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FACULTY OF AGRICULTURE SCIENCES AND ALLIED INDUSTRIES

(Crop Improvement I (Kharif))

For

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RAMA UNIVERSITY

Course Instructor

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Major Cereals, **Pulses**, Oilseed, Fodder, cash , vegetable and horticulture crops (*Kharif Seson*)

PULSES The pulse crops in general give lower yields than the cereals. Pulses are rich in protein and it takes more energy weight for weight to synthesise protein than carbohydrates. When you compare the energy requirement of various metabolic pathways. one gram of glucose can give rise to 0.8g of carbohydrate but on an average only about 0.5 g protein and even less of oil. Further maintenance of nitrogen fixation in roots require prolonged use of photosynthate and thus may reduce the energy available for storage in seeds. Other reasons for low yield are 1. Raised in submarginal lands. 2. Indeterminate growth habit. 3. Irregular flowering 4. Photosensitiveness. The protein from pulses are incomplete. Legumes are good source of lysine, tryptophan and threonine but are low in suphur containing amino acids methionine, cystine and cystene which are adequate in cereals. So a mixture of cereals and pulses are recommended for food. Many grain legumes contain toxic inhibitors which are removed while cooking.

RED GRAM Arhar, Tur Pigeon pea Cajanus cajan (2n = 22) Place of origin : Africa / Asia Wild Species : Cajanus kerstingii Related crossable genera : Rhynchosia Putative parent : The view is that cultivated cajanus arose from Atylosia. Atylosia lineata may be the progenitor of cajanus. In Western ghats A.lineata and A.sericea are known to local people as 'barn tur' (wild tur) so also in West Bengal and orissa A.scaraboides and A.cajanifolia are known as wild tur. The genus Atylosia has now been included in Cajanus. Two botanicaly distinct varieties were described. Cajanus cajan var. bicolor (Arhar) perennial, late maturing, large bushy plant bearing purple streaked yellow flower. The pods are dark purple mostly cultivated in North India. Cajanus cajan var. flavus (Tur) short duration early maturing. Color of standard petal yellow. Pods green, glabrous cultivated in South India. But the above classification is no longer valid because there are number of intermediate forms and it is hard to differentiate the varieties because of often cross pollination nature of the crop. Breeding objectives : 1. Evolution of long duration high yielding variety suitable for rainfed to replace the local land races : SA1 - Released during 1940 Co6 - result of mutation breeding 2. To evolve short duration (105 days) varieties suitable for irrigated / mixed crop with ground nut. ICPL 87 - ICRISAT Vamban 1 - 110 days. 3. Breeding for bold grain type with desirable seed coat color HY 3C long duration variety with dull white seed coat and bold grains. 4. Breeding for vegetable type Hosur area - Green pods with bold seeds are used as substitute for green peas. Perennial types like Attapadi local are used. BSRI is a perennial red gram whose green pods are used as vegetable. 5. Breeding for resistance to pests. Heliothis is the major pest, Terminal cluster types are highly susceptible. All our varieties are highly susceptible. 48 6. Breeding for disease resistance : Sterility mosaic, root rot, blight are important diseases. Wild species Cajanus scaraboides, C.lineata are having resistance. 7. Breeding for high protein content and quality Mean protein content 23%. The wild species have 27% to 29% Red seed coat contains more polyphenol (Tannin) than white seed coat. So preference is towards white seed coat. Red grain contains lesser amount of sulphur containing amino acid. When we increase protein content there will be lesser amount of these amino acids. So care is to be taken to increase them. 8. Breeding high yielding perennial redgram suitable for bund cropping BSR 1, Attapadi selections Breeding methods : 1. Introduction : E.g. Prabhat short duration variety from IARI, ICPL 87 from ICRISAT. 2. Pure line selection Earlier breeding work was based on the assumption that Redgram is a self pollinated crop. However it was later found to be often cross pollinated crop. SAI is a pure line selection from Tirupathur local. 3. Hybridization and selection : Inter varietal : VBN 1 (Prabath x NY 34) (T.12 x 102) Inter generic : C. cajanus x Cajanus lineata C.cajanus x C. scaraboides are being attempted 4. Mass selection : 5. Population improvement : Using male sterile line and recurrent

