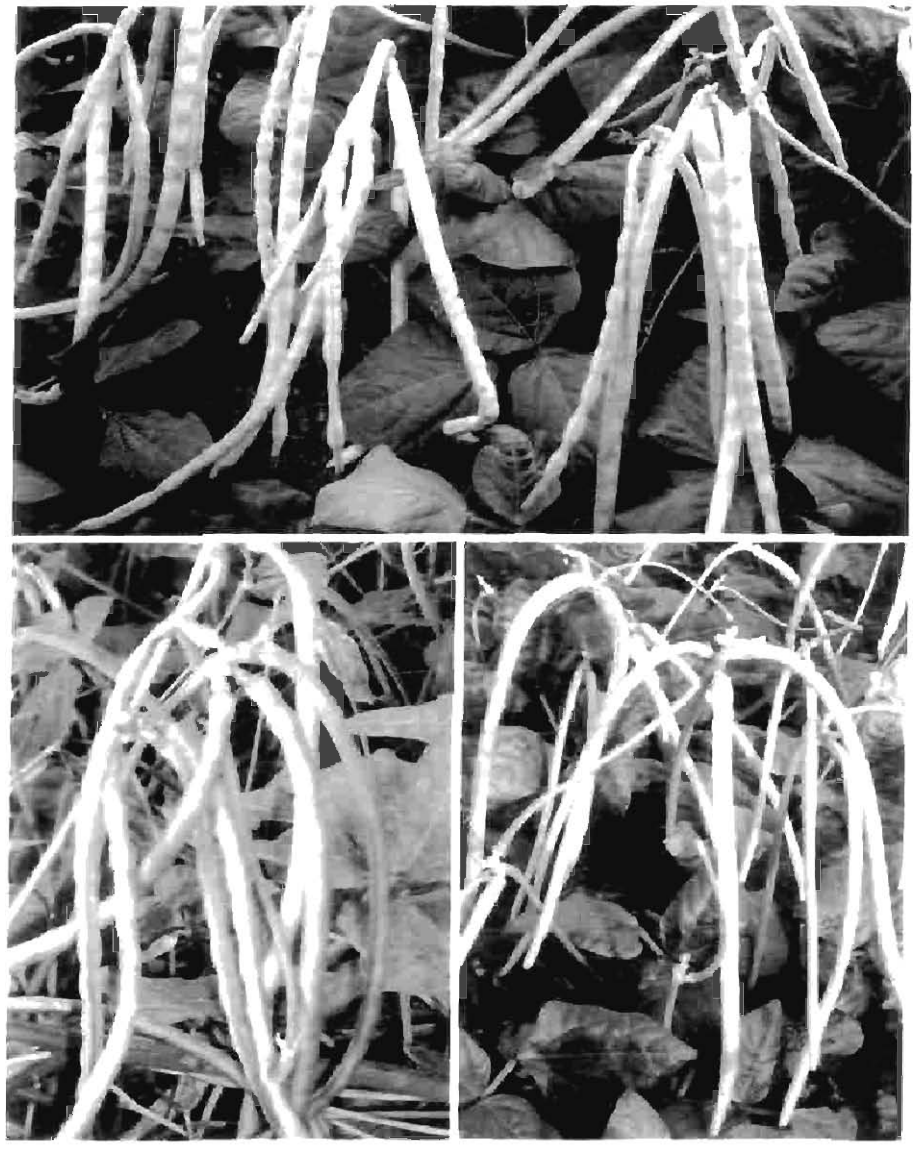
PRODUCTION TECHNOLOGY FOR COWPEA



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All India Coordinated Research Project on Arid Legumes

Central Arid Zone Research Institute, Jodhpur - 342 003

(Indian Council of Agricultural Research)

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February, 2005

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Correct Citation

D. Kumar and P. Narain (2005) *Production technology for cow* bea, ACIRP on Arid Legumes, CAZRI, Jodhpur - 342 003, Rajasthan

Year of Publication : 2005

Published by

Project Coordinator,

AICRP on Arid Legumes,

Central Arid Zone Research Institute, Jodhpur

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Printed by

Evergreen Printers

C - 162, Shastri Nagar, Jodhpur

Tel. . 2434647

Cover Page : Photograph from Sarpan Agri-Hort. Centre, Dharwad

Preface

Cowpea is assumed to be the principal ancient pulse crop of India It is characteristically known for wide geographic distribution and adaptation across the soil types, soil inputs and agroclimatological zones. Hence, it is widely grown in tropics and subtropics world over, however, Central and Western Africa only account for more than 60% world area. It is estimated to be cultivated in almost 13.0 million hectares of lands with annual production of almost 3.0 million tons world over In India cowpea is grown as sole, mix-crop, inter-crop in agro-forestry combinations and in other systems hence, exact figures, on its area are not available Cowpea is however, the only arid pulse suited to both arid and semi-arid regions and adapted better than any other pulses in high rainfall regions Known for drought-hardy nature with strong tap root system, it has potential to grow very quickly in the initial stage suppressing the weeds and conserving soil and soil moisture due to broad and drooping leaves As a good source of protein, calcium and iron, it is recognized for many routine uses of food, feed, forage, fodder, vegetable and a number of dishes prepared from its grains

Bestowed with a series of merits it is also known for some biological bottlenecks of poor productivity due to inefficient plant types with less and slow conversion of dry matters to grain However, in recent years, concerted efforts at various levels have led to the development of amenable technological advancements The same, however, have dismally slow advancements reach to the consumers and the growers. Thus, there is need to compile and collect convenient and cheap technological information and to make them available to the needed farmers, so as to break the barrier of yield stagnation of pulses through yield increment in cowpea

Present bulletin "**Production Technology for Cowpea**" is composed of vital knowledge of practical relevance to the farmers and other intended users The same, it is hoped would be useful as a reference to cultivars in tackling day to day problems in cultivation of cowpea to raise cowpea for bumper harvest and to accelerate cost benefit ratio The compilation presented in simple knowledge will also pave ways to further cowpea uses and probable products Present compilation may, therefore, be helpful in diversification of agriculture, improving soil health and providing substitute to intensive ageold cropping sequences and siphoning of nutrients.

D. Kumar

CONTENTS

INTRODUCTION

An annual legume, cowpea is perhaps the oldest source of human food Even though, acquisation with varied range of soils and rainfall patterns, has yet confined to the arid and semi-arid regions world over. Its capacity to manure the soil and the capacity to enriching the microbial population gives immense stress on utility of this legume. Broad and drooping leaves of this crop, help conserve soil water and soil by reducing temperature due to shade effects. Known for initial fast growth, cowpea can easily suppress weed growth; therefore, reducing weed-canopy competition. The attributes like, staple fodder, nutritive and medicinal significance, have established it as the crop of desertic regions world over including Asia, Africa continents and the parts of Southern Europe, USA and Southern America The main cowpea growing countries in Asia are: India, Sri Lanka, Bangladesh, Maynmar, China, Korea, Thialand, Indonasia, Nepal, Pakistan, Malaysia and Phillippines Generally the marginal and submarginal farmers in semi-arid and humid regions of Africa are the major producers and consumers of cowpea

Almost 3 3 mt of dry cowpea grains are produced world over, of which Nigeria alone produces 2.1 million ton, followed by Niger (0.65 mt) and Mali (0.11 mt), making Nigeria therefore, World's single largest grower Total global area of cowpea grown is almost 13.0 m ha, of the same nearly 9 3 m ha is grown in Africa only. In India cowpea is grown in almost 1.3 m ha particularly in Western, Central and peninsular regions In some of Indian states including Maharashtra, this crop is grown in all three seasons.

Taxonomy

The cowpea belongs to genus **Vigna,** an amplified genus, comprising many pulse crops of the old world. This species contains two wild (**dekindtiana, mensensis**) and three cultivated (**unguiculata, cylindrical and sesquipedalis**) forms. The taxonomic relationship among various species has been given in Table 1. Marechal *et al*, (1978) assigned all the cultivated forms of cowpea to sub-species **unguiculata.** However, Westphal (1974) classified it in four distinct cultivar groups viz , **unguiculata, biflora** (=cylindrical), **sesquipedalis** and **textilis.**

Table 1: Taxonomy of cowpea

Vigna unguiculata (L.) Walpers
ssp unguiculata cv gr. unguiculata cr gr biflora cr. gr sesquipedalis cv gr. textilies
ssp. dekindtiana (Harms) Verdcourt var. dekindtiana (Harms) Verdcourt
var mensensis (Schweinf) Marechal, Mascherpa & Stainer
var. pubescens (Wilczec) Marechal, Mascherpa & Stainer
var protracta (E Mey) Verdcourt
ssp Tenuis (E Mey) Marechal, Mascherpa & Stainer
ssp Stenophylla (Harvey) Marechal, Mascherpa & Stainer

The cowpea has been recognized as a crop of African origin. Marechal et al., (1978) viewed that the distribution of wild forms covers much of tropical Africa, whereas the greater part of variability within the wild species is confined to south Africa It has been emphasized that the cultivated forms, **cylindrical** and **sesquipedalis** have evolved in Asia while the subspecies **unguiculata** is prevalent in all the cowpea growing regions of the world.

