Technical Bulletin

Rainfed Farming

A Profile of Doable Technologies

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Contents

CRIDA Terrace

Background

The practice of contour or graded bunding with large cross sections for soil and water conservation is cost-intensive. Partitioning of fields and area lost for cultivation by such bunds hinder their adoption by the farmers. Since soil and water conservation is of paramount importance for maintaining the land productivity, research has been going on to reduce the cost and develop systems that are more acceptable to the farmers. CRIDA terrace is the result of this research.

Technology

CRIDA terrace is a terrace-level soil and water conservation package essentially consisting of a small section (0.1–0.2 sqm) bund strengthened at valley lines or depressions and stabilized with vegetation of farmer's choice. It can be aligned on field boundaries. The special features of the technology package are: (i) it can be formed by running a tractor-drawn reversible plough to cover large areas per unit time (1.0 ha/hr); the channel on the upstream side of the bund made by reversible plough is helpful to enhance the runoff handling capacity of the terrace while the terrace gets stabilized (ii) the terrace can be utilized to grow fodder grasses such as hybrid napier and guinea grass to enhance fodder availability or for raising green manure crop like Gliricidia to meet the nutrient requirement of the crop or it can even be stabilized with natural vegetation (iii) surplussing systems at individual terrace level can be accommodated either at outlets near waterways or at local valley lines depending on the level difference between them, when the bund is required to be aligned on field boundaries.

Advantage

The cost of construction is about Rs. 300-500 per ha compared to about Rs.2, 700/- per ha for conventional graded bunds. The pay back period is 2-3 years.

Constraints

Bunding including small section bunds are being practiced extensively under watershed management programs. The suggested features of CRIDA terrace in terms of construction methodology, location of surplussing system and use of terrace area for growing economic species (e.g., fodder grasses) can be incorporated in future programs for cost reduction and income generation.

Water Harvesting Check Dam

Background

Crop failure due to moisture stress/drought is common in drylands. Water harvesting for providing supplemental or life saving irrigation to crops is an important component of watershed management. The water harvested in such structures can also be used as drinking water, for grazing cattle and for agricultural purposes such as spraying of pesticide in fields. Depending on the availability of water, they can also be used to grow post-monsoon crops.

Technology

The water harvesting check dam is essentially a masonry structure consisting of a head wall, head wall extension, cut off wall, sidewall, wing wall, toe wall and downstream apron.

The dimensions of various components will depend upon the width and depth of the nala at the selected site, the type of soil and the foundation conditions. Most importantly a spillway (generally rectangular) should be constructed as part of the head wall for surplussing the design peak flow from the watershed area above the structure after the reservoir created by the check dam is full. The cost of water harvesting check dam will depend on the dimensions of the structure, materials used and its location. A rough estimate for a pucca check dam is Rs.4,000/- per m length. The pay back period is 4-6 years.

Advantage

Depending on runoff and the storage created, assured crops can be taken with supplemental irrigation in a couple of hectares. In Chevella (black soil) watershed in Medak district of Andhra Pradesh, an 18 m long, 3 m high check dam was found to create storage of 1200 cu m in the ephemeral stream. This structure with watershed area of 35 ha has enough water to provide supplemental irrigation to about 2.0 ha area in kharif season and 0.5 ha in rabi.

Constraints

Water harvesting check dams are generally constructed under watershed development programs because they are cost intensive. They have found acceptance widely in the National Watershed Programme and farmers have derived substantial benefits from such structures.

Dugout Farm Pond

Background

Rainwater collection through farm ponds is essential for efficient utilization of excess rainfall for the benefit of the crops & environment. When designed properly, the stored water can effectively be utilized during the off-season for growing cash crops like vegetables, irrigating horticulture crops. Also, during the season depending on the frequency of filling and availability, the water can be utilized for one or two life saving/ supplemental irrigation to crops in the nearby fields during dry spells.

Technology

The farm ponds are constructed at the lower side of the fields. The runoff from the contributing fields is canalized into the pond. In light soil the dugout ponds can be lined to improve the storage efficiency by containing the seepage losses. Considering an average of two fillings in a year, the capacity of farm ponds may be designed to store 100 to 200 m^3 of runoff per hectare of contributing area in a semi-arid environment. In order to minimize the seepage area as well as evaporation losses a dugout farm pond can be best designed for a given storage volume (V), depth (D) and side slope Z: 1 (Z horizontal to 1 vertical) using the following equations.

$$X = (0.5/C) \left[\sqrt{\{DZ(1+C)\}^2 - 4C\{2D^2Z^2 - (V/D)\}} - DZ(1+C) \right] \quad \text{...... (Eq. 1)}$$

Where, X, Y = Two sides of the dug out pond (rectangular) at the bottom and C = Y/X

For a square section (C=1, i.e. X=Y) the above equation is simplified as follows:

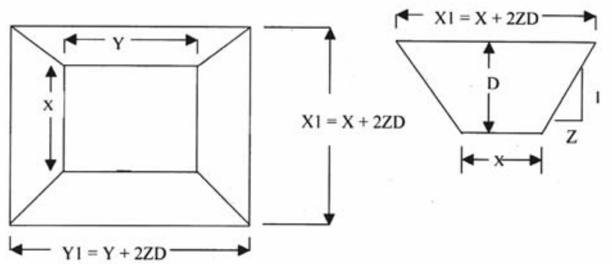
$$X = \sqrt{[(V/D) - D^2Z^2]} - DZ \quad \text{...............} \quad \text{(Eq. 2)}$$

For a square bottom section having side slope 1:1 (Z=1) the Eq.2 can be further simplified as

$$X = \sqrt{[(V/D) - D^2]} - D. \quad \text{...........} \quad \text{(Eq. 3)}$$

Advantage

The experience at farm level has shown enough potential of farm pond (brick lined) technology in growing vegetables in the off-season by satisfying water requirement at 50% of weekly evaporation. An economic analysis of the above pond with tomato as test crop shows a pay back period of 10 years with BCR 1.5 and IRR 18.9%. This technology will be more viable and economical in Vertisols where lining is not essential. The BCR will certainly be higher if intangible benefits are quantified and the use of water during the season (if any) is also considered.



Dugout Farm Pond

Constraint

The poor farmers find it difficult to go for high initial investment to adopt this technology for which subsidized credit support is needed. The spread of bore wells has affected the potential of farm ponds.

Conservation Furrows

Background

High intensity rainstorms during monsoon season cause high runoff rates, poor soil moisture storage / low groundwater recharge and significant loss of topsoil both in the Alfisols and Vertisols in the semi - arid region. Estimates show that 10-17 % rainfall is lost as runoff from cropped area in a few storms of high intensity. Therefore, concerted efforts are necessary to conserve and utilize every drop of rainwater effectively for grain and biomass production, as the success of dryland agriculture is based on rainwater conservation. Conservation furrows have proved successful as a measure of rainwater conservation and runoff management in rainfed region of India.


Conservation Furrows in Farmers' Field

Technology

Conservation furrows are dead furrows opened parallel to the rainfed crop rows across the prevailing land slope, employing a country plough, 3-4 weeks after the germination of the main crop. These furrows are 20-25 cm wide at top, 25-30 cm deep and are spaced @ 0.9-3.0 m regular horizontal interval depending upon the soil physical characteristics and nature of the crop (close growing, row crops, etc.). During runoff causing rainfall events, the rainwater gets concentrated within these furrows, infiltrates into the soil (root zone) and is available to the crop for meeting the evapotranspiration demand for a longer duration compared to the control. The conservation furrows are temporary and therefore are required to be opened every season with *kharif* crops.

Advantage / Impact

The conservation furrow fields store 4-38 % additional soil moisture over control throughout the growing season, thereby resulting in 12-23 percent higher crop yields fetching an additional economic return of Rs. 600-800 ha^{-1}. The technology has proved its worth in on-farm studies during last five years and has been adopted widely in the rainfed regions of India.

Constraints

No constraints have been reported in the adoption of technology from anywhere in the country.

Contingency Crop Planning in Rainfed Alfisols

Background

Farmers in southern Telangana zone of Andhra Pradesh are growing sorghum, pigeonpea and castor in Alfisols under rainfed environment. The productivity of these crops is often low and unstable due to variation in onset and withdrawal of monsoon with intermittent breaks. The small and marginal farmers who do not have accessibility of bullock power used to sow castor even up to first fortnight of August. As a result, the yield of these crops is drastically reduced (150 kg/ha). Keeping these limitations in view, CRIDA has developed appropriate crop planning based upon the rainfall period to achieve stability of production and profitability.

