In sorghum N,P,K Content of vegetative parts decrease with an advance in age from seedling stage to fully maturity.

The efficiency of N application was found to increase when applied along with P.

B and B + Mn increased the yield of sorghum by 35 to 40 percent respectively.

Ratooning of sorghum :

Ratooning means allowing the stubbles left after harvesting to grow into a crop with a view to save cost of field preparation.

Ratooning give equal or more grain geld than the first crop.

Hasvesting above 10-15 cm height of crop→ broken leaf & stems are collected & burnt out soon after irrigation → application of ½ N & full dose of fertilizer → weeker sprout should be removed→ it needs irrigation as it is a post monsoon crop.

Its mature earlier → 80-85 days

Shots duration varieties is used (CSH-1)

Second ratooning is done in condition of full insect and pest management, out of these give poor yield.

Low production of jowar :

The low yield /ha grain spread of high yielding hybrids in the country is till slow, since by hybrid are capable of yielding 20qt/ha in the drought years & up to 60qt/ha under normal rainfall condition in the farmer's field, the best way of increasing the jowar production in the country are.

1. To replace the traditional tell low yielding varieties with fertilizes response HYV.
2. To grew by grow hybrid & varieties with recommended agronomic practices .
3. To protect the crop perform attacks of diseases pest's, particularly shoot fly.

Harvesting :

Depend upon varieties

Generally 90- 120 days

Wherever there is fear of rain at harvest time ear heads alone are cut and threshed, other wish the whole plant can be cut and stacked in the field with the ear heads facing upwards for 3-4 days to dry to facilatetransporting .

Yield :

50-65q/ha

Fodder Sorghum :

Main characters in given in this chapter rest of characters & his Agronomy is same as grain sorghum.

Plant characteristic:

Annual & perennial crop

5-6m in height , 5-3 cm diameter

Leaves → 30-100 cm long leaves, 12 cm width, waxy .

Toxicities ;

Appreciable quantities of cynogenic glycosides called Dhurrin occur in sorghum species on enzyme by hydrolysis, Dhurrin yields the aghycone (Methylglucsunlates) which spontaneously dissociates to hydrogen cyanide and aldehydi. These compounds are toxic and effect patability of the fodder.

Environment, nutrient status, genotype etc influence the level of toxicity.

- Nitrogen ,sulphur increase level of toxic
- Drought → increase leave of toxic
- Low temp (2c) → increase leave of toxic

On dry weight basis 500 ppp of HCN in leaf is dangerous to feed to cattle. Plants damaged by frost, disease or mechanical injury→ content high HCN and not safe to live stock .

Sudan gas lees in glycoside than jowaer .

Varieties:

M.P chari, Dudhia, sudan grass, CHS-1, IGFRI-S-4277, Ludhiana HC 136

Spacing :

25-35 X 10-15

Seed Rate :

40-50 kg/ha

Some time 100kg/ha

Manning &fertilizer :

FYM = 10t/ha for dray land

25t/ha for irrigated

100kg Urea + 175 SSPkg +50 kg KCL

40N 28P205 25K2O, or 50-30-30

Irrigation :

50-70 cm of Water needed

5-7 irrigation

Harvesting:

At flowering stage low concentration of HCN

Plant at heading rage can be safely grazed or fed to animal.

Harvesting = 50% flowing

The multi cut varieties, the first cut is usually taken after two months and sub-sequent cuts after 35 to 40 days.

A long duration varieties when cut two or three times at 15cm, better yield of quality forage are obtained than when cut once at flowering.

Yield:

10-45 t/ha dry land

65-85 t/ha irrigated and good management

Conservation:

Feed value of sorghum silage is much higher then green fodder.

No risk of toxicity in making silage .

Silage from mature plants keeps better and that from immature plants often become acidic so for silage sorghum is harvested at milk or soft dough stage with 65-70% moisture.

Seed production:

Cross pollinated crop but also self comp table

seed yield direct correlated to 1 / spaying

Spraying of cycocel 0.5kg/ha at 45 DAS or 15-20 day before flowering improves seed yield 6.3 -15.4 qt/ha

Nutritive Value:

CP highest at boot leaf stage (carbohydrate = 56.8%)

CP	EE	CF	TA	NFF
7.75	1.73	32.36	8.55	49.61

Utilization :

India - food & fodder

Africa – food, fodder & brewing beer

USA - grain, fodder, poultry &syrum& brooms from→ long panicle

Varieties – “broom corn”.

Paddy *(Orizasitiva)*

Family- Gramine

Origin :

India & Burma

Wild sp =21, cultivatedsp = 2 →OrizaSativa, Orizaglabessima

OrizaSativa is growing in all rice crop are

Orizaglabessima growing in west Africa only .

Genetic classification :

O Sativa -3 varieties

India ,Japanica, Javanica → (Wild from)

Indica :

Grown in tropic late maturity, photosensitive having tall, week thin culms with long drooping, thin pale green leaves, lax panicles.

Japonica :

Temperate zone, early maturity photo non sensitive, thin shots & sturdy culms, leaves are short narrow erect & dark green color, plants are very responsive to nitrogenous fertilize, no lodging tendency in them. If there is rain of maturity the grain may germinate on the panicle.

Structure of rice:

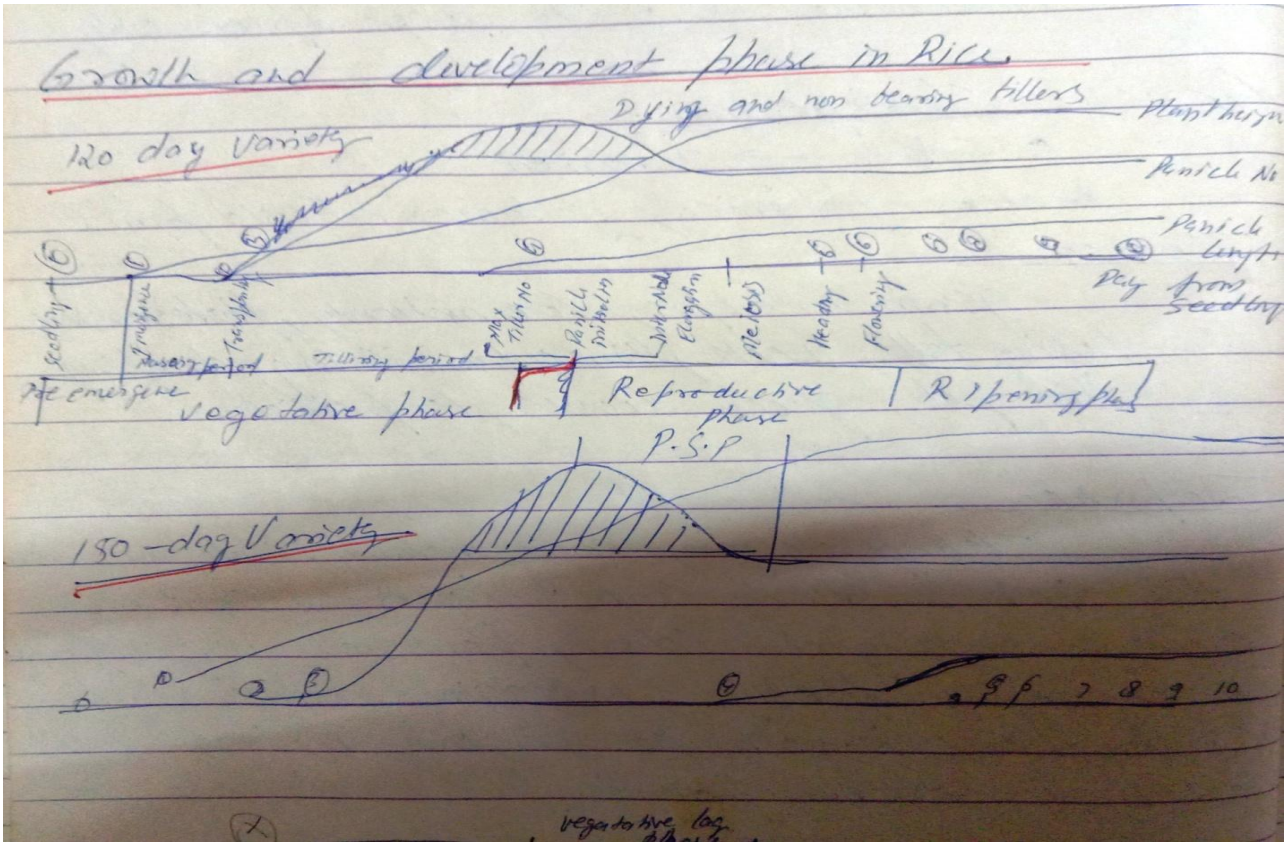
	Aleurone (inner)
Bran layer	Tegmen (meddle)
	Paricarp (upper)

Embryo :

Scutellum, epiblast, Oleoptile, plumule, Radical, coleorhiza.

Rice plant have both auricles and ligules which make a distinguishing character of rice to differentiate from Echinochloa spp. (a most common weed in rice field).

Growth and development phase in paddy:



1. Germination stage – from seedily to the emergence of coleoptiles from soil.
2. Seedling stage – coleoptiles → 5 inches leaf in seed bed.
3. Transplanting & recovering stage – uprooting from seedbed to full recover transplant.
4. Tillering stage – fist tiller → panicle initiation.
5. Elongation and booting stage – panicle initiation → full development of panicle inside flag leaf sheath .
6. Heading stage – first appearance of panicle tip out of the flag sheath to more than 90% panicle emergence.
7. Flowering stage - first flowering → completion of flowering.
8. Milk stage – caryopses waterey to milky
9. Dough stage – caryopsis in soft to hard dough
10. Maturity stage – grain repining more than 80%
11. Over –ripened stage – straw is dead over- ripened spikelet shatter from panicle

Vegetative lag phase

This is the period between may filleting and panicle imitation in which some of the tiller die because of tiller mortality. This phase is aabsent in early maturing varieties but it occur in long duration ones. Lag is a start of rest period. The vegetative lag phase is also known as photo period sensitive phase (PSP) this is and of the basic vegetative phase (bvp).

Ecological Requirement:

Temp = 25-33C day, 15-20c night,

Paddy yields are higher in warm temperate regions that have a low summer rain fall with a high light intensity than in the humid tropics.

Growing seasons :

Kharif → Jane to Sept.
Rabi → Oct. to Jan.
Summer→ Jan. to March

Summers crop is generally of short duration & if saves irrigation cost .

Rainfall:

More then 1500mm is desirable

Soil:

Ph = 5.5-6.5 (best)
Ph = 4.5-8.5 (Economical)

40% to 60% clag and silt, but paddy has adapted itself to lighter soils, acidic & alkaline soil reaction also sandy soil are not suitable as they do not have clay pan and there water retentivity is very poor.

Climatic zone:

1. Western Himalayan humid region →upland rainfed
2. Assam & Bengal humid basins → rainfed deep water.
3. E. Himalayan & Bay island → rainfed
4. Sutlej- Ganga plan of sub humid → poor yield, rain fed & irrigated
5. E.& S.E region of humid to sub humid →upland poor productivity.
6. Western arid plains → upland poor productivity.
7. Central highland & lava plateau of sub arid → soil→ acidic
8. Karnataka plateau & W. ghat of humid to sub humid →Crop grown natural soil reaction, but tolerant to acidic & alkalinity.

Ecophysiology:

1. Relative warm climate throughout the growing season(with a mean temp. of 70 F. or above)
2. An abundant supply of water of proper irrigation.
3. Topography→ level, high water, high capacity, with for much seepage.
4. Adequate surface drainage .