Cowpea is an annual herb with a strong tap root system with different growth habits i e erect, semi erect, trailing or climbing, bushy annual with glabrous stem. The first pair of leaves above the cotyledonary node is simple and opposites. The trifoliate leaves arise alternately and terminal leaflet is frequently longer and of larger area than that of asymmetrical lateral leaflets.

Flowers are racemose or indeterminate inflorescence, at the distal ends of peduncles which are in leaf axil Terminal inflorescences are rare, perhaps only occurring in subsp. **cylindrical.** The flower is typical with five sepals in gamosepalous condition and five petal in polypetelous condition (1+2+2) The outermost posterior petal is standard, two lateral petals (wings) are clawed almost covering two interior petals which are loosely connate to form boat shaped keel

Both androecium and gynaecium are enclosed inside the keel petals. The gynaecium is monocarpillary Ovary is sessile, multilocular and grows out into a pod after fertilization The style is longitudinally beared along inner side and ends in oblique stigma and androecium is diadelphous consisting of 10 (9+1) stamens. The flowers are

borne in alternate pairs and although 6-12 pairs may occur per inflorescence frequently only the first two pairs develop. The flowers are borne on short pedicels and corollas vary in colour. Flowers generally open before dawn (4.30-5.00 a.m) and most of them shut by noon, with sporadic flower opening in the afternoon. The dehiscence of anthers is much earlier to anthesis Flower dehisce from 10.00 p.m. to 0 45 a m. and this variation may be affected by environmental factors like moonlight, clear sky and dry warm atmosphere which result self pollination in cowpea

Uses

Cowpea seed is a nutritious component in the human diet, and cheap livestock feed, as well Cowpea grown to maturity can be used as a feed, fodder or its pods can be harvested and eaten as vegetable. The tender green leaves are mainly used as vegetable, especially by small scale farmers in rural areas.

The chemical composition of cowpea seeds (Table 2) corresponds to that of most common edible legumes grown in arid and semi-arid regions The seeds also contain small proportions of b-carotene, thiamin, riboflavin, vitamin A, niacin, folic acid and ascorbic acid The use of cowpea seeds as a vegetable provides cheap source of protein in vegetarian dominated diets of undeveloped nations. Fresh leaves and fast growing twigs of cowpea are often picked up and taken like spinach.

Table 2: Chemical composition (%) of different parts of cowpea

S. No.	Constituents	Seed	Hay	Leaves
1	Carbohydrate	55-66	-	8 0
2	Protein	22-24	18 0	4 7
3	Water	11 0	9.6	85 0
4.	Crude fibre	5.9-7.3	23 3	2.0
5.	Ash	3.4-3.9	11.3	-
6	Fat	1.3-1.5	2 6	0.3
7.	Phosphorous	0 146	-	0 063
8.	Calcium	0.104-0.076	-	0.256
9.	Iron	0 005	-	0.005

Immature snapped pods are used in the same way as snap beans, often being mixed with other foods. Green cowpea seeds are boiled as a fresh vegetable or may be canned or frozen.

The beans are nutritious and provide complementary proteins to cereals diets

Some people eat both the fresh pods and leaves, and the dried seeds are popular ingredients in a variety of dishes. It has been grouped into the market classes based on seed type and seed color: black and purple eye, brown eye, crowder, cream, clay and white acre

The dried purple eye or black eye types are used as food products. The dried beans are frequently sold directly to the consumers on cleaning and bagging. Another common product is the canned product, which is cooked with water prior to canning Various soups and bean mixes will incorporate this product as well. The cowpea seed protein is rich in the amino acids, particularly, lysine and tryptophan, compared to cereal grains, however, compared to animal protein cowpea proteins are deficient in methionine and cystine contents

In many parts of the world, cowpea is regarded as the only available high quality legume hay for livestock feed Digestibility and yield of certain cultivars have been shown comparable to alfalfa It is suitable for grazing and may be grazed during the growing season, while still leaving sufficient material for hay or silage production at the end of season Organic matter provided by this legume is quickly decomposed by soil microorganisms and does not persist for longer period in the soil

Agronomy :

Cowpea thrives better in 27 - 35^{0}C and can be cultivated successfully in acidic to neutral soils but alkaline soils are less adapted to it. The optimum sowing time of the crop during summer is March - April, while for kharif crops middle June to end of July. For raising pure crop of grain and vegetable purpose 20-25 kg ha^{-1} seed rate is used, while 35-40 kg ha^{-1} seed rate can be used for raising fodder and green manure crop. If needed only a minimum of nitrogen fertilizer as a starter dose of 20 kg ha-1 be applied but phosphatic fertilizer helping root growth and function of Rhizobium bacteria are equally important. Green pods to be used a vegetable may be picked up at the tender stage, delay may lead to the development of fibres for green manure, crop is ploughed at the flowering stage itself.

Major diseases and insect-pests

Cowpea is affected by a number of fungal, bacterial and viral diseases at different growth stages. The major fungal diseases are: Anthracnose, Charcoal rot, Sclerotinia rot, Fusarium Wilt, Cercospora leaf spot, Brown rust/ leaf rust, Powdery mildew, seedling rot etc. Dry, warm and high humid conditions are more conducive for disease development and dissemination of their fungal spores. Among viral diseases:

cowpea yellow mosaic, cowpea mild mottle, cowpea cucmo-virus, southern bean mosaic and cowpea tabacovirus are important A characteristic symptom of the mosaic virus disease is intermixing of light and dark-brown areas Infected plants may be dwarf, bushy and giving poor yields Mosaic diseases can be reduced using a rotation with other crops for four to five years and planting of certified seeds of resistant varieties While bacterial blight is caused by the bacteria **Xanthomonas oxonopodis** pv. **Vignicola** is the major disease in tropical and subtropical parts of Africa, USA and India.

Almost every part of cowpea plant is infested by one or another insect species The important ones causing considerable damage to the crop are white fly, jassids, leaf damaging weevil, pod borers, cutworms, hairy caterpillars, whitegrubs, termites, grasshoppers and bruchids. Population of hairy caterpillar, sporadic in appearance is maximum during the second and third week of July. Jassids appear on the crop during second and third week of August and their population generally rises to the peak in a fortnight only. The whitefly acts as a vector for yellow mosaic virus. Weevils attack is more severe, when there is dry spell of at least 25-30 days, while grasshopper are found as minor pests during the entire cropping season.

Abiotic Stresses :

Cowpeas have deeper root system and roots further develop vertically, plants are therefore, gradually exposed to water stress, still cowpea has low water uptake ability, hence is suited nicely to water scarce situations Screening of some important crops to drought at seedling stage based on percentage of dead plants, soybean appeared the most susceptible and cowpea the most drought tolerant, as per the following ranking:

Soybean < black gram < moong bean < ground nut < maize < sorghum < pearl millet < bambara nut < lab lab bean < cowpea.

Cowpea are rarely insensitive to photo period but are typically quantitative short day plants wherein photoperiods longer than 12 5 and 13 5 h d^{-1} increase the days to flowering. Both photoperiod insensitive and photoperiod - sensitive genotypes flower sooner in warmer than cooler temperature.

Cowpea lines are available that have heat tolerance during early flowering but are susceptible during pod set Night temperature in the range of 25-30°C may induce substantial damage to heat susceptible cultivars

Improved Varieties

Role of improved varieties in enhancing the production potential of agricultural crops in various agro-ecosystems including harsh environments has been very well documented. Role of photosynthetically effective genotypes in the crops of second priority of the farmers and marginal and submarginal status has also been recognized at various quarters Among such crops, cowpea is one grown through out arid and semi-arid regions with uncertain and limited inputs in various types of soils having different soil moisture conservation potential The wide adaptive variability has led this crop to be known with a number of plant types showing large range of maturity, disease resistance potential, grain color and shape and differential response to various abiotic constrains. In all, today's available cultivars in the recent past were considered with production of high biomass but poor translocations towards sinks Faster initial growth and wider canopy doesn't allow weeds to grown in it's vicinity, at the same time, having their regeneration potential, cowpea was therefore, anciently recognized as a fodder crop The challenges is to convert it from fodder plant type (bushy, wide conopy, indeterminate growth habit) to grain type with improved source-sink relations or retaining dual purpose with a balance between grain and fodder traits.

Intense research efforts at Coordinated Centers of AICRP on Arid Legumes have proved fruitful in developing desired types of varieties using appropriate traditional genetic tools The main efforts directed were curtailing the maturity period from more than 90 days to as short as 60-65 days and alteration in plant types from bushy, viny, indeterminate to compact, erect, non-viny and somewhat determinate types Present day varieties have, therefore, proved highly productive under the same set of environments. These varieties backed - up with needed soil and agronomic inputs will help bridge the gap of realized and relealizable yields on the cultivators' fields. Dissemination of these varieties to the farmers sieved through various extension tools and techniques will bring record yield improvement It is, therefore, more appropriate in modern context of reeling drought in arid regions, that we list some of these varieties, being used in active seed chain. The same will also help increased concentration and resource mobilization from administrators, planners and extension agencies, to fulfilling the target of breaking the yield ceiling from 13-14 million ton annually to more than 15-16 million ton which is, unattainable for quite long past Brief discussion on some important cowpea varieties is given below

CoVu-702 (CO-7) : Developed from Tamil Nadu Agricultural University, Coimbatore, was released for commercial cultivation in rainfed and irrigated conditions for whole

country during 2004 An early and synchronous in maturity, takes 67-73 days to mature It is moderately resistant to pod borer and tolerant to major diseases It can give grain yield of 900-1200 kg ha ^{1} with green fodder yield of 16500 to 19200 kg ha-1 Seeds are brownish white This variety is more suited to southern zones (Plate 1).