selection methods. Two populations are used, one is seed parent and the other is pollen parent. The seed parent must have one or two easily identifiable recessive character and the pollen parent more dominant genes. The seed and pollen parents are sown in alternate rows so as to maximize natural cross pollination. The F1's and selfed ones are identified in, So generation. The identified F1s are space planted in the next generation S1. In S2 generation they are yield tested in 3 environments and best ones are either recycled or taken to conventional breeding programme. 6. Mutation breeding Co2 - Chemical mutagenesis EMS. Co5 - Mutant of Co 1 gamma rays. Co6 - Mutant of SA 1 gamma rays. 49 7. Heterosis breeding Ms T 21 x ICPL 87109 CoRH 1 Ms Co 5 x ICPL 83027 CoRH 2 Red gram Ideal plant type - long duration : The genotype that have steady rate of growth and have a moderate harvest index. High seed weight Long pods Increased number of pod bearing branches. Short duration : Dwarf in nature with erect branches having high dry matter production High seed wt. Long pods. Increased no of seeds / Pod Less flower drop. RED GRAM VARIETIES FOR TAMIL NADU Varieties Varieties Parentage Duration SA 1 Pureline selection from Thirupattur local 160-180 Co 3 Mutant of Co1 90-95 Co 4 Pure line selection from gene pool 90-95 Co5 Mutant of Co 1 100-110 Co6 Mutant of SA 1 160-180 Vamban 1 (Prabath x NY 34) (T12 x 102) 95-100 APK 1 PLS from ICPL 87101 95-105 VBN2 ICPL 341 x BSR local 170-185 Hybrids CoRH 1 Ms T 21 x ICPL 87109 110 CoRH 2 Ms Co 5 x ICPL 83027 110 50 Hybrid Seed Production of CoRH. 1 Pigeonpea In the exploitation of hybrid vigour for commercial cultivation, efficient production of hybrid seed is essential for which a full knowledge of the various steps involved in hybrid seed production is necessary to achieve the twin objectives of maximizing the hybrid seed production and improvement in quality of hybrid seed. For hybrid seed production, a ratio of 4:1 of male sterile pollen parent is adopted. Sufficient isolation distance i.e., more than 200 metres for the hybrid seed production plot is needed. There should not be any pigeonpea crop within a radius of 200 metres from the seed production plot. Since the male sterility is maintained in heterozygous state following the test cross principle, there would be fertile and sterile plants in the ratio 1:1 in the male sterile population. It is therefore imperative to remove the male fertile plants in the male sterile population before flower opening. The roguing should be done thoroughly to avoid contamination by the pollen from any left out fertile plants. Steps involved in hybrid seed production 1. Selection of site (i) Fertile field with an irrigation source (ii) Previous crop should not be pigeonpea (iii) Isolation distance of 200m from any other variety of pigeonpea. 2. Fertilizer (i) Farm yard manure @ 20 cart loads per hectare (ii) 25 Kg N + 50 Kg of P as basal application 3. Sowing (i) The female and male parents are sown in the ratio of 4:1 with two border rows of pollinator parent. (ii) The pollen parent (ICPL 87109) should be sown one week after sowing the female parent (MS T.21). (iii) Row spacing of 45 cm. (iv) Plant to plant spacing should be 15 cm. (v) Dibble 2-3 seeds per hill for the female parent (vi) Seed rate (per hectare) for 4:1 ratio 40 Kg of female parent, 5 kg of male parent. (vii) Sowing should be done during first fortnight of June or first fortnight of December. (viii) The whole plot should be bordered with sunflower to increase the bee activity to effect cross pollination. 4. Irrigation (i) First irrigation after sowing and a life irrigation 2-3 days after sowing. (ii) irrigate the plot at 7-10 days interval depending upon the moisture in the field 5. Rogueing (a) Male sterile line or female parent : 51 (i) Remove the off type plants (ii) Remove the male fertile plants by examining the colour of the anthers (yellow) at the time of first flower formation, one-day before flower opening. (iii)Rogueing should be completed in 7-10 days time (iv) Remove the late flowering plants also. (b) Male fertile line or pollen parent : (i) Rogue out off types. (ii) Remove the immature pods set in the plants from time to time to induce continuous flowering and to ensure pollen availability for a longer period. 6. Harvesting Collect the pods from the female parent i.e., male sterile parent. This will give the hybrid seeds. Production and maintenance of male sterile line Genetic male sterility is utilized in hybrid seed production. In case of pigeonpea, the male sterile line will segregate in 1:1 ratio of fertile to sterile. For the maintenance of the male sterile population (to be raised under isolation), the male sterile plants have to be identified and tagged and the fertile plants have to be retained without tagging. The male sterile lines will be pollinated naturally by the pollen from the male

fertile plants in the population through insect pollinators. After maturity, the seeds from the tagged male sterile plants are collected and will be used for producing male sterile lines again or for producing hybrid seeds. The main difference between the hybrid seed production and the male sterile line maintenance is, during hybrid seed production the male fertile plants from the male sterile population are to be rogued off, while they are retained during male sterile line maintenance.