- Rice cannot endure frost at any stage of growth

Rice Production aria:

1 Irrigated rice =43%
2 Rainfed low land =38%
3 Rainfed upland =14%
4 Deep water rice = 5%
= 100%

Irrigated Rice :

- To supplement irrigation by cannel, river, pumps, tanks etc.
- Rice is transplanted
- Productivity 24 q/ha
- Weed infestation is high & poor fertilizing
- Lack of water at proper time (seed bed prep.)drainage, abnormal rainfall are serious constrains
- Water level at field 3.5cm
- In Rabi productivity is high

Rain fed low land Rice :

- Maximum water depth from tillring to flowering 35-100 cm
- Rice is trans planted
- More fertile soil then upland
- Av. productivity 13q/ha
- Flood & drought are common
- Plant population is not adequate due to poor tillring, in water logged poor drainage
- Delayed sowing & premature lodging to tall varieties
- Severe loses →from insect, pest
- Lack or suitable varieties
- Fertilizer & pest management is difficult.
- H.Y.V & disuse resistance give good yield in submerged condition.(50 cm water)
- Neem extract (Nimin) increase N use efpiuery

Upland Rice:

- Depth of water in growth stage 6-30cm

- Plant population is low due to broad castings
- Av yield is low due to broad castings 11q/ha
- Low productivity due to moisture stress & poor nutrient management
- Weed infestation is high
- Stem bores & leaf folder are common
- Leaf & Neck blast is major disease
- Vast are of high iron & low nitrogen
- Water harvesting, moisture conservation increase yield
- H.Y.V & increased fertilizes used is needed

Deep water Rice :

- Water depth from tillering to flowering = 1mt
- In some cases tillering to flowering = 6mt
- Sowing is normally by broad cast
- Poor plant population (due to mortality of seedling)
- Av. Yield = 8q.ha
- Fertilizer & water management are difficult
- Lack of H.Y.V & disease, pest resistant varities

Raising Rice seedlings:

Heavier seed having Sp. gravity = 1.13

Seed are floating in 27% salt solution. The selected seed are immediately washed.

For Breaking Dormancy

1. Heat treatment – seed with 11-12% moister→exposes for 4-7 day in 47-50 C .
2. Nitric acid treatinent – 1% solution of HNO3 for 1kg seed →soaked for 16-24 hr →washed.

Test of viability:

1% Tetrazolium chloride, Gordix acid → for 6 hr. →viable seeds embryo colorized .

Seed soaking → 10-12 hr depending upon boldness.

Seed incubation → soaked seed is covered with polythen sheet so that seed could not dried.

Method of raising rice seeding:

Wet – bed method → 25-30 days before

→width 1 to 1.5 mt

→well puddle (with plough and harrow)

→for 1ha →500-800 m^2

→ Soil will be sub merged

Dry bed Method:

- In high rainfall aria
- Light soil are preferred
- Land is ploughed, harrowed (not puddle)
- Bed size 8-10 cm height → 8-10 1-1.5 m
- Drainage channel 30cm
- 50-60 bed for 1ha

DepogMethod :

- Without contact of soil
- Ready for transplantation in 12 days
- Concrete floor, wooden planks, tragus can be used
- Seed are uniformly broadcasted on polythen sheets
- Seed rate 1.5kg/m^2 or 50 time test weight
- Bed are kept moist constantly and pressed slightly 2-3 times day for 3 days
- Nursery can be cut and roll after 12 days like mat
- 1sq mt for 200 sqmt area

Ideal stage of seedling :

4 leaves stage

Not more or less than 3-5 leave→ 20-30 day D.A.S.

Fertilizes :

	N	P	K
Dwarf	130	23-45	20
Tall	35-90	30	20

ZnSO4 = 15-20 kg/ha

The ammonical source of N is better than overall & slow relised fertilizes is preferred .

Green manuring with azoll culture or B.G.A, this supply 30-40 kg/ha N suppress the weed growth.

1/3 N as a basal , ½ at active tillering& rest at panicle innition stage

Drain the field prior to top dressing and reflood, 1-2 days later.

Water management :

1. Water needed for nursery =185 mm/ha
2. Water needed for pudding =190 mm/ha
3. Water needed pudding up to tilliring =322 mm/ha
4. Water needed tilliring to boot loaf stage =235 mm/ha
5. Water needed B.L.S to maturity =366 mm/ha

Total-1298 = 1300 mm/ha

- Growth of paddy/plant is affected as soil moisture reduced to field capacity.
- Rice plant can temporarily wilt at soil moisturer tension much below P.W.P
- Critical period →Dwarf rice → tilliring (0-20 days) and prionorelia growth to flowering (40-60 days) at these stages submergence of field in must .
- Critical Period for drought injury → flowering stage
- Consummative use of water by rice plant has been observed to increase slightly by fertilizer application particularly ((NH4)SO4).
- Variation in plant distance → not influences the water requirement.
- Total applied water (40% E.T, 60% seepage)
- For H.Y.V (Dwarf) continuously submerged us is not necessary.
- Drainage is Beneficial.
-

Harvesting :

Short duration varieties are preferred to allow double cropping and a pulse crop in the year. The japonica crosses are photo-intensive and there fit for cultivation throughout the year. The duration of the present day paddy varieties ranges from 95 day to 135 days. Depending upon this on seeding, the grains maturity the sheaves are threshed on the threshing floor and groins winnowed and cleaned.

Weed management:

1-2 kg/ha →2-4D at 4-6 week stage

chara&nitella control by 2-3 ppm CuSO4

Algae growth → PCP 3.75 - 4.4kg/ha &NaPcP 2.5to 3.75kg/ha

Disease & Pest:

1. Blast → thriram, agrosan → 25-30g/kg seed
2. Brown spot → thriram, agrosan → 1part/100part seed
3. Stem rot →AgrosanCeresan → 2g/kg seed
4. Foot Rot →AgrosanCeresan → 2g/kg seed
5. Bacterial blight → Soaking 30mn in streptlocylin (100ppm)
   Soaking 30mn in Agrosan+ Ceresan
   1. Rice sink bug – Early mowing & winter burning
   2. Stalk borer – Heavy Grazing & heavy flooding of stubble

Rice Quality :

Un hulled (rough)			Hulled husked	
Grain class	Length {mm}	Thickness{mm}	Length	Thickness
Short	7.2	3.7	5.5	3.2
Medium	8-8.7	3.2-3.4	6-6.7	2.6-2.9
Long	9-9.8	2.4-3.4	6.6-7.7	2.6-2.9

Milling &Hulling :

Removed of husk & past of milling bran loges

Storage condition :

Moisture = <9%

Water absorption test:

Rice absorber max water at 72C = soft cooking type

Rice absorber max water at 77c = intermediate cooking type

Rice absorber max water at 82c = hard cooking type

Volume expansion:

High V.E → best cooking quality depend on amylose content in rice.

Parboiling:

Hydrothermal treatment of cereal grain immediately followed by drying peror to milling to prepare parboiled grains.

A. Easy to shell out the parboiled rice due to the splitting of the husk
B. % of broking grain reduced → parboiled provides on extra strength to the grain
C. More nutritious than the raw one grain
D. More resistant to pest during storage
E. More oil content in parboiled rice bran

H.Y.V:

- Introduced by I.R.RI [Philippines]
- Shots straw resistant to lodging
- Leaves are short, stiff to medium growing time (100-130 day)
- Plot resistant to pest & poor quality

Rice:

90% grown & consumed in Asia

6% America
3% Africa
1% Europe
21% of world calorie

35% Asia& 30% India calorie received by rice

Consumption:		Av. Prod. t/ha
India	66kg/year/capital	2.6
Asia	8.5 kg/year/capital	3.6
World	55 kg/gr/capital	3.5

Highest production /ha → Australia = 8.2 t/ha

Ground Nut (*Arachishypogaea*)

leguminasae , 2n=40

Sub -family – PapiPlionaceae

Origin – bolvia

Groundnut also known as – peanut, monkey nut ,earthnut, manillanot

Groundnut as poor man almond –

G/N = 25% protein
15.6% Arginine
4.1% Histidine
6.6% lysine
1.5% Cystine

Digestibility = 86% (Highest vegetative protein)

Oil = 47-53%

G/N	Kernel Content			G/N	Protein
p	0.25	to	66%	1.3	times higher than meat
Fe	0.002	to	0.1%	2.5	times higher than egg
K	0.68	to	0.89%	8	times higher than fruits
Ca	0.2	to	0.8%		

G/N oil also content Vita. –A,B,E,B_{12}

G/N deoiled Cake contain :

Fat	92%
Protein	46%
Soluble carbohydrate	24.2%
Fiber	8.4%
Ash	5.8%
N	7.5%
P2O5	1.5%
K2O	1.5%

Pegeging :

The flower open between 6-8 am and fertilization is completed before mid day after which the flower Droops the corolla closes and the calyx tube bends down by 4 pm and the flower with ers within three days.

The peg is formed by the elongation of the basal position of the ovary (Which is called stipe) and bends down at such an angle to the stem as to reach the soil in the shortest distance. Growth of the peg is due to the positive geotropism, humorous minute plastids developed after fertilization in the epidermal walls of the pegs. The pegs become visible in about 5-7 days of flowering and 2-8 days in spreading type.

The fruit only begins to grow when the tip of the carpophores has reached its depth in of the soil (5-10cm under the surface) it then grows horizontally. When the fruit beares does not succeed in entering the soil the fruit does not develop.

Production :

Important food crop in tropics be sub tropics sub tropics
Asia (15.4), Africa (4.6), America (2.7) million tons
First →India (6.4) → China (6.0) → USA (1.7).

Eco-physiology :

Development and vegetation period for the G/N are chiefly dependent on the temp.
For germination 30c
Vegetative growth 27c
At temp. =15c G/N becomes chlorasis

G/N are fairly drought tolerant because they very quickly develop deep reaching root system, at flowering time the carpophores enter more easily in to damp soil which is not too hot rather them into dry, over heated soil .

Rainfall:

The limit for their cultivation is generally 500mm annual rainfall
For early cultivars 250-300mm rain fall during the vegetation period is enough

In very rainy regions (over 100mm) the soil must be permeable or else they must be grown on ridges for sufficient drainage.

Soil:

The soil should be light, well drainaged and airerated, heavy soil are un suitable.
Ph = 6.5-75(slight acidic)

Land preparation;

2 ploughing by M.B. plough
2 harrowing followed by planking
25kg/ha of heptachlor/ chlordane application for white grubs.
Land should be fine leveled to prevent logging.

Seed selection & treatment:

Seed should be bold, unbroken, disease free, viable, pure and uniform in size.

Germination % =90% must

Bunch type = 90-95% G%

Spreading type = 85-90% G%

For rodents % craw = pinetar/kerosene → seed teamer

Treatment for seed form disease:

Captan/ thiram 75% W.D.P slurry

Mix 125g thiram, captan for 100kg kernel in 500ml water

Difolotan dust 2.5kg seed

Spreading type of seed have dormancy of 60-75 days before germination .

Treatment by growth prompting Harmon Gebrlic Acid

Rizobium culture treatment:

For better nodulation growth & development

For 50 kg of kernels, prepare 10% solution of gum Arabic in water add jaggary (gur) to make a solution of 5% add 2-3 packets (200g each) of peat based culture pour the G/N kennels and agitate the content to make a slurry.

Spread slurry uniformly on the news paper sheets in the shade

Dried seed is used for sowing, left over could not used second time.

Seed Sowing:

N. India – April/July = irrigated

June/July = Rain fed

T.N. =May to July

A.P&Guj = Jan to March

Seed Rate:

Spreading type = 60-70kg/ha

Bunch type =85-90kg/ha

Bold size T- 64 = 100kg/ha

Method of sowing:

Best method is ridge & furrow sowing

→Pora method

→Dibbling method

Spacing:

Bunch type = 20-30 X 8-10 cm

Semi Spreading type= 30-40 X 10-15 cm

Spreading type = 50 X 15-20 cm

Fertilizes: (Kg/ha)

	F.Y.M	N	P	K
Rainfed crop	6.25t/ha	10-20	20-40	20-40
Irrigated	12.5 t/ha	20-40	40-90	20-40

N= ½ before sowing + ½ (30-45)D.A.S

At the time of pegging 200 Kg/ha of well powered gypsum is to be applied is much benifical.

Irrigation:

Most- critical stage = pod formation

Critical stage = branching, flowering, pod formation

One pre irri. = for better seed germination

Use of Hormones:

50% of plant energy is wasted in producing non-effective pods and effetive pods germinate if there is rain or irrigation .

Application of L-NAA in the form of plan planofix and vardhak at the time of flowering have been found to reduce the excessive vegetative growth & flowering period which ultimately increases the no. of effective pods/plant, test weight and yield/unit area.