RC-101: Released by the State of Rajasthan in 2001 is the earlied to mature in almost 65-70 days in arid zone situations, has yield potential of 700-1050 kg ha^{-1}. Variety is determinate, non-viny type with white seeded (Plate 1).

GC-3 : Developed from Gujarat Agricultural University, S.K. Nagar, was released for commercial cultivation in 1997 It matures in 65-75 days and yields almost 900-1500 kg ha^{-1} It is one of the earliest and widely adapted varieties. It is however, particularly suited to arid, semi-arid and humid regions of Southern India, comprising AP, Karnataka, T N and Kerala. It is tall growing with erect growth habit, but pods are of smaller size (Plate 2).

V-585 (Pusa Sampada) : Released in 1997 for commercial cultivation, matures in 900-100 days with grain yield potential of 800-1000 kg ha ^{1} The variety is tall type, having light green foliage, medium bold creamy seeds, is said to be having field tolerance to major cowpea diseases It is more suitable for semi-arid regions (Plate 3).

V-240 (Rambha) : Released in 1997, takes almost 90-95 days to mature. It is known for tall and trailing growth habit, dark green foliage, medium sized dark red seeds It has proved highly adaptive to arid and semi-arid regions with very high grain yield potential to the extent of 1200-1500 kg ha ^{1} under moderate rainfed conditions. The variety is however, photosensitive (Plate 2)

V-38 (Swarna) : Developed by chemical treatment (DMS) from Pusa Phalguni It is early maturing (80-100 days) having non-trailing growth habit The variety is good for grain and vegetable purposes Seeds are moderately small, fawn around, biocolored. It is said to be immune to almost all the major diseases of cowpea. It has high potential of 1200-1500 kg ha^{-1} It was developed at IARI, New Delhi

Vamban - 1: The variety was released in 1997 from Vamban centre of Tamil Nadu Agriculture University, Regional Agricultural Research Station, Vamban It matures in almost 105 days and has yield potential to the extent of 820 kg ha ^{1}. The variety possesses bold seeds with light color, has been basically recommended for rainfed conditions of Tamil Nadu.

RC-19 : Released in 1993 was developed from Rajasthan Agricultural University, Regional Research Station Durgapura. This is an early variety, matures in 65-70 days and is known for sinchronus maturity (Plate 3).

Cowpea - 88 : It was developed from Punjab Agricultural University, Ludhiana and released in 1990 It is dual purpose variety with high fodder and grain production. Variety is characterized with chocklet brown colored large seeds. It is highly tolerant to anthracnose and cowpea yellow mosaic virus

C-152 : Released in 1985, takes almost 90 to 95 days to mature with moderate yield potential of 700-800 kg ha-1. It has bold light colored seeds It shows better adaptation in Southern states.

V - 16 (Amba) : The variety released in 1984, was developed from Indian Agricultural Research Institute, New Delhi. It matures in 90-100 days and has yield potential to the extent of 1000-1200 kg ha-1 The variety is erect type with non-trailing growth habit, having dark green foliage, medium sized dark red seeds.

RC-19

V-585

PLATE 3 : Improved varieties of Cowpea

PRODUCTION TECHNOLOGY

Cowpea grown across arid and semi-arid regions, is adapted to a variety of soils (sandy, sandy loam, coarse, gravel, red loam, black clay, loam soils) has, therefore, very wide geographic distribution. Methods, sequence, pattern of sowing and other agronomic procedures differ from one climatic zone to next, therefore resulting in variable grain and biomass production. Like other arid legumes and pulses, cowpea is one, hardly grown as sole but as mixed and inter-crop for a variety of uses. Agronomic inputs have, therefore, to be critically evaluated for their relative impacts on ultimate production The same may be modified in view of crop being grown for the specific purpose, in specific zone and season A package of crop husbandry along with improved cultivars may result in yield enhancement of legumes including cowpea It is therefore, of practical significance that appropriate agronomic packages are listed as per their priority contributions. This is more important because arid and semi-arid farmers cultivating cowpea hardly use improved technological packages due probably to their less impact or poor dissemination Mind set of cowpea growers from traditional and ancient technologies to newers and advance ones, which are highly responsive, productive, operative and economic in terms of time and input have to be changed A confidence building by exposing few, simple, result oriented technological back-up is judiciously needed. This chapter deals with the important remunerative agronomic back-ups which can help raise production of cowpea from resource constraint situation in terms of per unit of water, time and land.

Climate : In India, cowpea is grown in central and peninsular regions Being a warm weather crop, it can considerably withstand drought. Cowpea is more tolerant to heavy rainfalls than other pulses This crop thrives best between 27 to 35^{0}C. It can grow well under shade but can't tolerant cold and frost. It does well when raised in warm days and night with longer days

Soil : Even though, cowpea is adapted to a variety of soils yet performs very well on well drained loam or slightly heavy soils It is also grown in poor gravelly lands in hill tracts, heavy loamy soils, Sometime also does well in black cotton soils and light textured sandy soils

Field preparation : Cowpea requires a normal seed bed preparation as other pulses In hard soils, one deep ploughing followed by two or three harrowing and planking are required. Soil should be leveled to avoid any waterlogging. Disc - harrowing may be

adopted in sandy loam soils for large scale production. Conventional tillage and reduced tillage may be preferred over no tillage A combination of minimum tillage and straw mulch are most appropriate soil management for dry season cowpea production in rice fallows

Sowing time : Cowpea can be cultivated in almost all seasons, however, too early and too late plantings are not recommended. Cowpea as rainfed are sown from early June to late July, rabi cowpea is planted October to November and summer cowpeas are grown in March. In hills this crop is sown in April-May. Sowing time of cowpea thus, greatly varies depending on the season, place and purpose. However, specific sowing times may be given below

Karnatka		Whole of July
Andhra Pradesh	.	At the onset of monsoon
Maharashtra	·	1st June to 30 June
UP (summer cowpea)	:	5 -10th March
Kerala (Kharif)	:	After first week of June
Floor crop in coconut		May to September
Homestead garden		Throughout the year
Green manuring	:	Middle June to first week of July
Fodder crop	·	Beginning of February

Seed rate: Seed rate is an important agronomic component which ensures optimum plant stand necessary for raising and stabilization of yield levels under rainfed conditions Seed rate is quite variable factor and depends on sowing time, type of soil, seed size, purpose, soil moisture availability Following seeds may be adopted.

Normal rainfed situation :

a. Grain and vegetable purposes for pure crop 20-25 kg ha^{-1}

b. Mixed crop Reduced proportionally

c Green manuring and fodder 30-35 kg ha^{-1}

Summer season : Due to reduced vegetative growth rate, close planting with increased seed rate may be done as following :

a. Grain · 30 kg ha ^{1}

b Green pods and green manuring 40 kg ha^{-1}

Method of sowing: Sowing of cowpea is done following broad casting, line sowing and dibbling of seeds depending on the purpose and the season. Line sowing has been better over broadcasting method of sowing However, for fodder and green manuring broadcasting method of sowing is considered better Ridge - furrow system has been better over flat system of sowing in Maharashtra and Kerala In Kerala conditions, dibbling two seeds per hole were suitable for grain and dual purpose cowpea. In high rainfall zone, 30 cm wide 15 deep, 2 cm apart channels are made for draining of excess rain waters Second crop of cowpea in Southern India in September to December, can be taken as fring crop at either side of bunds on the day of transplanting of paddy. In Northern arid zone sowing for grain purpose following line sowing may be adopted.

Inter-row spacing is quite crucial for cowpea due to busy, trailing and erect type varieties being used for different purposes in traditional and non-traditional seasons. Thus, inter-row spacing may be carefully used For bushy and dwarf varieties close spacing of 30 cm may be adopted, whereas for semi-spreading types 40-45 cm spacing may be used. For vegetable types (spreading) 40 x 15 cm spacings are suitable In Bangalore and Pattambi closer spacing of 30 cm was observed better to wider spacing whereas, reverse may be the case in rainfed arid regions In late planting during kharif, close spacing may be preferred. In spring and summer season due to lesser vegetative growth, closer spacing of 25-30 cm may be kept

Nutrients Management : For sustained growth and production, nutrient management is essential for pulse soils which are generally deficient in organic matter, therefore, organic manures may be preferred over inorganic fertilizers.

Organic manures : Generally on nutrient deficient, degraded soil, 5-15 t ha^{-1} FYM may be applied. However, long term fertility experiments revealed that optimum dose of chemical fertilizer alongwith FYM may be much useful than the fertilizer alone. Even cow dung and poultry manure are better over inorganic fertilizer Vermicompost may increase yield of cowpea by 23% over FYM@ 20 t ha^{-1}, followed by ermicompost 10 t ha-1 Thus, substituting bulky and costly FYM and vermicompost by humic compound may reduce the cost of cultivation of cowpea without reducing yield.