Technology

The rainfed Alfisols in Telangana region has an effective growing season of 150 days to get stable yields. Based on onset of the monsoon, CRIDA has developed contingency crop planning for stabilized productivity. The technology includes (i) sowing of sorghum (CSV-15/ SPV-462) + pigeonpea (Maruti/ PRG-100 in 2 or 3:1 ratio) up to the end of June, (ii) Pearlmillet (MBH-1)+ pigeonpea (Abhaya) up to 15th July (iii) Castor (Jyothi/ Kranti) up to the 15th July (iv) Sunflower (Morden/ KBSH-1) up to the end of July (v) Greengram (ML-295/ ML-267)/ Cowpea (C-152) up to the 2nd week of August (vi) Horse gram (Palem-1) up to the end of August.

Time of planting

Advantage/ Impact

Based on the distribution of rainfall the technological modules with the principle of effective growing season were implemented in TAR-IVLP villages in Ranga Reddy district of Andhra Pradesh for the last 5 years. The results showed that sowing of sorghum and pigeonpea with improved varieties at 30 cm apart (3:1) gave sorghum grain equivalents of 2342 kg/ha with B:C ratio of 3.73 during the 2nd fortnight of June. But, the same system sown in the 1st week of July reduced its yield by 60% compared to the sowings done during the month of June. Similarly, castor with improved varieties (Kranti/ Jyothi) on an average gave the yield of 659 kg/ha with net returns of Rs. 4251/ha.

Castor sown during the 1st week of August gave only 361 kg/ha with net returns of Rs. 2063/ha. Under delayed conditions, sowing of sunflower (Morden) and mungbean gave higher profitability by 113 and 59% compared to the castor . Thus, short duration pulses (greengram and sunflower) can fit the short growing season and were found better alternative crops for delayed sowing of castor during the month of August. Medium and big farmers showed preference for sowing alternate crops of mungbean and sunflower under delayed conditions. Small and marginal farmers preferred castor even in the month of August due to non-availability of good varieties and also due to heavy bird menace in sunflower.

Mulch cum Manure in Rainfed Vertisols

Background

Soil degradation particularly in vertisols is a severe problem in Karnataka. In traditional farming systems, farmers fallow their land during kharif (rainy season) and crops are raised under residual moisture. The soils have low infiltration capacity and have low fertility. The productivity of rabi crops of sorghum and sunflower can be stabilized by adopting mulch cum manure technology along with conservation of soil resources.

Technologies

The green leaf manuring crop of sunhemp has to be sown 30 cm apart @ 50 kg/ha during the end of June. At the time of planting 70 kg of DAP has to be placed while sowing the crop. After 45 DAS (preferably September) the biomass generated from the field has to be incorporated by rotavator and allowed 2-3 weeks for decomposition. The rabi crop like sorghum (M 35-1 or CSH-8 R) can be sown at 30 cm apart with recommended dose of fertilizers (DAP-63kg and Urea-25kg/ha) during first week of October. Alternatively, the sunflower crop (MSFH-8) has to be sown at 60 cm apart using 7.5 kg/ha with seed drill. At the time of sowing recommended dose of (30:50:50) NPK/ha should be applied. Interculture at 30-40 DAS has to be done for both crops during rabi period. Frequent deep interculture will help to close soil cracks by creating thick dust mulch.

Advantage/ Impact

Mulch cum manure technology with sunhemp besides giving yield and economic advantages, also reduces the runoff (2%), soil loss (1.75 t/ha) and loss of nitrogen (18.5 kg/ha) as compared to farmers practice. The performance of this technology on

ECONOMICS

Sorghum	FP	FP+ MCM
Seed yield (kg/ha)	1302	1817
Fodder (kg/ha)	3710	4090
Cost of production (Rs/ha)	3107	3667
Gross returns(Rs/ha)	15664	21096
Net returns (Rs/ha)	12556	17424
BC ratio	5.04	5.75

Sunflower		
Seed yield (kg/ha)	1141	1706
Fodder (kg/ha)	2604	2798
Cost of production (Rs/ha)	3484	3773
Gross returns(Rs/ha)	12551	18766
Net returns (Rs/ha)	9067	14993
BC ratio	3.6	4.97

FP-Farmers Practice;
MCM-Mulch cum manure technology

farmers field at Madhubhavi (Karnataka) gave additional returns of Rs.1792/ha compared to farmers' practice of fallow – sorghum system. The runoff due to MCM was reduced by 96.5 mm besides reducing the nutrient losses of 18-40 kg N, 5-8 kg P and 8-15 kg K_2O per hectare. Farmers opined that growing of sunhemp, greengram and rainfed vegetables like cucurbits in kharif fallows reduce the impact of rain and also gave the higher benefit for rabi crop yields.

Production Technology for Rainfed Sorghum + Pigeonpea System

Background

Sorghum and pigeonpea intercropping system is very common in rainfed red chalka soils of southern Telangana zone of Andhra Pradesh. The productivity of this system in the farmers' field was low and unstable due to growing of local varieties, adoption of poor management practices, intermittent dry spells and heavy incidence of pod borer in pigeonpea.

Technology

Off-season tillage: Tillage with blade harrow or ploughing (1 or 2 times) has to be done during pre-monsoon showers (April- May) depending upon the quantity of rainfall received. This operation helps in exposing the soil for better water intake, weed control and high coverage of sowing with the onset of monsoon.

Varieties and fertilizer use: Sowing of improved varieties of sorghum (CSV-15/ SPV-462) with pigeonpea (Maruthi/ PRG-100) has to be done at 45X10 cms apart (3S: 1P) with 10 kg seed of sorghum and 8 kg of pigeonpea/ha across the slope during the month of June. At the time of sowing 10:30:0 NPK/ha (67 kg

DAP) has to be applied basally for both component crops. Use of CRIDA plough drill/ planter facilitates coverage of wider area (1 ha/day) and save the cost of sowing (Rs.100/ha) compared to the farmers practice of sowing behind the plough. Top dressing of nitrogen @ 30 kg N/ha in the form of urea (65 kg/ha) has to be applied to sorghum rows only during 30-45 days after sowing (DAS). Ensure better weed control with blade harrow twice and one hand weeding within 50 DAS.

Moisture conservation: Conservation furrows with a plough for every 4 rows (after top dressing of urea) helps in better moisture conservation and growth of the crops. Creation of the dust mulch through interculture during dry spells at vegetative stage (10-45 DAS) and additional N application (22 kg urea/ha) after relief of the dry spell enhance the productivity by 30% compared to the farmers practice of no conservation furrows.

Plant protection: Timely sowing of crops minimizes the pest problems of sorghum and pigeonpea system. However, pod borer in pigeonpea can be a menace and reduce the profitability by 60% in some of the years. Pod borer in pigeonpea can be managed by deep ploughing once in 3 years during pre-monsoon showers, use of tolerant varieties of pigeonpea (LRG-30 and ICPL-332), installation of bird perches @ 30 numbers /ha at flowering, spraying with neem based pesticide (5% NSKE) when the pod borer is in egg stage and NPV virus spray (250 LE/ha).

Harvesting: Harvest sorghum at physiological maturity to avoid grain mold due to continuous wet spells.

Advantage/ Impact

The results in TAR-IVLP villages showed that use of improved varieties in sorghum and pigeonpea system (3:1) contributed to higher productivity and profitability by 79% and 137% respectively compared to the local varieties (Rs. 3685). Conservation

ECONOMICS	
Seed yield (t/ha)	2.15 (S) + 0.89 (P)
Fodder (t/ha)	10.31(S) + 0.63 (P)
Cost of production (Rs/ha)	3140
Gross returns (Rs/ha)	10293
Net returns (Rs/ha)	7153
BC ratio	8.6

S: Sorghum; P:Pigeonpea

furrows gave the profit of Rs. 300/ha at an additional investment of Rs. 100/ha. Optimum fertilizer use in the system contributed to 70% increased yield over the farmers practice (1897kg/ha).

Neem and custardapple formulations at 5% reduced pest incidence and enhanced the productivity of pigeonpea by 35% compared to farmer's practice. The area under improved varieties in sorghum and pigeonpea increased by 40% compared to the pre project period (30 ha). At present about 40% of the farmers, particularly small and medium farmers are adopting conservation furrows in sorghum and pigeonpea, in Telangana region of A.P.