Application of M.H (Malic Hydozide) near maturity results in inducing dormancy in the pods for about 20-30 days which break the germination of matured pods even of they get water.

Harvesting:

Yellowing of leaves and dropping of old or leaves are the symptoms. The pulled out plants is are stacked in the open for a few days for drying and then the pods are stripped.

In the southern districts the pods are immediately removed from the plans and then dried up to a moisture level of 5%.

Spreading type is harvested by digging out of plant.

Yield:

Irrigated=30-35qt/ha

Rainfed=15-20qt/ha

Shelling %= 70-75

Oil % = 40-45

Storage:

Damaged/injured pods →Short out

Moisture = less then 5%

The under size/under developed and un-filled pods (Pop-pods) should be discharge because their presence reduces the market price.

Aflatoxin in G/N:

Aflotoxin are toxic metabolic substance produced by certain toxigenic stain of Aspergillusflavous and parasiticus fungi, growing in various feed and fodder commodities. They are most potent help to carcinogenous. A very small amount of aflotoxin in feed (10-12 ppm) can produce fatel liver cancer in young animal. G/N and its product are good substract for the growth of aflatoxin flavour

If moistur % grater then 5→dampness → fermination of pod → develop poisonous mould(aflatoxin flavour)

The mould lead to contamination with aflatoxinaflatoxin flavour crat health hazard → human/cattle.

Causes of aflatoxin:

1-Nature of Strain
2-Substrat
3-P^H
4-Temperature optimum for growth 30-32C
5-R^H optimum for growth 8.2-8.5 %
6-Moistur content of substract 15-30 %
7-Airation

Control of aflatoxin:

1-Use resistant Varities, CGC-2,7 ,S-230,Faizpur
2-Aviod mechinical,biological damage
3-Avoid plant stress during podding and peak maturity
4-Reduced moistur % of kernal
5-store the produce to low tempreture and low humidity

Soya been (*Glayxin max L.)*

Area & production:

The largest produces in 1988 were the U.S.A 41.9 mt, Brazil 18% ,China 10.9%, and Argentina9.8%, there afr four countries grow 90% of the total world production .

More than half of the worlds production of soya is exported as bean or as oil &cake . About 50% of the expert is supplied by the U.S.A, 17% Brazil & 10% by Argentina.

This crop was intoduced in India in the 1950. It is mainly grown in M.P, U.P. Mah. & Rajasthan. It ranks third in importance after G/N & Rapeseed/Mustard in oilseed crop with a production of 18.5mt of out of which 1.45mt conln is booted by M.P. alone.

Ecophysiology:

The Paris of the sub tropics is which are always humid provied the best climate for the soya been. The optima temp. =24-25c it is pronounced sensitivity to photoporiod and most cultivar only bloom when the day length is less than 14 hours very short days(less then 12 hours) lead to pre mature flowering so that the plants remain small & have reduced yield.

In the main are of culhvation the growing period is 4-5 months. In warm countries 500-700mm rain fall are necessary for good yelds dry spell are enduced and if should not rain too much during the ripening period, growth & yield are definitely influenad by symbiosis with rhizobium.

Acidic condition is favourable for soyabeen cultivation.

Ph value of 6-6.5 being optimal there aehoweves also cultivars thrive well on acid (Ph5.5), alkaline (Ph7.5), soil is important for nodule formation and Mo fertilizers can be necessary in acid soil, the production of 1 tonne of seed, removes from soil about 15kg P,50kgK.

Soil:

light to black cotton of M.P, best sandy loam.

Seed bed preparation:

If lack of moisture ii field→ one pre irrigation

Two ploughing by MB plough

Two by desi plough, levelled by planking.

Fertilizer :

50 cart loads of FYM

Well powered oil lake 250-500kg/ha

Gypsum = 375-500kg /ha

N P K = 40:100:96

25kg urea, 100kg DAP, 50kg KCL

N= 1/3 as basal dressing, 1/3 after sowing ,1/3 -40 DAS foliar application of DAP 2kg, potash 1 kg & urea 5kg in 100 liters of water boots yields

Rhizoidal culture of seed treatment :

The response of rhizobial culture in soya bean is very high. The culture is particular very essential when soya bean is first cultivated in field.

The quality of the culture used is also important. The general recommendation is about l0 gm of culture to every 1kg of seed. Doubling or tripling this to 20or 30 gm has provide high beneficial and may require about 125kg of culture per ha. This ensures earlier nodulation. Healthy nodules increase the quantum fixation of organic nitrogen to around 20kg/ha benefitting higher seed weight and yield.

Secondary Elements:

Ca has a telling effete on nodulation & plant growth irrespechve of soil pH,Ca effete are more in acid soil.

Sowing time:

Kharif = June last to July first

Kharif Irrigated = mide June

Spring = 15thfeb.to 15th march

Method of sowing:

Line sowing

Spacing:

Kharif =45-60 cm

Spring =30-45 cm

Seed depth =2 to 3 cm

Heavy soil = 3-4cm

Seed rate:

For grain purpose =20-30kg/ha

Fodder =70-75kg/ha

Spring/ summer =120kg /ha

Inter cropping =25-30kg /ha

Irrigation:

About 7 irrigation at every 10-15 days are necessary depending upon soil, climate and rainfall. This can be reduced to once in 7-10 days when there will be maximum flowering, pod setting and grain maturation. Excusive irrigation can be harm fall

Yield & harvesting:

500 to 100 kg grain per hector on an average, where it is grown as folder, the plants have to be harvested before the pods are set, dried and stacked so that these plants can be mixed with paddy straw while feeding for cattle .

Early variety = 90-120 days

Late variety = 140-190 days

Harvest when moisture content 14-16%

Causes of poor production:

Poor plant population:

The optimum plant population is 400000 ha while on the farmers field much less plant population is maintained. This is mainly due to poor germination of seeds. Which is due to use of own seeds as soya been loose viability quickly if not stored under appropriate condition. If require 50% moisture of its weight for germination, while maize, paddy and bajara need 30,26,13% respectively. The formation of hypocotyls arch (epigeal crop). Which is soft, tender & breaks easily formation of crusts if a rain occurs after planting are also important reasons for poor germination.

Delayed planting:

Generally the onset of monsoon is deluge causing delayed planting. Soya bean being a photo-sensitive crop comes to flowering even without attaining desired vegetative growth which adversely affected the yield.

Poor fertilization:

Poor nodulation:

In efficient pest and disease management:

Soya been is susceptible to a number of pest & disease but no protection cover is given to it against them. The incidence of girdle beetle, blue beetle ,pea stem fly affect yield adversely.

Lack of improved varieties:

Non irrigation :

Thee is a wrong conception among former that soya been can grow well with out irrigation, where as in long dry spell it's required. The scarcity of water is more critical at the germination, flowering and pod filling stage.

Lack of appropriate market support:

Generally processed soya been produces are consumed and row soya been is not used.

Gap in transfer of technology:

The production tech developed and standardized at a considerable cost is not adopted by even 30% of the farmer, particularly for fertilizer and plant protection .

Non popularity of soya Product:

Quality & uses:

Soya seed high yielding content 10% oil, 38% protein (with individual cultivars the oil content can reach 25% and the protein content 43% and some small seeded Asiatic cultivars content 50% protein) the meal and flakes from the oil extracting represents more than 40% of the value of the crop without this dual purpose, the cultivation of a crop with such a low oil content would not be economic .

Because of the low oil content of the seeds the oil is preferable won by solvent extraction it belongs to the linolenic acid group, 11% linolenic acid & because of that it become rancid more easily then others vegetable oils its main uses world mide are for the production of margarine.

Off all oil soya been has the higher content of lecithin's (1.1-3.2%)which are centrifuged off after the steam treatment of the "miscall"(the mixture of soya been oil dining extraction) soya lecithin is surface active compound and is used as an emulsifies in the food industry .

The protein in the extraction meal as used not only for human and animal food, but also for technical purposes (synthetic fibers glues, foam-forming agents)

The unripe seed are eaten in E. Asia and the USA as a vegetable like peas and beans. The ripe seeds are difficult to digest, and in the raw state they contain toxic compound and they also have an unpleasant taste in East Asia, a range of other preparation techniques are common which produce value able foods such as temp, soya (soya sauce) and other products obtained by microbial process as well as soya milk from milled beans & toffee (soya bean curd which is soya

precipitated using acid and salt). Finally, soya bean sprouts are an important vegetable in E. Asia. The green plants can be used for grazing or given to animals as green forage. It is well suited to sillaging.

Edible soya flour:

This is the best protein source in all respects, it can easily replaces partially (fully, the costly pulse dhalls) of red gram, black gram, bengal gram and green gram. These pulse dhalls contain only 18-20% protein and cost is high, soya flour contains 50% protein and is priced as is very low. It has a lot of health advantages reducing the risk of heart disease, gout, rheumatirm etc.

RED GRAM – (*Cajanuscajan L.*) mill sp.

It is a crop of the tropical climate, suited to arid regions. It thrives up to an elevation of 2000 mt and stands water logging for a few days. Annual rainfall of at least 350 mm in necessary.

Uttar Pradesh, Bihar, Madhya Pradesh, Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu and the important states in India growing this crop.

Pigeon pea and Arhar are the other name for red gram.

Soil:

Archer grows in sandy soils, loams and also clay soils. With better moisture retentively in soil yields are better but there should be good drainage.

Cultivation: the land has to be prepared well by repeated ploughing whenever there are early rains. This before in removal of weeds and also better nodule formation of the roots as they penetrate deeper

Spacing:

For short duration varieties/hybrid spacing between rows can be 60 cm and between plants 20 to 30 cm.

Mixed crop:

Mixed cropping of red gram with groundnut, Jowar, Bajra, Maize and other pulses is common. The seeds of the above crops are mixed sown broadcast and ploughed to cover them. The proportion of mixing is based on the age of the crop, its growing and rooting habit and each should not harm the other by shading or competing very much for moisture or fertility in the soil. The red gram grows even after the harvest of the companion crops. The mixed crop practice is an insurance against crop failure due to drought, pests and diseases .

Intercropping:

Here, the seeds of red gram and the companion crops are sown in separate lines. Between 2 rows of red gram 2 to 3 rows or a pulse are sown. Short duration varieties of growth, after the harvest of the companion crop, to give normal yield.

Seed rate:

20-25 kg/ha for a pure crop- the quantity is reduced by 1/3 to ½ when red gram is grown as a mixture or intercrop, depending upon the nature of companion crop.

Manuring:

Pulses in general are not manure, But if farm yard manure or compost is applied there is good response. 20-25 kg/ha of N in the form of ammonium sulphate, 60 kg/ha of phosphorus and 40 kg/ha of potash will appreciably improve the yield. The above fertilizers are to be applied during the last ploughing and covered.

Irrigation:

Red gram in small pockets is cultivated under irrigation in the country.

Plant protection:

Generally pulses are very much damaged by pod- borers. One to two dusting with endosulphan 10% will greatly benefit the crop and good yield can be obtained.

The improved varieties of red gram with details on regions of cultivation, duration and other characteristics are appended.

Pusa -64: An improved varicty of red gram (arhar).

DA 9 = Rapid growing with resistance to Alternariablight ;

DA 11= Yields 20 to 30 per cent more than control.

Improved varieties of pigeon pea (red gram) suitable for dryland farming in different zones:

North Western plain Zone	T21, UPAS 120, pusa 84, mak A1 15, ICPL151, pusa33, H 82-1 Pusa 855.
North Eastern Plain Zone	Bahr, T7, ICPL151, T 21, Laxmi, W.B20(5), NP(WR) 15, Sweta.
Central Zone	Gwalior3, T21, shards,C11, No148, JA4, BDN2 T15-15,Vishaka 1, ICPH8, ICPL 87, ICPL 87119.
Southern Zone	Visaka 1, Hy 3C LGR 36, C 11, T21, Maruthi Sharda, CO5

Hybrid pigeon pea:

Collaborative programmer between ICAE and ICRISAT over the past eight years has been fruitful and the first commercial pigeon pea hybrid ICPH-8 has been released from commercial cultivation. This was developed using Ms Preheat (DT) and ICPL 161. It matures in 13-132 days and the average seed yield of this hybrid is 20q/ha.