Chemical fertilizer : The application of nitrogen in cowpea basically depends on the status of organic carbon in the soil. In case organic matter in the soil is below 0.5% full

dose of nitrogen may be applied, if it is between 0.5 to 2 0%, the dose may be accordingly modified However if organic matter in the soil is more than 2.0%, nitrogen application may be suspended In general, however, cowpea may require only 15-20 kg N ha-1 as a starter dose

Phosphorus application for cowpea is crucial as it improves root growth, nodulation, plant nutrients uptake, plant growth, yield traits and yield Cowpea responds to P application from 30 to 80 kg P_2O_5 However, irrespective of the region, 30-40 kg P_2O_5 may be applied at sowing of the crop

Optimum nitrogen and phosphorus doses for the regions of Karnatka, Kerala and Gujarat are 20 kg N + 40 kg P_2O_5, however, for dry tracts of Rajasthan and Haryana 15-20 kg N + 30-40 kg P_2O_5 may be sufficient. In addition to nitrogen and phosphorus, role of potassium (10 kg ha^{-1}) has been lauded in cowpea for promoting growth and mitigating drought effects during sub-optimal soil water stress.

Calcium is equally important for cowpea, particularly, for slightly alkali and acidic soils, hence gypsum on the former and calcium carbonate on the latter soil @ 200-300 kg ha^{-1} may be applied as single dose at sowing Sulphur is more important to pulses including cowpea than nitrogen, it is infact second important nutrient after phosphorus, the former increases yield and quality of legumes

Method of fertilizers application is equally important to their respective and combined applications. Lime or gypsum may be applied at the first ploughing of the soil. However, full dose of nitrogen and potassium may be applied at a single stance at the final ploughing before sowing. Half N may be applied alongwith full dose phosphorus or lime and remaining dose after 20-30 days of planting: Fertilizer at sowing may be drilled 5-7 below the seed zone Foliar application of nutrients in cowpea may be more useful than their soil application in full dose. Foliar application of 2% urea and soil application of N+P_2O_5 with 2% DAP spray (twice) have proved quite useful in yield increment of cowpea

Biofertilizers: Biofertilizers like **Rhizobium**, Vesicular Arbuscular Mycorrhizal (VAM) fungus and Phosphate solubilizing bacteria (PSB) have greater role in leguminous cowpea due to their known reasons Among these, **Rhizobium** providing better root grown and reducing the requirement of nitrogen has therefore, principal role in

yield enhancement (Table 1). Following table indicates increased yield of cowpea in Pantnagar during summer season, similar responses were observed in Rajasthan and UP also

Table 1: Effect of Rhizobium inoculation on the grain yield (q ha^{-1}) of three cowpea varieties at Pantnagar

Variety	Uninoculated	Inoculated	Mean
Pusa Phalguni	4 66	6.66	5 78
Pusa Dophasli	5 77	6.66	6.22
FS-68	7.33	7 77	7.75

VAM fungus offers promise in cowpea as it enables the inoculated plants to uptake more effectively the available phosphorus from the soil, also there is enhanced absorption of water, N, K and micro-nutrients.

PSB are another group of bio - fertilizers which increase P availability to cowpea. In nutshell it is said that dual application of **Rhizobium** and VAM fungus coupled with FYM may prove much beneficial in cowpea production.

Soil application is done for all the biofertilizers but **Rhizobium**. Recommended practices is the application of 1-2 kg biofertilizers after mixing with FYM in 1:25 ratio On an average basis 200-250 kg commercially bio fertilizer for seed treatment will be sufficient for one ha^{-1}

Weed Management : Weed infestation may in general reduce cowpea yield 50-62% Therefore, weed free conditions throughout the crop period is essential for bumper harvest. Manual weeding is becoming difficult due to lack of labours and proving time consuming operation. Therefore, integrated weed management comprising optimum sowing time, plant population, inter-cropping, timely management of weeds, mechanically, physically or chemically. Research efforts at various places indicate that effective weed control at 20-25 days of sowing through hoeing may take care during whole life cycle. However, if weeds still develop due to repeated showers, one more weeding 20-25 days later may be done. Integrated weed management reveal that pendimethalin @ 0.75 kg ai ha^{-1} plus a hand weeding at 35 DAS may result in least weed index, maximum grain yield and benefit cost ratio (Table 2).

Table 2: Effect of weed management on cowpea

Treatment	Weed index	Grain yield (kg ha^{-1})	Benefit: cost ratio
Check	62 2	232	1.10
Pedımethalın 0 75 kg ha^{-1}	46 8	326	1 22
Pedımethalın 1 kg ha^{-1}	35 2	397	1.39
Pedımethalın 1 25 kg ha^{-1}	38.2	378	1.25
Hand weedıng 20 DAS	42.3	354	1.15
Hoeıng 20 DAS	35.9	393	1.43
Pedimethalın 0.75 kg ha^{-1} + hand weedıng 35 DAS	18.1	502	1.67
Pedımethalın 0.75 kg ha^{-1} +hoeing 35 DAS	38.8	375	1 32
Weed free	-	613	1 45
C D 5%	-	85.0	-

DISEASES AND THEIR MANAGEMENT

Cowpea due to its wide adaptation across the regions and soils harbours a number of diseases which considerably influence growth and productivity potential The major diseases account for more than 20 viral, 30 Jungal, 10 bacterial and nematode origin All diseases are not equally devastating but their intensity greatly fluctuates Many of the disease are seed/soil born in nature but most destructive ones are viral ones and may be transmitted from one generation to next through seed and thus, disseminated to most cowpea producing regions of the country. Thus, in view to raise a successful crop of cowpea on farmers' fields a brief sketch is provided dealing with symptoms and control of major diseases in true practical sense.

Fungal Diseases

Anthracnose : This disease caused by **Colletotrichum lindemuthianum** results in heavy yield losses in Southern India. Under artificial inoculation conditions, it can cause 35-50% yield losses The pathogen causes leaf spot, stem blackening, pod discoloration, seed rot and seedling blight in cowpea.

Symptoms : Tannish red spots surrounded by a yellow halo develop on the leaf lamina. Severely infected pods are mis-shapen, curled and do not attain normal size and may remain without seed. The affected seeds may be brownish lesions. Wet and cooler weathers favour the spread of this disease

Control : Seed treatment with mancozeb, benomyl and thiram were effective while application of mancozeb (0.2% ai) as spray at fortnight interval may also provide good control.

Charcoal rot/seedling blight/root rot : The stem blight caused by **Macrophomina phaseolina** is quite common in cowpea and other beans It may infect plants at various growth stages.

Symptoms : The seedlings affected by this pathogen, show stunted growth and develop rot in hypocotyls, roots exhibit rotting and seedling may dry up In mature cowpea plants, the common symptoms are dry or wet grayesh black shunken lesions on the lower stem Generally higher temperature (30-35°C) and low soil moisture (40-60%) favour development of this disease (Plate 4).

Control : Higher doses of **neem**, **kusam** and **mahua** cakes may increase per cent germination of cowpea seed, 1 5% **neem** cake was most effective in reducing disease

infection Combined treatment of bavistin (1 g kg^{-1}) seed treatment and foliar spray of Blitox-50 (0.03%) performed best in reducing stem blight. Amendment with 150 kg ha^{-1} of neem cake registered minimum populations of *M. phaseolina* in rhizosphere and non-rhizosphere soils. For deriving maximum benefit, inoculation of seeds with VAM fungi (*Glomus fasciculatum*) on nutrient deficient soil is necessary.

Fusarium Wilt : Wilt disease is quite common in northern India.

Symptoms : Diseased plants show stunted growth, chlorosis, droping, withering of leaves and veinal necrosis The warm soil and dry conditions tend to trigger irreversible wilting The pathogen is seed and soil transmitted.

Control : The disease is severe on nutrient deficient soils with CEC 4 9. There is negative correlation between fungal population and CEC. Seed treatment with Thiram (0.3%) Captan (0.2%) singly or in combination have proved very effective. Biocontrol agents such as **Trichoderma harzianum** and T. **viride** and some plant products such as neem cake, **Delonix regia** also play important role in management of this disease

Cercospora Leaf Spot (Cercospora canescens)

Two pathogens viz., **Cercospora canescens** and **C. cruenta** have been observed to cause this disease world over. However, latter organism has been found more prevalent in northern central India.

Symptoms : Rough circular cherry red to dark red spots on the upper leaf surface can be seen on infected plants. On becoming numberous spots, leaves may turn yellow leading to defoliation. On the lower leaf surface lesions are red. Disease is favoured by humid weather resulting in defoliation.

Control : Destruction of diseased debris is essential to avoid perpetuation of pathogens. Seeds from healthy plants may be used to avoid infection. Seed treatment with thiram or captan @ 2.5 g kg^{-1} seed is most effective. Pathogens can be effectively controlled by foliar application of Dithan M-45 (0.2% ai) or Dithan Z-78 (0 2% ai).

Powdery Mildew : It is wide spread disease in India particularly in Southern India. Powdery mildew is caused by **Erysiphe polygoni.**

Symptoms : Small white patches appear on the upper surface of the leaves, petioles, branches, stem and pods. The affected plants remain short statured, leaves turn yellowish, curl, wither and die. It is more favoured in crowded and shaded plants. Disease is favoured by cool nights followed by higher day temperature (Plate 4).