Drought Management Options in Sorghum + Pigeonpea System

Background

Sorghum and pigeonpea are important crops grown in rainfed Alfisols of Southern Telangana of Andhra Pradesh. Farmers in this region are cultivating these crops as intercrops either in 5:1 or 3:1 ratio. However, the productivity of these crops in the system fluctuate due to vagaries of monsoon and also due to intermittent dry spells during different growth stages of the crops. Most of the times, crop failures occur due to erratic distribution of the rainfall.

Technology

CRIDA through on farm research identified appropriate technologies viz., (i) formation of conservation furrows for moisture conservation at every 4 rows after 35 DAS (ii) operation of blade harrow to create dust mulch during the dry spell at vegetative stage (30 DAS) (iii) application of 10 kg additional N / ha in the form of Urea (22 kg) after the relief of dry spell at vegetative stage to regain the loss of vigour during the dry spell.

Advantage / Impact

The results from TAR-IVLP programme at CRIDA showed that conservation furrows contributed for higher net income of Rs. 893/ ha compared to the farmers practice without drought management option (Rs. 1317/ha). The cost of the technology for making conservation furrows works out to be Rs. 300/ha. Application of 22 kg urea/ ha after the relief of dry spell gave higher net returns of Rs.3229/ha compared to the control (Rs.1317/ha). The expenditure involved in adopting this practice is Rs. 550/ha. The combination of conservation furrows and additional nitrogen fertilizer application realized a net income of Rs.4090/ha at the cost of both operations amounting to Rs.850/ ha compared to the farmers practice. Farmers perceived that the formation of conservation furrows is a simple and affordable practice. It can be adopted by even small and marginal farmers with minimal cost.

Agro Techniques for Sunflower + Pigeonpea System

Background

Pigeonpea is an important pulse grown as an intercrop with sorghum and maize in rainfed red soils of southern Telangana zone in Andhra Pradesh. Pigeonpea crop can accommodate high demanding oilseed crop like sunflower due to its initial slow growth for higher overall production and lower risk. Keeping this perspective, CRIDA developed agro techniques for sunflower pigeonpea inter cropping system for rainfed environment.

Technology

Land preparation with 2 ploughings followed by one blade harrow has to be done with the onset of monsoon. Improved varieties of pigeonpea (Maruthi, PRG-100, Abhaya) and sunflower (MSFH-8, KBSH-1 and Morden) with 12 and 10 kg/ ha has to be sown at 45 cm apart alternatively either behind the

plough or with CRIDA plough planter. At the time of sowing 20 kg N and 60 kg P_2O_5 /ha has to be applied in the form of Di-ammonium phosphate (134 kg/ha) uniformly for both the crops. After effective weed control through two blade harrowings and one hand weeding, top dressing of nitrogen (40 kg N/ha) in the form of urea (86 kg/ha) has to be applied to the sunflower rows only in the system. The incidence of *Helicoverpa* in pigeonpea and sunflower can be effectively controlled by mechanical shaking when the larvae is small or spraying of Endosulfan @ 0.05 % at the time of grain filling of the component crops.

Advantage/ Impact

Inter cropping of sunflower with pigeonpea gave higher net returns of Rs. 1412 and Rs. 1486 /ha as compared to sole crop of sunflower and pigeonpea respectively over the years. The farmers in Ranga Reddy and Mahaboobnagar districts of Andhra Pradesh opined that this system yields both oilseeds and pulses not only to meet their domestic requirement but also to fetch high market price compared to the traditional sorghum + pigeonpea system. Few farmers expressed the problem of incidence of *Helicoverapa* pod borers on pigeonpea and sunflower during continuous wet spell years.

ECONOMICS

	S	P	S+P (1:1)
Seed yield (Kg/ha)	788	572	621 + 460
Cost of production (Rs/ha)	2500	2000	3100
Gross returns (Rs/ha)	4201	3627	6213
Net returns (Rs/ha)	1701	1627	3113

S: Sunflower; P: Pigeonpea

Elite Neem clone with High Azadirachtin for Planting in Drylands

Background

Neem tree is one of the most adapted multipurpose trees that grow successfully in arid and semi arid regions of India. It provides bio pesticide, timber and fodder during drought years and can come up on highly degraded lands. Though the potential of the tree is well known, definite strategies for its utilization in agricultural production and employment generation in the rural areas have been lacking. CRIDA has conducted extensive research on selection of plus trees of neem with superior qualities and developed propagation methods for mass multiplication and plantation in drylands.

Technology


CRI-8, a plus neem tree selected by CRIDA

Though there are many bioactive compounds in neem tree, azadirachtin is the most important in determining the antifeedant and repellent properties of neem. An extensive survey in semi arid regions has been carried out for three years to identify plus trees of neem with superior traits like high yield, straight bole, better kernel to seed ratio, high azadirachtin content and tolerance to angiospermic parasites. More than 400 eco types have been studied from 6 states and 25 districts.

Five plus trees with azadirachtin content of more than 0.6% and mean yields of 50 kg air dried fruits per tree have been selected from different parts of the country. Survival and seed yield data are promising from clone CRI-8. The plantation of this elite clone

Planting material of Neem produced from Plus trees

may be taken up on farm boundaries at 8 x 8 m spacing and also in blocks with 8 x 6 m. Pits of 1.5 feet deep are to be dug in the summer and filled with equal proportions of FYM, tank silt and red soil. Six months old seedlings or vegetatively propagated plants can be planted at the recommended spacing. The plants survive well during monsoon. However, protective irrigation during dry periods boosts the growth and results in quick height gain and canopy development. Need based pest control measures are to be taken up at least, for 2 years after planting and a straight bole is to be encouraged by removing the laterals close to the ground. The tree starts yielding from 3-4 year onwards and on an average produces 4 kg air dried fruits in 5th year, which increases with age.

Advantage/Impact

Neem can be planted under a variety of soil and climatic conditions in the homesteads, on farm boundaries, in agroforestry and block plantations. Planting of the superior genetic stock selected by CRIDA has potential to produce better seed yield containing more azadirachtin as compared to the local material. Small farmers can plant 5-6 trees around boundaries to produce quality seed for preparation of neem seed kernel extracts as part of IPM. Besides farmers, commercial firms producing neem based bio pesticides can take up plantations to produce large quantity of seed with relatively higher azadirachtin content.

The benefit from planting the progeny from selected plus trees of neem will be known to the farmer after 5 years onwards. On an average each tree can produce 4-5 kg air dried fruit from 5 th

year onwards. The de-pulped seeds can be used for preparation of NSKE or marketed @ Rs.1.5 to 2/kg depending on the quality. The cost benefit ratio and internal rate of returns are more favourable as compared to normal neem plantations as the additional cost of planting material is only marginally higher.

Biennial Pigeonpea

Background

The per person availability of pulses is far below (40 g) the recommended dietary allowance (70 g). Hence, there is a need to maximize yield of the pulse crops in general and pigeonpea in particular, as it is a major dryland pulse crop occupying second largest area after chickpea. The major reasons for poor productivity of pigeonpea on the drylands are unsuitable plant type, shallow soil depth, poor rainfall, soil moisture stress, poor fertility, lower plant stand etc.

Technology

The profuse growth of biennial pigeonpea during ratooning (second year) is due to well-established roots, early start of growth with the first rain, low weeds and earliness as compared to annual type Hy-2. Bushy pigeonpea (ICP 8094) gives higher grain yield than erect type (ICP 8860). However, the survival was found poor during ratooning.

Pits of 35 cm diameter and 70 cm depth are dug and refilled with mixture of native soil (50%), tank silt (33%), manure (10%) and paddy husk (7%) at the planting spacing of 1.5 m between rows and 0.9 m between plants within a row. This not only extends the survival of the plants by one more year (biennial) but also useful in doubling the grain yield as compared to normal flat bed. This is attributed to higher water conservation as well as available water to the plants and low bulk density of the pit mixture.

The annual growth of ICP 8094 (in the pits) is cut at 60 cm height after the harvest of pods, sticks for fuel and twigs for fodder.

This encourages growth of new shoots and increases stem girth in the off-season. The off-season growth can be harvested for fodder and the regrowth is allowed during the *kharif* season. N and P_2O_5 @ 10 and 30 kg/ha are supplied. This results in remarkable higher seed yield of pigeonpea (19.88 q/ha) in ratoon. Moreover, there was a high leaf fall (1 t/ha), which contributed organic matter to the soil. The legume crop also contributes to the soil fertility by fixing atmospheric nitrogen up to 30 kg N/ha.