Presently, in India, nine centers are working on hybrid pigeon pea programmer. Cost of hybrid seed is being worked out and it is hoped that the hybrid crop would spread to more areas.

Cotton

Cotton (Gossipium sp.) is a commercial crop of great importance and plays a key role in the economic and industrial affairs of the world. It supplies the basic raw material for the cotton textile industry. It is cultivated in about 60 countries of the world, from about 9· N to 31 N latitude, button countries viz, the C.I.S the USA, china, India, Brazil, Pakistan, Turkey, Egypt, Mexico and Sudan are the most important cotton growing countries. In India it is grown in the states of Maharashtra, Gujarat, Karnataka, Madhya Pradesh, Punjab, Tamil Nadu, Andhra Pradesh, Rajasthan and Haryana. About 9.8 million bales of cotton are produced from about 7.4 million hectares (1990-91).

Cultivated species of cotton:

the varieties of cotton grown in India fall under four species of Gossipium, viz. arboreum, hirsutum, herbaceum and barbadense. Of these, the first two are diploids(2n=26) and are known as Asiatic cottons whereas the latter two species are tetraploid cottons (2n=52) of these two G. herbaceous is known as American cotton and G. barb dense is known as sea island cotton.

Hybrid cottons:

Besides the development of intra- and inter-specific hybrids within the diploid species in the tetraploid species also, successful work for the utilization of F_1 hybrid vigor has been done. We have under commercial cultivation, both intra-specific and interspecific f_1 hybrids in India.

Economic importance:

The Indian textile industry is the largest single industrial segment in terms of annual value of output and labour employed.

Area Under cultivation: In India, cotton in largely cultivated under rain fed conditions.

Climate and soils:

It is a tropical and sub tropical crop. It is grown on a variety of soils, like alluvial, red sandy loams and late rite soils.

Crop season and rotation:

It is essentially a kharif crop. The common rotations- cotton wheat, cotton jowar, cotton-bajra, cotton sessamum, pulses etc. are practiced in drought prone regions.

Irrigated cottons are raised in September- October giving the pickings from January to March.

Cotton is raised in summer season also in certain pockets of Tamil Nadu under irrigation as a rotation with other garden crops. There is a practice of growing cotton in deltaic paddy area after the harvest of paddy. This is known as summer rice fallow cotton. Irrigation is from point tube wells fitted with electric motor or oil engine.

Land preparation and Sowing:

In well prepared land, seed is sown at 15 to 25 kg/ha with an inter-row spacing of 45 to 60 cm. In dry lands, seeds are sown in lines through drills or behind a wooden plough. Irrigated cotton is dibbled by hand on the furrows.

Manuring:

Cotton responds to judicious application on N.A leguminous crop or a green manure crop taken before cotton has beneficial effects. Phosphate and potash are generally sufficient in cotton soils. About 40 to 100 kg/ha of N can be applied with beneficial results. Band placing of N has been found to be more fruitful for the irrigated cotton.

Inter-cultivation:

Inter cultivating in line-sown crops is essential to keep the plots free of weeds. Thinning is necessary to obtain the optimum population to get high yields. A proper irrigation schedule adjusted to the soil, weather and variety should be implemented.

Harvesting and yield:

While machine picking is practiced in some advanced countries, in India it is generally hand-picked. This has to be done twice a week in the peak period of bursting of kapas and at longer intervals later on to complete harvesting. Yield of cotton lint rain fed crop 150kg/ha Irrigated crop 500kg/ha .

Pests and Diseases:

A number of pests attack cotton from germination till picking. They include aphids jassids, thrips bollworms leaf-worms and mites all of which ultimately affect the yield and quality of the cotton .

Diseases of cotton are, root, rot, wilt, bacterial blight and anthracnose. Control measures like seed-treatment, soil drenching, spraying the foliage with fungicides, and use of resistant varieties will help to keep the adverse effects under check.

Processing and evaluation :

Ginning: The removal of seeds from the picked cotton is called ginning. The percentage by weight of cotton lint to cotton Kapas or seed cotton is called “ginning percentage.”

Highest Standard Count (HSC): The quality and price of a sample of cotton is related to the quality of the yarn which can be spun from it. The fineness of the yarn is usually expressed in terms of the "counts". A count is the number of "hanks" of 840 yards each in one pound of yarn. The important fiber characteristic, which determine quality are the fiber-length fineness, maturity and strength. Fiber length or staple is the most critical attribute which determines price. The staple-length classification followed in India is as follows:

Long staple - 24 mm and above

Medium staple- 20 mm to 24 mm

Short staple - 19 mm to below

Recent Promising Hybrid Cotton

Savitha- Developed at Coimbatore, Tamil Nadu Medium-tall puts out large, 4 locale bolls weighting 1.5 to 5 gms. Needs 165-175 days for complete boll bursting, yields 26q/ha of seed cotton, staple 32 m.m long micron ire value 3.5 to 3.8 highest spinning intra-hirsute hybrid is tolerant to jassidsVertucillium wilt.

Abadhita- 1 is a new pest-resistant cotton variety. Field tests with suitable controls have shown that it is resistant to bollworm and jassids. It is also resistant to stem weevil. It has been fully field tested in south Tamil Nadu.

Cluster bean

Cluster bean (CyamopsistetragonolobaL.Taub.), commonly known as guar, has come to be recognized as one of the most important commercial crop of arid and semi-arid region. It is a drought hardy leguminous crop because of its deep tap rooting system and has high capacity to recover from water stress. The seed of cluster bean contains about 30-33% gum in the endosperm. The discovery of the galactomannan gum in the endosperm during 1948, led to this hitherto insignificant plant gaining importance as an industrial crop.

The gum is utilized for many food items like ice creams, baked and dairy products etc. Moreover, its gum also used in many other industries like pharmaceuticals, cosmetics, mining, textile, paper, oil drilling, explosive industry etc. Traditionally, pods of the cluster bean are used for vegetable purpose. Its plant, seed and straw are good source of nutritive fodder and feed for livestock. Cluster bean is also raised as a green manure and cover crop. Being a leguminous crop, it enriches the soil fertility by fixing the atmospheric nitrogen. The crop is mainly grown during rainy season, but it can also be grown successfully during summer season under irrigated condition. However, the average yield of cluster bean in arid and semiarid region is very low as compared to its potential. The productivity can be significantly increased with the use of the following improved production technologies.

Climate:

Clusterbean is a tropical plant. It requires warm growing season. The crop requires 30 to 35^0C temperatures at the sowing time for proper germination and 32 to 38^0C temperatures encourages good vegetative growth, but high temperature at flowering stage photosensitive and indeterminate crop. Atmospheric humidity encourages the infestation of many diseases like bacterial leaf blight, root rot etc.

Rotations and Intercropping:

In the rainfed condition of Rajasthan, clusterbean is traditionally grown as a mixed crop with pearl millet, mung bean, moth bean and sesame. But in some areas, sole cropping of clusterbean is also being taken. Clusterbean can be successfully intercropped with pearl millet in 2:1 row proportion of clusterbean and pearl millet. This system is quite profitable as compared to sole cropping of pearl millet.

Following crop rotation can be followed.

- Clusterbean-pearlmillet (two year crop rotation in rainfed condition)
- Clusterbean-wheat (one year rotation for irrigated condition)
- Clusterbean-cumin (one year rotation for irrigated condition)
- Clusterbean-wheat-clusterbean-cumin (two year rotation)
- Clusterbean-wheat-mung bean-mustard (two year crop rotation)

- Clusterbean-cumin-pearlmillet-mustard (two year crop rotation)
- Clusterbean-wheat-pearlmillet-cumin (two year crop rotation)

Soil:

The Cluster bean is grown in medium to light textured soil having a pH of 7.0 to 8.5. Water logged conditions affects the crop growth. Heavy loam soils are not suitable for cultivation of cluster bean. Also the crop growth is affected in the high moisturized area.

Land preparation:

Field should be well prepared for good germination. It should be fine texture, free from weeds and not too many clods. There is no need of preparing an extremely fine field. The first ploughing should be done with soil turning plough or disc harrow so that at least 20-25 cm deep soil may become loose. It should be followed by one or two cross harrowing or ploughings. The ploughing should be followed by planking so that soil is well pulverized and leveled. Properly leveled field is required for good drainage.

Seed and sowing time:

Quality of seeds is of utmost importance for maintaining optimum plant stand. Certified seed of improved varieties obtained from reliable sources should be used for sowing. Seed produced by the farmers should be graded before sowing. Discard very small, shriveled and damaged seed. Only bold seeds that are free from weed seeds and other impurities should be used for sowing purpose. Crop should be sown at the onset of monsoon in the first fortnight of July under rainfed condition. Delay in sowing after 15^{th} July can cause reduction in the yield. Under irrigated condition, it can be sown up to the last week of July. Planting time also plays very important role for the crop grown during summer season. Last week of February to first week of March is the most suitable time for cluster bean sowing for summer scrop. Delayed in sowing, flowering may be affected due to high temperature which may result in decrease in seed yield. Therefore, timely sowing for summer crop is very important non-monetary input. Temperature should be 25 to 30^0 C at the sowing time of summer cluster bean.

Improved Varieties:

For seeds and Gum- HG-365, HG-563, RCG- 1066, RCG-1003		
For vegetables- DurgaBahaar, PusaNavbahaar, PusaSadabahar		
For Fodder- HFG-119, HFG- 156		
State wise recommended varieties		
S No.	**State**	**Varieties**
1	A.P.	RGM-112, RCG-936, HG-563, HG-365
2	Gujarat	GC-1, GC-2
3	Haryana	HG-75, HG-182, HG-258, HG-365, HG-563, HG-870, HG-884, HG-

		867, HG-2-20
4	M.P.	HG-365, HG-563
5	Maharashtra	HG-365, HG-563, RCG-936
6	Punjab	AG-112 and varieties from Haryana
7	Rajasthan	RCG- 1033, RCG-1066, RCG-1055, RCG-1038, RCG-1003, RCG-1002, RCG-986, RGM-112, RCG-197
8	U.P	HG-563, HG-365

Manure and Fertilizer:

Cluster bean being a leguminous crop, needs a small quantity of nitrogen as a starter dose during early growth period. Cluster bean requires 20 kg N and 40 kg P_2 O_5 per hectare. 2.5 Full dose of nitrogen and phosphorus should be applied at the sowing time. It is advisable to follow integrated nutrient management practices for cluster bean. About 2.5 tons of compost or FYM should be applied at least 15 days before sowing. Application of FYM or compost is useful for improving water holding capacity of the soil and also to supply all the nutrients require for the plant growth. At the sowing time, 10 kg nitrogen and 20 kg P_2O_5 ha^{-1} should be applied as basal dose. Fertilizer should be placed at least 5 cm below the seed. Seed inoculation with suitable rhizobium strains and phosphorus solubilising bacteria (PSB) is beneficial for increasing crop yield.

Water Management:

Usually, cluster bean is grown as rain fed crop in arid and semi-arid condition. The irrigation should, however, be provided whenever, crop suffers moisture stress, if irrigation facilities are available. Life saving irrigation should be given to the crop particularly at the time of flowering and seed formation stage. Since crop often suffers moisture stress in arid region, it is recommended that water management practices like bunding of the field, mulching with plant residues @ 3-5 t ha^{-1} be used for conserving moisture in the soil and avoiding moisture loss due to evaporation. Spray of 0.1% thiourea solution at 25 and 45 DAS also improves the yield of cluster bean during moisture stress condition. Adequate moisture is required for the crop grown during summer season. Crop should be sown after applying pre-sowing irrigation. If crop does not germinate properly, a light irrigation can be given at 6-7 days after sowing. At least 5 irrigation should be given after the germination of the crop at an interval of 15 days. Never allow water to stand in cluster bean field at any stage of its growth. Crop yield may be affected due to high temperature and low humidity at the seed setting time. Therefore, irrigating crop at seed setting time is beneficial for obtaining good yield during summer season also. Suitable drainage conditions should be provided for the removal of excess water from the field.

Weed Management:

In cluster bean two manual weeding given at 20-25 and 40-45 days after sowing are sufficient to keep the crop weed free. However, sometimes due to non –availability of labour chemical weed control can be done. Before germination of the crop application of Pendimethalin 0.75 kg/ha a.i. as pre emergence and for post emergence application Imazehtapyr 40g/ha a.i. in 600 litres of water is applied at 20-25 DAS is suitable for weed control. Wheel hoe and Hand Hoe is used for Inter Culture operation to reduce the expenditure. Flat Fan Nozzle should be used for spraying.