Charcoal rot/root rot of Cowpea

Powdery milolew disease of Cowpea

PLATE 4

Control : The disease can be managed by spraying the crop with wettable sulphur (0 2%) or Afugan (0 1%). Excellent control of cowpea powdery mildew can be done by application of Benomyl (0.2%) Application of 0.05% Kerthane as spray immediately on appearance of disease twice at 15 days interval can effectively reduce the intensity of disease spread

Bacterial Diseases

Bacterial blight (Xanthomonas axonopodis pv. Vignicola)

The disease is widely distributed in tropical and subtropical parts of Africa, USA and India In severe conditions, it may kill the entire plant. The loss in seed yield may vary from 2.66 to 92.24 % depending on the nature of cultivar and the stage of infection

Symptoms : The first symptoms of this disease are water soaked dots which appear on the lower surface of the leaf The lesions vary in size from 0 5 to 2 0 cm During severe infection, complete defoliation may occur The vascular system becomes brown The infected stems become cankerous near the ground level and cracking occurs The pods also show water soaked lesions which later become circular with dark green spots The plants become stunted and bushy in appearance.

Control : The disease intensity increases with increase in plant population Hot water treatment at 52°C for 15 minutes was most effective in eliminating the seed borne pathogens. Treatments with mercuric chloride, antibiotics, solar heat treatments and hot water treatment for surface sterilization of infected seeds is recommended.

Viral Diseases

The viral diseases of cowpea have recorded more attention due to their devastating effects and being a major constraint to large scale cowpea production in India. Different manifestations of mosaic are commonly observed in cowpea. The economically important virus diseases affecting cowpea production are described below.

Cowpea Mosaic : This disease caused by cowpea Yellow Mosaic Virus is widely distributed in many parts of the world and yield reduction to the extent of 40-100 % have been reported. A large number of insect vectors have been reported. Beetle vectors mainly remain viruliferous for one to more than eight days

Symptoms : The leaves may turn blight yellow Under natural conditions, two distinct types of necrotic local lesions or chlorotic local lesions are generally observed. The positive systemic reactions vary from a barley discernible green mosaic to complete death of the plant.

Control : For effective disease management, the weeds that act as alternative host should be removed and destroyed The rouging of infected plants just after appearance of symptoms may reduce spread of the disease. The other possible method of controlling, includes vector control by use of insecticides Spraying the crop with 0 2 per cent Endosulfan may check the insect vectors. However, application of insecticides may not achieve complete control of this disease

The higher level of phenolic compounds and peroxide enzyme activity have been reported to contribute towards resistance to CPMV.

Cowpea Yellow Mosaic

The causal virus of cowpea yellow mosaic is identified as Alfalfa Mosaic Virus (AMV). The prevalence of AMV infected cowpeas is generally less than 10 per cent, although inoculation of cowpea in the field with AMV at the full bloom and prebloom stages reduces seed yield by about 15 and 50 per cent, respectively.

Symptoms : The naturally infected cowpea plants exhibit yellow.(Calico) mosaic foliage symptoms, at times, leaf yellowing accompanied by leaflet deformation and dwarfing and plant stunting. Infected pods turn yellow without any discoloration Uration of seeds.

Control : To control the causal virus of cowpea yellow mosaic disease, similar cultural and chemical practices may be applied as in cowpea mosaic Till now no resistance to AMV in cowpea has been reported in India.

INSEET - PESTS AND THEIR MANAGEMENT

Cowpea, even though, a widely adapted legume across the soils, regions and seasons, yet suffers from poor productivity. There can be several reasons for the same including defects inherited in the traditional plant types, poor response to the inputs, occupying secondary status amongst the farmers etc The simple reason at certain places and during favourable season is moderate to heavy infestation of cowpea to certain insectpests Luxurious growth of cowpea makes it amenable to insect pests. Almost 85 insect species cause injury to cowpea. Certain insects cause injury during the specific period and growth stages but others are affecting whole plant body during entire growth period. Extent of damage, however, depends on the congenial situations for the specific insect developing at the critical practical stage/ period It is, therefore, desired to ascertain the symptoms, extent of losses and preventive and control measures against major insect-pests so that yield levels by preventing or lessening their impacts could be enhanced at the farm levels

Critical periods : In view to have effective control strategy on insect-pest infestation, it is essential to know the population pressure of a particular insect in reference to the growth stage. The same is briefed below :

S. No.	Name of the pest	Period of sever attack
1.	Hairy caterpillar	Maximum appearance in 2nd and 3rd week of July
2	Jassids	Appear on the crop in 2nd and 3rd week of August
3	White fly	Comparatively less damage compared to moth bean and mung bean
4	Weevils	Middle August, but disappears in 1st and 2nd week of September.
		Severity of damage
1	Termite	Infestation more severe when dry spell is almost 20-35 day
2	Grass hopper	Remains as minor pest during entire growth
3	Aphids	Infestation depends on the magnitude of humidity, sunshine and cloudy weather

Effect sowing time on the extent of incidence : It has been observed that the climatological conditions such as humidity, sunshine hours and cloudy weather, particularly, during August are important for insect infestation, leading to early appearance and multiplication of aphid population on cowpea. Results reveal that sowing of crop during 8-15 July attract minimum infestation of Jassids, white fly and weevils, delayed sowing affected the Growth of plants and yields due to increased insect attacks. The seed yield due to insect pest damage when the crop sown in last week of July may even decrease more than 50% due to build-up of more favourable conditions for the insects Thus, early planting of crop upto 20th July must be ensured in arid Rajasthan

Distribution, symptoms and control of major insects:

Whiteflies : This insect is common in pulse growing states of Rajasthan, Gujarat, Haryana, Madhya Pradesh and Andhra Pradesh

This insect feeds on the plants and also transmits YMV The entire leaf turns yellow, chlorophyll of leaves is destroyed, plants growth is stopped and the loss may range from 12 to 65%

Control : Many insecticides, *viz* , monocrotophos, dimethoate, disulfoton and phorate are known to reduce the population of whitefly and therefore, checking YMV spread. Monocrotophos @ 0.25 kg ai ha^{-1} applied 3 times at 15 days interval starting from 15 days of sowing, has been quite effective and therefore, recommended. Application of phorate and aldicarb @ 1.0 to 1.25 kg ha^{-1} at sowing keeps the whilefly population checked upto 4 weeks of plant growth Dimethoate @ 0 04% has also been very effective in control of whitefly population in cowpea

Jassids : This is serious pest causing extensive damage to almost all the kharif pulses In India, it is **Empoasca kerri** the species most common one, besides some wild species also damage the crop and alternate hosts also to Jassid. It is sucking pest, sucks leaf sap, leaflets become cup shape and yellow at the edges In heavy infestation, leaves turn brown and dry up.

Control : Results on the control of Jassids indicate that quinolphos, **carboryl** and dimethoate may provide the crop good protection upto 20-25 days. Application of seed coating of aldicarb @ 1.0 kg a i ha^{-1} has also been highly effective In addition use of aldicarb at sowing time, followed by monocrotophos spray in 3-5 week old cowpea crop, has also been effectively recommended for control of Jassids in cowpea.

Aphids : Aphids are sporadic but serious pest during kharif but seldom thrive in kharif due to high temperature and existence of their natural enemies.

Young seedlings become twisted and on heavy infestation seedlings may show mortality. Due to sucking of sap, plant growth is stopped Nymphs and adults can also damage the crop In favourable conditions, yield losses may range 44 to 87%.

Control : Dimethoate @ 0 04% has been observed most effective in controlling cowpea aphids. In addition effective control can be done by spraying dimethoate (0 03%), endosulphan (0.07%), monocrotophos (0.04%) or lindane (0.01%). There are some natural enemies of aphids like lady birds **(Coccinella septempunctata)** and syrphid larvae (*Ischieden scutellaris*) which can control the population of aphids effectively.

Weevils : Leaf damaging weevils are found throughout the country They feed on kharif pulses, cereals and are known common pest of cotton also. These insects chew the leaflets generally at the margin and make central hole The grubs feed in the soil and crop roots consequently may destroy roots in longer time The adults feed on leaves, buds, flowers and young ponds

Control : Spray of malathion dust @ 20-25 kg ha ^{1} may completely control weevils.

Pod Borer (*Helicoverpa armigera*)

Pod borer : It is widely distributed insect of cosmopolitan in nature in India and is serious pest of cowpea, other kharif pulses and also damages cotton, maize, sorghum, okra etc

The larvae being polyphagous but prefer to feed on arhar, moong, bean, cowpea and gram pods They feed on foliage in young stage and later on in seeds therefore, causing serious yield losses A single larva may destroy 30-40 pods before reaching adult stage If flowers and pods are not available for feeding they may feed on leaflets leaving veins maket veins

Control : Researches carried out at various places indicate that the same can be effectively control by spraying 0.05-0 07% endosulphan @ 700 l ha ^{1}. Carboryl (0 01%), phosphemidon (0 04%) may also effectively control pods borers attacking cowpea.