Advantage / Impact

Biennial pigeonpea is sown only once in two years thereby saving expenditure on field preparation and sowing. Moreover the weeds are few during the second year resulting in saving of expenditure on weeding. The loss of topsoil is negligible during second year as the vegetation covers the ground. The cost benefit ratio is 1: 1.2.

Constraints

Currently the seed availability is a limitation. A strong seed chain has to be developed for this variety.

Management of Drought in Rainfed Castor

Background

Castor is one of the important non-edible oilseed crops grown by the rainfed farmers in Alfisols of southern Telangana zone of Andhra Pradesh.

The productivity of this crop in the farmers' fields' was very low due to variation in the rainfall both in terms of quantity and distribution. Further the low water holding capacity of rainfed Alfisols results in dry spells reducing the yield of this crop. The intermittent dry spells may occur either at early (0-45 DAS), mid (45-90 DAS) or terminal (90-120 DAS) growth stages of the crop.

Technology

The technologies for the management of drought in rainfed castor include (i) sowing of drought tolerant cultivars like Jyothi, Kranti and 48-1 during June 15th – July 1st week across the slope (ii) formation of conservation furrows for every 2 rows planted at 90 cm apart (iii) operation of blade harrow in between castor rows during early growth stage of the crop and (iv) additional nitrogen application @ 10 kg N/ ha (22 kg of urea) after the relief of the dry spells either at early (up to 45 DAS) or mid (45-90 DAS) growth stages of the crop.

Advantage/ Impact

Crop cutting surveys from TAR-IVLP villages of Ranga Reddy district (AP) showed that sowing of Kranti and Jyoti gave 42 and 24% higher yield respectively as compared to the farmers own seed (216 kg/ha), while hybrids GCH-32 and GCH-4 gave 577 and 536 kg/ha respectively over a period of 4 years. Conservation furrows for every 2 rows of castor contributed to higher productivity by 15 % than farmers' practice. Operation of blade harrow as a part of interculture during dry spell at vegetative stage showed equal performance in realizing the benefit as that of conservation furrows. Application of 10kg N /ha in the form of urea (22 kg /ha) gave the yield advantage of 24% over the farmers practice. The practices of conservation furrows and interculture are simple, cost effective and easy to adopt by the farmers. At present 90% of the castor growing farming community are adopting conservation furrows to mitigate the drought in target villages of Ranga Reddy district. However, medium and big farmers preferred the practice of additional N application after dryspell at vegetative / flowering stages.

Profitability of Castor and Cluster Bean Intercropping System

Background

Castor, the major non–edible oil seed crop is grown under rainfed conditions in Alfisols of Telangana region of Andhra Pradesh. The productivity of this crop in this region is low (160-240 kg/ha) and varies due to variations of rainfall and management practices. The profitability of castor can be increased and stabilized by intercropping with short duration legumes like cluster bean.

Technology

Land preparation with 2 ploughings followed by one blade harrow has to be done with the onset of monsoon. The improved varieties of castor (Kranti, Jyothi, GCH-4 /DCH-32) and cluster bean (Pusa Navabahar) with 10 and 12 kg/ha have to be sown at 45 cm apart in 1:1 ratio either behind the plough or with CRIDA plough drill. At the time of sowing 20 kg N and 60 kg P_2O_5 /ha has to be applied in the form of Di-ammonium phosphate (134 kg/ha) uniformly for both the crops. After effective weed control through 2 blade harrowings and one hand weeding, top dressing of nitrogen (40 kg N/ha) in the form of urea (86 kg/ha) has to be applied to castor rows only in the system. Semilooper has to be managed by spraying of Quinolphos @ 2ml/L for higher yields of castor in the system.

Advantage/ Impact

The results from on station and farmers fields over three years showed that castor intercropped with cluster bean gave higher profitability of Rs. 1239 / ha as compared to sole castor (Rs 1554 /ha). Farmers observed that harvesting of green pods of intercropped cluster bean provides cash to meet the family needs during the cropping season besides getting the higher income over castor alone. This system provides insurance when the castor yields decline due to prolonged dry spells and also early with drawl of rainfall. The system can be easily adopted by farmers with accessibility of the market for sale of cluster bean as green vegetable.

ECONOMICS		
	C	C + CB (1:1)
Seed yield (kg/ha)	936	777+2450*
Cost of production (Rs/ha)	2000	2500
Gross returns (Rs/ha)	3554	5293
Net returns (Rs/ha)	1554	2793
BC Ratio	1.77	2.12
C: Sole Castor; CB: Cluster bean *Greenpods		

Microsite Improvement to Enhance Survival and Productivity of Perennials in Rainfed Areas

Background

Perennials are important part in dryland agriculture. They play positive role in ameliorating degraded sites. Though lots of trees are planted each year through various tree-planting programs, the survival and growth of these trees is often quite poor. This is due to many factors, among which poor planting site is an important issue. Studies on the effect of micro-site improvement of degraded soils for different tree species made at CRIDA showed that, this practice greatly enhances their survival and growth in the harsh environments.

Technology

In the land where perennials are to be planted, first the tree planting spots in the area are marked with pegs as per the spacing requirement of the tree species, viz., 5m X 5m or 10m X 10m etc. In these spots (micro-sites) pits of size appropriate to the species to be planted are dug either manually or using tractor drawn post-hole digger.

The typical pit sizes for manual digging are 30cm X 30 cm X 30cm, 45cm X45cm X 45cm or 1mX 1m X1m. In case of tractor drawn post-hole digger, the sizes are 30cm diameter and 45 or 60 cm depth, 45cm diameter and 45 or 60 cm depth or 60cm diameter and 1m depth. For big trees like mango, tamarind etc. large size pits are used and for small trees like teak, curry leaf and drumstick small sized pits are used.

After digging of pits, they are exposed to hot sun for 1-2 months. Then the pits are refilled with a mixture of original soil (minus stones), tank silt or black soil and farmyard manure (FYM) in a ratio of 1/3 each by volume. To this mixture 100 to 200 g single super phosphate to promote root growth; and 100 to 200g of 1.5% Dursban dust or 2% Folidol dust for controlling soil borne insect pests like root grubs, termites and red hairy caterpillar are added. While filling the pits care has to be taken to pack the mixture firmly to eliminate air pockets. Gap of one month is desirable after filling of the pits and before planting for allowing the soil mixture settle firmly.

The technology is relevant in the degraded soils of rainfed regions, where the rainfall is poor in quantity and distribution, soils have poor fertility and irrigation facilities are lacking.

Advantages / Impact

Micro-site improvement enhances the soil moisture holding capacity, improves survival of trees and initial growth of the trees. CRIDA in its various outreach programs involving agroforestry and tree-crop combinations is propagating this technology in different districts of AP.

Ferti-Seed Planters for Drylands

Background

Timely seeding of crops is the most crucial operations in dryland agriculture. Delayed sowing stretches cropping cycle beyond the normal length of growing season, thereby, raising the prospect of moisture stress during crop growth. With the current practices, farmers are unable to sow the crop at most appropriate time. The conventional devices are slow and imprecise. The non-uniform crop stand also create imbalance in utilization of nutrients and moisture reducing the crop productivity. These devices require high labour input, thereby, increasing cost of production.

To improve the productivity and reduce the cost of production, improved designs of ferti-seed planters were designed at CRIDA and extensively evaluated in partnership with the farmers. Suitable modifications were incorporated based on field experience gained and the models were upgraded to cater the need of different category of dryland farmers based on holding size, draft power available and affordbility.

Technology

Six-farmer friendly models of ferti planters were released and commercialized by CRIDA. These models are: (a) drill plough (b) plough planter (c) two-row planter (d) four-row planter (e) six-row planter and (f) nine-row planter.

Drill plough is based on gravity


Drill Plough


Plough Planter


Two-row Planter


Four-row Planter


Six-row multi crop Planter


Nine-row Planter

and agitator type mechanism, whereas all other models are based on inclined plate metering mechanism. These models are versatile with adjustability in depth and row spacing. Multi row units can be used to sow intercrops of different row ratios. Most of the dryland crops can be sown simply by changing the seed metering plates. Seed metering plates are designed to match the seed size and to obtain recommended seed spacing within the row. Fertilizer mechanism is suitable for drilling granular fertilizers only. The rate of application can be adjusted by adjusting the size of the orifice.