Harvesting and Threshing:

For grain purpose crop, harvesting is done when leaves become dry and 50% pod turn brown & dry. After harvesting crop should be sun drying then threshing is done by manually or thressure. For fodder crop, crop cut when crop at flowering stage.

Yield and Economic Returns:

If crop is grown by adopting all improved package of practices, it is possible to get nearly 7-8 q ha^{-1} seed yield of cluster bean under rainfed condition and 12-15 q ha^{-1} in irrigated condition during kharif season and 10-12 q ha^{-1} during summer season. Average cost of cultivation per ha occurs about Rs.18000-20000 ha^{-1} for rainfed crop and about Rs.28000-30000 ha^{-1} for irrigated crop. If the market price of guar seed is Rs. 80 kg^{-1}, then farmer is likely to get net returns of Rs. 30,000-40,000 ha^{-1}.

Mothbean

BotanicalName - *Vignaacontifolia*

Origin - India

Mothbean (*Vignaacontifolia*) is a native crop of hot and dry habitats of northern and western parts of India. These very adjusting abilities have rendered this crop as an indispensable component of cropping system prevailing in arid regions. This crop is used as a source of food, feed, fodder, green manuring and green pasture. Green pods are delicious source of vegetables. Being a pulse, it is a cheap source of vegetable protein for balancing nutritionaldeficiency.

Crop status-

A total of 9.26 lakh hectares and 2.77 lakh tonnes of Moth production was recorded in the country during the twelfth plan (2012-15) period. Area and production of moth bean has been highest in Rajasthan (96.75% and 94.49%) followed by Gujarat (2.38% and 3.6%). However, yield of Rajasthan (292 kg/ha) was below the National average yield of (299 kg/ha).

Climate-

It can tolerate high temperature without any adverse effect on flowering and fruit development. Optimum temperature requirement for growth and development is 25-37ºc. Bulk of the cultivation is, confined to dry-lands of arid zone with 250-500 mm rainfall requirement with arrangement of proper drainage.

Varieties-

Normal maturity group (> 90 days) Moth Guj. 1 (MG-1), Jadra (IPCMO 943), Jwala (IPCMO-926) , IPCMO 880 (26%Protein).

Medium maturity group (70-90 days) with uniform rainfall throughout season (i) IPCMO 912 (ii) CZM 1 (both 75-80 days duration) c) **Earlymaturity group 60-65 days,** higher yield, escape terminal drought especially suitable for late season, drought areas, resistant toYMV.

Yield Gap-

It is observed that in general average yield gap between FLD and Local yield is about 25- 45% gap, need to be improved yield level through adopt the improved package of practice as recommended by research organization and Local KVK etc.

Field Preparation-

In a good rainfall year, one ploughing with mouldboard plough and a cross harrowing serve the purpose in arid conditions of western Rajasthan. Other alternative is Sweep Cultivation with a

ferti seed drill (developed at CAZRI) that can also be used for inter cultivation in wide spacedcrop.

Sowing Time-

With the onset of monsoon. Generally start with first soaking rain to second rain after onset of monsoon. Optimum sowing time 2nd to 3rd week of July. Delay in sowing may result in poor growth, poor germination, increased seedling mortality and incidence of pest and diseases and more conspicuously moisture stress at the flowering, the most critical stage.

Seed rate and spacing-

10-15 kg/ha (short statured, spreading to erect RMO-40 type) for grain and 4-5 kg for mixed crop. For fodder purpose 20-25 kg/ha seed required. Spacing should be maintained as 30-45 cm x 10-20 cm.

Seed Treatment-

Seed treatment with 2 g thiram + 1 g Carbendazim / kg of seed. After fungicide treatment seed inocultion with Rhizobium and PSB culture @ 5-7 g /kg of seed.

Irrigation-

It is cultivated in dry land and rainfed condition but in long dry spell one irrigation should be given at pod formation stage.

Cropping system-

- Generally grown as single (mono) crop in a year mixed or as a sole crop. However, in a year of good rainfall, it can be rotated withmustard.
- Mixed cropping with pearl millet, cluster bean, cowpea, mung& sesame in risk prone areas during monsoon. Varieties recommended are RMO 40 & FMM 96 of mothbean and HHB 67 ofBajra.
- Inter cropping (2:1) - 2/3 rows of mothbean in between two rows of pearlmillet.

Plant nutrient management-

Besides their N-fixing capacity they have greater power for absorbing less soluble form of 'P'. Recommendation is 20-25 tonnes FYM for improving physical condition and improving water holding capacity of soil along with 10 kg N + 40 kg P_2O_5/ha as basal at the time of sowing or last preparation.

Weed Management-

Application of Pendimethalin 30 % EC @ 0.75 -1 kg a.i. / ha as pre emergence and one hand weeding at 25-30 days after sowing.

Harvesting , threshing & Storage-

Crop is ready to harvest when pods get mature and turn brown. Plant show drying symptom or yellowing of leaves. Estimated Post harvest losses are 9-10% during threshing transportation, processing and storage. Sun drying, heat treatment, and storage at low temperature with low moisture percentage in seeds (8-9%), is recommended.

Yield-

With adoptionofimprovedtechnology6-8quintalgrainyieldandifitiscultivated for fodder 12-25 q/ha green fodder yield (depend on variety) can beachieved.

Recommendation to achieved higher production-

- Deep summer ploughing once in 3years.
- Seed treatment should be done beforesowing.
- Application of fertilizer should be based on soil testvalue.
- Weed control should be done at righttime.
- Adopt integrated approach for plantprotection.

Cowpea

Cowpea is grown predominantly under rainfed conditions in a mixed farming system in the North Eastern region of India. The foliage, green pods, immature seeds and flowers are readily eaten by animals. Being rich in proteins and containing many other nutrients like fat, carbohydrate, calcium and iron, the crops forms excellent forage.

Climate & Soil-

The crops are well adapted to moderately humid tropic and sub tropical region up to 1200-1500 m elevation. They thrives best between 27-35^{0}C temperature but cannot tolerate cold and frost.

Well drained loam or slightly heavy soils of pH 5.0-6.5 are best suited for these crops.

Land preparation-

2-3 ploughing followed by planking to get fine tilth is necessary.

Sowing time-

In hill conditions these crops are sown in Mid June-Mid July before the onset of monsoon.

Cultivated varieties-

Varieties	**Yield**
UPC-287,UPC-5286, UOC-9202	30-45 tonnes/ha
UPC-4200	35-45 tonnes/ha
Bundel Lobia-1	30-35 tonnes/ha
UPC-618, UPC-622	35-40 tonnes/ha

Seed & Sowing-

Seed rate –

30-35 Kg/ha

Spacing –

30 cm row to row and 10 cm plant to plant.

Manures & fertilizers-

FYM @ 2-3 tonnes/ha may be applied for higher yield.

20 kg N and 80 kg P_2O_5/ha has to be applied as basal at the time of ploughing.

Weed management-

Hoeing and weeding have to be given as and whennecessary.

Pest & Disease management-

In cowpea, seed treatment with Carbendazim @ 2g/Kg followed by two sprays of neem kernel extract @ 3% in 30 & 45 days crops is the most economical and productive measure for managing pest in an integrated way.

one spray of systemic fungicide like Carbendazim @ 1g/l of water may be sprayed. For controlling pest like aphids, flea beetle etc. Spraying of Malalthion 50 EC @ 1-1.5 l/ha in 500l may be applied.

But, in forage crops use of resistant varieties and cultural practices like early planting, destruction of crop residues, crop rotation are to be adopted avoiding use of chemicals.

Harvesting-

At 60-80 days of sowing or 50% flowering.

Green fodder yield-

It differs from variety to variety which are cultivated in the North Eastern region

Sesame/Til

Sesame (Sesamumindicum L.) is the oldest indigenous oilseed crop, with longest history of cultivation in India. Sesame or gingelly is commonly known as til (Hindi, Punjabi, Assamese, Bengali, Marathi), tal (Gujarati), nuvvulu, manchinuvvulu (Telugu), ellu (Tamil, Malayalam, Kannada), tila/pitratarpana (Sanskrit) and rasi (Odia) in different parts of India.
India ranks first in world with 19.47 Lakh ha area and 8.66 Lakh tonnes production. The average yield of sesame (413 kg/ha) in India is low as compared with other countries in the world (535 kg / ha). The main reasons for low productivity of sesame are its rainfed cultivation in marginal and submarginal lands under poor management and input starved conditions. However, improved varieties and agro production technologies capable of increasing the productivity levels of sesame are now developed for different agro ecological situations in the country. A well managed crop of sesame can yield 1200 - 1500 kg/ha under irrigated and 800 - 1000 kg/ha under rainfed conditions.

Season –
Kharif in arid and semi-arid tropics and rabi/summer in cooler areas.

Climate –
Semi arid climate of Western India, Central, Eastern and Southern part of India including lower Himalayas

Varieties-
For upland cultivation use varieties with long duration of 100-110 days and for low land, use varieties with duration of 80-99 days.

Soil-
Sesame can be grown on a wide range of soils but well drained light to medium textured soils are preferred. The optimum pH range is 5.5 to 8.0, acidic or alkaline soils are not suitable.

Preparation of land-

Prepare the soil into a fine tilth by ploughing 2-4 times and breaking the clods. Broadcast seeds evenly. To facilitate easy seeding and even distribution seed is mixed with either sand or dry soil or well sieved farm yard manure in 1:20 ratio. Work with harrow, followed by pressing with wooden plank so as to cover the seed in the soil.

Seed Rate-
A seed rate of 5 kg/ha is adequate to achieve the required plant population.

Sowing-

Sowing should be done at a row spacing of 30 cm. Seed should be sown 4 to 5 cm deep with a pora or tube attached to the desi plough. Aftercompletegermination,extraplantsshouldbe thinned to maintain plant to plant spacing of 15 cm.

Manure and Fertilizer-

Apply cattle manure/compost as basal dressing and incorporate into the soil along with last ploughing. Apply fertilizers as basal dose when there is enough moisture in the soil. Urea is preferable to ammonium sulphate. Nitrogen may be applied in split doses, 75 per cent as basal and the balance as foliar spray at 3 per cent concentration, 20-35 days after sowing keeping the discharge rate at 500 1 ha-1.

Drill 21 kg nitrogen (45 kg urea) per acre before sowing. Avoid excessive manuring as it induces heavy vegetative growth.

Weed Control-

The crop is very sensitive to weed competition during the first 20-25 days. Two weeding, one after 15-20 days of sowing and other at 30-35 days after sowing are required to keep the field weed free and to make moisture and nutrients available to the crop.

Pre-emergence application of Lasso 50 EC (Alachlor) @ 1200 ml/acre dissolved in 200 litres of water within two days ofsowing.

Irrigation-

- Usually the crop is grown under rainfed conditions. When facilities are available, the crop may be irrigated to field capacity after thinning operation and thereafter at 15-20 days interval.
- Stop irrigation just before the pods begin to mature. Surface irrigation at 3 cm depth during the critical stages, viz., 4-5 leaves, branching, flowering and pod formation will increase the yield by 35-52 per cent.
- Two irrigations of 3 cm depth each in the vegetative phase (4-5 leaf stage or branching) and in reproductive phase (at flowering or pod formation) are the best, registering maximum yield and water use efficiency.
- In the case of single irrigation, it can be best given in the reproductive phase.
- In the tail end fields in command area, best use of the sparingly available water can be made for augmenting sesame production.

Pest Control-

- **Sesame leaf webber and capsule borer:** Monitor the crop regularly and spray the crop with 100 ml Sumicidin/ Fenval/ Agrofen 20EC (fenvalerate) **or** 150 ml Decis 2.8 EC

(deltamethrin) **or** 200 ml Ripcord 10EC (cypermethrin) in 100 litres of water per acre.