BLACK GRAM (URAD, ULUNDU) Vigna mungo (2n = 22, 24) Origin : India Putative parents V. trinerivus / V. sublobata or V.mungo var. sylvestris. Breeding objectives 1. Evolving medium duration high yielding varieties for dry land cultivation. Co5 black gram. Suitable for dry land cultivation. 2. Evolving short duration high yielding varieties suitable for irrigated conditions. This can be used as mixed crop in cotton, turmeric Short duration varieties are Co2, Vamban 1, 2 and 3. 3. Evolving short duration varieties suitable for rice follow condition ADT 3. 4. Breeding varieties resistant to diseases YMV is a serious disease. Leaf crinkle virus, powdery mildew. VBN 1, Karaikal, BDN 1, VBN 2, VBN 3 - resistant to YMV 5. Pest : White fly vector for YMV and leaf crinkle, leaf eating caterpillar 6. Breeding for better quality 24% protein. There are lines having 27% protein. These can be utilised Quality of black gram is determined by a) Protein content b) Methionine content 1.17% c) cooking quality - Time d) % of hard seeds. e) Dhall recovery 70% Breeding methods 1. Introduction : E.g. T.9 from U.P. 2. Pure line selection : Co3 - Alangudi local Co5 - musiri local 3. Hybridization and selection a) Intervarietial KM 2 (Derivative from T9 x L.64) TMV 1 - Derivative from Midhiulundu x KM1 ADT 4 - 29 x AD 2 x 6114 53 VBN 3 - LBG 402 x LBG 17. b) Inter specific : Vigna mungo x V.mungo var.sylvestris - Pant nagar. YMV resistant lines obtained. But pod shatters. More number of Back crosses suggested. Vigna mungo x V.radiata for increasing pod length, digestibility. Sterility is the main problem. Few plants obtained revert back to parental form. 4) Mutation breeding Variety Co4 - derived from Co1 by EMS treatment 5) Embryo rescue - Attempted in inter specific crosses. Ideal plant type For irrigated and Rice fallows Determinate type, short duration, high dry matter producing with 30cm plant ht. Photo insensitive. For rainfed condition. Semi determinate with pod setting from base of the main stem; higher pod length and more number of seeds / pod. BLACK GRAM VARIETIES FOR TAMIL NADU VARIETIES Varieties Parentage Duration Co 4 Mutant of Co 1 70 Co 5 Pure line selection from Mustri Local 70-75 KM 2 Derivative from T 9 x L. 64 60-65 VBN 1 KM 1 x H 76-1 60-65 T 9 Pure line selection 65-70 ADT 2 Derivative from Thirunelveli Local x ADT 1 70-75 ADT 3 Pure line selection from Thriunelveli Local 70-75 TMV 1 Derivative from Midhiulundu x KM 1 65-70 ADT 4 29/ ADT 2 / Plant 6114 60-65 ADT 5 Pure line selection Kanpur variety 62 VBN 2 Reselection from T 9 70 VBN 3 LBG 402 X LBG 17 70 54 GREEN GRAM (MUNG BEAN) vigna radiata (2n = 22) It is esteemed as the most wholesome among the pulses, free from the heaviness and tendency to cause flatulence, which is associated with other pulses. Place of origin : India Wild relative : Vigna radiata var. sublobata Breeding objective : 1. High yield, medium duration dry land varieties Co1 long duration, indeterminate plant habit. 2. High yielding, short duration irrigated varieties : Lines having rapid growth rate or dry matter increase associated with high harvest index. They must give high biological yield and productive racemes. Co2 3. Breeding for rice fallows ADT 2, ADT 3 4. Breeding for disease resistance YMV Leaf crinkle virus Tarai local Lm 214 - resistant 5. Breeding for quality a) Mung bean has highest digestibility among grain legumes from 83 to 90%. Varieties having bold seeds to use as sprouts is the aim. b) Transfer of high methionine content from black gram to green gram. c) High dhall recovery - 80% and more d) Less hard seed. Breeding Methods : 1. Introduction - Pusa baisaki 2. Pure line selection - Co1 3. Hybridisation and selection Inter Varietal : ADT 1, ADT 2, Co 5, VBN 1 Inter specific - To transfer high methionine content from black gram to green gram. Green gram x V.umbellata rice bean to transfer resistance to bean fly crossing with V.radiata var. sublobata resistance to bruchids 5. Mutation breeding Co4 - mutant of Co1 55 6. Embryo culture : Green gram x Black gram Ideal plant type 1. 60 - 65 duration with determinate habit for irrigated conditions 2. 80 days duration with indeterminate type for dry land condition Plants with more pods and seeds, increased branches poding from base of main stem with synchronised maturity non - shattering habit. GREEN GRAM VARIETIES FOR TAMILNADU VARIETIE S