Advantages/Impact

Major advantages are (a) Single Row devices are compatible with country plough (b) Seed and fertilizers are simultaneously placed followed by simultaneous covering (c) Improved devices cover 2-20 times higher area depending upon their size (d) Uniform seed spacing and balanced use of moisture and nutrients improve input use efficiency (e) Multi row units are suitable for intercropping (f) Gives optimum crop stand (g) Saving in time, labour and cost (h) Increase in crop yield and profitability.

All these equipments save on human labour, energy, time and cost. Improved timeliness and precision contributes to 10-30% increase in yield. Initial investment ranges between Rs. 650-18,500 depending on size of the machine and payback period is just in one season. The designs are licensed to industries for manufacturing and sale in addition to production at CRIDA workshop. These equipments are also ideal for custom hiring services by different agencies. CRIDA offers non-exclusive license to interested industries for manufacturing and sale of these implements

Conservation Tools for Interculture

Background

Moisture conservation is a key factor in dryland farming, as crops are grown under limiting moisture conditions. Weeds compete with the crop for moisture and nutrients. Hence cultural practices to reduce weed growth and conservation of moisture are essential in dryland farming. These tools create soil mulch apart from removal of weeds. Conventional tools like khurpi and wooden hoes are slow and require high manpower, thereby, prolonging the interculture operation. Improved manual, bullock drawn and tractor drawn weeders are developed at CRIDA matching to different power sources and needs of the farmers. These tools improve the efficiency of available power and make best use of available moisture while reducing the cost of operation.

Technology

Manual Weeder : This is manually pushed wheeled device followed by vertically adjustable sweep or blade mounted on a tool frame. A long handle with wooden grip provides most comfort to the person operating the tool. The operation of this tool saves 72% of time as compared to hand weeding by khurpi. It covers 0.14 - 0.16 ha/day depending upon the capacity of the operator. It is simple, low cost and easily adoptable equipment.

Bullock Drawn Weeder: A metal tool frame on which a single narrow shovel with shank is mounted at front center of the frame and at rear a blade matching to crop row spacing is mounted. A pipe beam is attached to frame, which is hitched by a pair of bullocks. The blades are either straight or V-shape depending upon the field condition and weed intensity. Since all components are made of metal, it is long lasting with negligible maintenance.

The tools, not only effective in removing the weeds but also creating a concave structure between the rows for capturing the rainwater and also supporting the plants with soil mass. This requires one pair of bullock and one person for operation and covers 0.8- 0.9 ha/day. The device is lightweight, low cost, controls weed effectively and covers the area much faster than conventional tool.

Tractor Drawn Weeder: Tractor drawn cultivator frame is used to mount different sizes of straight and V-blades depending on crop row spacing. This can cover 3-5 rows spacing at a time thereby increasing the field coverage up to 6 - 7 ha/day. This is most suitable in the field sown by tractor drawn planter. The rows are straight and intercul-ture operation is much faster with minimum damage to plants. The advantages of this tool are faster coverage, efficient weed control, creating soil mulch, support of soil mass to plants and low cost of operation. The additional cost of tool mounting on tiller frame is Rs. 2000/-.

Advantages/Impact

The cost of operation for these tools range from Rs. 125–335 per ha. The initial investment on manual, bullock drawn and tractor drawn weeder is Rs. 350/-, 1250/- and 2000/- respectively which can be recovered back by using this equipment just for one season. This design has been licensed to 5 industries in A.P and

Maharashtra for manufacturing and sale. CRIDA offers non-exclusive license to interested industries for manufacturing and sale of these tools.

Orchard Sprayer

Background

Orchard crops like mango, oranges etc suffer from heavy attack of pests and diseases. The heavy infestations results in lowering quality of fruits and low market prices resulting in heavy losses. Conventional hydraulic sprayers are used for controlling these pests and diseases. However, these devices are incapable of reaching to tree top and under surface of leaves, thereby, ineffective control of pests and diseases and wastage of costly chemicals. Air carrier spraying device designed at CRIDA achieves the target spraying for effective control of pests and diseases in orchards.

Technology

Air-carrier orchard sprayer designed at CRIDA is capable of covering complete tree canopy including under leaf surfaces. The spraying machine consists of (a) axial flow blower (b) inlet and outlet cone (c) diffuser (d) air outlets (e) pump (f) storage tank (g) power transmission unit, and (h) mounting frame. The main components like blower, inlet outlet cone, diffuser, air outlets and frame covers are made of Fibre Reinforced Plastic (FRP). The complete unit is mounted on 3-point linkage of the tractor. The blower unit creates an air jet, which is directed to both sides through adjustable outlets towards tree canopy. The blower is designed to get required air output to cover the complete tree canopy and generate enough air velocity to reach treetop. The chemical solution

stored in the tank is pumped and distributed to nozzles mounted at outlet of the air jet thereby, injecting the chemical droplets into air stream. The chemical laden air carries the droplets to tree canopy, which are settled on both side of leaves and at treetop. This ensures proper coverage and effective control of insects and diseases.

The sprayer mounted on the tractor takes power from PTO and transmit it to blower and pump through universal drive shaft. Pesticide tank of 150-litre capacity is mounted on the mudguard of the tractor. Once the tank is filled the tractor operator drives the tractor between two rows of the orchard trees. The air jet with chemical droplets from both outlets reaches the half tree canopy on both sides. The outlet angle is adjustable depending upon the tree height. One full tank is enough to spray about 1.2 ha in one hour.

The sprayer can cover 8-10 ha/day depending upon the field and climatic conditions. The size and density of droplet is 100-110 µ vmd and 100-120 droplets/cm^2 respectively, which is most ideal for effective control of most of the pests and diseases.

Advantages/Impact

Major advantages are (a) faster coverage (b) saving in labour (c) low cost of operation (d) 50% saving of chemicals and (e) adaptability to different type and size of orchards. Initial investment of about Rs. 50,000 is recovered in a payback period of 3 years. The cost of operation is five times lower than the conventional spraying. The design has been licensed to industry and commercially available in the market. CRIDA offers non-exclusive license to interested industries for manufacturing and sale.

Castor Sheller

Background

Castor is an important cash crop predominantly grown in Telangana region of A.P and Gujarat. This is very hardy and drought resistant crop, making it most suitable to grow in dryland conditions. Castor shelling is one of the important operations, which requires large number of human labour. The present practice is manually beating the dried castor shells, which is time-consuming. In conventional method, one person can give output of about 60 kg/hr. The shelling cost is about Rs.100 per quintal. During the peak shelling season, there is acute shortage of human labour for this operation thereby, the delay in processing and marketing of the produce. Considering these constraints and demand registered by farmers in the region, the power-operated castor-shelling machine was designed at CRIDA.

Technology

Castor shelling machine consists of a threshing drum, concave, feeding tray, set of sieves and blower unit. The machine requires 2 hp electric motor. Castor shells are fed manually through a feeder tray, which enters the threshing unit. The castor shells are crushed between threshing drum and concave, which causes the breakage of shells without damaging the seeds. The threshed material then falls on the inclined screen where the air jet from blower fixed opposite to screen blows away the broken shells, which are lighter in weight. The grains which are heavier slide down the screen and move to grading sieve. The graded grains are separately collected from the outlets. It requires 2 persons for operation. The unit is mounted on the rubberized wheels, which can be easily transported from one place to other place. The castor sheller gave 97% shelling efficiency and 95% cleaning efficiency with output of 700 kg/hr. The shelling cost was significantly reduced to Rs. 5 per quintal.

Advantages/Impact

Major advantages are (a) Operation of shelling is independent of human labour (b) Higher shelling and cleaning efficiency with negligible seed damage (c) Significantly lower shelling cost (d) Higher output enables catching the good market. The castor-shelling machine gives clean output with good quality grains. The higher output of the machine reduced 20 times processing cost. Initial cost of the machine is about Rs. 25,000 and is feasible for custom hiring business. The payback period is just one season of operation. Castor sheller design has been licensed to industry and is commercially available in the market. CRIDA offers non-exclusive license to interested industries for manufacturing and sale.