- **Jassid:** Avoid early sowing in June and spray the crop with 400 ml Malathion 50 EC in 100 litres of water per acre atleast two times at 15 days interval.
- **Phyllody:** Avoid early sowing in June and uproot and destroy the infected plants. Control vector (jassid) population as indicated above.
- **Cercospora blight:** Spray the crop twice with Bavistin 50 WP @ 100 g/ acre in 100 litres of water at 10 days interval when the disease is noticed in the field.

Harvesting and Threshing-

- Harvest the crop, when the leaves turn yellow and start drooping and the bottom capsules are lemon yellow by pulling out the plants. Harvest during the morning hours.
- Cut the root portion and stack the plants in bundles for 3-4 days when the leaves will fall off. Spread in the sun and beat with sticks to break open the capsules.
- Repeat this for 3 days. Preserve seeds collected during the first day for seed purposes. Clean and dry in sun for about 7 days before storing.

Average yield of the varieties per acre-

2.8 quintals per acre for Punjab, Til No. 2-2.6 quintals per acre for RT 346

Quality characteristics of the variety-

Seeds of Punjab Til No. 2 have less crude fibre, are soft and better in palatability.

Storage of seeds-

- By keeping sesame seeds in polybags, tin bins, wooden receptacles or in earthen pots, the viability can be maintained for about one year.
- Admixture of seeds with ash will drastically reduce germination.

Castor

Climate

Basically castor is considered to be a drought hardy crop and comes up well under dry and warm regions receiving a rainfall of 50-75 cm. In heavy rainfall areas, the crop puts up excessive vegetative growth and acquires perennial habit. The crop can come up well at altitudes of 1200 to 2100m. It requires a moderately high temperature (20-26oC) with low humidity to produce higher yields.

Condition in India For Castor

In India the crop is cultivated principally in Gujarat, Telangana and Andhra Pradesh. To a lesser extent it is produced in states like Rajasthan, Karnataka, Tamil Nadu, Maharashtra and Orissa. There is potential to produce castor in Madhya Pradesh, Chattisgarh, Bihar and Haryana states also. In Gujarat and Rajasthan, it is raised under irrigated situations with high productivity, while in Andhra Pradesh and other states it is grown under rainfed conditions with low yields.

Soil

Castor can be grown on all types of soils having good drainage. It is generally grown on red sandy loams in Peninsular India and on light alluvial soils in the North-Western states. Soils that are not suitable for cultivation of food crops and commercial crops are often put to castor cultivation in our country. The crop responds well to good management and copious inputs.

Field Preparation

The castor soils should be prepared immediately after the receipt of pre-monsoon showers. For this the field should be ploughed across slope twice. This should be followed by two harrowings with blade harrow to control weeds and to conserve soil moisture. If soil moisture is sufficient, summer ploughing helps in moisture conservation apart from insect-pest and disease management.

Sowing Time

The best sowing time is immediately after onset of monsoon in kharif season. The optimum time is from second fortnight of June in Telangana, Andhra Pradesh and other Southern States. The best time for sowing in Gujarat and Rajasthan is first fortnight of July. As the sowings are delayed, there would be reduction in yields.

For sowing in rabi season, September 15 to October 15 is ideal time; while for summer crop January is the proper sowing time.

Seed Rate

For sowing in drylands, a seed rate of 8-10 kg/ha is required; while for irrigated conditions and hybrids, a seed rate of 5 kg/ha will be sufficient.

Sowing Time

In dry land farming, if sowing of crops like groundnut, sorghum, etc. is not possible, castor can be taken up as the best 'contingent crop' which can provide stability to rainfed farming in drought prone areas. It serves as a cushion against drought periods and provides a back up for economic security.

Spacing and Fertilizer

Under unfavourable conditions, it is recommended to grow short duration varieties like Jyothi, Kranti, GC-2. A close spacing of 60 x 30 cm has to be adopted. Through repeated intercultures with blade harrow, soil mulch has to be created to reduce evaporation losses and to conserve moisture. Following a rain, application of 20 kg N/ha helps in enhancing yields. Providing two limited irrigations at critical stages (50-75 days) coinciding with spike development would contribute to enhanced yields. Even in command areas, when rice plantings cannot be taken up, castor can be taken up as a contingent crop in August-September or October-January with limited irrigations.

Agronomical Practices for higher Yield

To improve productivity of castor the important considerations are (i) use of quality seed of recommended variety/hybrid (ii) following proper crop rotation, especially in wilt endemic areas (iii) sowing at optimum time immediately after onset of monsoon, (iv) seed treatment with fungicide before sowing (v) application of recommended fertilizer, (vi) application of protective irrigations at critical stages, (vii) Integrated management of important pests and diseases, (viii) harvesting at physiological maturity, (ix) adoption of low- cost production practices. These practices will greatly aid in reducing production costs and enhancing yield and income level both in irrigated and rainfed situations.

Varieties

Varieties suitable for rainfed areas should be of short / medium duration.

The varieties for rainfed areas: RC 8, Jwala(48-1), Jyoti (DCS 9), TMV 5, TMV 6, Kranti (PCS 4), AKC 1, CH 1, Kiran, Harita.

For irrigated areas – GC 2 variety is suitable.

varieties suitable for rearing eri silk worm

As per the preliminary information available, genotypes such as 48-1, DCH 177,DCH 32,GCH 4, are suitable for rearing eri silkworm in peninsular Indian states like A.P, Karnataka, Tamil Nadu

Insect-Pest

Though more than 60 species of insects feed on castor, about half-a-dozen are of economic importance. The red hairy caterpillar, semilooper, Spodopteralitura, the leaf hopper and capsule borer are the important insect pests on kharif sown castor.

The red hairy caterpillar (RHC) usually infests rainfed castor during germination and early crop growth stage in June and July. The damage is done mostly by the migrating caterpillars, often necessitating resowing of the fields. The semilooper becomes serious during July-August and Spodoptera during August-October. These two pests feed on leaves and defoliate the crop. During colder months leaf hopper becomes active and suck sap from the plants. The infestation of capsule borer starts from flowering stage and continuous till the harvest of the crop.

Disease

The diseases that come through seed are Alternaria blight, bacterial leaf blight, Fusarium wilt and Botrytis grey rot.

Seedling blight caused by Phytophthoraparasitica is a serious disease of germinating seed, affecting cotyledonary leaves and growing points, causing plant mortality resulting in loss of plant stand.

Use

Castor oil has since long been utilized as lamp and lubricant oil. Since this oil is 16 times more viscous than other oils, it is one of the best lubricants. Castor oil can stay as liquid at high and low temperatures and hence it has gained greater importance as aviation lubricant. Its hydroxy group reacts in the intestine and functions as a laxative. It also serves as a very good hair oil and body massage oil. Castor oil, like any other oil, can be utilized in the manufacture of soaps. This oil serves as a preservative of grains in homes and markets.

Bio-Diesel

Castor oil is highly viscous. It will be difficult to spray as a mist in internal combustion engines. Another factor which is against its use as bio-fuel is its prohibitive cost. However, castor, when dehydrated, gives a product called dehydrated castor oil (DCO) which can be used as biofuel, since its viscosity will be similar to that of other vegetable oils. Another route through which castor oil can be used as diesel substitute is by transesterifying the oil to its methyl esters. The methyl esters can serve more efficiently as biofuel. The higher cost of castor oil and its products seem to be the major limitation for using it as bio-fuel.

Black gram

BotanicalName - *Vignamungo*

Origin - India

Synonym - Urd, Biri,Mash

Mungbean (*Vignaradiata*) and Urdbean (*Vignamungo*) are important pulse crops. Both are important short duration grain legume crops with wide adaptability, low input requirement and have the ability to improve soil fertility by fixing atmospheric nitrogen. There is often confusion between mungbean and urdbean, the two being different only at the species (*radiata*and *mungo*) level. What our farmers traditionally grow in the southern foothills is actually Urdbean, but we are used to calling it Mungbean (the same way we say Orange for Mandarin). There are many local varieties of Urdbean but none in Mungbean. Again, there are no improved varieties of Urdbean, but there are two improved varieties of Mungbean (Bari Mung 2 and KPS-2) released from RDC Wengkhar.

Crop Status-

During the twelfth Plan (2012-2015) the total production was 18.29 lakh tonnes on an area of 31.29 lakh hectares. As regards the total contribution from states, Madhya Pradesh stand first in respect of area (19.40%) followed by U.P. (17.88%) and Andhra Pradesh (11.69%), whereas in production U.P. stands first (16.98%) followed by Andhra Pradesh (16.75%) and Madhya Pradesh (15.07%). The highest yield was recorded by the state of Bihar (898 kg/ha) followed by Sikkim (895 kg/ha) and Jharkhand (890 kg/ha) the National yield average was (585 kg/ha). The lowest yield was recorded in the state of C.G. (309 kg/ha) followed by Odisha (326 kg/ha) and J&K (385 kg/ha) *(DES,2015-16).*

Varieties-

Pant Urd 19, Pant Urd 31, Pant Urd 35, NDU 1, Uttra, Sekher 1, Sekher 2 an improved variety high yielder with more oil percentage.

Climate requirement-

Being a crop of tropical region, it requires hot and humid climate for best growth. It is basically a warm weather crop. In North parts of the country where the temperatures duringwinterarequitelow,itiscultivatedgenerallyduringrainyandsummerseason in the eastern states, it is also grown during winter In Central and Southern states, where there is not much variation in the climate, it is cultivated during winter and rainyseasons.

Soil & Land Preparation-

Black gram can be grown on variety of soils ranging from sandy soils to heavy cotton soils. The most ideal soil is a well drained loam with pH of 6.5 to 7.8. Black gram cannot be grown on alkaline and saline soils. Land is prepared like any other kharif season pulse crop. However during summer it requires a thorough preparation to give a pulverized free from stubbles and weeds completely.

Seed Treatment and Seed Rate-

For the prevention of soil and seed borne diseases and better yield, seeds should be treated with Rhizobium and Phoshorus Solubilising Bacteria. Seed should be treated with 2.5 g thiram or 2 g carbendazim/kg of seed for the prevention of soil borne diseases. After seed treatment, the seed should be mixed with Rhizobium culture. One packet of Rhizobium culture (250g) is sufficient for the seed required for one acre. Rhizobium treatment increases the nodule formation, 10-15% increase in yield, and also minimizes the use of nitrogenous fertilizers for the subsequent crop.

Generally, a seed rate of 20 – 25 kg/ha of mungbean and urdbean is used. If sown in lines, the distance between two lines should be 30 – 35cm. Seed should be sown at a depth of 4-5 cm.

Sowing Time & Method-

- **Kharif** : In kharif season sowing is done with the onset of monsoon in later part of June or early part of July.
- **Rabi** : Second fortnight of October (upland) second fortnight of November (Ricefallow).
- **Summer** : The sowing could be done from the third week of February to first week of April. Sowing should be done in furrows opened at a distance of 20-25 cm. seed drill could be used for this purpose.

Fertilizer-

For sole crop 15-20 kg/ha Nitrogen, 40-50 kg/ha Phosphorus, 30-40 kg/ha Potash, 20 kg/ha Sulphur is should be applied at the time of last ploughing. However phosphatic and potassic fertilizer should be applied as per soil test value. Fertilizer should be applied by drilling either at the time of sowing or just before sowing in such a way that they are placed about 5-7 cm below the seed. Use of gypsum @ 100 kg/ha would ensures availability of calcium and sulphur at economicalrates.

Irrigation-

Kharif urdbean is grown in the rainy season. It does not require irrigation unless prolonged through situation occurs. Cultivated urdbean in summer season is possible only where adequate irrigation facilities exist. Sufficient moisture should be ensured by a pre-sowing irrigation. The

first irrigation should be given 25-30 DAS. Subsequent irrigations may be seduced at the interval of 12-15 days. About 3-4 irrigations are sufficient for summerurdbean.

Plant Protection-

Yellow mosaic: it is a widespread viral disease. It is a serious disease of urdbean. Disease spared by white fly and control fly through systemic insecticide.

Insect-

Bihar hairy caterpillar-This insect is usually found in batches on the under surface of leaves. They feed on the leaves by scraping the lower surface leaving the upper cuticle and stout veins insect. It can be controlled by spraying of insecticides such as Thioben, Rogor etc.

Harvesting and threshing-

The crop should be harvested when most of the pods turn black. Over maturity may result in shattering and loss. Harvested crop should be dried and threshed manually. A well managed crop can yield between 1.5-2.0 t/ha.