Cut worm : Reported all over country, this is widely spreaded polyphagous insect

Seedlings are cut completely at the ground level The pest can be controlled by mixing chlorophyryphos at the crop planting time or dusting methyl-perathion dust @ 20-25 kg ha ^{1} at the crop foliage in the evening

White grubs : Whitegrubs prefer soils rich in decaying organic matter. Loose soils are in general preferred by whitegrubs whereas, termites prefer clay for gallery making.

Whitegrubs are the active root feeders. In endemic tracts, the damage is regular and the problem begins, when the organic matter applied before sowing the crop, is not completely rotted The young grubs soon after hatching, start damaging root regions irrespective of the plage beginning from May - June to October. The young plants show abrupt drying of the whole body due to abrupt cut in the roots hence, can be easily pulled of the soil. The older plants showing yellowing in their foliage. Due to fine root lets alongwith tap root systems, legumes may be more susceptible to this pest than cereals having adventious roots. In a soil depth of 7-10 cm as many as 6-7 grubles may be found around each plant.

Control : Killing of beetles, which are attracted towards light in the night is easiest way. The trapped beetles may be destroyed by burning or dipping in insects cidal solution Soil treatment is costly as the size of grubs is big hence, more quantity of insecticide is required.

Termites : Termite are common in arid and semi-arid regions. The damage increases under drought situations or the interval between two irrigations / rains.

Control : For control of termites spray or dusting of insecticides are not recommended because problem is in the soil. Mixing of soil insecticides like chlorophyriphos @ 25 kg ha^{1} of dust formulation before sowing of the crop is recommended In case patches of termite presences are evident in the field, emulifiable concentrate of chlorphyriphos may be mixed with water of sand in side the soil

Bruchides :

Callosobruchus maculates Fab. is common sp in almost all the pulses, these bruchids feed in the field and in sored seeds as well. Other common species found in stored seed are **C. chinensis** and **C. analis.**

Bruchids attack matured and dried pods preferably The round holes and eggs on the pods can be seen Infested store seeds also exhibit presence of eggs and round holes on them

Arahar followed by bean, cowpea, urad, moth bean are preferred by **maculatus** sp. Bruchids fail to penetrate guar and rice bean seed coats.

Beetles are guided in their oviposition with preference of bright, colored, smooth surface with greater seed volume. Egg laying was minimum on wrinkled seed surface The amount of food consumed by the bruchids increased with protein concentration of the grain. The resistant cowpea varieties show lesser protein content of the seeds (21 to 24%).

Resistant cv. : Screening of cowpea varieties against bruchids is effectively done on the basis of food consumed and loss in the seed weight. Screening done on more than 70 lines of cowpea revealed better resistance in TVU-2027, TVU-11952, C-152, V-38 .

Oil treated seeds cause mortality of eggs on seed surface but no effects on those entered in seeds. Of various oils coconut, groundnut, safflower, mustard, neem leaf powder and malathion dust, the latter was most effective and could prevent infestation for 8 months

Control : The grain stored must be completely dry, having minimum moisture as far as possible before storage.

The grains may be stored in earthen container with sealed earthern lid or a top cover of sand or ash (7 00 cm thick).

The grains may be treated with neem oil or linseed oil @ 10 ml kg-1 seed followed by storage in sealed polythene bags.

A sand layer over the stored grains in earthen containers is very simple way of preventing external infestation of pulses beetle

Integrated Pest Management : Integration of early sowing of the crop, use of appropriate agronomic practices, insecticides, plant extracts and cultivating resistant varieties may lead to effective control major pests of cowpea

1 Planting of crop in first or second week of July is treated most profitable with increased yield and reduced pests populations.

2 Use of aqueous neem, neem kernel extracts and neem seed powder may provide complete pest protection to kharif pulses including cowpea.

3. Initial application of neem seeds pellets @ 200 kg ha ^{1} at the time of sowing placed in furrows may check the crop against termite and white grub.

4 Neem seed extract acts as repellent and growth inhibitors against red hairy caterpillar.

Cowpea for Forage

Increased urbanization, income and changed life style in developing countries may considerably increase the demands of livestock products like milk and meat. By and large livestock production in India is carried out by small - holders, characterized by lower production of milk growth and extended calving period The forage available to these livestocks is understood to be rich in fibre and deficient in many nutrients Leguminous forage, rich in protein and minerals have potential to enhance fibre degradation in rumen, can therefore serve as strategic supplements to other forage resources Among the legumes, it is cowpea which is attractive in mixed crop/ livestock system where both grain and fodder can be used from the same crop. The use of cowpea as fodder is much advanced in India, where green crop is used for grazing or cut and mixed in combination with cereals and other crops for locating crops Harvesting of cowpea 60 days after planting, provides the beat DM yield of highest quality Cowpea in India can maintain milk yield of >1 5 gallons cow ^{1} day^{-1} by giving DM yields of >1 8 t acre ^{1} and protein content upto 26.0% Cowpea is therefore, the most potential legume for fodder production, crucial for crop-livestock integration, enrichment of the soil, conservation of soil moisture and preventing soil erosion Predominantly being a fodder crop due to quick and high biomass production, is cultivated in around 3 0 lakh ha for this purpose in India In view to cater the need of livestock, fodder on farming system, it is desired to develop and disseminate agrotechniques suited in different regions and situation

Soil and Climate : Cowpeas for fodder are adapted to wider ranges of soils from sandy to clay. Waterlogging is unfit for cowpea cultivation due to its good drainage requirement It flourishes very well in deep, drained, fertile soils, moderately susceptible to salinity, therefore, its grain yield declines at ECe 1 3 dS m^{-1} onwards.

Important Varieties : Use of cowpea as a double purpose crop providing both grain and fodder is important from mixed cropping and livestock system view point, where lands and feeds are becoming increasingly scarce, particularly in arid regions Thus, need of dry-season dual-purpose cowpea varieties adapted to arid and semi-arid region are desired. A list of certain important varieties which are high yielding, disease resistant suitable for different cropping systems and agroclimatic conditions, is provided below:

All India basis:

Kharif . GFC-1, GFC-2, GFC-3, GFC-4· these entries may give 25-35 t ha ^{1} fodder.

Summer : GFC-4: It may give 20-30 t ha-1 fodder yield.

Haryana, Punjab and Delhi · FOS-1, FOS-10, K-395, K-585, IGFRI, C-88 (25-35 t ha^{-1} fodder yield in Punjab), HFC-128

Northern India : UPC-5287 (30-45 t ha^{-1}), Russian Gant (30-35 t ha^{-1}).

Gujarat :-Charodi-14-20, Charodi-26-28.

North, West and Central India . Bundel Lobia - 2 (30-35 t ha^{-1}), North-West, UPC-4200 (35-45 t ha^{-1}).

Himachal Pradesh : PC-1, PC-3, PC-14, PC-16 exhibiting resistance to collar rot

Southern States and West Bengal : CO-1, Russian Giant, EC-4216, TNFC-9901

Planting : Cowpea does not suffer with seed dormancy, but it possesses epigeal type germination. Moderate seed bed preparation with one harrowing and ploughing are sufficient. Cowpea needs a seed rate of 40 kg ha^{-1} (line sowing) 50 kg ha^{-1} (broadcasting) for fodder purpose but for grain purpose 20-25 kg ha-1 would be sufficient. Seed rate for intercropping with cereal forage may vary from 15-20 kg ha^{-1}. A sowing depth of 3-5 cm has been found optimum.

Fertilizer : Cowpea needs only a starter dose of 15-20 kg N ha^{-1} due to its capacity of nodulating freely with native *Rhizobia* and inoculation of seeds with efficient *Rhizobium* strains The efficient cowpea *Rhizobium* strains are: Cowpea-109, UAS-IV-5 and TAL-169, DC-6, GMBS-1 Cowpeas nodulate with *Rhizobium Japonicum* also which nodulates lima bean, groundnut, soy bean. With high N application and soils rich in organic matter, fixations of N is poor. Phosphoatic fertilizers which promote root growth and nodulation, may be used @ 40 kg P_2O_5 ha-1, optimum dose of VAM and PSB were also found important for P nutrition for this crop.

Irrigation : Being drought hardy deep rooted annual cowpea can penetrate soil upto 1.5-2 m under favourable soil conditions, it therefore, doses not require irrigation. During summer 3-4 irrigations of 3-4 cm depth each at 15-20 days intervals may be applied. It may, however, not require irrigation during rainy season.

Cropping Systems : Intercropping of cowpea with sorghum/bajra/maize is quite prominent in South-Central-Deccan Plateau zone, North-Western Semi-arid and arid zones and Central Semi-arid Vindhyan zone as the main source of fodder to the animals In Himalayan foot hill regions, maize-cowpea-oat (fodder) cropping system is extensively followed. The most important sequential food cropping system involving cowpea is maize-potato-wheat-cowpea (fodder) in Northern India and rice-rice-cowpea is Kerala (Table 1).

In coconut gardens of Kerala, cowpea, guinea grass and **Stylosanthes guianensis** are grown Further in foothill regions of West Bengal and Assam, dinanath grass **(Pennesetum pedicellatum)** + cowpea/ rice bean/ **Stylosanthes** intercropping system is popular. Cowpea is also intercropped with guinea grass and napier bajra hybrids in Western and South India, repectively.