Groundnut Stripper

Background

Groundnut is a major oil seed crop grown on 9.8 million ha in India. Groundnut cultivation is mainly dependent on human and animal power using conventional devices. Groundnut harvesting and stripping is predominantly manual operation requiring large number of human labour during harvesting. This operation is increasingly becoming costlier due to higher labour wages and their shortage during peak demand period. Labour dependent operations prolong for longer period and often loose the market advantage. Farmers are often reducing area under groundnut due to non-availability of human labour for groundnut stripping. One person can strip about 50 kg pods per day. About 100 man-days are required for stripping operation per ha, which increases the cost of production. Identifying the constraints and need of the farmers, power operated groundnut stripper has been designed by CRIDA. This device not only minimize the cost of operation but also reduces the tediousness involved in manual stripping operation.

Technology

The groundnut-stripping machine consists of stripping drum with 'U'-Shaped loops arranged in a staggered manner to facilitate effective pod separation. This has hold-on type feeding platform. The separated pods are collected on vibrating perforated screen and conveyed to outlet. The power is taken

from 1 hp single phase or three-phase electric motor. The power transmission is through belt and pulley. The nylon bushes fixed at different points makes the units sound free during operation.

This machine requires 3 persons for operation. One person collects and supplies groundnut plants to other two persons consistently holding the bunch of plants on the feeding platform. The groundnut pods are separated with the impact of 'U'-shape loops. The persons feeding the plants throw the vines after pod separation on collection site. The pods falling on this vibrating screen move down to outlet while soil is separated and fall below the screen. The cleaned pods fetch better price in the market. The output of the machine is 150 kg/hr with 3 persons for operation. Increasing the feeding rate can further increase the output. The plants after stripping can be completely utilized as fodder to animals. In hand stripping, only pods are separated and the plant roots along with soil remain intact thereby 50% of the plant cannot be utilized as fodder and leads to wastage. The machine improves the output of 3 human labours 8 times as compared to manual stripping.

Advantages/Impact

Major advantages are (a) 50% saving on labour and operation cost (b) Utilization of complete plant as fodder due to removal of soil (c) Immediate sale at higher market prices (d) Labour independent operation. Total saving on stripping operation alone is Rs. 2500 per ha and additional fodder availability is worth Rs. 1800 per ha. Initial investment on machine is Rs. 8000. The pay back period is just one season. The design is licensed to 2 industries at Pune and Nagpur where commercial production has been started. CRIDA offers non-exclusive license to interested industries for manufacturing and sale.

Vegetable Preservator

Background

Fruits and vegetable preservation at the farmer's level is a major problem in India. Though many cold storage units are available, they are restricted to bulk produce and high value products only. A considerable amount of fruits and vegetables produced in India is lost due to improper post harvest operations. This loss can be reduced by providing appropriate preservation and storage structures. Low cost portable preservator has been developed at CRIDA for increasing shelf-life of perishable vegetables and fruits.

Technology

It is made up fibre reinforced plastic (FRP) and plastic for longer life. It consists of two compartments with circular holes all around their periphery. They are kept offset by 1 inch to accommodate the pine grass mats. The water is dripped on to the mats continuously as per the requirement through the drippers below a circular tank. This system keeps the basket temperature 8 to 10^0 C less than the room temperature with 80-85% humidity.

Precautions

a) It should be kept above the ground level

b) Fresh and semi ripened products should be kept for longer life

c) Infested and damaged produce should be avoided

d) Don't allow the water inside the basket, but the water should be continuously dripped on grass mats.

Advantages/Impact

Major advantages are (a) Preservator keeps the basket temperature 8 to 10^0 C less than room temperature (b) The higher humidity (around 80 to 85%) with aeration inside the basket increases the shelf life of the produce(c) It is portable (d) This structure reduces the handling damages (e) Shelf life of the produce can be extended to 7 to 12 days based on the product. These units are most suitable for household use, vegetable vendors, farmers level and during transport of fruits and vegetable to market. It is estimated that there are 10-20% losses in household use, vegetable vendors and at farmers level which can be saved by use of portable vegetable preservator.

Vegetable preservators are available in 4 models based on its capacity. The cost varies as per capacity of the model (a) 5 kg – Rs. 600 (b) 15 kg – Rs. 1000 (c) 30 kg – Rs. 13000 (d) 50 kg – Rs. 1600. In addition there is a special 50 kg model for transport purpose, which is square in shape and available for Rs. 2000. The design has been licensed to industry. There are two models available (i) FRP model and (ii) Plastic model. CRIDA offers non-exclusive license to interested industries for manufacturing and sale.

CRIDA Portable Drip System

Background

This is a low cost, sub-surface drip system and is used to supply specified-quantity of water to the plants. It is ideal for marginal farmers and can be locally fabricated using indigenous materials. This system does not need external power source as it works on gravitational force. It saves water as it delivers specified-quantity of water at the root zone, thus avoiding, losses due to run-off, evaporation and deep infiltration.

Technology

It consists of a 200 litter capacity metallic drum, fitted with an outlet manifold. Twelve 4mm diameter pipes are welded to this manifold. Plastic tubes of 4mm diameter are connected to the individual pipes to conduct water from the drum to the plant and conventional pin-tap emitters are fitted at the end of the micro-tubes. These emitters can be adjusted to deliver between 0.5 and 5 litres of water per hour.

At the base of the plant, a plastic pipe of 25-mm diameter and 25 cm length is driven into the soil at an angle of 45 degrees, and it is designed to conduct water directly to the active root zone. The top end of this pipe has to project above the ground at least by 2.5 cm. This is to avoid soil particles entering the tube and clogging it. The pin-tap emitters are just inserted into this sub-surface tube. Inside the drum, provision is made to provide a dead storage of about 2.5 cm. This helps in settling suspended particles in the water, so that clogging of emitters is avoided. The inlet to the manifold is an L-bend, with provision for fitting plastic pipes of different heights (20 cm, 40 cm and 65 cm) and these pipes at varying heights could be used for emptying layers of water unto pre-determined heights. This enables supply of 50 litres of water per day, though water is filled up to 200 litre (full capacity) on the first day. This unit is used for watering 12 plants with a spacement of 5m X 5m and 8m X 8m. Drum is filled ones in four days, manually.

This unit costs around Rs. 1500/- or Rs. 125/- per plant. Since the unit can be used for watering another set of twelve plants by shifting within the small holding, the cost per plant reduces by half, i.e., Rs. 63 per plant.

Advantages

a) It saves water as it delivers specified quantity of water, that too right at the active root zone-thus avoiding losses due to runoff, evaporation and deep infiltration.

b) This is a low cost system and works without any external power source, as it works on gravitational force.

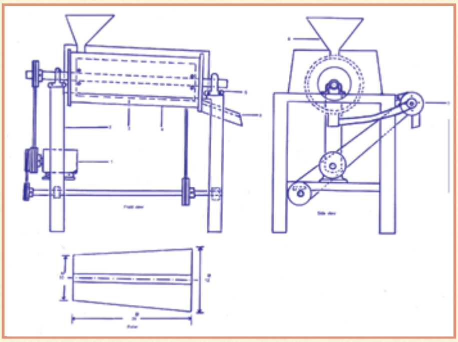
Constraints

This unit is ideal for watering few plants and not suitable to big farms.

Dal Mill

Back ground

Pulses form an integral part of Indian diet. Many varieties of pulses are grown and consumed in different types of food products after processing. Black gram is the third highest pulse crop in Indian subcontinent which accounts 10% of the total production. It is mostly consumed in the form of dehusked dal or rounds. It is estimated that 40% of the black gram processing is carried out on a cottage industry level by the farmers and small traders either for trade purpose or custom hiring basis. The machines used at cottage industry level only split the grain leaving the husk intact with the dal. With the change in consumption pattern of black gram, the unhusked dal obtained from cottage industry is not liked by the consumer. Hence there is great demand from the farmers and small traders to upgrade their existing milling machinery to obtain dehulled black gram dal. Removal of the seed coat reduces water and manual energy requirement in further processing of dal. CRIDA has conducted research on black gram dehusking, dal making and developed a small capacity dal mill suitable to on farm processing of black gram.



Technology

The dal mill consists of a 205 mm uniform diameter and 430 mm length cylinder made of high silicon content emery material. A 2mm dia mesh of mild steel is provided concentric to the cylinder. The annular space between the cylinder and mesh is about 15 mm. The emery roller rotates at a speed of 900 rpm. A pretreatment method for dehusking of black gram was standardized to suite to the mill. The machine has been tested and results show 95% dehusking efficiency and 75% dal recovery. The machine is powered by a 3-hp, 960-rpm electric motor.