Recommendation to achieved higher production-

- Deep summer ploughing once in 3years.
- Seed treatment should be done beforesowing.
- Application of fertilizer should be based on soil testvalue.
- In kharif season sowing should be done by ridge & furrowmethod.
- Yellow mosaic resistant/ tolerant varieties IPU 94-1 (Uttara), shekhar 3(KU 309), Ujala(OBJ 17), VBN(Bg) 7, Pratapurd 1 etc choose as per suitability ofregion.
- Weed control should be done at righttime.
- Adopt integrated approach for plantprotection.

Sunn Hemp

Sunn Hemp is *Crotalaria juncea*, one of the fastest growing legumes known. Saia oats (black oats) and Sunn Hemp are the two main cover crops grown around the world, and for good reason.

Sunn Hemp is called this because of its bright yellow flowers and that it can be a source of fibre (hemp). It is an erect, branching, annual summer legume. It is a rapid, vigorous grower with a strong taproot and branching root system. It reaches a height of over 1.2m in 60 days when grown under favourable conditions (hot and wet). It can attain a height of over 1.8m in approximately 90 days. Plants are usually unbranched from the ground to 2 ft (60 cm) and many branches develop above this height. It does not self- seed easily and is therefore a low weed risk.

Sunn Hemp is drought hardy, fast growing, a huge producer of nitrogen, not fussy with soil types, diseases, water, nutrition etc…, and it kills/reduces CCN (Cereal Cyst nematode), RLN (Root Lesion Nematodes), rhizoctonia and take-all.

There are various "selections" of Sunn Hemp around the world based on its use as a source of hemp fibre or as a green manure (cover) crop.

For Australia, the main use is as a cover crop or green manure crop. The best known selection for this purpose is from Brazil and Paraguay, but unfortunately it is not able to meet Australian quarantine rules (it frequently contains banned seeds and the suppliers will not use herbicides or roguing to remove them before bagging), and therefore is not being imported.

Sunn Hemp is not a weed because it sets very low levels of seed, and it has no hard-seededness (ie. no dormancy).

It will only produce seed in tropical to sub-tropical areas because it must have warm nights, preferably over 25C for maximum seed production. Therefore unless you are in areas like this, you will not be able to produce enough seed to be worth harvesting. You will only be able to grow it as a green manure cover crop.

Seed rate-

For seed production attempts, 3-5kg/ha.For cover crop purposes, 5-10kg/ha. Use higher seedrates in cooler climates as it will not branch as much. Sow with no-till andpress-wheels.

Seed depth-

2-5cm depth is adequate with 2-3cm being the most ideal. However, it is a strong germinator and will come up frombelow 5cm depth if you need to place it deeper ontomoisture.

Row spacing-

30cm-1m rows. For anyone trying to bulk up seed, sow on the 1m row spacings. In hot conditions with reasonable moisture levels, at 1m row spacings it will soon cover the inter-row space with its branches. Overseas trials showed best yields occur at low seed rates and wide row spacings, making the plants branchmore.

Inoculation-

Growers from Brazil and Paraguay say it does not need it, but in Australia it does. It "must" be inoculated with rhizobia for a successful crop otherwise it will not nodulate and will not thrive.

Americans suggest using the EL (cowpea) inoculum, but in Australia there was a specific strain of rhizobium to use - Group M. You can obtain this by ordering it through your normal farm merchandise suppliers. Seed should be inoculated and sown immediately.

Seed pickles-

Sometimes Sunn Hemp has suffered from pythium fungi in Australia. There is no registration for any products at the moment on Sunn Hemp, but 1L of Apron XL (350g/L metalaxyl) per tonne of seed works very well. If you are allowed to use that product, it needs to be applied at least 1 day before inoculating the seed with rhizobium. If there is a risk of early insect problems, adding fipronil and/or imidacloprid type insecticides to the seed is useful. As an example, 1L/tonne of Cosmos (500g/L fipronil) + 3L/tonne Gaucho (600g/L imidacloprid).

Sowing Time-

There are no hard and fast measurements yet of what temperature it needs to germinate.

Experience has shown that it has germinated quickly when average soil temperatures were 14C. However, once it emerged, it did not grow very much until the weather warmed up. It loves hot weather (30-40C days). Measuring the soil temperature at 9am at 3-5cm depth gives a close approximation to the average soil temperature for the day. It is best to sow when the temperature is on a rising trend. In southern Australia, the best sowing times will be August-December depending on where you are, but any time in summer will be fine as long as there is moisture to germinate it. In northern Australia, you will be able to grow it at any time of the year.

Soil types & pH-

This is a robust species. It will grow happily from 5.0-8.5pH (in $CaCl_2$) and on any soil type.

Down as low as pH 4.5 should be OK. If anything, American experience has shown it does not like the very high pH (alkaline) soils as much as it does the acidic soils.

Fertilisers-

Sunn Hemp is not fussy with nutrition as it grows well on low fertility soils. However, until you gain a few years experience growing it, apply ~10-20kg/P/ha with the seed and 5-10kg S/ha if needed. If potassium is marginal, add 50-80kg muriate of potash before sowing (top-dressed or drilled away from the seed). If the soil is fertile, you should not need any fertilizer.

Herbicides-

This has been the hardest to find information on because no one usually needs to use a herbicide. Common replies have been that it smothers all the weeds – except at low seed rates. I have found some information and have made some educated guesses to make the following suggestions.

Herbicides that should be safe pre-sowing.Sakura (pyroxasulfone), Terbyne (terbuthylazine), Raptor (Imazamox), Spinnaker (Imazethypyr), Dual (Metolachlor), Treflan (trifluralin), Stomp (pendimethalin) and propyzamide.

May not be safe at high rates pre-sowing but are worth trying – Diuron, Simazine, Atrazine, Bladex (cyanazine), metribuzin.

Should be safe post-emergent - All grass selective herbicides normally used in broadleaf crops.

Will not be safe post-emergent – Glyphosate, Sprayseed, Reglone, Gramoxone, 2,4-D's, MCPA's, Lontrel (clopyralid), SU's and dicamba.

Pests-

It is quite tolerate to many pests because it out grows them, except soon after emergence in cool conditions. Every bug under the sun seems to like it until the true leaves appear. Not many insects seem to like the true leaves. Applying 1L Cosmos (500g/L Fipronil) per tonne of seed will help on some hard shelled insects and locusts, but before sowing, use something in the knockdown herbicide like 200ml Chlorpyrifos (500g/L) + 75ml Cypermethrin (200g/L) to clear the deck before the seed emerges. If Bryobia mites are a problem, use 150ml Lemat (290g/L omethoate) instead of Chlorpyrifos. However, it is a successful cover crop around the world because it does not suffer many serious diseases or pests. Plan A should be to not spray any insecticides but use them on the seed so that the "good" bugs are not killed.

Harvesting-

This is all I could find about header settings – "*Initially set the concave clearance at 1/8 to 3/16 inches and the cylinder speed at 1150 to 1200 RPM. Adjust as needed according to crop conditions*." However, the chances of harvesting seed in southern Australia are very remote.

When the pods rattle, the seed is ready to harvest. It can be desiccated with glyphosate or paraquat/diquat if needed, but it should dry down on its own.

Planted by mid-October, I expect it to be harvested by late February/early March (later if it has been a cool summer).

As a cover crop-

Maximum nitrogen production occurs by or just before flowering (~40-50 days from sowing in hot weather). No one in other countries lets it go much past this point before killing it as the stems become too fibrous. Average nitrogen concentration is ~5% when young, but falls back to about 1.75% at flowering. Many crops around the world have produced >150kgN/ha from 10t/ha biomass, so it is a very valuable input of nitrogen to the soil, as well as organic matter.

Effects on Livestock-

Seeds, stems and leaves of Sunn Hemp are non-toxic in laboratory tests and feeding trials. Livestock may initially find it unpalatable but should not suffer health problems. As always though, be cautious and do not put hungry stock into it. There are many cases around the world where cattle and goats perform very well when grazing it.

Role in Bio-Diversity-

The main role of Sunn Hemp as a short lived cover crop to put nitrogen into the soil, reduce nematode problems, cover the soil and add the all important "diversity". After you have harvested a winter crop, if the ground is wet or rain is imminent, sow the Sunn Hemp and allow it to grow until it is about waist high, then spray it out with glyphosate (and any other herbicides as needed depending on what weeds are present).

Because it is a cover crop, rarely should you add a herbicide to control weeds. They are going to be sprayed out anyway. Only if weeds are going to out compete the Sunn Hemp or you want to try and growit to harvest should you use aherbicide.

Planting it after canola, a *Pratylenchusneglectus*nematode promoter, is an ideal place to sow it before sowing to a cereal crop in the winter. Sowing in front of any cereal crop is a good option because it will quickly add free nitrogen for the cereal crop to use.

Napier

The hybrid Napier for fodder is highly valued for its abundant herbage yield, palatability and good herbage quality. It contains 8.7-10.2% CP, 28-30.5% crude fibre and 10-11.5% ash on dry matter basis. It provides nutritious and palatable fodder all the year round. It grows faster and produces more herbage and the stems are hard. It is triploid grass and thus does not produce seeds. The oxalate contain of some of the varieties may be high (> 3%). It can be mitigated if harvested at longer intervals (45-60 days). The grass is ideal for green fodder, silage and hay. Legumes fodder may be mixed with grass in the ratio of 1:2 to produce balanced silage. A combination of napier grass with berseem, lucerne or cowpea provide good quality palatable fodder for cattle. It is considered as a soil restoring crop also as grass leaves the soil richer in organic matter.

Climatic requirement-

It grow well at high temperatures, can withstand to drought conditions for fairly long spell. It grows in areas with rainfall of over 1000 mm but it cannot tolerate the flooding /water logging. The optimum temperature is 31^0 C but it performs well in areas having temperatures above 15^0 C. Light showered alternated with bright sunshine are very congenial to the crop. It is a tropical grass which can withstand drought for a short spell and regenerate with rains.

Soils -

It can grow on almost all type and fertility status of soils but being exhaustive species, well drained clay loam soils are preferred. The crop can bear soils acidity to limited extent (pH-5.5). It is a long duration crop.

Seed and sowing-

It is propagated by stem cuttings with two buds called rooted slips. About 25000 to 40000 rooted slips or stem cuttings/ha are needed. Planting can be done at any time of year except during winter months. February planting is most suitable in areas where assured irrigation facility is available. Under rainfed conditions July-August planting is preferred. Stem cuttings are placed into the soil at an angle of 45^0, so that one node is pushed into the soil and one remains above the soil surface. Rooted slips are prepared by uprooting a clump, dividing it into rooted slips with small stem. They should be planted in to field with a spacing of 70x50 cm for sole cropping and 100x50 cm for intercropping. Irrigation should be done just after the planting of crop.

Nutrient Management-

Itisaheavyfeedercropthereforeitrequiresheavyamountoforganicandinorganicfertilizers.20-25 tFYM/hashouldbewell mixedin soilatthetimeoflandpreparation.At sowingtimeabasaldoseof 60 kg N, 50 kg P_2O_5 and 40 kg K_2O/ha should be applied in bands prior to planting.

Subsequently20 kg and 10 kg N should respectively be top dressed just after and 20 days after the cut. Alternatively, the crop may be fertilized with 40 kg N just after thecut.

Irrigation-

The crop should be planted in well moist soil condition. During monsoon seasons the irrigation is rarelyneededineventoflongmonsoonfailure.Thecropneedsregularirrigationatanintervalof15-18 days in March to May, at 10-12 days interval in summermonths.

Weed management-

The gap filling may be done after 20 days of planting. Regular hand weeding/hoeing and ensures good aeration and crop growth as well as control weed growth.

Harvesting-

First cut at 60-65 days after planting and subsequent cuts are obtained at 25-30 days interval. At least 6-8 cuts are possible annually. In order to encourage quicker regeneration from the basal buds, stubbles of 10-15 cm are to be left out at harvest.

Minor Millet

Minor millets are small-seeded species crops , grown around the world for food and fodder. Essentialsimilarities of the members of this group of species are there salience and ability to thrive in harsh environments, along with nutritious seed content. They have been cultivated since immemorial time.