Table 1: Intensive fodder crop rotations with cowpea for different agro-climatic zones in India

Zones	Crop rotation	Green fodder yield ($t\ ha^{-1}\ annum^{-1}$)
Northern	Hybrid napier intercropped with berseem	211.7
	Hybrid napier + lucerne	176.0
	Maize + cowpea – maize + cowpea – turnip – oat	190 0
Central and Western	Hybrid napier + cowpea – berseem + mustard	286 3
	Maize + cowpea – M P. chari-berseem + mustard	197.2
	M P. chari-turnip-oat	192 3
	M P. chari + cowpea – berseem + mustard – jowar + cowpea	168 6
	Maize + cowpea – maize + cowpea – oat – maize + cowpea	168.5
Eastern	Maize + cowpea – oat – bajra + cowpea	102 6
	Jowar + cowpea – berseem + mustard – maize + cowpea	96 0
	Maize + ricebean – berseem + mustard	111.5
	Hybrid napier alone	144 2
Southern	Sorghum + cowpea – maize + cowpea – maize + cowpea	110 7
	Maize + cowpea – maize + cowpea – maize + cowpea	106.0
	Guineagrass round the year	93 5

Overlapping system : The overlapping cropping system evolved by taking advantage of the growth periods of different species ensures a uniform supply of green fodder throughout the year, once such system continues for three years. The best rotation in this system is berseem + Japani sarson - hybrid napier + cowpea - hybrid napier, (October-April)- (April - June) - (June - October), respectively Some of the important intensive fodder - crops rotations and the expected yields from each, are summarized in Table 2

Table 2: Fodder crops rotations and the expected yields

1	Maize + cowpea - maize + cowpea + teosinte - berseem + mustard (300 q/ ha) (450 q/ha) (1,000 q/ha)
2.	Sweet sudan + cowpea - berseem + oats (1,000 q/ha) (1,000 q/ha)
3.	Hybrid napier + lecerne (1,250 q/ha) (850 q/ha)
4.	Maize + cowpea - jowar + cowpea - berseem + mustard (300 q/ha) (400 q/ha) (1,000 q/ha)
5.	Teosinte + bajra + cowpea - berseem + oats (1,000 q/ha) (1,000 q/ha)
6	Sweet sudan + cowpea - mustard - oats + peas (1,000 q/ha) (250 q/ha) (500 q/ha)

Fodder production in arable farming : There is ample scope for fitting in the short-duration fodder crops, either single or in mixture, with the other crops during the gap period between two main cash crops Two distinct fallow periods as available for raising short duration fodder crops, which provide adequate resources, as available. In case of wheat-jowar rotation, gap periods between April and June and between October and November are available for each crop as fodder Thus, in the first rotation. M P. chari + cowpea, maize + cowpea, bajra + cowpea is successfully grown and an additional green-fodder yield to the tune of 300-350 q per ha is obtained. Similarly, in the second gap period (October-November), which is shorter, the growing of fodder turnips and short-duration mustard varieties help to get 250-300 q per ha fodder yield without disturbing normal cropping system. Some promising rotation for green fodder at specific places are given in Table 3.

Table 3: Stratified fodder-production potential of the best fodder-crops rotations in various regions

(A)	Some promising rotations at various centers	Green fodder yield (q/ha)
Jhansi		
1	Hybrid napier + cowpea - *berseem* + *sarson*	2,863
2	Maize + cowpea - M P chari - *berseem* + *sarson*	1,972
Hyderabad		
1	Hybrid napier + cowpea – hybrid napier + cowpea – hybrid napier + *berseem*	1,334
2	Maize + cowpea – *bajra* + cowpea + *berseem*	1,267
3.	*Madikattujonna* + cowpea - jonna (ratoon) + cowpea – *berseem*	1,098
4.	Hybrid napier + guar – lucerne	2,529
5.	Maize + cowpea – maize – cowpea – oats – maize + cowpea	1,685
Kalyani		
1.	Maize + cowpea – *P pedicellatum* – oats	1,308
2	Maize + cowpea – rice bean – *berseem* + *sarson*	1,115
3	Maize + cowpea – *jowar* + *cowpea* – *oats*	884
Kanke		
1	Maize + cowpea – oats – *bajra* + cowpea	1,026
2	*Jowar* + cowpea – berseem + sarson – maize + cowpea	960
3.	*Bajra* + cowpea – *berseem* + *sarson* - maize + cowpea	959
Jorhat		
1	Maize + cowpea – maize – jowar– oats	664
Hisar		
1	*Berseem* + Japan rape – jowar + cowpea - jowar + cowpea	1,705
Coimbatore		
1	Sorghum + cowpea - maize + cowpea – maize + cowpea	1,107
2	Maize + cowpea - maize + cowpea - maize + cowpea	1,060
Palampur		
1	Maize + cowpea – lucerne + oats + *sarson*	844
2	Maize + cowpea – turnip + oats + pea – cowpea	833
3.	M P chari + cowpea – oats + pea – cowpea	782
Jabalpur		
1.	Hybrid napier intercropped with cowpea – *berseem* and cowpea	1,761
2.	M P chari - cowpea – *berseem* + *sarson* – *jowar* + cowpea	1,686

Source. (All-India Coordinated Project for Research on Forage Crops)

Fodder production under dryland farming : In these areas, farmers usually grow at least one crop in rabi season for utilizing the residual moisture Thus, there is scope for raising two crops under such situations, firstly, growing of a fodder crop which gets ready in 45-50 days after sowing (cowpea, guar, moth, etc.), yielding 150-250 q per ha of green fodder After harvesting the fodder crops, other crops such as gram, linseed, barley, wheat and mustard are raised on the conserved moisture.

Yield and Quality of fodder

Cowpea is a single cut crop but can give two cuts in summer. The crop is cut alongwith the intercropped cereal irrespective of its age. Green fodder yield to the tune of 30-45 t ha^{-1} with superior quality free of antinutritional factors is obtained. It can provide good quality silage with addition of molasses (30-40 kg t^{-1}), generally ensiled with jowar and maize (1:2). It also provides good hay Cowpea seed can also be used as a concentrate in animal feeds.

Crude protein content of cowpea fodder varies from 16 to 21%, largely depending on the cultivars. The nutritive value of fresh biomass of cowpea (DM basis) is almost 12 5%, digestible Crude Protein (DCP 62.0%), total digestible Nutrition (TDN) 2.7 M cal kg-1 digestible energy and 2.2 M cal kg-1 metabolizedable energy. The corresponding values for its hay and seed are. 10 2, 53.0, 2.4; and 1.9; and 21.1, 84.0, 3.7 and 3.3%, respectively Cowpea, however, like other legumes contains trypsin inhibitors which limit protein utilization

COWPEA UTILIZATION

Cowpea, like other pulses are the cheapest sources of vegetable protein, essential amino acids, vitamins and minerals. Many products made of cowpea grain are used in many confectionary items, have merited cowpea as the crop of high value. Being crop of poor regions and farmers, with wide adaptive ecology, it is becoming popular among growers and consumers. Listing and compiling the information on its nutritive significance, suppliment nutrients and certain antinutritional factors and common and uncommon products will help its popularity and expansion of uses among rural and urban inhabitants.

Chemical and Nutritive Composition : Cowpea is a rich source of protein, fat, fibre and carbohydrate contents Cowpea grains contain 23-26% protein contents, however in dry zones, protein content is bit more. The tender leaves are also good source of high quality protein Carbohydrate proportion in cowpea varies 39 to 56%, with a range of 1.75 to 4 05% fat contents cater the need of essential fatty acid of adults Germinated cowpea seeds are a good source of vitamin C, it also significantly contributes for vitamin B uptake. Cowpea is a source of lysine but deficient in methionine content. The nutritive value of cowpea alongwith two other sister pulses can be well assessed from Table 1

Table 1: Nutritive value of cowpea in relation to bengal gram and green gram seeds

Nutrients	Cowpea	Bengalgram	Greengram
Protein (g)	24.1	17.1	24
Arginine (mg/g)	420	570	500
Histidine (mg/g)	200	160	170
Lysine (mg/g)	430	440	460
Tryptophan (mg/g)	70	50	60
Phenylalanine (mg/g)	320	360	350
Tyrosine (mg/g)	230	180	100
Methionine (mg/g)	90	80	80
Cystine (mg/g)	80	80	60
Threonine (mg/g)	230	220	200
Leucine (mg/g)	480	580	510
Iso leucine (mg/g)	270	320	350
Valine (mg/g)	310	310	320
Fat (g) .	1 0	5 3	1.3

Minerals (g)	3.2	3 0	3.5
Magnesium (mg/100g of edible portion)	210	119	127
Sodium (mg/100g of edible portion)	23.2	37 3	28
Potassium (mg/100g of edible portion)	1131	808	843
Copper (mg/100g of edible portion)	0.87	1.18	0.39
Manganese (mg/100g of edible portion)	1.34	1 21	2.47
Molybdenum (mg/100g of edible portion)	1.890	0 154	0.304
Zinc (mg/100g of edible portion)	4 6	6.1	3.0
Chromium (mg/100g of edible portion)	0.029	0 008	0.014
Sulphur (mg/100g of edible portion)	165	179	188
Calcium (mg/100g of edible portion)	77	202	124
Iron (mg/100g of edible portion)	8.6	4.6	4.4
Phosphorous (mg/100g of edible) portion	414	312	326
Vitamins			
Carotene (µg)	12	189	94
Thiamine (mg)	0.51	0.30	0 47
Riboflavin (mg)	0 20	0.15	0.27
Niacin (mg)	1.3	2.9	2.1
Total B6 (mg)	-	-	-
Vitamin C (mg)	0	3	0
Folic acid			
Free (µg)	69 0	34.0	-
Total (µg)	133.0	186.0	-
Fibre (g)	3 8	3.9	4 1
Carbohydrate (g)	54.5	60 9	56.7
Energy (Kcal)	323	360	334

All values are per 100 g of edible portion

Antinutritional Factors (ANF) : Cowpea contains some ANFs which create some physiological disorders on consumption Some of them are protease inhibitors, anti vitamins, phytase, saponians, amylase inhibitors, tannins, aflatoxins etc. Trypsin inhibitors which reduce protein digestibility, can be destroyed and protein quality/digestibility can be improved on heating or autoclaving. However, simple heating and soaking may not easily remove heat stable compounds (polyphenols and phytates). The same can be reduced on germination and or fermentation. Polyphenols are found more in dark colored seeds.