Advantage / Impact

The mill has lot of potential in south India where dehusked black gram dal is used in variety of daily use dishes. Use of this dal mill eases the dehusking operation of black gram thereby water and drudgery involved can be reduced to an extent of 25 – 30% in further processing of the dal. A farmer can use this mill for on–farm processing of black gram. Besides farmers, unemployed youth and self help women groups can take up value addition activity using the mill for self employment .The technology can be transferred to the manufacturing industry as per ICAR norms for the benefit of the farmers and small scale enterprenurers.

Constraints

The mill needs to be fed with pretreated black gram grain just like commercial mills for optimum performance. For medium scale commercial application a pre-treater cum dal polisher is also developed as an extra equipment to suit to the mini dal mill.

Integrated Nutrient Management in Sorghum and Greengram in Rainfed Alfisols

Background

Majority farmers in rainfed areas have small and medium size holdings. Despite the fact that fertilizer application to dryland crops pays most, farmers are unable to apply fertilizers as recommended. Since drylands have poor fertility, desired yield levels cannot be obtained without fertilizer use. Thus, integrated nutrient management options become important. Various low cost INM practices for sorghum and green gram were standardized for the region.

Technology


Sorghum and green gram in strip crop/ rotation with INM

Conjunctive use of 4t compost + 20 kg N through urea, 2t gliricidia loppings + 20 kg N through urea and 4t compost + 2t gliricidia loppings (all equivalent to 40 kg N/ ha) in sorghum and 2t compost + 10 kg N through urea, 1t gliricidia loppings + 10 kg N through urea and 2t compost + 1t gliricidia loppings (all equivalent to 20 kg N/ha) in case of green gram when grown as a strip crop in rotation has been tested successively for 5 years from 1998-2002 in Alfisols.

For *in situ* conservation of water and to enhance response of crops to INM treatments, conservation furrows of 30(w) x 20 (d) cm dimensions at 2m intervals across the strips were also tested. While applying, compost (containing about 0.5-0.8 % N) can be spread before sowing after primary tillage, whereas, inorganic N/gliricidia loppings (containing 3-4 % N on dry weight basis) can be applied at the time of top dressing. For better results, gliricidia loppings can be placed in a 10-15 cm furrow (in case of sorghum) opened with bullock drawn plough. Whereas in case of green gram, the compost and fertilizer N can be applied as a basal dose at the time of sowing while, gliricidia loppings can be placed on the surface near the crop rows after 20-25 days of sowing. Phosphorus through SSP @ 30 kg P_2O_5 ha^{-1} as basal application is adequate to meet the requirements of the crops.

On farm composting can be done using materials such as cowdung, green gram stover, leaves and twigs of gliricidia and *Leucaena leucocephala* in a pit of dimensions 6 x 5 x 4 ft. Depending upon the availability, these materials can be added in the pit and it can be covered with soil. Current year deposited material will be ready for use during the next year as compost.

Advantage/Impact

By following either of the combinations suggested above for sorghum, a yield level of 1.7 – 1.9 t/ha of grains can be achieved. In this way, 50% of N requirement of sorghum can be easily met through low cost farm based organics such as compost and leaves + twigs of *Gliricidia*. Hence expenditure towards 20kg N through urea can be avoided. Similarly, in case of green gram, the yield levels of 0.81 – 0.83 t ha^{-1} can be achieved by following the above INM treatments suggested. Apart from supplying the nutrients, this technology will also help in improving the soil organic matter and consequently the physical health of the soil. The technology is farmer friendly, simple, economical, easy to adopt, and sustainable.

Constraint

The compost used in the process of developing this technology was prepared out of cowdung, green gram stover, loppings + twigs of gliricidia and leucaena. Availability of cowdung may be limited in some cases where farmers do not possess livestock animals. Hence, this module may work successfully with the farmers having at least 2-3 animals.

Integrated Nutrient Management Through Use of Low Cost Farm-based Organic Materials in Rainfed Alfisol

Background

Dryland soils are poor in organic matter. Since organic matter is a storehouse of many nutrients, deficiency of organic matter in these soils has resulted in serious decline in fertility and deterioration of physical health. Because of low rainfall, the cropping intensity of dryland regions is low compared to the irrigated areas. Consequently, the biomass turnover is very low, and virtually there is a very poor return of crop residues to these soils. At the same time, because of poverty and marginal land holdings, majority farmers are below the economic threshold level. In view of these facts, there is no option except to develop farmer friendly low cost INM strategies.

Sorghum crop under INM field experiment

Technology

Conjunctive use of inorganic N through urea and loppings of farm based organics such as subabul (*Leucaena leucocephala*) and Gliricidia (*Gliricidia maculata*) in sorghum has been proved as potential option of integrated nutrient management. Leucaena and Gliricidia loppings on dry weight basis contain 3-4% nitrogen. The recommended dose of N for sorghum crop in Alfisols of dryland areas is 40 kg N/ha. Out of this 40 kg N, 20 kg N can be applied through urea. Remaining 20 kg N can be supplemented through the fresh loppings of leucaena or gliricidia. Considering 3.0% N on dry weight basis and moisture content of fresh loppings about 70%, 667 kg of fresh loppings (leaves + twigs) are required to supplement 20 kg N through either of these two materials. The fresh loppings can be added to the crop at the age of 25-35 days after sowing by opening 10-15 cm furrows with the help of bullock drawn plough. Followed by this, the furrows can be covered with soil to get better results. *Leucaena leucocephala* and *Gliricidia maculata* are nitrogen-fixing tree and shrub respectively, which can be easily grown on bunds, field boundaries or in some part of the spare land. These species can also be grown as part of hedge and alley systems. Within 3-5 year of plantation, *Leucaena leucocephala* can generate about 15-20 tonnes of fresh biomass per year per hectare. *Leucaena* can be grown by making nursery or directly by sowing the seed. However, *Gliricidia* can be easily planted by using the cuttings during rainy season.

Advantage/Impact

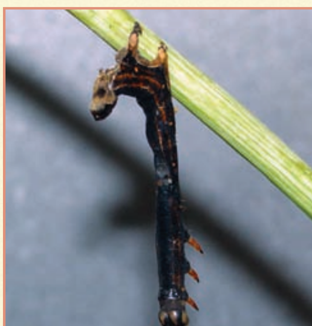
This technology is very easy and simple to adopt even by poor farmers. Since these farm based materials have C: N ratios of less than 20, they decompose rapidly. The technology is farmer friendly, economical and can be successfully adopted by using the farmers own family labour. Average yield level of about 1.7 t/ha of sorghum grain can be achieved by using 50% N through urea + 50% N through either of these two materials. In this manner, 50% of N requirement of sorghum can be substituted through farm based organic sources of nutrients. Apart from supplying nutrients, the practice will help in improving soil health by improving soil organic matter.

Constraints

The likely constraint in the adoption of the technology is the raising of these plants by the farmers in open grazed lands, as leucaena is browsable by the animals. Through social fencing it is possible.

Viral Biopesticide for the Management of Castor Semilooper, *Achaea janata*

Background



In the recent decades, awareness on the hazardous impacts of pesticide use on the environment and human health has resulted in efforts to incline towards alternate approaches for pest management. Granulosis Virus (GV) is a naturally occurring bio-control agent that plays a key role in management of semilooper, a key pest on castor.

Mode of infection is via midgut following ingestion of inclusion bodies, which release the virus particles on rupturing. Semilooper larvae infected with the GV have a characteristic shiny-oily appearance and turn milky white. Virus infected insect stops feeding, becomes extremely fragile and the cuticle ruptures easily to release milky white haemolymph containing infectious viral particles on the plant material. Virus is spread to other insects when a healthy insect eats the contaminated plant material and also during mating.

Protocol was standardized at CRIDA for *in vivo* mass multiplication GV in semilooper larvae. This virus is environmentally safe with proven safety to other natural enemies of semilooper and fits well into the IPM programmes along with other components. GV is amenable for mass production even at the village level.

Technology

Viral biopesticide (AjGV) is an aqueous suspension (AS) formulation with 0.4% w/w active ingredient (a.i.) produced *in vivo* in third instar semilooper larvae using castor leaves as feed material. The product has an estimated minimum count of 5 x 10^9 polyhedral-occluded bodies (POBs) per ml.