Minor millets (as opposed to other millets like pearl millet and sorghum) are also described as nutritious millets and have received far less research and development attention than other crops with regard to crop improvement, cultivation practices and utilization. They include finger millet (Eleusinecoracana), foxtail or Italian millet (Setariaitalica), kodos millet (Paspalumscrobiculatum), common or proso millet (Panicummiliaceum), little millet (Panicumsumatrense), and barnyard or sawamillet (Echinochloautilis).

Minor millets account for less than one percentof the food grains producedintheworldtoday.Thustheyarenotimportantintermsof the overall world food production, but they are strategic in terms of theirnutritionalcontribution,andtheirroleinlocalagro-ecosystems. They are mostly grown in marginal areas or under agricultural conditionswheremajorcerealswouldfailtogivesustainableyields.

Properties-

Minor millets are used as food sources mainly in arid and semi- arid regions of the world thanks to their low water requirements and capacity to grow in marginal lands.

They can often be used in recipes instead of rice. The protein content in these species is very close to that of wheat, but in addition they are also rich in B vitamins, especially niacin, B6 and folacin, calcium, iron, potassium, magnesium, and zinc. Minor millets contain no gluten, so they cannot be used in raised bread making. For the same reason, they are appropriate foods for those with coeliac disease or other forms of allergies/ wheat intolerance.

Foodpreparation-

In Western India, millet flour (called “Bajari” in Marathi) has been commonly used with “Jowar” (Sorghum) flour for hundreds of years to make the local staple flat bread known as “Bhakri”. Minor millets are traditionally important grains used in brewing millet beer in some cultures.

Health-

Celiac patients can replace certain cereal grains in their diets by consuming millets in various forms including breakfast cereals.

Otheruses-

Millet sprays are often recommended as healthy treats to finicky pet birds, as they are easily eaten and easily broken.

Growing-

Minor millets are grown in rotation with wheat, using the same can plant millet as a fill-in or as a catch crop on land to which their winter wheat crop, for one reason or another, was a failure. Reportedly tillage, planting, and harvesting equipment that farmers use for wheat. Farmers, millet leaves the soil loose and relatively free of weeds, and provides a good residue cover.

Harvesting-

Harvesting millet involves cutting and windrowing the plant for a period of additional drying. Then, the millet is picked up with a combine and thrashed. In rural communities where the farmers do not have modern harvesting equipment, the harvesting is a very time consuming task as the seed clusters must be cut stem bystem.Whentheharvesttimeapproaches,aswellasduringthe harvesttime,familymembersmustkeeparoundtheclockwatch to keep the predators such as monkeys from prowling the fields and feeding on the villagers'crops.

Processing-

After the crops have been harvested comes the task of threshing the grain clusters. If there are no mechanical devices available for thispurpose, it is accomplished manually with the help of animals or large poles. The next step is grinding it into flour. A major factor indiscouraging minor millet cultivation and consumption is the drudgery associated with its processing. One of the main aims of an IFADglobalprojectledbyBioversityInternational,hasbeentoremove the drudgery associated with traditional house-hold processing by introducing mechanical processing. Thus small mills have been set up andgroupsofwomenorganizedasself-helpgroups.

Achieving social and ecological sustainability-

There are ongoing projects for sustainable development involvingmilletproductionthataimtoempowertheruralpoor (in particular, women, young people and farmers' groups, associations, and communities). Inter alia, they promote the development of a better distribution system for agricultural inputs, in particular seeds. They also provide financial assistance so that communities can construct waterholes and boreholes, set up water-harvesting schemes for millet andhome-

gardenproduction,andrehabilitateafewkeyrural andfeederroadstoallowaccesstohigh-potentialproduction zones. The projects also support the development of an appropriate and sustainable rural financial system (micro- credit schemes) capable of providing financial services to the rural poor, particularly women and youth, so they can effectively participate in determining which community projects should obtain project financing. Target communities and beneficiaries can thus plan and prioritize their needs and manage the resources received from the project. The managerial and technical capacities of farmers' groups, associations and communities are strengthened and their negotiating skillsreinforced.

Finger millet

Soiltype/condition-

alluvial, loamy and sandy with gooddrainage

Climate-

Mean temp of26-29°C

Rainfall500-900mm

Fieldpreparation-

Deep ploughing cum shallowharrowing

Finetilth

Form beds &channels with 10 to 20m^{-2}

Apply FYM / compost before formingbeds

Varieties-

VL Mandua315, VL Mandua324, VL Mandua347, VL Mandua352, GPU 48, GPU 66, GPU 67, KMR301

Seed treatment-

Carbendazim or Thiram2-3 g/kg of seed.

Organic: Trichodermaharzianumand Pseudomonas fluorscens5g each/kgseed.

Time ofsowing-

Mid May to mid June(hills), June-July as rainfedcrop(Plains)

First fortnight of June is best forrainfed

Spacing & seedrate-

Direct seeding: 4.0kg/acre; Row spacing 20-30 cm, plant to plant: 10 cm

Transplanting: 2.0 kg/acre, 15x15 cm spacing, 21-25 day old seedlings, 2seedlings/hill.

Standestablishment-

2 seedlings /hill

3 cmdepth

Thin the population in direct seededcrop

Irrigation-

For rainfedcrop :Mainirrigation at tillering,flowering

Irrigation based on growthphases

- Establishment 2irrigation
- Vegetative up to 25 days – 2irrigations
- Flowering – 25-55 d – 3 irrigations
- Maturity – 56 – onwards – one ortwo
- Stop irrigation after doughstage

Nutrientmanagement-

Generalrecommendation

60:30:30 kg/ha(N:P:K)

Half N &full P & Kbasal

Remaining N at 15 DAT /25DAS

Weedmanagement-

Herbicides like Butachlor1.25 kg as pre-emergence for transplantedcrop

Pre-emergence (within 2 DAS) Isoproturon0.75kga.i./hand manual weeding at 30 days afteremergence

For direct seeded post-emergence 2,4 D Na salt @0.5 kg 10 days after crop germination

Croppingsystems-

In hilly areas mixed with soybean. Intercropping ratio of1:1

Majorproblems-

Blast (Finger millet): Mancozeb@2.5g/l water or Tricyclazole@0.6g /l ofwater

Helminthosporiumleaf spot (Barnyard millet): Mancozeb@2.5g/l ofwater

Organic control: Seed treatment with Trichodermaharzianum(5g/kgseed) and two sprays of Pseudomonas fluoresces(0.5%)

Downy mildew (Foxtail millet): Seed treatment with RidomilMZ @ 2g/litre

Harvest-

Ear head harvested withsickle

Staggeredharvesting

Ear heads are dried and manual / machinethreshed

Panicum

Overview-

This perennial grass spreads via its large, branching rhizomes, which are thick and pointed. The pointed shape of the rhizome tip gives the plant the name torpedograss. The rhizomes creep along the ground or float in water, forming floating mats. They can reach a length of 6 meters (20 ft) and a soil depth of 7 meters (23 ft), and they can form a mat 15 centimeters (5.9 in) thick. The spreading rhizomes sprout repeatedly to form colonies of stems. The stems are 20 to 90 centimeters (7.9 to 35.4 in) tall, sometimes reaching 1 meter (3 ft 3 in). They grow erect or bend down. The leaves are stiff and straight, linear in shape, and flat or folded. They are sometimes white in color and waxy in texture. The inflorescence is a loose panicle of branches bearing small spikelets 2 to 3 millimeters (0.079 to 0.118 in) long.

Habitat-

This grass grows throughout the world in tropical and subtropical areas. It was introduced to the United States in seed for forage grasses and probably in ballast water from ships. It was also imported by the United States Department of Agriculture to grow as a forage grass for cattle. It was deliberately planted throughout southern Florida and it easily escaped cultivation, eventually becoming "one of the most serious weeds in Florida," spreading to more than 70% of the waterways in the state. In Lake Okeechobee it has invaded more than 16,000 acres of marsh. It displaces native plants, growing colonially in thick monotypic stands. Dense mats or stands of the grass cause hypoxia in the water. Torpedograss management in flood control systems costs an estimated US$2 million per year.

The plant is established in sandy coastal habitat on the United States' Gulf Coast, such as beaches and dunes, from Florida to Texas. There it occurs with beach plants such as turtleweed (*Batismaritima*), saltgrass (*Distichlisspicata*), marsh fimbry (*Fimbristyliscastanea*), largeleaf pennywort (*Hydrocotylebonariensis*), and dwarf saltwort (*Salicorniabigelovii*). It grows on many barrier islands. It grows in many types of wetland habitat, in and out of the water. It grows in freshwater marshes, salt marshes, mud flats, wet prairies, tide pools, bogs, and lakesides. It also invades drier habitat, such as coastal pine forests and white sand scrub. It easily moves into disturbed and cultivated areas such as ditches and canals. It is a nuisance in sod production. In Hawaii, it is a weed of sugarcane (*Saccharumofficinarum*). In other areas it can be found in turf and orchards. In the Florida turfgrass industry it is the second worst weed known. The grass can grow in a variety of

habitats, but it does not tolerate cold and it is rarely found above subtropical latitudes or at altitude.

Propagation-

The grass spreads primarily via its rhizome. It has been noted to grow 1.3 centimeters (0.51 in) in length per day. The stems and rhizomes also produce tillers. The rhizome can endure drying and flooding. Dry or wet conditions may reduce the number of shoots produced by the rhizome, but they do not kill it. The rhizome can disperse when parts of it break off and drop onto the substrate elsewhere, anchoring and putting up new shoots. The plant survives and sprouts after herbicide application, grazing, cutting, plowing or disking, and burning. The grass rarely reproduces by seed. It has been noted to reproduce by seed in Portugal, but does not do so in the United States, and it was described as "incapable of fruiting" in Japan. Seeds are sometimes observed but they are apparently rarely viable, with many studies describing zero germination.

The grass has been widely planted as forage for cattle because it is so hardy, withstanding grazing and trampling, and it can be made into hay. However, it is not one of the more palatable or nutritious grasses. It is also good for erosion control because it binds the soil. Indeed, it is still recommended for planting along shorelines to stabilize them.

Cenchrus

Description-

African foxtail grass is a perennial grass growing to 20 to 120 cm tall. The leaves are linear, 3 to 25 cm long and 4 to 10 mm wide. The flowers are produced in a panicle 2 to 14 cm long and 1 to 2.6 cm wide.

Distribution-

African foxtail grass is native to tropical Africa, the Mediterranean region and the hotter and drier parts of Asia. It is a deep-rooted grass, tolerates drought, and will grow at altitudes of up to 2,000 m (6,600 ft). It is considered a good forage grass in Africa. It prefers light soils with a high phosphorus content. It is also sown in Queensland, Australia and elsewhere for grazing, hay and silage. In the Sonoran Desert it was introduced for erosion control. In the Mexican part of the Sonoran Desert, it is still being planted and irrigated for livestock grazing. *Cenchrusciliaris* has become naturalised and often an invasive species in Australia, the southwestern United States, Hawaii, Mexico, Central America, South America, and Macaronesia.

As an invasive species-

It was introduced in the 1930s into Arizona, United States, to provide grazing. The introduction was largely unsuccessful but the grass began to appear as a weed beside highways and in cleared fields or over-grazed land. It spreads very quickly and will often kill local native plants such as paloverdes by taking away nearby water. This plant has a very low ignition threshold and can burn even during the peak growing season. Its flammability (injurious to neighbors) and quick regrowth allow it to compete successfully against almost all vegetation in the Sonoran Desert region.

Another problem of buffelgrass in the Sonoran Desert is that it intensifies wildfires such that saguaro cacti that normally survive wildfires can erupt into flames when growing in areas taken over by the grass.

In Queensland, Australia, the grass has also been attributed to causing a decline in the native grass species fed on by the critically endangered northern hairy-nosed wombat, and cited as a factor in the wombats' decline. In South Australia, it is a declared plant under the Natural

Resources Management Act and weed management activities are guided by the South Australia Buffel Grass Strategic Plan (2012–17). In Australia's Northern Territory, invasive buffel grass was implicated in making fire control more challenging following the extensive wild fires that destroyed ancient trees in oases such as Standley Chasm in February 2019.