Cooking quality : Cowpea is consumed mainly as cooked food, cooking/heating has therefore, both good and adverse effects. There is little loss of protein, fat or carbohy-

drates during ordinary cooking. However, some protein and minerals (Na, K and Ca) are lost if food is cooked in water containing salts. Thus, minimum water be used for cooking or cooked water may be used as soup. Washing may remove as much as 40% of thiamine and nicotinic acid Cooking destroys food-born micro-organisms. Moreover, quality of protein is increased after heating since their access to enzymes and digestibility are improved. Cooking in limited water and in presence of acids may help preserve certain vitamin and minerals. The use of cowpea in cereal based food may improve their nutritional quality.

Cowpea products : Cowpea is used for various preparations. It is consumed as greens (green, roasted, boiled, fried, crushed and cooked), as mature dried grains (boiled, boiled and fried cooked as dal), dehushed splits (cotyledons) as sambhar/dahal.

Cowpea are utilized in the following form:

1. Whole/green cowpea (fresh, boiled and roasted).
2. Sprouted and germination (boiled and fried)
3. Puffed and roasted (spiced/salted).
4. Milled and cooked (Steamed, boiled and fried).
5. Fermented products (dhokala, idli etc).

A resume of the products made from cowpea based on common Indian diet is give in Table 2.

Post - harvest technology

Milling: It refers to reduction of grains into meal or flour. Milling is an overall process and it includes reduction in size, hulling, scarification, polishing, sorting, mixing etc. The proportion of seed coat, cotyledons and embryo in relation to whole seed in cowpea is 10.6, 87 2 and 2.1%, respectively.

Pre-milling treatment : This treatment is given to affect the gum contents present in between seed coat and cotyledons, so as to lessen the husk, ease of milling, reduce breakage and improving the quality of splits The same is done by the following method.

Dry method, thermal treatment, chemical treatment, polishing, packaging and milling performance.

Table 2: Cowpea Products Based on Indian Diets

Preparation	Ingredients	Nutritional quality	Cost of the product (Rs./serving)	Cooking Time (min.)
Whole/Green Cowpea				
Cowpea vegetable	Cowpea, onion, garlic, ginger, green chilli, tomato, coriander leaves, salt and spices and fat	Protein - 7.37 Fat – 15 4 CHO-21 72 Energy-255 25	3 00	30*
Cutlets	Cowpeas, boiled potato, onion, green chilli, ginger, coriander leaves, cumin (roasted) and salt	Protein – 31 7 Fat – 26 45 CHO-136 2 Energy-908 5	8 00	30*
Bonda	Potato, cowpea, coriander leaves, ginger, gram flour, green chilli, fat, salt and spices	Protein – 24 05 Fat – 53.4 CHO-79.75 Energy-894 5	5.00	30
Cowpea paneer	Cowpea, paneer, tomato, onion, garlic, green chilli, ginger, coriander leaves, fat, cumin seeds, salt and spices.	Protein – 10 58 Fat – 19 53 CHO-18 81 Energy-293 5	5.00	30
Cowpea pods vegetable	Green cowpea, onion, tomato, oil	Protein – 4 6 Fat – 5 3 CHO-15 3 Energy-127.5	3 00	20
Sprouted and Germinated				
Sprouted pulses salad	Green gram, bengal gram, cowpea, groundnut, salt, green chilli, onion and lemon juice	Protein – 47 05 Fat – 23 95 CHO-111 7 Energy-851	7 00	10*
Milled and cooked products				
Wheat and Cowpea vadai	Whole wheat dalia, cowpea dalia, potato, ginger, green chilli, onion, spices and oil	Protein – 5 73 Fat – 25 37 CHO-30.16 Energy-	3 00	30*

Kachori	For crust-Maida, fat and salt. For filling-cowpea, spices, salt, coriander leaves, green chilli and oil	Protein – 8.12 Fat – 25 47 CHO-33 07 Energy-394	2 50	45
Porridge	Wheat dalia, cowpea dalia, milk and sugar	Protein – 8 48 Fat - 5 42 CHO-31 15 Energy-207 1	2 50	150*
Laddoos	Semolina, cowpea flour, sugar, khoa, grated coconut, cardamom and ghee	Protein – 14 64 Fat – 21.26 CHO-76 09 Energy-554 6	5 50	45
Biscuits	Madia, cowpea flour, ghee, powdered sugar, milk, baking powder	Protein – 6 06 Fat – 21 3 CHO-35 26 Energy-357 1	4 00	60
Puri	Wheat flour, cowpea flour, oil and salt	Protein – 9 04 Fat – 23.17 CHO-30 97 Energy-368 5	2 28	60
Batti	Wheat flour, cowpea flour, ghee and salt	Protein – 9 04 Fat – 30.67 CHO-30 97 Energy-436	5 00	330
Stuffed parantha	Wheat flour, cowpea flour, potato, oil, green chilli, coriander leaves, turmeric powder and salt	Protein – 9 52 Fat – 5 7 CHO-37 75 Energy-240 1	1 50	30
Mathari	Maida, cowpea flour, oil and salt	Protein – 8.77 Fat – 27 97 CHO-32 09 Energy-415 2	3 00	20

Muffin	Maize flour, cowpea flour, sugar, baking powder, salt, milk, egg, ghee and cardamom powder	Protein – 12 79 Fat – 11 27 CHO-55 55 Energy-374 6	3 00	60
Rabri	Butter milk, Bajra flour, cowpea flour, salt, cumin	Protein – 4 77 Fat - 2 25 CHO-12 95 Energy-90 9	1 00	30
Chikki	Cowpea flour, sugar, khoa, ghee and milk	Protein – 17.21 Fat – 37 17 CHO-73 45 Energy-697.3	9 00	90
Dahi vada	Green gram, black gram, cowpea, curd, salt and oil	Protein – 8.81 Fat - 12 36 CHO-18 9 Energy-221 8	2 50	60*
Halwa	Cowpea, ghee, sugar and cardamom powder	Protein – 7 23 Fat – 30 3 CHO-46 17 Energy-486 3	6 00	120*
Moong dal vadi	Green gram dhal (dehusked), cowpea, salt, green chilli and oil	Protein – 80 42 Fat – 8 87 CHO-187 39 Energy-1149 8	-	190*
Papad	Green gram dhal flour, cowpea flour, baking soda, salt, black pepper and cumin seeds	Protein – 277 72 Fat – 19 25 CHO-662 95 Energy-3931 5	-	240*
Gattaa curry	Gram flour, cowpea flour, oil, cumin powder, omum seeds,	Protein – 11 22	2 50	30

Poshtik soup	Cowpea, green gram dhal, spinach, salt, cumin seed, pepper, butter	Protein – 12 64 Fat – 12 87 CHO-29.31 Energy-283 6	3 50	30
Fermented products				
Dhokala	Cowpea flour, onion, ginger, coriander leaves, salt, oil, cumin seeds, sodium bicarbonate and curd	Protein – 15 63 Fat – 17 69 CHO-42 58 Energy-392 2	5 00	60
Idli	Rice, black gram dhal, cowpea and salt	Protein – 6 17 Fat – 0 34 CHO-27 05 Energy-136	1 00	30*
Puffed and roasted products				
Chutney	Fresh coconut, roasted cowpea, green chilli, salt, curd, mustard seeds, curry leaves and oil	Protein – 4 3 Fat – 13 5 CHO-9 45 Energy-176.3	2 00	10
Burfi	Cowpeas, khoa, sugar and coconut powder	Protein – 13 4 Fat – 7.0 CHO-54 45 Energy-334.6	5 00	30*
Poshak	Whole wheat, cowpea and groundnut	Protein – 9 04 Fat – 3.6 CHO-31.48 Energy-194 7	1 00	60
Poshak laddoo	Poshak mixture, powdered sugar, ghee and cardamom powder	Protein – 9.04 Fat – 13 6 CHO-61 3 Energy-404 1	3 00	20

Units of nutritional quality Protein, g; Fat, g, CHO, g, Energy, Kcal

* Excluding soaking time (2-3 h - overnight)


COWPEA
GERMPLASM