Varieties Parentage Duration Paiyur 1 Pure line Selection from DPT 703 85-90 ADT 2 AB-33 x ADT 1 70-75 ADT 3 Hybrid derivative H 70-16 / Rajemdran / G 65 66 Co 4 Mutant of Co 1 85 KM 2 Hybrid derivative of No. 127 x S.9 65-70 VBN 1 Hybrid derivative of S.8 x PIMS 3 65 Co 5 Hybrid derivative of KM 2 x MG 50.10 (G) 70-75 K1 Co 4 x ML 65 70 Co6 WGG 37 x Co 5 65 HORSE GRAM Macrotylema uniflorum (2n = 24) Place of origin : Hindusthan centre Putative parent : Not known Breeding objectives : 1. Increased yield : Co1 Mudukalathur local 2. Non - Photo sensitive, short duration varieties 3. Varieties with low trypsin inhibitors Methods of breeding : 1. Introduction HPK varieties from Himachal Pradesh. 2. Pure line selection Co1 from Mudukalathur local. Paiyur 1 from Mettur local. 56 3. Hybridization and selection a) Intervarietal b) Interspecific Dolichos lab lab x M. biflorum Crossable. 4. Mutation breeding SOY BEAN Glycine max (2n = 40) Place of origin : China. Probable ancestors : Glysine usuriensis Slender, viny plant with small seeds grows wild is Japan, Manchuria and korea. It is considered to be the progenitor for G.max Another view is that G.max arose form natural hybridization between G.usuriensis and G.tomentella which grows wild in china. A fourth species Glycine gracilis is intermediate between G.max and G. usuriensis. Cultivated types of G.gracilis are found in Manchuria. All the above species are crossable with each other. Many other species in Glycine have been identified but the exact classification of most of them is still in doubt. Breeding objectives : 1. Breeding for short duration high yielding varieties The yield of soy bean plant is determined by size, number of seeds per pod and number or pods / plant. The number of pods/ plant is determined by no of nodes / plant, number of pods / node. Each of the above components of yield are polygeneic in inheritance and so it is complex. The duration is also determined by multiple genes. Maturity is correlated with height or the plant. Early varieties will be short is stature. 2. Breeding varieties suitable for rice fallows Short plants 65 -70 days duration. Suitable for inter cropping also in banana and sugarcane. 3. Breeding for quality a) Seed color and quality b) Oil content and quality c) Protein content a) Seed coat color : May be yellow, green black, brown or combination of all the above colours. For oil extraction yellow color is preferred because of high oil content where as black seeded varieties are low in oil content but high is protein content. Seed coat color other than yellow will give unattractive oil cake which is not preferred. 57 b) Oil content and quality : Oil content greatly determined by environment : Yellow seed coat varieties are rich in oil. Complex character determined by poly genes. c) Protein content and quality : Ranges from 35 to 50% protein content is negatively correlated with oil content so white breeding for high protein content a compromise is to be made. 4. Breeding for vegetable type AVRDC, Taiwan has evolved vegetable types 5. Breeding for forage type of soy bean 6. Breeding for non-shattering type E.g. Lee, Co2 7. Breeding for YMV resistant lines Co 2 Breeding Methods: 1. Introduction : Ec 39821 from Taiwan - released as Co1 2. Pure line selection Co1 3. Hybridization and selection Clark, Co 2 (AS 335 x UGM 21)YMV tolerance 4. Mutation breeding. VARIETIES OF TAMIL NADU Co 1 - Pure line selection from EC 39821 Co 2 - (AS 335 x UGM 21) ADT 1 - Selection from HILL.