Dosage and Application

- Must be applied at the correct stage of the pest - early instar larvae are the suitable stages for their effective control.
- Field dosage requirement – A minimum of 100 billion inclusions (1 x 10^{12-13}) per hectare is required for effective control. The production per larvae is 5 x 10^9 inclusions and hence field application rates could be around 500 larval equivalents per hectare.
- Adjuvant like jaggery (0.5%) and UV protectant (0.05-0.1%) like robin blue or teepol should be used for longer field persistence of the virus.
- Virus sprayed on open foliage is inactivated by the UV-B fraction of sunlight; hence the sprays should be done preferably in the evening hours. This gives a 12 h feeding time for the nocturnal insect, which is sufficient for the infection.
- Virus treated plant material must be eaten by the target insect

to get infected. Good spray coverage on both the surfaces of leaf is therefore important.

Advantage

- Unlike conventional pesticides they are safe to humans and natural enemies.
- Pest specific – hence, only the target pest will be affected.
- Virus production technology is amenable for small-scale production and village level production

Constraints

- Short life span under field conditions
- Unlike chemical insecticides, viruses are relatively slow in their action - they may take 5-7 days to provide adequate control
- Viruses are highly host specific and therefore do not tackle multi-pest situations under field conditions.
- Virus production is in insect larvae and is labour intensive. The cost of the viral bio-pesticide would therefore be the cost of producing the host insect.

Botanical Insecticide from Custard apple, *Annona squamosa*

Background

Plants are the richest source of organic chemicals on earth. Many other plants are presently investigated for the presence of feeding inhibiting compounds and many fruit plants extracts tested on devastating insect pests. The seeds and leaves of custard apple, *Annona squamosa* contain active insecticidal principles. Most of the seeds of custard apple are thrown as a waste after consuming the fruit. Various pesticide formulations have been prepared from custard apple seeds and seed oil to develop effective botanical pesticides, which can serve as a key component of integrated pest management strategy.

Technology

Leaf extracts are prepared by grinding 50g fresh leaves in one litre or boiling in water till dark colour is obtained. Cooled extract is filtered and sprayed. In case of seed extracts 500g powder can be suspended in 10 litres. After 12h soaking, it is ready for spray.

Advantage/impact

- They are safe to humans and also to non target organisms
- Custard apple seeds are readily available at farm level.
- They are effective against major pests on dryland crop like *Helicoverpa armigera*, *Spodoptera litura*, *Achaea janata* and *Spilosoma obliqua*
- Easily fits into the IPM as a compatible component

Constraints

- Organized collection of large quantity of seeds should be established through mass campaigning and by creating awareness among the farmers.
- Formulations are not commercially available in the market.
- Shelf life of the botanical formulations is low (18 months) compared to the chemical insecticides.
- The residual toxicity and field persistence is less when compared to chemical insecticides.
- Custard apple oil extracts causes irritation to eyes and skin. Even making seed powder results in fumes, which cause allergy. Thus farmers need to be trained properly in handling custard apple products.

Integrated Pest Management in Castor

Background

Castor is an important non-edible oil seed crop contributing significantly to Indian economy. Damage by insect pests is one of the major reasons for yield reductions in this crop. Hence, an Integrated Pest Management module involving several components of pest management has been developed at CRIDA.

Technology

Decision-making tools for pest management in castor were evolved. Semilooper on castor completes five to six generations under field conditions. Pest control is warranted for II and III generation populations between 6-14 weeks after sowing. Thereafter, natural biological control keeps the pest under check. The egg parasitoid, *Trichogramma* sp, an early larval solitary endo parasitoid *Snellenius maculipennis* and late gregarious larval parasitoid *Euplectrus leucostomus* are the three key natural enemies of castor semilooper contributing to 30, 90 and 15 per cent parasitisation, respectively.

Trichogramma

Microplitis

Euplectrus

Initiation of pest control measures is recommended (ETL) when the semilooper population per 10 plants reaches 8 and 25 at 30 and 60 day after sowing respectively. Installation of bird perches @ 20 per ha and sequential spray of either Bt (0.2%) or Granulosis Virus 250 LE per ha and Quinalphos (0.05%) was the most effective in controlling semilooper. Two sprays of Neem Seed Kernel Extract (5%) at 7 days interval reduced semilooper population by 50 per cent. Quinalphos (0.05%) at 15 days interval effectively reduced capsule borer incidence.

Advantage/impact

Analysis of life tables of pests provides basic information on the number of generations a pest under goes in a season and the various natural key mortality factors that are acting upon. Decision making in any sound pest management programme relies upon Economic Threshold Levels. Such levels are indispensable as they indicate the course of action to be taken in any given situation and have bearing on the economic returns. Following economic threshold levels help in avoiding unwarranted pesticide usage and conserve the natural enemies population

Constraints

- Lack of awareness on the natural bio-agents, skills in their identification and the deleterious effects of chemical insecticides on the beneficial fauna
- Lack of awareness among farmers on the long-term benefits of IPM
- Low C: B ratios with the use of bioagents such as semilooper virus and Bt

Integrated Pest Management in Pigeonpea

Background

Pigeonpea, *Cajanus cajan* is an important grain legume and is the third important pulse crop. In India the productivity fell from 748 kg/ha in triennium 1952-53 to 703 kg/ha in the triennium ending 1998-99. Such a reduction in yield was attributed mostly to the incidence of insect pests. Chemical control of insect pests did not give encouraging results and thus Integrated Pest Management (IPM), as an alternative strategy is suggested. The effect of intercropping on pest fluctuations in pigeonpea based cropping systems was quantified. The causative factors (abiotic and biotic) for change in pest incidence were also identified. CRIDA has conducted extensive research on selection and integration of various components of IPM and in the formulation of IPM modules.

Technology

Sorghum and castor as inter crops with short and medium duration pigeonpea cultivars reduces the incidence of major pests on pigeonpea. The sequential application of Ha NPV 500 LE/ha, Endosulfan 0.07% and Neem seed kernel extract (NSKE) 5% with the installation of bird perches @ 10-15 per acre and integrated into a pest management module. This IPM module is cost effective with a cost benefit ratio of 1:6.

Advantage/impact

- Selection of short or medium duration of pigeonpea and suitable intercrop reduces pest incidence which in turn results in reduction in number of sprays
- IPM module increases the yields of pigeonpea besides conserving natural enemies

Constraints

- Farmers are reluctant to change their existing cropping system
- Lack of awareness on IPM
- Farmers like to adopt chemical control, which shows immediate effect.

Weather Dependent Spray Schedule (WDSS) to Control Leaf Spot Disease of Groundnut

Background

The most important disease of groundnut is leaf spot disease caused by *Corcospore arachidicola* and *C. personata.* Yield losses are estimated to be 15 to 50%. The infection is favoured by temperature between 25^0 to 30^0C and long period of high humidity. High humidity appears to be more critical than temperature. This disease is successfully controlled by application of fungicides, but there are indiscriminate uses of fungicides and cultivation is becoming costlier. For judicial use of fungicide, a technology has been developed, which is called as Weather Dependent Spray Schedule (WDSS).

Technology

WDSS treatment is followed from the 3rd to 10th week of sowing. Maximum number of sprays will be restricted to 3 during this period and the time interval between two sprays should be a minimum of 14 days.

WDSS is based on the following criteria, which must be assessed twice a week (preferably Monday and Thursday) to decide fungicidal application. For disease threshold determination select 5 plants at random in the field and assess leaf spot non – destructively as follows:

- Count number of intact leaves on the main stem and multiply by 4 to give leaflet number.
- Count number of diseased leaflets (with one or more lesions).

- Calculate the ratio of the above two counts and multiply by 100.

To calculate wetness index total wetness hours from leaf wetness sensors for each of the previous seven days should be considered. The WI is calculated by summing up the wetness periods of one or many spells in a day. If the number of hours is less than 20, then WI = WH / 20 and if the number of hours is more than 20, then WI = 4.5 – 0.175 WH.

If disease scouting indicates lesions on at least 10% of main stem, leaflets and the cumulative wetness index is more than 2.3, the crop should be sprayed on day 1 of week 4 or the earliest possible time depending on the prevailing weather condition i.e. when rain is unlikely during the next 12 hrs.

Advantage / Impact

This technology helps groundnut farmers by reducing number of fungicidal sprays and manpower and reduces environmental.

Constraints

For operationalizig the technology, a leaf wetness sensor is required to record leaf wetness period. It may not be possible for all the farmers to have one unit each. Therefore it can be purchased on a community basis. One sensor can serve for an approximate area of 10 km grid.

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