COWPEA Vigna unguiculata (2n = 22) Place of origin : India Putative parent : Wild sub species V.unguiculate SSP. dekindtiana or SSP. menensis Classification : According to Faris 1965 three subspecies are recognised. 1. Vigna unguiculata subsp. unguiculata (Syn V.u. subsp. catjang) - grain cowpea : Primitive of all cowpea types. Pods 8 to 13cm long. Neither flabby nor inflated. Pods remain erect at maturity. 2. V.unguiculata subsp. sinensis - Grain type cowpea. Pod length 20 to 30 cm. Pods are not inflated. Pods fibrous when green. The stature of pods are pendent when matured. Seed size medium 6-9 mm. Seeds are closely packed in the pod. 3. V.unguiculata subsp. sesquipedalis - Yard long bean - vegetable cowpea: Pod size may be 30 to 100 cm, pendent. No fibre content is geeen pods. Seeds are sparsely arranged, kidney shaped and usually double coloured. Pods inflated when green, shriveled on drying. Distinguishing feature : * Kidney shaped seed * White hilum surrounded by brown or black ring. * Pubescant througout plant body. Breeding objectives. 1. Breeding for medium duration high yielding varieties for dry land conditions Co1 old variety resistance to YMV. Indeterminate Plant habit. Co4 - 85

days duration. Seed colour mottled C 152 - 85 days, buff color seed. 2. Breeding for short duration varieties suited for irrigated and mixed cropping conditions. Pusa do fasli - Short duration variety Co6 - 70 days durations. 3. Breeding for vegetable cowpea Co 2 - (C 521 x C 419), VBN 2 Selection from IT 81-D-1228-1 mottled seed. 4. Breeding for disease resistance Aphid borne mosaic virus Co6 - (Ms 9804 x C 152) Cercospora leaf spot Fusarium wilt YMV - Co1 resistant. 59 5. Breeding for pest resistance Leaf hopper - Antibiosis and tolerance Aphids - Antibiosis and tolerance Pod borer - Antibiosis 6. Breeding for Forage cowpea. Var. Co5 from Co 1 by gamma irradiation Breeding Methods : 1. Introduction Iron cowpea Russian giant. 2. Selection : PLS cowpea Co1 is PLS from C 57 a local collection from Shirgali 3. Hybridisatioin and selection a) Intervarietal Co6 (Ms 9804 x C 152 Co2 (C 521 x C 419) b) Interspecific V.u x V.vexillata - (having tuberous roots which is edible) V.u x V.umbellata. 4. Mutation breeding Co5 Forage cowpea 5. Embryo rescue technique For inter-specific crosses. Ideal plant type Short duration : Determinate plant with high harvest index The branching must be erect. Flower drop to be minimum. Bushy plants are ideal Long duration types. Indeterminate plant habit with steady growth rate. COWPEA VARIETIES FOR TAMIL NADU VARIETIES Varieties Parentage Duration (days) Co2 Hybrid derivative (C 521 x C 419) 90 Co 3 Pureline from C 152 Vegetable type 80 Co 4 Selection from Russian Giant 85 KM 1 Hybrid derivative (JC 5 x Dofasli) 60-65 Paiyur 1 Selection from VM 16 90 Co 6 MS 9804 x C152 65-70 Co 5 Mutant of Co 1 Forage Cowpea 100 60 LAB LAB (2n=22, 24) Lab lab purpureus var. typicus Garden bean ‘Pandal avarai’ Lab lab purpueus var. lignosus Field bean Mochai. Origin : India Distribution : India, Central America, China and Africa. In India mostly cultivated, in southern states of Tamil Nadu, Karnataka, Andhra pradesh. Var typicus : Perennial. Twining herb. Cultivated as an annual. The pods are long, tapering. The long axis of seeds parallel to the suture. With out oilglands and ‘Mochai’ smell. Entire pod is edible as vegetable. Var. lignosus Semi erect bushy, perennial usually grown as annual. The pods are relatively shorter, oblong and fibrous 4 to 6 almost round seeded. Seeds vertical to the suture Plants give ‘mochai’ odour. Avarai Mochai Habit Perennial Twining herb requires support for normal performance Semi erect bushy perennial, cultivated as annual Plant part No ‘Mochai’ odour ‘Mochai’ odour present Pod Whole pod as vegetable. matured green seeds vegetable Green seeds alone as vegetable pericarp tough, parchment like. Seed arrangement Parallel to the length of suture Vertical Photosensitivity Photosensitive Photosensitive Breeding objectives: To evolve non season bound vegetable type, short duration varieties. In Mochai there is one non season bound, short duration - Thenkasi local DL 3196. By crossing this with Panthal avarai, short duration, non season bound varieties were evolved. Example Co 11, Co 12, Co 13. Varieties : Mochai Co 1 Pure line selection Co 2 Pure line selection Avarai (Bushy type) of MS 98678. Co 9 Natural mutant of Co 6 Co 11, Co 12, Co 13.